HYD1128_GLEN.DIMPLEX_LD_LLFA_L02

24th August 2026

FORMER GLEN DIMPLEX, STONEY LANE, WHISTON
Planning Reference: 25/00672/FUL
CONSULTATION RESPONSE

To whom it may concern,

We have been requested to provide a formal response to Knowsley Metropolitan Borough Council in relation to the comments issued by the Lead Local Flood Authority (LLFA) dated 23rd July 2026. The comments provided are in relation to planning application reference 25/00672/FUL.

We have compiled a comprehensive table (presented overleaf) that addresses each outstanding comment individually. This table includes our responses, the supporting information provided, and clarifications where necessary.

For ease of reference and to facilitate the review process by the LLFA, we have also cross-referenced within the response table subsequently to the exact location (documents, drawings, and paragraph numbers) where relevant updates or additional information can be found.

This submission is intended to fully address the outstanding concerns raised by the LLFA and to support the continued determination of the planning application. The additional information has been incorporated into the Drainage Management Strategy Report (Revision 2.0) for completeness. I trust you will find the above of assistance, however, if you have any queries or require any further information, please do not hesitate to contact myself or the team.

Yours sincerely,

Liam Davies *BA, MSc*
Graduate Flood Risk Analyst
BETTS HYDRO LIMITED

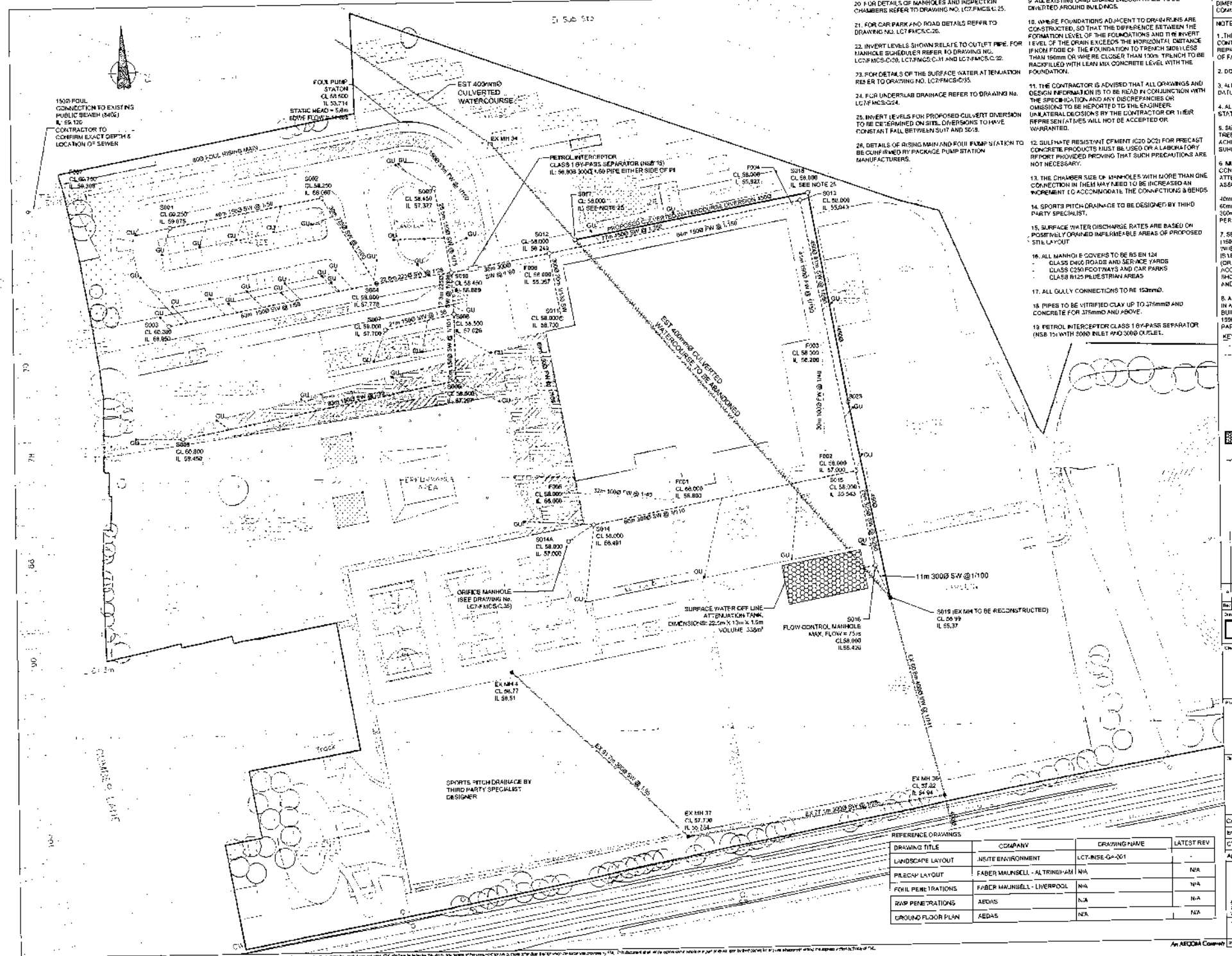
NO.	LLFA COMMENT	BETTS RESPONSE	DOCUMENT REFERENCES
1	The site is at risk of surface water flooding from north where Stoney Lane is located. As stated in the Flood Risk Assessment, the site is bounded by a boundary wall which protects the site from entering the site at some locations. Despite this, it appears that there are still gaps along the boundary wall allowing the surface water to enter the site. No mechanism has been proposed to protect the site. To the south of the site where Arrowsmith Catholic Academy is laid, ground levels are generally lower than the development site and there is a chance that the surface water may enter the neighbouring site; for which no interception mechanism is proposed.	The northern boundary along Stoney Lane comprises a mix of brick walling, concrete panel fencing and metal palisade fencing with associated gates. Stoney Lane is a formal adopted highway corridor served by highway drainage infrastructure and public sewer assets. The carriageway is separated from the site by a conventional kerbed edge (typically providing an upstand of approximately 125 mm). Whilst a theoretical pathway exists for surface water runoff from Stoney Lane to enter the site during extreme exceedance events (where rainfall exceeds the capacity of the highway drainage system), runoff will preferentially be conveyed along the highway corridor towards lower ground to the east. The likelihood and magnitude of surface water ingress from the north is therefore considered limited. To the south, a comparison of LiDAR-derived ground levels on the Academy side (circa. 57.8–58.2 mAOD) against the site's proposed design levels at the southern boundary (circa. 59.2–59.3 mAOD) confirms a level difference of circa 1–1.5 m, with the site sitting higher than the Academy. To manage potential flows in both directions, a surface water interception drain is proposed along the full southern site boundary. The interception drain comprises a lined trench incorporating an impermeable membrane and a perforated pipe wrapped in permeable geotextile within a clean stone fill, discharging via catch pits/silt traps into the site's proposed surface water sewer network (which ultimately outfalls to Whiston Brook). This feature intercepts surface water flows entering or leaving the development and prevents uncontrolled runoff towards the Academy.	Refer to paragraphs 4.4.15–4.4.25 of the Flood Risk Assessment (Revision 2.0) for the full assessment of pluvial risk from the north and south, including boundary treatments, highway drainage, level differences and the proposed interception drain. Refer to paragraphs 4.3.14–4.3.18 and Section 4.2 of the Drainage Management Strategy (Revision 2.0) for the interception drain design and exceedance management. Refer to the Preliminary Drainage Layout (Appendix I)within the DMS.
2	As recommended by the drainage strategy report, an assessment of ground conditions and the potential for infiltration of surface water utilising the BRE 365 method shall be required. To assess the feasibility of infiltration techniques as part of the proposed drainage strategy, evidence must be provided to show that a suitable number of soakaway tests have been completed across the whole site within different geology and to a suitable depth. Justifications provided in Paragraph 4.5.3 of the Surface Water Strategy report are not sufficient to preclude the use of infiltrating-based SuDS features as part of the drainage design. The exclusion of infiltrating-based SuDS features would require solid evidence of groundwater contamination risk. Parts of the site that is located within Environment Agency designated Zone III (Total Catchment) Source Protection Zone, the infiltrating-based SuDS, as a minimum, should be proposed at locations only receiving roof waters. Should the groundwater contamination risk is established, shallow inlined infiltration can be considered.	In accordance with the National Standards for SuDS hierarchy and CIRIA C753, infiltration has been fully assessed and discounted (in full and in part) on the basis of site-specific evidence. The Phase I and II Geoenvironmental Site Assessment (E3P) identifies significant volumes of low-permeability clay, extensive Made Ground, and widespread VOC contamination (including TCE and breakdown products) within both Made Ground and groundwater, together with a confirmed groundwater plume. Groundwater levels are shallow (0.60–5.47 m bgl) and the site is underlain by a Principal Aquifer within SPZ3. Introducing additional infiltration would mobilise contaminants and create/exacerbate a pathway to the Principal Aquifer. E3P specifically concludes that retaining hardstanding reduces infiltration and leachate production, thereby reducing risk to the aquifer. Regional groundwater data (Richmond Park) confirm monitoring was undertaken during a period of typically declining levels, yet shallow groundwater was still recorded. Soilscapes and BGS mapping further indicate slowly permeable clayey soils and variable superficial deposits unfavourable to infiltration.	Refer to Section 4.1 (Priority 2: Discharged to Ground), paragraphs 4.1.7–4.1.29 of the Drainage Management Strategy (Revision 2.0) for the full hierarchy assessment, contamination evidence, groundwater levels, SPZ3 considerations and conclusions. Refer to the E3P Phase I and II Geoenvironmental Site Assessment within Appendix I of this LLFA consultation Response Refer also to paragraphs 4.5.1–4.5.11 of the Flood Risk Assessment (Revision 2.0) regarding groundwater and SPZ3.
3	The revised drainage strategy submitted, aside from the proposed attenuation basin, does not still demonstrate an integrated SuDS strategy incorporating source control measures and linked green/blue infrastructure features or corridors. In accordance with the 2025 update to the SuDS Manual, SuDS design should seek to minimise impacts on water quantity and quality while maximising amenity and biodiversity benefits. The proposed planters at the rear gardens would not solely be considered as source control features given their size and its potential impact. In developing an appropriate SuDS strategy, the LLFA would ordinarily expect the integration of source control features (i.e. deep infiltrating or shallow inlined infiltrating surfaces, and raingardens along highways/footpaths) within a wider green/blue infrastructure network, with a preference for above-ground, vegetated attenuation features to enhance water quality treatment, visual amenity and ecological value. The current submission does not set out such a SuDS hierarchy, nor does it provide any justification for the omission of source control and green infrastructure components. Given the apparent availability of space and feasibility for their inclusion, the absence of these features is not considered consistent with the	Source-control SuDS features have been incorporated in the form of lined Filter Drains serving plot-level driveway and roof water runoff (providing source control, interception of the first 5 mm of rainfall, and initial treatment nearer to source) together with an Interception Drain along the southern site boundary. These are complemented by the central above-ground attenuation basin, which provides further treatment, storage, amenity and biodiversity benefits. Due to confirmed ground contamination and the Principal Aquifer/SPZ3, all source-control features are fully lined with a positive outfall; deep or shallow infiltrating surfaces are not feasible. The Filter Drains and Interception Drain form vegetated linear corridors that contribute to green/blue infrastructure connectivity. The attenuation basin is designed as multi-functional public open space with gently sloping naturalistic side slopes and marginal planting to maximise amenity and biodiversity value.	Refer to paragraphs 4.2–4.3 (Standards 2 and 3), 4.4 (Water Quality), 4.5 (Amenity) and 4.6 (Biodiversity) of the Drainage Management Strategy (Revision 2.0). Refer to the Preliminary Drainage Layout (Appendix K / Drawing Ref. TAY143-GDX-BET-ZZ-XX-DR-C-0001, Rev P13) showing Filter Drains, Interception Drain and attenuation basin. Refer to the Water Quality Assessment (Simple Index Approach) in Appendix N of the DMS which show the existing and proposed site conditions, and the SuDS Maintenance & Management Plan in Appendix O of the DMS.

	objectives of promoting water quality, amenity and biodiversity. A revised Drainage Strategy shall then be required.	A Water Quality Assessment (Simple Index Approach) demonstrates that the multi-stage treatment train (Filter Drains + basin) delivers mitigation indices that comfortably exceed the post-development residential pollution hazard indices. The strategy accords with Standards 2–6 of the National Standards for SuDS and the preference for above-ground vegetated features where feasible.	
4	Despite the provision of CCTV survey information for sections of the culverted watercourses to the east and south of the site, the submitted documentation does not provide a clear understanding of the watercourses' alignment, connectivity, route, or condition between their points of entry and exit from the site. The available information indicates that certain sections of the existing culverted watercourses may require repair or replacement. The proposed diversion of the culverted watercourses is not considered acceptable in its current form due to the incorporation of sharp bends within the design. Where practicable, the LLFA would strongly support the de-culverting of these watercourses and their integration into the site landscape as open green corridors. Accordingly, a revised site layout will be required to accommodate and safeguard the watercourse corridors. This should include a minimum easement of 4 to 6 metres from the top of each bank to facilitate future access, maintenance, and any potential restoration or enhancement works.	A CCTV survey undertaken by Taylor Wimpey on 17 July 2026 (Appendix H of the DMS/FRA) has confirmed that the former eastern culverted watercourse has been abandoned and is fully obstructed by 100% concrete or other hardened material along its length. The watercourse is therefore redundant. All culverted sections of this feature will be removed from the site as part of the proposals; no diversion of an active watercourse is proposed. An onsite culverted watercourse is located within the south of the site and flows south, and ultimately outfalls to Whiston Brook. Connectivity and condition of the southern sewer system have been confirmed via the earlier CCTV and dye-tracing surveys. The proposals mimic the existing regime by discharging post-development surface water to this private surface water sewer via new MH32. As the eastern feature is confirmed redundant and is to be removed, there is no active watercourse corridor requiring easements or de-culverting. The Preliminary Drainage Layout shows the proposed network, offsets from retained infrastructure, and the southern interception drain	Refer to paragraphs 3.1.3–3.1.5 and 4.1 of the Drainage Management Strategy (Revision 2.0) and paragraphs 3.1.5 and 4.1.6 of the Flood Risk Assessment (Revision 2.0) for the updated status of the culverted features. Refer to Appendix H (Culvert Investigations / CCTV Survey, July 2026) of both the DMS and FRA confirming the eastern feature is abandoned and fully obstructed. Refer to the Preliminary Drainage Layout (Appendix I of the DMS) showing the proposed network and the existing southern surface water sewer connection.
5	The FRA report indicates that at manhole MH1 (cover level 59.120m AOD, invert level 56.730m AOD, providing 2.39m of available depth), there is adequate freeboard between the incoming pipe soffit and the cover level. It concludes that, in the event of a complete blockage of the culvert, water levels at the inlet would remain significantly below the manhole cover, and therefore there would be no material risk of surcharge or surface water flooding at MH1. However, further clarification is required regarding the exceedance routing - specifically, where surface water runoff from the site and flows arriving via the culverted watercourse would discharge under such blockage conditions.	An Exceedance Flood Flow Routing Plan has been prepared to demonstrate where any exceedance flows would be conveyed post-development in a scenario whereby no sub-surface drainage systems are operational (including blockage of the downstream network). The proposed drainage network has been designed to accommodate the 1 in 100-year critical storm event including 45% climate change. Modelling identifies the 1 in 800-year event as the first point of exceedance, with limited above-ground flooding (approximately 14 m³) at manhole S7. Exceedance flows arising at this location are contained within the proposed carriageway and are directed away from both proposed and existing dwellings. No flood water is shown to pool or flow towards site boundaries, buildings or adjacent third-party land. The southern interception drain provides additional control of any residual flows at the boundary. As the former eastern culverted watercourse is confirmed abandoned and is to be removed, there are no external watercourse flows arriving at the site under blockage conditions.	Refer to paragraphs 4.3.14–4.3.18 of the Drainage Management Strategy (Revision 2.0) and the associated hydraulic modelling results (Appendix L). Refer to the Exceedance Flow Routing Plan (Appendix M of the DMS). Refer also to paragraphs 4.8.2–4.8.9 of the Flood Risk Assessment (Revision 2.0) regarding residual risk and exceedance management.
6	Upon the provision of a revised drainage strategy, catchment area to each of the proposed manholes shall be required.	An Impermeable Areas Plan has been prepared. The site has been sub-divided into individual sub-catchments corresponding to each manhole or connection point within the proposed surface water network. The plan identifies the impermeable and permeable contributing areas draining to each manhole, together with the resulting flows used to inform network design.	Refer to paragraphs 4.3.11–4.3.13 of the Drainage Management Strategy (Revision 2.0). Refer to the Impermeable Areas Plan (Appendix L of the DMS).
7	Upon the provision of a revised drainage strategy, results showing all the modelling criteria and summary network results for critical 1 in 2 years, 1 in 30 years and 1 in 100 years plus 45% CC storm events showing maximum water level, flow and velocity and details of any surface flooding anticipated shall be required.	Full hydraulic modelling of the proposed surface water network has been undertaken using MicroDrainage. Summary network results for the critical 1 in 2-year, 1 in 30-year and 1 in 100-year + 45% climate change storm events are provided, including maximum water levels, flows, velocities and any predicted surface flooding. The network is designed to contain the 1 in 100-year + 45% CC event on-site. Limited surface flooding is only predicted in the extreme 1 in 800-year event (see response to Comment 5).	Refer to Appendix K (Hydraulic Calculations & Drainage Network Details) of the Drainage Management Strategy (Revision 2.0), which includes the full modelling criteria, summary results and network details for the required return periods.

8	Upon the provision of a revised drainage strategy a Detailed Drainage Scheme Plan showing the layout of the proposed drainage network, post development impermeable area, Suds features, the location of the attenuation storage within the proposed development and how these relate to the submitted calculations, including any chamber, pipe numbers, direction of low, invert and cover levels, gradients diameters and dimensions. The methods of flow control must be detailed as should non-conventional elements such as pond and permeable paving.	A Preliminary Drainage Layout (Drawing Ref. TAY143-GDX-BET-ZZ-XX-DR-C-0001, Rev P13) has been prepared by Betts Associates. The drawing shows the full proposed drainage network layout, SuDS features (lined Filter Drains, Interception Drain and attenuation basin), chamber and pipe references, flow directions, invert and cover levels, gradients, diameters, dimensions, the location of attenuation storage, and the method of flow control. Post-development impermeable areas are identified and the layout is fully coordinated with the hydraulic calculations.	Refer to the Preliminary Drainage Layout (Appendix I) of the DMS Refer also to the associated hydraulic calculations and network details in Appendix L of the DMS. (Appendix K)
9	Upon the provision of a revised drainage strategy, Technical and design details of all SuDS features, hydraulic devices and outfalls and attenuation storage (including longitudinal and cross-sectional profiles if applicable) shall be required.	Technical and design details of the proposed SuDS features (lined Filter Drains, Interception Drain and attenuation basin), flow-control devices, outfalls and attenuation storage are provided within the Preliminary Drainage Layout and supporting hydraulic calculations. Longitudinal and cross-sectional profiles of the attenuation basin and key SuDS elements will be finalised at detailed design stage once the final planning layout is fixed; indicative details and design principles are already set out in the DMS.	Refer to the Preliminary Drainage Layout (Appendix I of the DMS) and Hydraulic Calculations & Drainage Network Details (Appendix K of the DMS). Refer to Appendix P for SuDs Examples for Filter Drain and Basin Details Refer to Sections 4.2–4.7 of the Drainage Management Strategy (Revision 2.0) for the design principles of all SuDS components, hydraulic devices and attenuation.
10	Upon the provision of a revised drainage strategy, exceedance flows and runoff in excess of design criteria shall be required. Calculations and plans shall be provided to show where above ground flooding might occur and where this would pool and flow. Where there is possibility of water ponding, the maximum extent and depth of flooded water shall be required to ensure that there would be sufficient resilience flood mitigation measures in place. If the design criterion is an event with the 1 in 100 years likelihood including 45% as the impact of climate change, then exceedance flows and runoff in excess of such an event must be considered.	Exceedance flows and runoff in excess of the 1 in 100-year + 45% climate change design standard have been assessed. Modelling identifies the 1 in 800-year event as the first point at which the below-ground network is exceeded. Above-ground flooding is limited to approximately 14 m³ at manhole S7 and is fully contained within the proposed carriageway, directed away from dwellings and site boundaries. An Exceedance Flow Routing Plan illustrates the anticipated overland flow routes, ponding locations and flow directions. No flooding of proposed or existing dwellings occurs even in this extreme event. The southern interception drain provides additional boundary control.	Refer to paragraphs 4.3.14–4.3.18 of the Drainage Management Strategy (Revision 2.0). Refer to the Exceedance Flow Routing Plan (Appendix M of the DMS)
11	Upon the provision of a revised drainage strategy, the mechanism for securing long-term maintenance will need to be considered and agreed between the applicant and the Local Planning Authority. This may involve discussions with those adopting and/or maintaining the proposed systems, which could include the Highway Authority, Planning Authority, Parish Councils, Water Companies and private management companies.	Long-term maintenance of the proposed drainage system (including all SuDS features) will be secured through a combination of adoption by the relevant statutory undertakers (where offered) and a private management company for any non-adopted elements. The precise mechanism will be agreed with the Local Planning Authority at the appropriate stage. A SuDS Maintenance and Management Plan has already been prepared setting out the typical maintenance requirements in accordance with CIRIA C753.	Refer to Section 4.7 (Standard 7) and Appendix O (SuDS Maintenance & Management Plan) of the Drainage Management Strategy (Revision 2.0). Discussions regarding adoption and long-term maintenance arrangements will be progressed with the relevant parties (UU, Highway Authority and LPA) as the detailed design advances.
12	Upon the provision of a revised drainage strategy, a revised management and maintenance plan for the proposed drainage system, arrangements for adoption and means of access for inspection and maintenance purposes shall be considered.	A SuDS Maintenance and Management Plan has been prepared in accordance with CIRIA C753, identifying the typical maintenance requirements, inspection frequencies and responsibilities for all proposed SuDS features (Filter Drains, Interception Drain, attenuation basin and associated hydraulic devices). Means of access for inspection and maintenance are provided via the proposed road network and open-space corridors. Arrangements for adoption of adoptable elements will be progressed with United Utilities and the Highway Authority; non-adopted elements will be maintained by a private management company under the approved plan.	Refer to Section 4.7 of the Drainage Management Strategy (Revision 2.0) and the full SuDS Maintenance & Management Plan in Appendix O of the DMS.

APPENDIX A – CULVERT INVESTIGATIONS (CCTV SURVEY – JULY 2026)

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20. FOR DETAILS OF MANHOLES AND INSPECTION CHAMBERS REFER TO DRAWING NO. LC7-FMCS-C-25.

21. FOR CAR PARK AND ROAD DETAILS REFER TO DRAWING NO. LC7-FMCS-C-26.

22. INVERT LEVELS SHOWN RELATE TO OUTLET PIPE. FOR MANHOLE SCHEDULES REFER TO DRAWING NO. LC7-FMCS-C-36, LC7-FMCS-C-34 AND LC7-FMCS-C-32.

23. FOR DETAILS OF THE SURFACE WATER ATTENUATION REFER TO DRAWING NO. LC7-FMCS-C-35.

24. FOR UNDERSLAB DRAINAGE REFER TO DRAWING No. LC7-FMCS-C-24.

25. INVERT LEVELS FOR PROPOSED CULVERT DIVERSION TO BE DETERMINED ON SITE. DIVERSIONS TO HAVE CONSTANT FALL BETWEEN S017 AND S018.

26. DETAILS OF RISING MAIN AND FOUL PUMP STATION TO BE CONFIRMED BY PACKAGE PUMP STATION MANUFACTURERS.

9. ALL EXISTING LAND DRAINS ENCOUNTERED TO BE DIVERTED AROUND BUILDINGS.

10. WHERE FOUNDATIONS ADJACENT TO DRAIN RUNS ARE CONSTRUCTED, SO THAT THE DIFFERENCE BETWEEN THE FORMATION LEVEL OF THE FOUNDATIONS AND THE INVERT LEVEL OF THE DRAIN EXCEEDS THE HORIZONTAL DISTANCE FROM FACE OF THE FOUNDATION TO TRENCH SIDE LESS THAN 150mm OR WHERE CLOSER THAN 150m TRENCH TO BE BACKFILLED WITH LEAN MIX CONCRETE LEVEL WITH THE FOUNDATION.

11. THE CONTRACTOR IS ADVISED THAT ALL DRAWINGS AND DESIGN INFORMATION IS TO BE READ IN CONJUNCTION WITH THE SPECIFICATION AND ANY DISCREPANCIES OR OMISSIONS TO BE REPORTED TO THE ENGINEER. UNILATERAL DECISIONS BY THE CONTRACTOR OR THEIR REPRESENTATIVES WILL NOT BE ACCEPTED OR WARRANTED.

12. SULPHATE RESISTANT CEMENT (CSS DC2) FOR PRECAST CONCRETE PRODUCTS MUST BE USED OR A LABORATORY REPORT PROVIDED PROVING THAT SUCH PRECAUTIONS ARE NOT NECESSARY.

13. THE CHAMBER SIZE OF MANHOLES WITH MORE THAN ONE CONNECTION IN THEM MAY NEED TO BE INCREASED AN INCREMENT TO ACCOMMODATE THE CONNECTIONS & BENDS

14. SPORTS PITCH DRAINAGE TO BE DESIGNED BY THIRD PARTY SPECIALIST.

15. SURFACE WATER DISCHARGE RATES ARE BASED ON POSITIVELY DRAINED IMPERMEABLE AREAS OF PROPOSED SITE LAYOUT

16. ALL MANHOLE COVERS TO BE BS EN 124
- CLASS D400 ROADS AND SERVICE YARDS
- CLASS C250 FOOTWAYS AND CAR PARKS
- CLASS B125 PEDESTRIAN AREAS

17. ALL GULLY CONNECTIONS TO BE 150mmØ.

18. PIPES TO BE VITRIFIED CLAY UP TO 375mmØ AND CONCRETE FOR 375mmØ AND ABOVE.

19. PETROL INTERCEPTOR CLASS 1 BY-PASS SEPARATOR (NSB 15) WITH 300Ø INLET AND 300Ø OUTLET.

NOTE:- CONTRACTOR TO CONFIRM ALL SITE DIMENSIONS/SETTING OUT PRIOR TO COMMENCEMENT OF WORK

NOTES

1. THIS DRAWING AND THE INFORMATION IT CONTAINS IS COPYRIGHT AND MUST NOT BE REPRODUCED WITHOUT THE WRITTEN CONSENT OF FABER MAUNSELL.

2. DO NOT SCALE FROM THIS DRAWING.

3. ALL LEVELS ARE IN METRES ABOVE ORDNANCE DATUM.

4. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS STATED OTHERWISE.

5. SEWERS MUST HAVE 5m CLEARANCE FROM TREES & HEDGES, WHERE IT IS NOT POSSIBLE TO ACHIEVE THIS CLEARANCE, CONCRETE BED & SURROUND IS REQUIRED.

6. MUGAYS TO BE DESIGNED BY SPECIALIST CONTRACTOR, MUGAS TO BE USED AS SW ATTENUATION. DESIGN OF SW DRAINAGE ASSUMES THE FOLLOWING:

40mm PERMEABLE WEARING COURSE
60mm SAND LAYER
300mm SINGLE SIZE GRAVEL (POROSITY 0.35)
PERFORATED PIPES AT 10m CENTRES

7. SEWERS TO BE LAID IN CLASS 'S' BEDDING 150mm GRANULAR BED AND SURROUND. WHERE DEPTH OF COVER TO TOP OF THE SEWER IS LESS THAN 1.2m IN HIGHWAYS AND VERGES (OR LESS THAN 900mm IN NONE VEHICULAR ACCESS AREAS) THEN A CONCRETE SLAB SHOULD BE PROVIDED ABOVE GRANULAR BED AND SURROUND.

8. ALL PRIVATE DRAINAGE TO BE CONSTRUCTED IN ACCORDANCE WITH PART H OF THE CURRENT BUILDING REGULATIONS AND BS EN 752 PART 1 1996, PART 2 1997 PART 3 1997, PART 4 1998, PART 5 1998 PART 6 1999 AND PART 7 1998

KEY

- PROPOSED FOUL SEWER
- PROPOSED SW SEWER
- IL INVERT LEVEL
- CL COVER LEVEL
- FOUL MANHOLE
- FOUL INSPECTION CHAMBER
- SW MANHOLE
- SW INSPECTION CHAMBER
- GU GULLY
- SW ATTENUATION
- EXISTING COMBINED SEWER
- EXISTING SW SEWER

Rev	Date	Detail	Made	Ckd	Appd
A	18/10/07	ISSUED FOR COMMENT	ASR	SCG	CJC

Drawing Status: FOR COMMENT

Client: BALFOUR BEATTY CONSTRUCTION

Project: KNOWSLEY BSF LC7 - KNOWSLEY CENTRAL RC LEARNING CENTRE

Title: PROPOSED DRAINAGE LAYOUT

REFERENCE DRAWINGS

DRAWING TITLE	COMPANY	DRAWING NAME	LATEST REV
LANDSCAPE LAYOUT	INSITE ENVIRONMENT	LC7-INSE-GA-001	-
PILECAP LAYOUT	FABER MAUNSELL - ALTRINCHAM	N/A	N/A
FOUL PENETRATIONS	FABER MAUNSELL - LIVERPOOL	N/A	N/A
RWP PENETRATIONS	AEDAS	N/A	N/A
GROUND FLOOR PLAN	AEDAS	N/A	N/A

CAD Ref:

Engineer	WJ	Made	WJ
Chkd	-	Date	18.10.07
App.	SJK	Scale	1:500 @ A1

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No. LC7/FMCS/C/23 Rev A

An AECOM Company

A1

Ex MH33

2250 VC

2250 VC

375Ø VC

Ex MH34
C.L.58.62m
I.L.56.96m

450Ø Concrete

450Ø Concrete

SW01
Buried Under Grass
G.L.58.23m

Partially exposed SW18 buried in grass. Unable to access





CCTV showing new 450Ø concrete pipe - culverted watercourse diversion

450Ø Concrete

SW02
Buried Under Grass

450Ø Concrete

SW03 Buried under grass but exposed

450Ø Concrete

SW04
Buried Under Grass. Line Comes in on T not bend so can not CCTV to outfall.

Outfall discharges under railway into Whiston Brook, confirmed via dye test.

Exposed SW20 buried in grass



Pin showing location of buried SW21. Unable to access



Dye in Whiston Brook from MH33 in Glen Dimplex



Key:

- Culverted watercourse diversion within St Edmunds Arrowsmith (CCTV completed)
- Existing culverted watercourse within St Edmunds Arrowsmith (CCTV unavailable)
- Buried Manholes. Locations confirmed by probing.

Rev	Description	Date	Initial

Revisions

Taylor Wimpey

Taylor Wimpey North West
Washington House, Birchwood Park,
Warrington, Cheshire WA3 6GR
Tel 01925 849 500 Fax 01925 849 501
www.taylorwimpey.com

DRAWING TITLE:

GLEN DIMPLEX

RAINHILL
CULVERTED WATERCOURSE DIVERSION INVESTIGATION

DRAWING STATUS: PRELIMINARY

DWG SCALE	DATE	DRAWN	CHECKED BY
NTS @ A1	03/09/25	CP	-

DRAWING NUMBER

SITE CODE	DRAWING CODE	DRAWING NO	REVISION
GLEN DIM	100	01	-

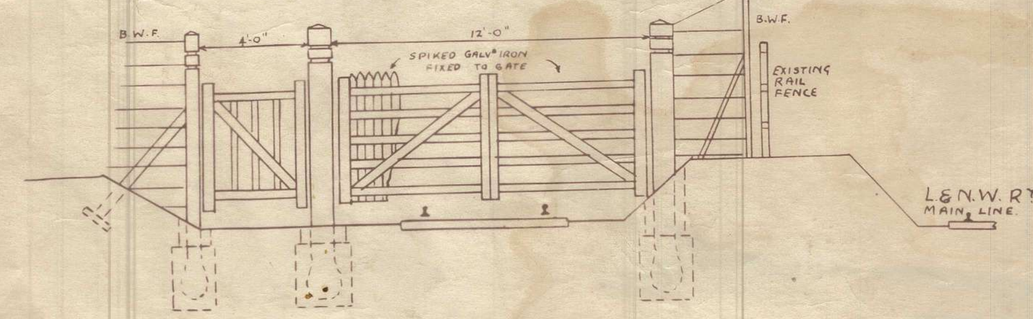
N.B. NEW MAINS TO BE TAKEN FROM EXISTING 6" MAINS IN DRAGON LANE ABOUT 1900 FEET WEST OF NEW STOP-COCKS AT K

WHISTON INFIRMARY

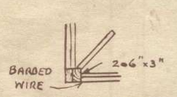
DESCRIPTION

GAS MAINS MARKED THUS ------
WATER MAINS " " ----------
ELECTRIC MAINS " " ----------
SEWER (EXISTING) " " ----------
NEW DRAINS " " ----------
SURFACE WATER DRAINS " " ----------
LAND DRAINS " " ----------
SLIDING DOORS " " ----------
SKYLIGHTS " " ----------
LEVELS " " ----------

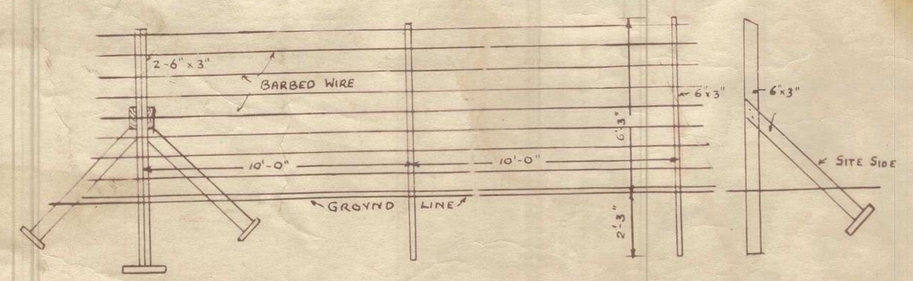
N.B. LEVELS TAKEN AS BEING ABOVE DATUM WHICH IS 40'-0" BELOW THE SIGNAL BOX GROUND LEVEL AT 'A'.



DETAIL OF GATES OVER RAILWAY



PLAN OF ANGLE POSTS.



STRAINING POST

DETAILS OF FENCING
SCALE 1/4" = 1 FOOT.

DETAIL OF EVERY 5TH POST.

N

DRAGON LANE

STONEY LANE

SHED No 2 TO FALL 1in 200

SHED No 1 TO FALL 1in 200

FLOOR LEVEL 49.00

FLOOR LEVEL 48.50

1971 LAND DRAIN

BRICK TRANSFORMER HOUSE 6'-0"x6'-0"x8'-0" INSIDE

EXISTING STREAMS TO BE DIVERTED

EXISTING 12" PIPE DRAIN

9" LAND DRAIN

1977

9" LAND DRAIN

SLIDING DOORS

SLIDING DOORS

9 STRAND B.W. FENCE

838'-6"

361'-6"

317'-6"

160'-0"

EXISTING 12" PIPE DRAIN

WELL

TO LIVERPOOL

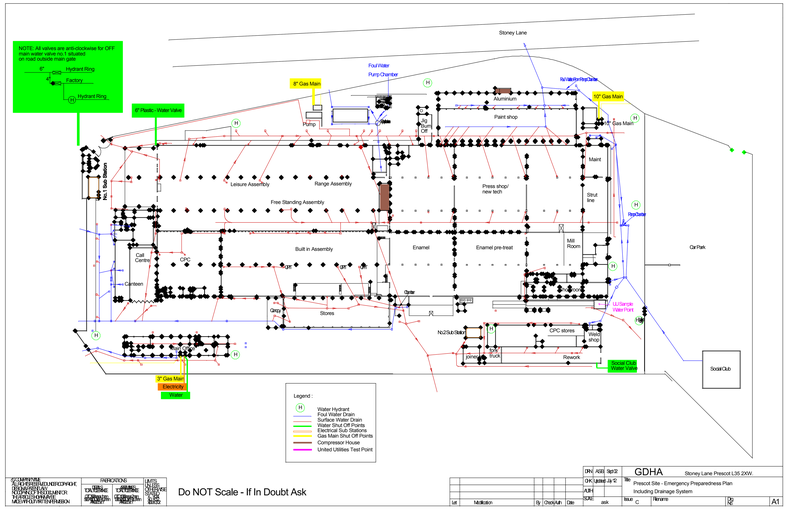
L. & N. W. RY. MAIN LINE TO LIVERPOOL MANCHESTER

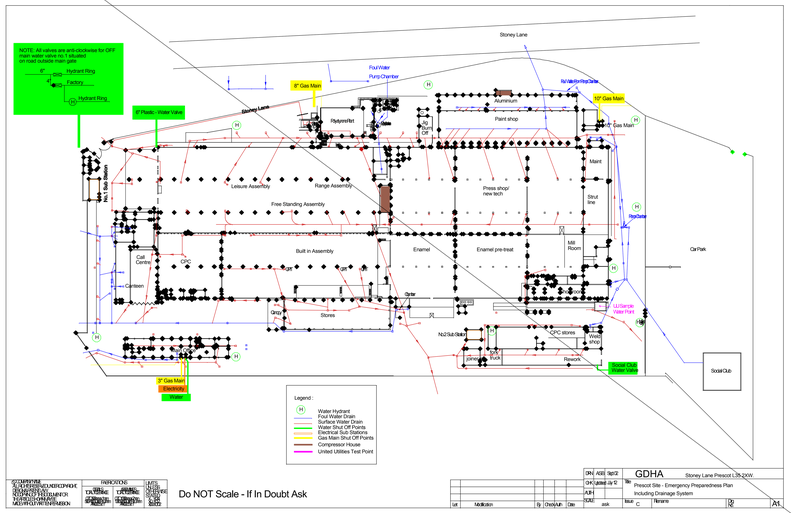
SCALE OF 56 FEET TO AN INCH.

COPIED FROM DRG No 1 H.M. OFFICE OF WORKS. STORE YS GATE WESTMINSTER S.W.

STOVES LIMITED RAINHI
PLAN OF WORKS
TRACED BY WAM
CHECKED BY

WHISTON RAINHILL: NR. LIVERPOOL. MVNITION STORE SITE PLAN.


NOTE: All valves are anti-clockwise for OFF
main water valve no 1 situated
on road outside main gate
8" Hydrant Ring
Factory
Hydrant Ring
8" Plastic - Water Valve
8" Gas Main
Foul Water
Pump Chamber
Stoney Lane
Hydrant Ring Circle
10" Gas Main
Pump
Oil Interceptor
Aluminium
Paint shop
Maint
No.1 Sub Station
Leisure Assembly
Range Assembly
Free Standing Assembly
Press shop/
new tech
Strut
line
Ring Circuit
Built in Assembly
Enamel
Enamel pre-treat
Mill
Room
Car Park
Call
Centre
Canteen
Qmpy
Stores
Qstor
CPC stores
Weld
shop
Joinery
Rework
Social Club
Water Valve
Social Club
3" Gas Main
Electricity
Water
Legend :
Water Hydrant
Foul Water Drain
Surface Water Drain
Water Shut Off Points
Electrical Sub Stations
Gas Main Shut Off Points
Compressor House
United Utilities Test Point
Do NOT Scale - If In Doubt Ask
GDHA
Stoney Lane Prescot L35 2XW.
Prescot Site - Emergency Preparedness Plan
Including Drainage System
A1


NOTE: All valves are anti-clockwise for OFF
main water valve no 1 situated
on road outside main gate
8" Hydrant Ring
Factory
Hydrant Ring
8" Plastic - Water Valve
8" Gas Main
Foul Water
Pump Chamber
Stoney Lane
Hydrant Ring Circle
10" Gas Main
Pump
Oil Interceptor
Aluminium
Paint shop
Maint
No.1 Sub Station
Leisure Assembly
Range Assembly
Free Standing Assembly
Press shop/
new tech
Strut
line
Ring Circuit
Built in Assembly
Enamel
Enamel pre-treat
Mill
Room
Car Park
Call
Centre
Canteen
Qmpy
Stores
Qstor
CPC stores
Weld
shop
Joinery
Rework
Social Club
Water Valve
Social Club
3" Gas Main
Electricity
Water
Legend :
Water Hydrant
Foul Water Drain
Surface Water Drain
Water Shut Off Points
Electrical Sub Stations
Gas Main Shut Off Points
Compressor House
United Utilities Test Point
Do NOT Scale - If In Doubt Ask
GDHA
Stoney Lane Prescot L35 2XW.
Prescot Site - Emergency Preparedness Plan
Including Drainage System
A1

NOTE: All valves are anti-clockwise for OFF
main water valve no.1 situated
on road outside main gate

6" Hydrant Ring
4" Factory
H Hydrant Ring

6" Plastic - Water Valve

Stoney Lane

Foul Water
Pump Chamber

8" Gas Main

Pump

Jig
Burn
Off

Foul Waste From Pump Chamber

10" Gas Main

Aluminium

Paint shop

10" Gas Main

Maint

No.1 Sub Station

Leisure Assembly

Range Assembly

Press shop/
new tech

Strut
line

Free Standing Assembly

Pump Chamber

Call
Centre

CPC

Built in Assembly

Enamel

Enamel pre-treat

Mill
Room

Car Park

Canteen

CPRT

CPRT

CPRT

Chamber

Showroom

UU Sample
Water Point

Canopy

Stores

No.2 Sub Station

CPC stores

Weld
shop

fork
truck

joiner

Rework

Social Club
Water Valve

Social Club

Main Office

3" Gas Main
Electricity
Water

Legend :

- H — Water Hydrant
- Foul Water Drain
- Surface Water Drain
- Water Shut Off Points
- Electrical Sub Stations
- Gas Main Shut Off Points
- Compressor House
- United Utilities Test Point

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FABRICATIONS

DETAILS TOTAL TOLERANCE	ASSEMBLIES TOTAL TOLERANCE
0 TO 500mm ± 1mm 500 AND OVER ± 3mm ANGLES ± 1°	0 TO 1000mm ± 2mm 1000 AND OVER ± 3mm ANGLES ± 1°

LIMITS UNLESS OTHERWISE STATED
x ± 0.4
x.0 ± 0.2
x.00 ± 0.02

Do NOT Scale - If In Doubt Ask

Let	Modification	By	Check/Auth	Date

DRN	A.S.B.	Sept 02
CHK	Updated	July 12
AUTH		
SCALE	ask	

GDHA Stoney Lane Prescot L35 2XW.

Title: Prescot Site - Emergency Preparedness Plan
Including Drainage System

Issue	Filename	Drg No.	
C			A1

NOTE: All valves are anti-clockwise for OFF
main water valve no.1 situated
on road outside main gate

6" Hydrant Ring
4" Factory
H Hydrant Ring

6" Plastic - Water Valve

Stoney Lane

8" Gas Main

Foul Water
Pump Chamber

Foul Waste From Pump Chamber

10" Gas Main

Pump

Polystyrene Plant

Polyesterlar

Jig
Burn
Off

Aluminium

Paint shop

10" Gas Main

Maint

No.1 Sub Station

Leisure Assembly

Range Assembly

Free Standing Assembly

Press shop/
new tech

Strut
line

Pump Chamber

Mill
Room

Built in Assembly

Enamel

Enamel pre-treat

Car Park

Call
Centre

CPC

CPIT

Canteen

Chamber

Showroom

UU Sample
Water Point

Canopy

Stores

No.2 Sub Station

CPC stores

Weld
shop

Main Office

joiner

fork
truck

Rework

Social Club
Water Valve

Social Club

3" Gas Main
Electricity
Water

Legend :

- H Water Hydrant
- Foul Water Drain
- Surface Water Drain
- Water Shut Off Points
- Electrical Sub Stations
- Gas Main Shut Off Points
- Compressor House
- United Utilities Test Point

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FABRICATIONS		LIMITS
DETAILS TOTAL TOLERANCE	ASSEMBLIES TOTAL TOLERANCE	UNLESS OTHERWISE STATED
0 TO 300mm ± 1mm 600 AND OVER ± 3mm ANGLES ± 1°	0 TO 1000mm ± 2mm 1000 AND OVER ± 3mm ANGLES ± 1°	x ± 0.4 x.0 ± 0.2 x.00 ± 0.02

Do NOT Scale - If In Doubt Ask

Let	Modification	By	Check	Auth	Date

DRN	A.S.B.	Sept 02
CHK	Updated	July 12
AUTH		
SCALE	ask	

GDHA Stoney Lane Prescot L35 2XW.

Title: Prescot Site - Emergency Preparedness Plan
Including Drainage System

Issue C | Filename | Drg No. | A1

NOTE: All valves are anti-clockwise for OFF
main water valve no.1 situated
on road outside main gate

6" Hydrant Ring
4" Factory
H Hydrant Ring

Stoney Lane

6" Plastic - Water Valve

8" Gas Main

Foul Water
Pump Chamber

Foul Waste From Pump Chamber

10" Gas Main

Stoney Lane

Polystyrene Plant

Pump

Hydrastar

Jig
Burn
Off

Aluminium

Paint shop

10" Gas Main

Maint

No.1 Sub Station

Leisure Assembly

Range Assembly

Free Standing Assembly

Press shop/
new tech

Strut
line

Pump Chamber

Call
Centre

CPC

Canteen

Built in Assembly

C/PIT

C/PIT

C/PIT

Enamel

Enamel pre-treat

Mill
Room

Car Park

Chamber

Showroom

UU Sample
Water Point

Canopy

Stores

No.2 Sub Station

CPC stores

Weld
shop

fork
truck

joiner

Rework

Social Club
Water Valve

Social Club

Main Office

3" Gas Main
Electricity
Water

Legend :

- Water Hydrant
- Foul Water Drain
- Surface Water Drain
- Water Shut Off Points
- Electrical Sub Stations
- Gas Main Shut Off Points
- Compressor House
- United Utilities Test Point

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FABRICATIONS		LIMITS
DETAILS TOTAL TOLERANCE	ASSEMBLIES TOTAL TOLERANCE	UNLESS OTHERWISE STATED

Do NOT Scale - If In Doubt Ask

DRN	A.S.B.	Sept 02
CHK	Updated	July 12
AUTH		

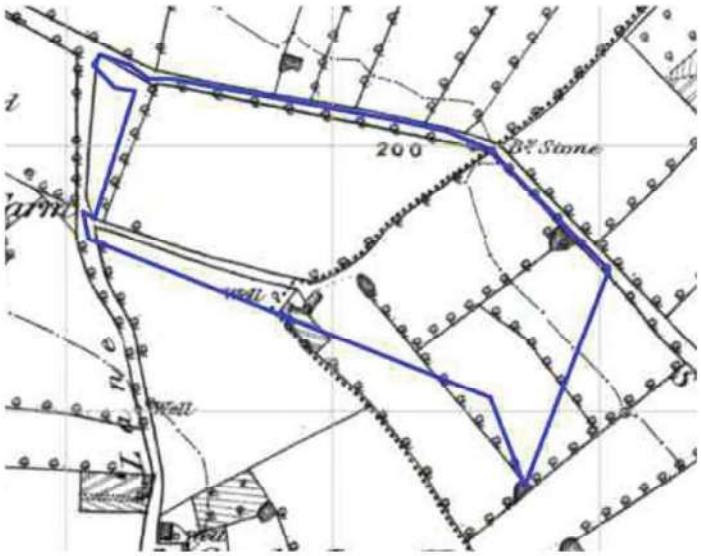
GDHA

Stoney Lane Prescot L35 2X

Title: Prescot Site - Emergency Preparedness Plan
Including Drainage System

On-site historical development of Glen Dimplex

1850 – Several segmenting field boundaries are present, with the site comprising seven smaller fields

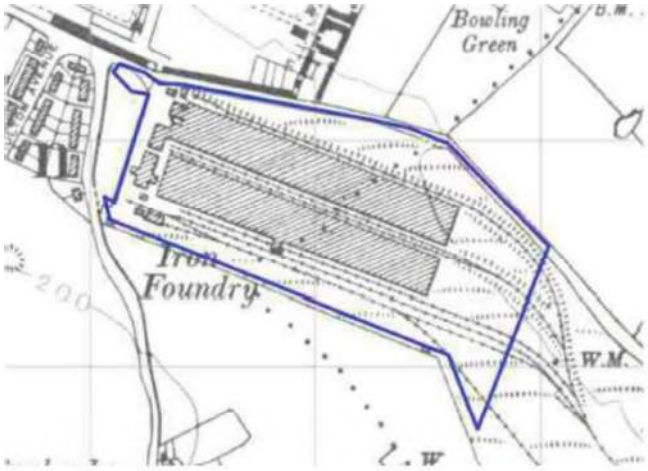


1892 – Majority of field boundaries removed and field boundary traversing through the centre of the site is now noted as a small hedge-lined road traversing from the south towards the northeast, continuing off site.

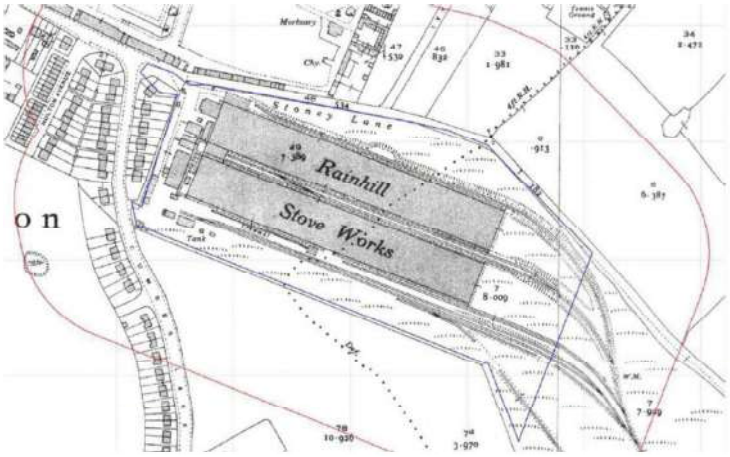


1907-1925 – Historical mapping unavailable but records held by Heritage Gateway indicates a factory had been developed used as munitions works.

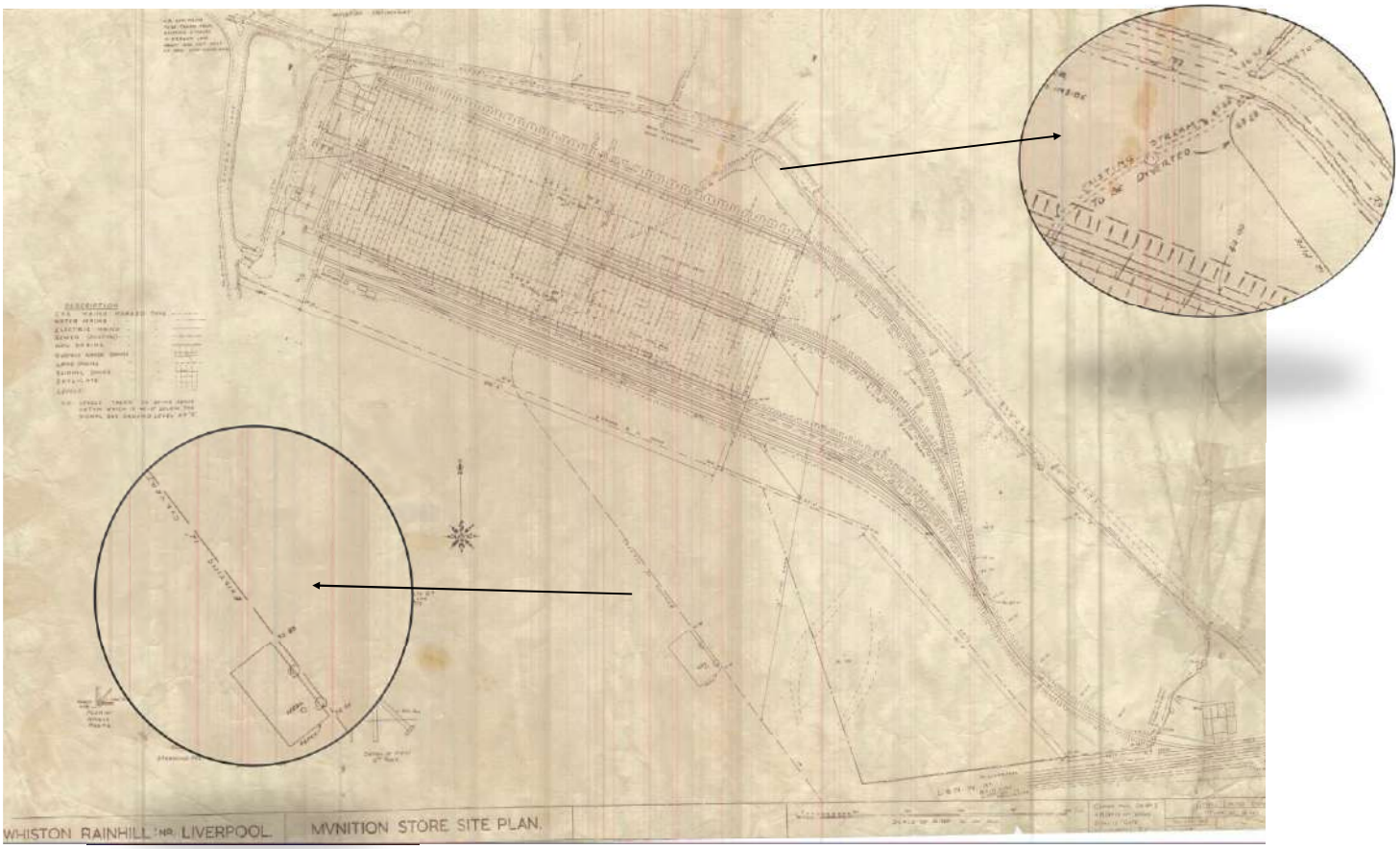
1925 – Site redeveloped and comprises an iron foundry with associated railway sidings



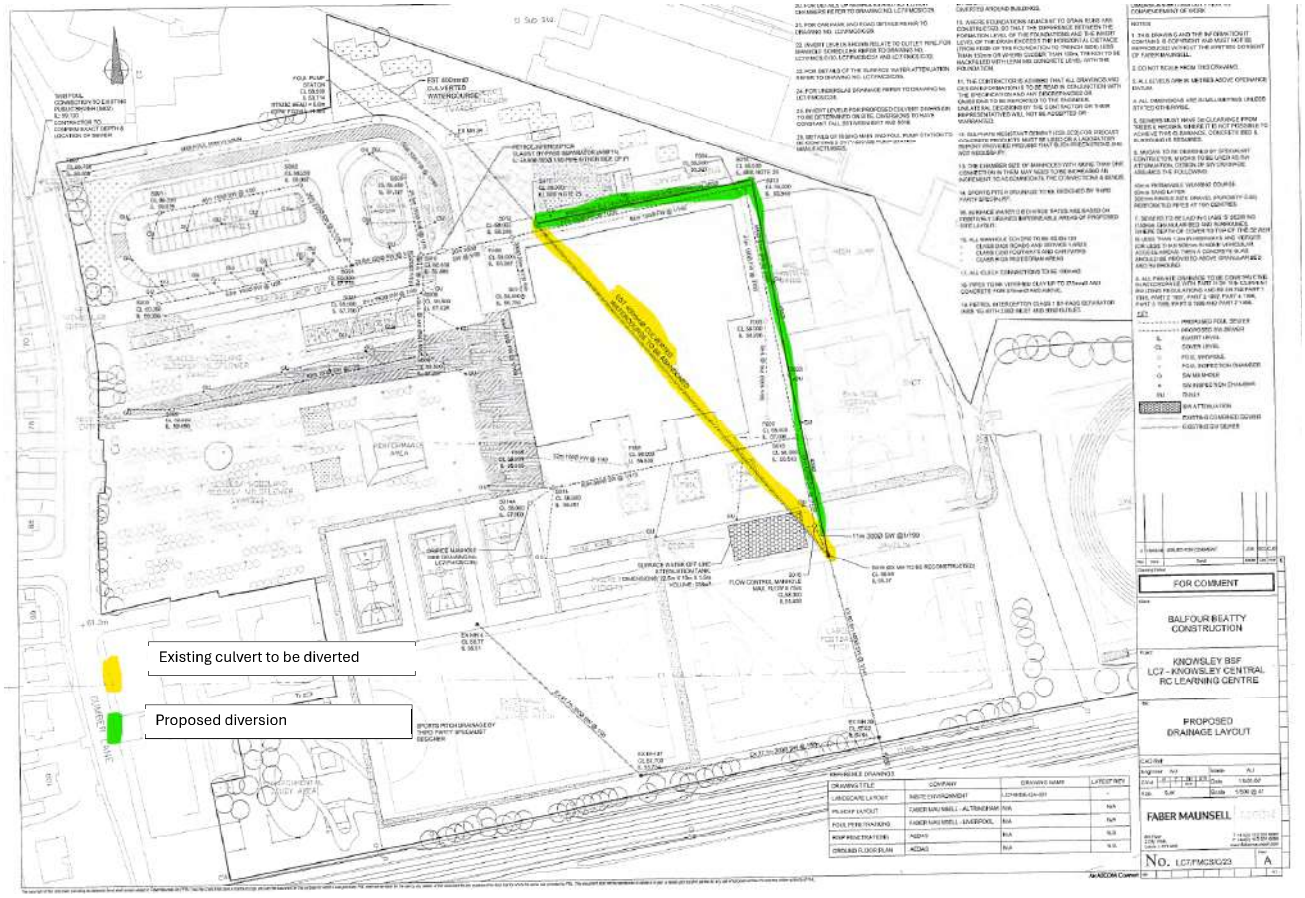
1937 – Site now renamed as Stove Works



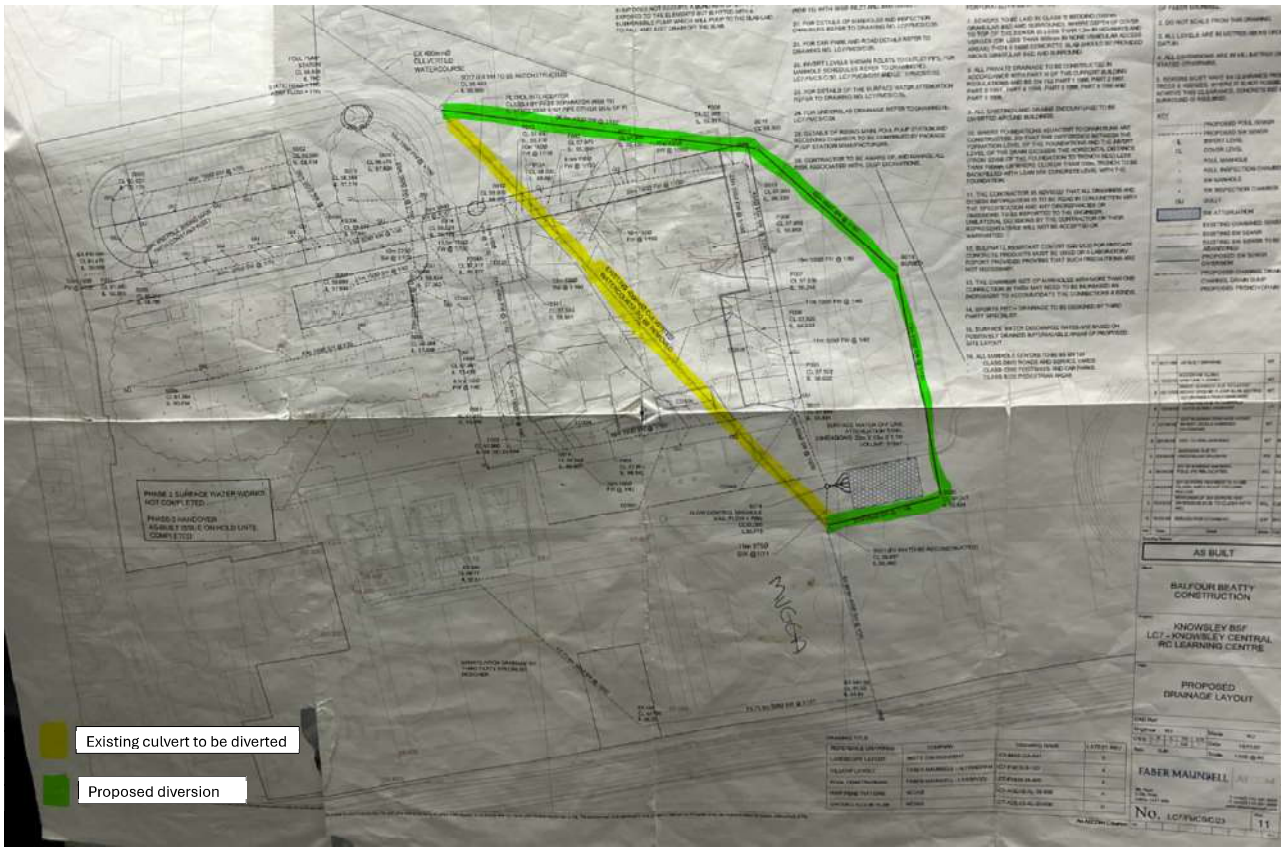
1955 – Historical map shows existing stream traversing along route of field boundary to be diverted to east of development into 12'' pipe (location and condition of eastern culverted watercourse still to be confirmed). Plan also references existing 12'' culvert to south of site



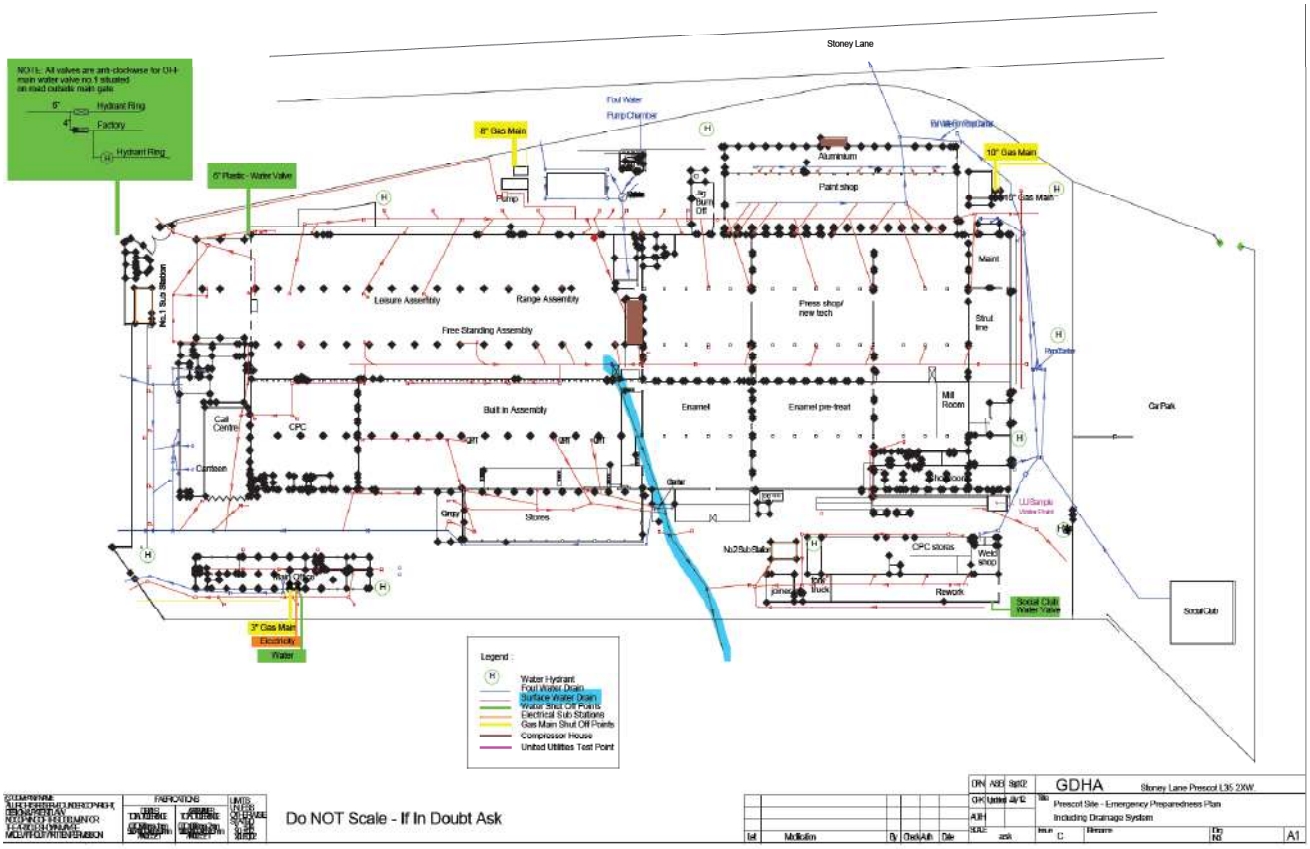
2007 – Revision A Faber Maunsell plans showing existing route of 400mm culverted watercourse to be abandoned downstream from MH34 and diverted as 450mm around new school building downstream to existing manhole S019.



2009 – Revision 11 of the Faber Maunsell proposed drainage diversion plan provided by St Edmunds Arrowsmith showing diversion directly from MH34.



2012 – Glen Dimplex emergency preparedness plan including drainage system showing surface water factory drains connecting into culverted watercourse to south.



Quinn Utilities
30 Lees Road, Knowsley

ryan.davies@quinnutilities.com

Project

Project Name:	M3382 Taylor Wimpey Glen Dimplex Stoney Lane Whiston 17 07 26
Project Date:	17/07/2026
Inspection Standard:	MSCC5 Sewers & Drainage GB (SRM5 Scoring)

Quinn Utilities
30 Lees Road, Knowsley

ryan.davies@quinnutilities.com

Table of Contents

Project Name	Project Number	Project Date
M3382 Taylor Wimpey Glen Dimplex Stoney Lane Whiston 17 07 26		17/07/2026

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Section Item 2: MH3 > 3A (MH3X) 3

Section Item 3: MH1 > MH0 (MH1X) 5

Section Item 4: MH0 > OOB (MH0X) 8

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Project Information

Project Name	Project Number	Project Date
M3382 Taylor Wimpey Glen Dimplex Stoney Lane Whiston 17 07 26		17/07/2026

Client

Company: Taylor Wimpey
Description: Taylor Wimpey North West
Contact: Chloe Powell
Department: Washington House
Street: Birchwood Park Avenue
Town or City: Birchwood
County: Warrington
Post Code: WA3 6GR

Site

Company: Taylor Wimpey
Department: Glen Dimplex
Street: Stoney Lane
Town or City: Whiston
County: Prescot
Post Code: L35 2XW

Contractor

Company: Quinn Utilities
Contact: Ryan Davies
Department: Business Development Mangaer
Street: 30 Lees Road
Town or City: Knowsley
County: Merseyside
Post Code: L33 7SE
Email: ryan.davies@quinnutilities.com

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30 Lees Road, Knowsley
ryan.davies@quinnutilities.com

Section Inspection - 17/07/2026 - MH2X

Item No.	Insp. No.	Date	Time	Client`s Job Ref	Weather	Pre Cleaned	PLR
1	1	17/07/26	9:08	Not Specified	No Rain Or Snow	Yes	MH2X

Operator	Vehicle	Camera	Preset Length	Legal Status	Alternative ID
K Heron	OY25 ZGO	Crawler	Not Specified	Watercourse	Not Specified

Town or Village:	Whiston	**Inspection Direction:**	Upstream	**Upstream Node:**	MH2
Road:	Stoney Lane	**Inspected Length:**	24.29 m	**Upstream Pipe Depth:**	
Location:	Other location	**Total Length:**	24.29 m	**Downstream Node:**	MH1
Surface Type:		**Joint Length:**		**Downstream Pipe Depth:**	2.750 m

Use:	Surface water	**Pipe Shape:**	Circular
Type of Pipe:	Gravity drain/sewer	**Dia/Height:**	375 mm
Flow Control:	No flow control	**Material:**	Vitrified clay
Year Constructed:	Not Specified	**Lining Type:**	No Lining
Inspection Purpose:	Sample condition survey	**Lining Material:**	No Lining

Comments:
Recommendations:

Scale: 1:211

Depth: 2.75 m
MH1



Position [m]	Code	Observation	MPEG	Photo	Grade
0.00	MH	Start node, manhole, reference: MH1	00:00:00		
0.00	WL	Water level, 5% of the vertical dimension	00:00:01		
10.53	JDM	Joint displaced, medium	00:01:39	MH2X_70b96853-f2dd-454a-9	1 / 3
12.85	JDM	Joint displaced, medium	00:02:02	MH2X_51476cb6-0e7a-4a51-a	1 / 3
15.93	JDM	Joint displaced, medium	00:02:27	MH2X_d78f335c-0e2b-4e60-9	1 / 3
23.47	FL	Fracture, longitudinal at 12 o'clock	00:03:17	MH2X_2b820b75-7151-4426-a	3 / 2
24.29	MHF	Finish node, manhole, reference: MH2	00:03:53		

MH2
Depth: m

Construction Features					Miscellaneous Features				
Structural Defects					Service & Operational Observations				
STR No. Def	**STR Peak**	**STR Mean**	**STR Total**	**STR Grade**	**SER No. Def**	**SER Peak**	**SER Mean**	**SER Total**	**SER Grade**
4	40.0	1.8	43.0	3.0	4	2.0	0.3	7.0	3.0

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Section Pictures - 17/07/2026 - MH2X

Item No.	Inspection Direction	PLR	Client`s Job Ref	Contractor`s Job Ref
1	Upstream	MH2X		



MH2X_70b96853-f2dd-454a-9ce1-c7ffbd0943df_20260717_091002_028.jpg, 00:01:39, 10.53 m
Joint displaced, medium



MH2X_51476cb6-0e7a-4a51-a76a-bdbbae8c9da7_20260717_091025_919.jpg, 00:02:02, 12.85 m
Joint displaced, medium



MH2X_d78f335c-0e2b-4e60-97e7-b1cd699de009_20260717_091052_749.jpg, 00:02:27, 15.93 m
Joint displaced, medium



MH2X_2b820b75-7151-4426-a22a-f04f192eac9f_20260717_091149_533.jpg, 00:03:17, 23.47 m
Fracture, longitudinal at 12 o'clock

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Section Inspection - 17/07/2026 - MH3X

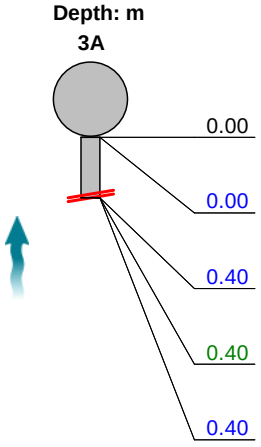
Item No.	Insp. No.	Date	Time	Client`s Job Ref	Weather	Pre Cleaned	PLR
2	1	17/07/26	11:14	Not Specified	No Rain Or Snow	Yes	MH3X

Operator	Vehicle	Camera	Preset Length	Legal Status	Alternative ID
K Heron	OY25 ZGO	Crawler	Not Specified	Watercourse	Not Specified

Town or Village:	Whiston	**Inspection Direction:**	Unknown	**Upstream Node:**	MH3
Road:	Stoney Lane	**Inspected Length:**	0.40 m	**Upstream Pipe Depth:**	
Location:	Other location	**Total Length:**	0.40 m	**Downstream Node:**	3A
Surface Type:		**Joint Length:**		**Downstream Pipe Depth:**	

Use:	Surface water	**Pipe Shape:**	Circular
Type of Pipe:	Gravity drain/sewer	**Dia/Height:**	300 mm
Flow Control:	No flow control	**Material:**	Vitrified clay
Year Constructed:	Not Specified	**Lining Type:**	No Lining
Inspection Purpose:	Sample condition survey	**Lining Material:**	No Lining

Comments:
Recommendations:



Scale: 1:50 Position [m]	Code	Observation	MPEG	Photo	Grade
0.00	MH	Start node, manhole, reference: MH3	00:00:00		
0.00	WL	Water level, 0% of the vertical dimension	00:00:01		
0.40	REM	General remark: Potential reduction in pipe size	00:00:34	MH3X_6ec5eae9-f7f7-4b36-bc9	
0.40	OBZ	Other obstacles from 12 o'clock to 12 o'clock, 100% cross-sectional area loss: Concrete or other hardened material	00:00:54	MH3X_039bc8c8-8b32-404e-8	5
0.40	SA	Survey abandoned: Due to obstruction	00:01:00		

Construction Features					Miscellaneous Features				
Structural Defects					Service & Operational Observations				
STR No. Def	**STR Peak**	**STR Mean**	**STR Total**	**STR Grade**	**SER No. Def**	**SER Peak**	**SER Mean**	**SER Total**	**SER Grade**
0	0.0	0.0	0.0	1.0	1	10.0	25.0	10.0	5.0

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ryan.davies@quinnutilities.com

Section Pictures - 17/07/2026 - MH3X

Item No.	Inspection Direction	PLR	Client`s Job Ref	Contractor`s Job Ref
2	Unknown	MH3X		



MH3X_6ec5eae9-f7f7-4b36-bc9b-21bc69e7c60b_20260717_111558_946.jpg, 00:00:34, 0.40 m
General remark, Potential reduction in pipe size



MH3X_039bc8c8-8b32-404e-85ed-5f8493afefc0_20260717_111628_907.jpg, 00:00:54, 0.40 m
Other obstacles from 12 o'clock to 12 o'clock, 100% cross-sectional area loss, Concrete or other hardened material

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ryan.davies@quinnutilities.com

Section Inspection - 17/07/2026 - MH1X

Item No.	Insp. No.	Date	Time	Client`s Job Ref	Weather	Pre Cleaned	PLR
3	2	17/07/26	14:54	Not Specified	No Rain Or Snow	Yes	MH1X

Operator	Vehicle	Camera	Preset Length	Legal Status	Alternative ID
K Heron	OY25 ZGO	Crawler	Not Specified	Watercourse	Not Specified

Town or Village:	Whiston	**Inspection Direction:**	Downstream	**Upstream Node:**	MH1
Road:	Stoney Lane	**Inspected Length:**	54.57 m	**Upstream Pipe Depth:**	
Location:	Other location	**Total Length:**	54.57 m	**Downstream Node:**	MH0
Surface Type:		**Joint Length:**		**Downstream Pipe Depth:**	

Use:	Surface water	**Pipe Shape:**	Circular
Type of Pipe:	Gravity drain/sewer	**Dia/Height:**	375 mm
Flow Control:	No flow control	**Material:**	Vitrified clay
Year Constructed:	Not Specified	**Lining Type:**	No Lining
Inspection Purpose:	Sample condition survey	**Lining Material:**	No Lining

Comments:
Recommendations:

Scale: 1:473



Position [m]	Code	Observation	MPEG	Photo	Grade
0.00	MH	Start node, manhole, reference: MH1	00:00:00		
0.00	WL	Water level, 5% of the vertical dimension	00:00:00		
3.94	JDM	Joint displaced, medium	00:00:39	MH1X_d1d000ce-2e63-47f9-9a	1 / 3
19.73	JDL	Joint displaced, large	00:01:49	MH1X_9d1ff4eb-c813-48e7-8c	1 / 4
19.73	FL	Fracture, longitudinal at 10 o'clock	00:01:53		3 / 2
19.73	FCJ	Fracture, circumferential at joint from 10 o'clock to 12 o'clock	00:01:53	MH1X_cd4f427d-3721-4f2e-915	3 / 2
21.12	WL	Water level, 35% of the vertical dimension	00:02:12		
22.83	IR	Infiltration, running at 1 o'clock	00:02:31	MH1X_3c2783cd-9cf6-4daf-ac6	
22.83	CL	Crack, longitudinal at 11 o'clock	00:02:38	MH1X_24b1b9f7-e9a1-409c-b	2 / 2
25.67	WL	Water level, 10% of the vertical dimension	00:03:00		
30.67	DES	Settled deposits, fine, 15% cross-sectional area loss	00:03:37		3
54.57	MHF	Finish node, manhole, reference: MH0	00:05:29		

Construction Features					Miscellaneous Features				
Structural Defects					Service & Operational Observations				
STR No. Def	**STR Peak**	**STR Mean**	**STR Total**	**STR Grade**	**SER No. Def**	**SER Peak**	**SER Mean**	**SER Total**	**SER Grade**
5	82.0	1.7	93.0	3.0	6	7.0	0.2	12.0	4.0

Quinn Utilities
30 Lees Road, Knowsley

ryan.davies@quinnutilities.com

Section Pictures - 17/07/2026 - MH1X

Item No.	Inspection Direction	PLR	Client`s Job Ref	Contractor`s Job Ref
3	Downstream	MH1X		



MH1X_d1d000ce-2e63-47f9-9aac-6a08f6949ada_20260717_145455_273.jpg, 00:00:39, 3.94 m
Joint displaced, medium



MH1X_9d1ff4eb-c813-48e7-8c01-65a6ef8fe5cb_20260717_145607_787.jpg, 00:01:49, 19.73 m
Joint displaced, large



MH1X_cd4f427d-3721-4f2e-9150-2226468e5617_20260717_145633_810.jpg, 00:01:53, 19.73 m
Fracture, circumferential at joint from 10 o'clock to 12 o'clock



MH1X_3c2783cd-9cf6-4daf-ac69-b8213db6fc7d_20260717_145712_139.jpg, 00:02:31, 22.83 m
Infiltration, running at 1 o'clock

Quinn Utilities
30 Lees Road, Knowsley

ryan.davies@quinnutilities.com

Section Pictures - 17/07/2026 - MH1X

Item No.	Inspection Direction	PLR	Client`s Job Ref	Contractor`s Job Ref
3	Downstream	MH1X		



MH1X_24b1b9f7-e9a1-409c-b5cc-b43551ab275d_20260717_145725_127.jpg, 00:02:38, 22.83 m
Crack, longitudinal at 11 o'clock

Quinn Utilities
30 Lees Road, Knowsley
ryan.davies@quinnutilities.com

Section Inspection - 17/07/2026 - MH0X

Item No.	Insp. No.	Date	Time	Client`s Job Ref	Weather	Pre Cleaned	PLR
4	1	17/07/26	15:18	Not Specified	No Rain Or Snow	Yes	MH0X

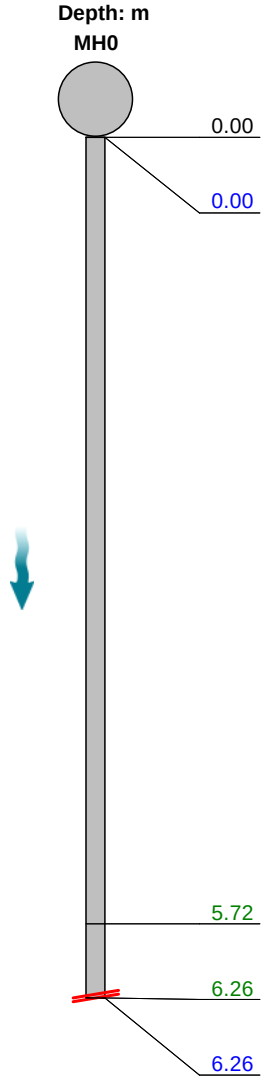
Operator	Vehicle	Camera	Preset Length	Legal Status	Alternative ID
K Heron	OY25 ZGO	Crawler	Not Specified	Watercourse	Not Specified

Town or Village:	Whiston	**Inspection Direction:**	Downstream	**Upstream Node:**	MH0
Road:	Stoney Lane	**Inspected Length:**	6.26 m	**Upstream Pipe Depth:**	
Location:	Other location	**Total Length:**	6.26 m	**Downstream Node:**	OOB
Surface Type:		**Joint Length:**		**Downstream Pipe Depth:**	

Use:	Surface water	**Pipe Shape:**	Circular
Type of Pipe:	Gravity drain/sewer	**Dia/Height:**	375 mm
Flow Control:	No flow control	**Material:**	Vitrified clay
Year Constructed:	Not Specified	**Lining Type:**	No Lining
Inspection Purpose:	Sample condition survey	**Lining Material:**	No Lining

Comments:
Recommendations:

Scale: 1:55



Position [m]	Code	Observation	MPEG	Photo	Grade
0.00	MH	Start node, manhole, reference: MH0	00:00:00		
0.00	WL	Water level, 5% of the vertical dimension	00:00:00		
5.72	RMJ	Roots, mass at joint, 15% cross-sectional area loss	00:00:39	MH0X_16 19bb27-03 6f-4894-82	3
6.26	RMJ	Roots, mass at joint, 40% cross-sectional area loss	00:01:01	MH0X_27 0af548-64 4a-4df9-8c	5
6.26	SA	Survey abandoned: Due to roots	00:01:03		

Construction Features					Miscellaneous Features				
Structural Defects					Service & Operational Observations				
STR No. Def	**STR Peak**	**STR Mean**	**STR Total**	**STR Grade**	**SER No. Def**	**SER Peak**	**SER Mean**	**SER Total**	**SER Grade**
0	0.0	0.0	0.0	1.0	2	10.0	2.2	14.0	5.0

Quinn Utilities
30 Lees Road, Knowsley

ryan.davies@quinnutilities.com

Section Pictures - 17/07/2026 - MH0X

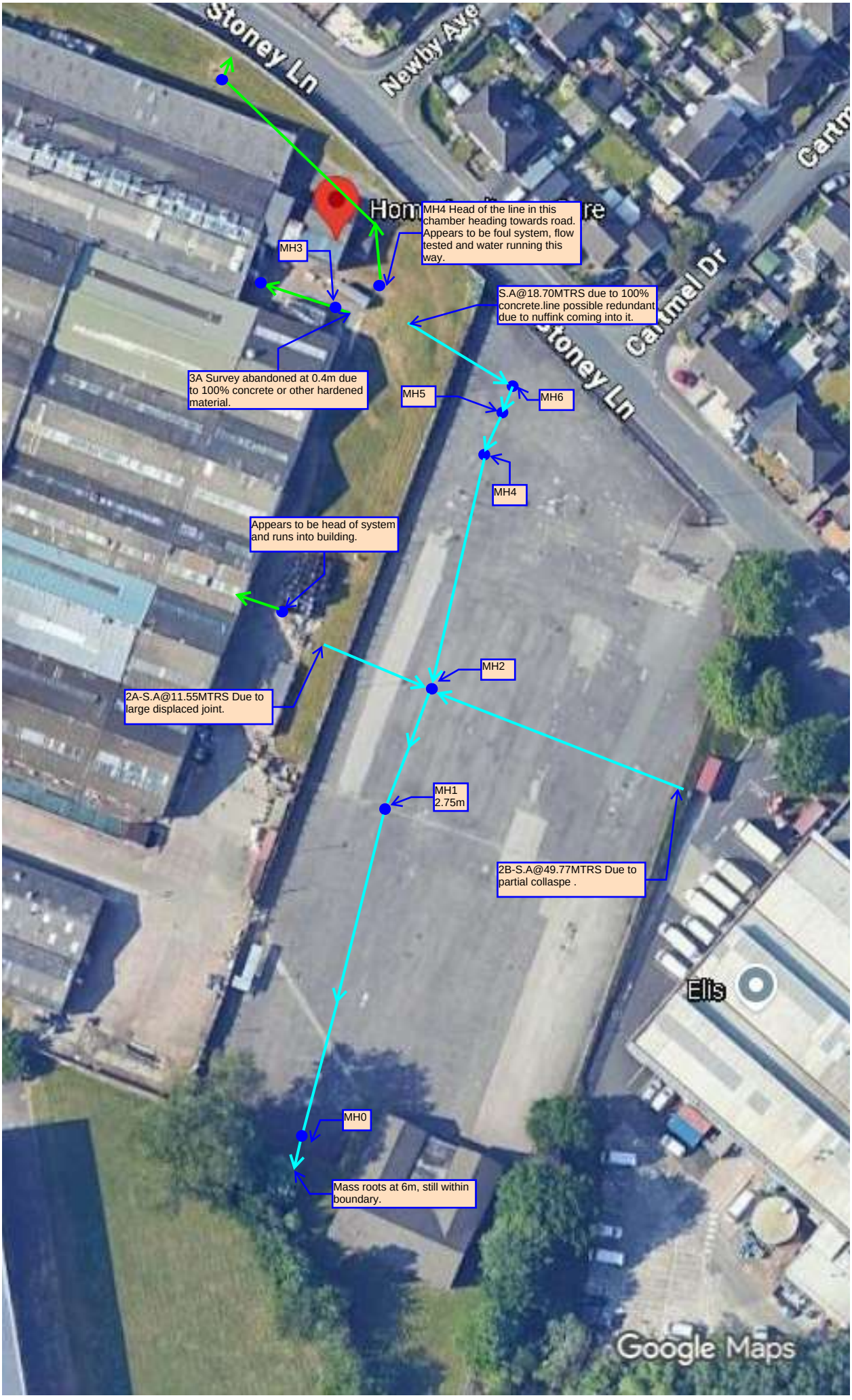
Item No.	Inspection Direction	PLR	Client`s Job Ref	Contractor`s Job Ref
4	Downstream	MH0X		



MH0X_1619bb27-036f-4894-822f-efa32403b63a_20260717_151943_329.jpg, 00:00:39, 5.72 m
Roots, mass at joint, 15% cross-sectional area loss



MH0X_270af548-644a-4df9-8cdf-657b3aa446a6_20260717_152005_522.jpg, 00:01:01, 6.26 m
Roots, mass at joint, 40% cross-sectional area loss


Stoney Ln
Newby Ave
Carmel Dr
Stoney Ln
Elis
Google Maps
MH4 Head of the line in this chamber heading towards road. Appears to be foul system, flow tested and water running this way.
MH3
S.A@18.70MTRS due to 100% concrete.line possible redundant due to nuffink coming into it.
3A Survey abandoned at 0.4m due to 100% concrete or other hardened material.
MH5
MH6
MH4
Appears to be head of system and runs into building.
MH2
2A-S.A@11.55MTRS Due to large displaced joint.
MH1
2.75m
2B-S.A@49.77MTRS Due to partial collaspe .
MH0
Mass roots at 6m, still within boundary.

APPENDIX B – PRELIMINARY DRAINAGE LAYOUT (BETTS ASSOCIATES)

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Drainage Strategy - Foul water

The proposed foul water drainage strategy for the development is divided into four separate drainage networks, each designed to discharge to the existing United Utilities public sewerage system.

Network 1
Network 1 comprises a gravity drainage system located within the north-west corner of the site. This network is designed to connect to the existing combined sewer within Stoney Lane, upstream of existing United Utilities manhole reference 8604.

Connection Manhole Details:

MH Ref: F24 (Proposed)
Cover Level (CL): 59.938 mAOD
Invert Level (IL): 57.853 mAOD (150mm Ø – proposed foul connection)
Invert Level (IL): 57.104 mAOD (900mm Ø – existing sewer)

Network 2
Network 2 serves the majority of the site and drains to a proposed pumping station located adjacent to **Plot 51** in the southern corner of the site. The associated rising main is wholly contained within the development and discharges to proposed manhole **F15**.

The ultimate discharge point is to an Existing United Utilities foul water manhole Ref. 8503, located within the site boundary. The existing downstream connection to the United Utilities combined sewer (MH Ref. 8501) within Cumber Lane is to remain and shall continue to serve the development as a foul water discharge point.

Connection Manhole Details:

MH Ref: 8503
Cover Level (CL): 58.518 mAOD
Invert Level (IL): 57.77 mAOD (150mm Ø - existing sewer)

Network 3
Network 3 comprises a gravity drainage system located within the northern part of the site, adjacent to Plot 180. This network is designed to connect to the existing United Utilities combined sewer within Stoney Lane via existing manhole reference UU9602.

Connection Manhole Details:

MH Ref: 9602 (Existing)
Cover Level (CL): 60.75 mAOD
Invert Level (IL): 58.330 mAOD (150mm Ø – proposed foul connection)
Invert Level (IL): 57.580 mAOD (900mm Ø – existing sewer)

Network 4
Network 4 comprises a gravity drainage system located within the northern part of the site, within Road 3, serving Plots 184–205. This network is designed to connect to the existing United Utilities combined sewer within Stoney Lane via existing manhole reference UU0601.

Connection Manhole Details:

MH Ref: 0601 (Existing)
Cover Level (CL): 61.03 mAOD
Invert Level (IL): 58.842 mAOD (150mm Ø – proposed foul connection)
Invert Level (IL): 58.167 mAOD (825mm Ø – existing sewer)

Overall, the proposed foul water drainage strategy utilises a combination of gravity drainage and a single adoptable pumping station to serve the development. Foul flows discharge to existing United Utilities foul and combined sewerage infrastructure via four separate connection points, with all new foul sewers and associated infrastructure designed in accordance with the relevant United Utilities and Sewers for Adoption requirements.

Drainage Strategy - Surface water

Surface water runoff generated by the proposed development will discharge to the existing on-site culverted watercourse via a new manhole reference **S33**, located along the southern site boundary, at a restricted discharge rate of **42.4 l/s**.

The surface water drainage network has been designed to accommodate the 1 in 30 year storm event, with additional attenuation provided by an online attenuation basin to manage the 1 in 100 year event plus 45% allowance for climate change.

Connection Manhole Details:
MH Ref: **S33** (Proposed)
Cover Level (CL): 59.549 mAOD
Invert Level (IL): 57.056 mAOD (225 mm Ø)

Proposed Foul Water Connection (F24 Proposed) Network 1

A new online manhole is proposed on the existing United Utilities 900mm Ø combined water sewer within Stoney Lane. The proposed development shall connect to the existing public foul water sewer via a 150mm Ø soffit to soffit connection.

MH Ref: F24
Cover Level (CL): 59.938 mAOD
Invert Level (IL): **57.853** mAOD *(150mm Ø – proposed foul connection)*
Invert Level (IL): 57.104 mAOD *(900mm Ø – existing sewer)*

Proposed Foul Water Connection (9602 Existing) Network 3

A new connection to existing manhole Ref 9602 is proposed, this United Utilities combined sewer is located within Stoney Lane. The proposed development shall connect to the existing public combined sewer via a 150mm Ø soffit to soffit connection.

MH Ref: **9602**
Cover Level (CL): 60.75 mAOD
Invert Level (IL): **58.330** mAOD *(150mm Ø – proposed foul connection)*
Invert Level (IL): 57.580 mAOD *(900mm Ø – existing sewer)*

Proposed Foul Water Connection (0601 Existing) Network 4

A new connection to existing manhole Ref 0601 is proposed, this United Utilities combined sewer is located within Stoney Lane. The proposed development shall connect to the existing public combined sewer via a 150mm Ø soffit to soffit connection.

MH Ref: **9602**
Cover Level (CL): 61.03 mAOD
Invert Level (IL): **58.842** mAOD *(150mm Ø – proposed foul connection)*
Invert Level (IL): 58.167 mAOD *(825mm Ø – existing sewer)*

Proposed Finished Levels
The levels indicated on this plan are indicative (+/-500mm) and subject to change following detailed levels design.

Proposed Filter Drain
Filter drain located to front of properties, parallel to the back of footway. Designed to collect surface water runoff from adjacent drives and roof areas. Surface water runoff is filtered through the surrounding granular stone and conveyed via perforated pipework to the proposed surface water drainage network.

Proposed Interception Drain
Interception drain located to rear of proposed gardens, along site boundary. Designed to intercept surface water runoff from adjacent land and prevent uncontrolled flows entering or leaving the development.

Proposed Foul Water Connection (8503 Existing) Network 2

Existing United Utilities foul water manhole to be retained and rebuilt/made good as necessary. The existing downstream connection to the United Utilities combined sewer (MH Ref. 8501) within Cumber Lane is to remain and shall continue to serve the development as a foul water discharge point.

MH Ref: **8503 Existing**
Cover Level (CL): 58.518 mAOD
Invert Level (IL): **57.77** mAOD *(150mm Ø)*

Foul Water Rising Main
The proposed foul water rising main will be routed through the site within the proposed road network and will discharge to proposed manhole F15. From this point, flows will continue via gravity to the existing Foul Water Manhole Ref. 8503, ultimately discharging to the existing combined sewer within Cumber Lane.

Rising Main Length: Approx. 320m
Termination Manhole: F15

Flow Control Chamber Manhole S31 HB
Hydro International HydroBrake Optimum
SHE-0263-4240-1900-4240
Design head = 1.900 m
Restricted discharge max. = 42.4 l/sec
Flow control orifice size 263mm
Cover level: 60.074 mAOD
Invert level: 57.585 mAOD

Proposed Diversion
Minor diversion works proposed to accommodate proposed site layout.

Proposed Surface Water Connection (S33)
A New manhole is to be constructed online of the existing on site culverted watercourse.

MH Ref: **S32** (Proposed)
Cover Level (CL): 59.549 mAOD
Invert Level (IL): 57.056 mAOD (225 mm Ø)

Attenuation Basin
To attenuate flows up to 1:100 year storm + 45% CC

Base Level:	57.383 m
Top of Bank Level:	59.383 m
Freeboard:	300 mm
Temp maximum storage volume:	1003.09 m³

Proposed Finished Levels
The levels indicated on this plan are indicative (+/-500mm) and subject to change following detailed levels design.

Proposed Interception Drain
Interception drain located to rear of proposed gardens, along site boundary. Designed to intercept surface water runoff from adjacent land and prevent uncontrolled flows entering or leaving the development.

Proposed Filter Drain
Filter drain located to front of properties, parallel to the back of footway. Designed to collect surface water runoff from adjacent drives and roof areas. Surface water runoff is filtered through the surrounding granular stone and conveyed via perforated pipework to the proposed surface water drainage network.

Proposed Interception Drain
Interception drain located to rear of proposed gardens, along site boundary. Designed to intercept surface water runoff from adjacent land and prevent uncontrolled flows entering or leaving the development.

Foul Water Rising Main
The proposed foul water rising main will be routed through the site within the proposed road network and will discharge to proposed manhole F15. From this point, flows will continue via gravity to the existing Foul Water Manhole Ref. 8503, ultimately discharging to the existing combined sewer within Cumber Lane.

Rising Main Length: Approx. 320m
Termination Manhole: F15

Foul Water Pumping Station
Proposed foul water pumping station serving the southern catchment of the development. Flows shall be conveyed via a proposed rising main to manhole F15, before continuing by gravity through the foul water network to existing United Utilities manhole Ref. 8503 and the existing combined sewer within Cumber Lane.

Existing Culverted Watercourse
Culverted Watercourse.

Existing Culverted Watercourse
Culverted Watercourse.

SW02 Buried Under Grass

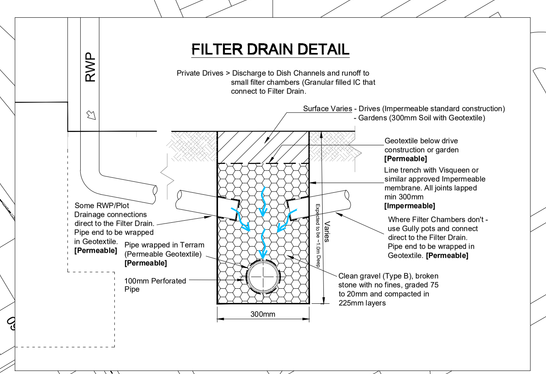
SW03 Buried under grass but exposed

SW04 Buried Under Grass. Line Comes in on T not bend so can not CCTV to outfall.

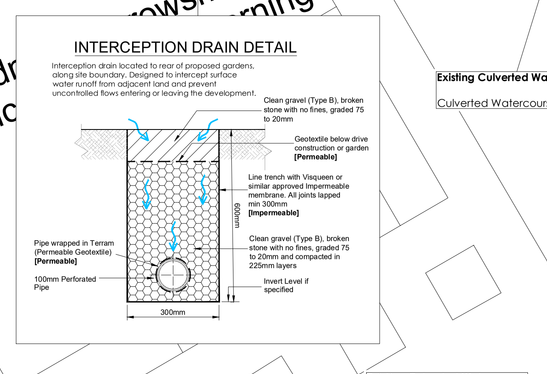
SW00 Buried Under Grass
CL:58.23m

Proposed Finished Levels
The levels indicated on this plan are indicative (+/-500mm) and subject to change following detailed levels design.

FILTER DRAIN DETAIL



INTERCEPTION DRAIN DETAIL



Legend

- Development boundary
- Proposed Adoptable Surface Water Sewer
- Highway Sewer & Manhole
- Highway Gully & Connection Pipe Work
- Proposed Adoptable Foul Water Sewer
- Proposed Adoptable Foul Water Rising Main
- Proposed Interception Drain
- Proposed Sewer Easement *(3m from Centre line)*
- Existing Public Foul Water Sewer
- Existing Public Surface Water Sewer
- Existing Public Combined Sewer
- Existing Ordinary Watercourse Culvert
- FFL 134.65 — Proposed Finished Floor Level
- +133.70 — Existing Boundary Ground Level
- +17.100 — Proposed Spot Level
- Proposed Earthwork Batter
- 4C — Underbuild - Measured from FFL to PGL
- 3C — Tanking - Measured from FFL to PGL
- FOE - 0.150m — Flag on Edge (up to 450mm)
- RET - 0.500m — Masonry Retaining Wall (over 450mm)

Notes

1. Planning layout ref.
Taylor Wimpey - 25053-VIM_2026-07-29
2. Topographical survey provided by 'Geographical Engineering Operations', ref 'G24104 Stoney Lane, Whiston Cross', Dated March 2024.
3. Road detail, levels and layout are subject to local authority section 38 Highways approval.

Notes

1. The use of any other flow control devices not associated with the Hydro International HydroBrake Optimum references provided may constitute a flood risk.
2. Drainage design and construction is in accordance with Design and Construction Guidance 2020 (DCG) and the requirements of the statutory undertaker.
3. Tolerances in pipe laying to be in accordance with Design and Construction Guidance 2020 (DCG).
4. For pipes 150-450mm dia. all rocker pipes to be in accordance with Design and Construction Guidance 2020 (DCG).
5. Engineering bricks shall not contain frogs or holes.
6. Brickwork to manholes to be English bond.
7. Where pipes are surrounded in concrete, flexibility is to be maintained at pipe joints by the use of a suitable compressible material eg. "FLexcell" or "Fibreboard".
8. All manhole covers and frames must comply with BS EN124, covers in roads to be grade D400 and be 150mm deep. manhole covers in car parking areas and drives to be grade B125, whilst landscaped areas may be grade A15.
9. Clayware pipes to be 65 extra strength quality "Hepseal" or similar approved.
10. Granolithic benching to manholes to be 40mm minimum thickness.
11. Precast concrete chamber rings to be reinforced.
12. The slope of benching in all cases should be 1 in 30.
13. Manholes shall not incorporate double square or double oblique channel junctions in their inverts.
14. All incoming pipes shall be surrounded with 150mm of concrete to the face of the collar of the first flexible joint and the outgoing pipe shall also be surrounded to within 50mm of the first flexible joint and a compressible filler used as a former between the concrete surround and downstream pipe collar.
15. All underground services to be confirmed by contractor prior to commencement on site, any discrepancies to be reported to engineer.
16. Private sewers not located in roads to be class F granular bed and surround as per standard details.
17. Sewers located under adopted roads to be class s granular bed and surround (more than 1.2m cover.)
18. Sewers located under private roads and car parking bays to be class f granular bed and surround as per standard details unless adopted, then provide class s (if more than 1.2m cover).
19. Private sewers with less than 0.6m of cover to be concrete surrounded as class Z on standard details.
20. Adopted sewers with less than 1.2m cover, provide class Z concrete bed and surround. concrete haunching may be suitable for large diameter storage sewers, guidance must be sought from adopting authority prior to use.
21. Road gullies to be pcc and trapped with 150mm ST4 concrete surround.
22. No deep or wide rooted trees to be planted within close proximity of the proposed and existing public sewer system.
23. Pipes less than 300mm dia. to be Polypipe UPVC unless otherwise stated.

NHBC Standards
Effective from 1st January 2025

IMPORTANT** - Invert levels at proposed points of connection are **to be confirmed prior** to any works commencing on site as onsite drainage and slab levels may be affected

P13 24.08.26	Minor amendment to notes	CP
P12 19.08.26	Updated with new layout and additional SUDs	CP
P11 26.03.26	Up-Fix filter indicated	CP
P10 23.03.26	Updated with additional notes & existing assets	CP
P09 19.01.26	Scale bar shown	TR
P08 05.12.25	Proposed discharge rate amended	CP
P07 05.12.25	Amended to suit new planning layout	NR
P06 15.10.25	Amended to suit layout dated: 09.10.25	TR NR
P05 02.10.25	Cellular storage removed & rising main shown	TR NR
P04 25.09.25	Amended to suit latest layout	TR NR
P03 11.04.25	Plots 13 and 14 FFL changed	NR
P02 07.04.25	Drainage strategy amended, pond removed, tank added, pipes downsized.	NR
P01 04.04.25	Preliminary issue for review	NR xx
Mark | Date	Details	By | Chk

Revision history

Drawing originator:

BETTS HYDRO CONSULTING ENGINEERS · BETTS ASSOCIATES CONSULTING ENGINEERS · BETTS GEO CONSULTING ENGINEERS

Client: Taylor Wimpey

Project title:

Glen Dimplex
Stoney Lane

Drawing title:

Preliminary Drainage Layout

Scale: 1:500 for the original size of A0

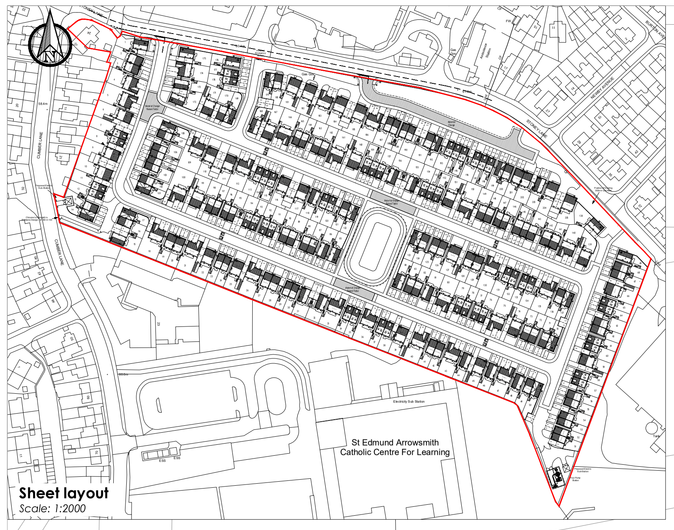
Drawn by: CP | Checked by: - | Passed by: - | Date: Apr 2025

Drawing status:

For Planning

Job No:	Drawing No: Project	Origin	Volume	Level	Type	Discip	Number	Revision:
TAY143	GDX	BET	ZZ	XX	DR	C	0001	P13

6-7 Old Hoarh Farm Barns, Welsh Road, Sealand, Flintshire, CH5 2LY
enquiries@betts-associates.co.uk
Chester 01244 288178



Sheet layout
Scale: 1:2000

LEGEND

- Site Boundary
- FFL 134.65 — Proposed Finished Floor Level
- +(133.70) — Existing Boundary Ground Level
- 16.500 — Proposed Road / Driveway Contour - Major (0.50m interval)
- 16.450 — Proposed Road / Driveway Contour - Minor (0.05m interval)
- ACO — Private Drainage (ACO Channel & Gully)
- 1 in 13 — Proposed Drive / Path Gradient & Direction
- 1 in 10 — Proposed Garden Gradient & Direction
- +17.100 — Proposed Spot Level
- Proposed Earthwork Batter
- S — Proposed Steps *(300mm going, 150mm rising)*
- STEP+450 — Stepped Foundation
- AC — Underbuild - Measured from FFL -150mm to PGL
- TC — Tanking - Measured from FFL -150mm to PGL
- SC — Stepped DPC - Measured from FFL -150mm to PGL

Retaining construction details to be provided by developer.

- FOE - 0.150m — Flag on Edge (up to 450mm) - *Retained height shown*
- RET - 0.500m — Masonry Retaining Wall (over 450mm) - *Retained height shown*

Notes

1. Planning layout ref. Taylor Wimpey - 25053-VIM_2026-07-29
2. Topographical survey provided by 'Geographical Engineering Operations', ref 'G24104 Stoney Lane, Whiston Cross', Dated March 2024.
3. Road detail, levels and layout are subject to local authority section 38 Highways approval.

Proposed Finished Levels
The levels indicated on this plan are indicative (*+/-500mm*) and subject to change following detailed levels design.

60.4m Adopted Emergency Access

61.0m

Road 2

Road 3

Road 5

Material Change Raised Table

Gas Gov

Proposed Electric Sub-Station

Chicane to Footpath to Eddisons Design, ref: SD-4-100

Mark	Date	Details	By	Chk
P08	24.08.26	Minor note amendments	CP	
P07	19.08.26	Updated with new layout & revised external levels	CP	
P06	19.01.26	Scale bar shown	TR	
P05	05.12.25	Amended to suit new layout	NR	
P04	15.10.25	Amended to suit layout dated: 09.10.25	TR	NR
P03	02.10.25	Road 4 levels changed	TR	NR
P02	25.09.25	Amended to suit latest layout	TR	NR
P01	11.04.25	Preliminary issue for review	NR	xx

Revision History

Drawing originator:

BETTS HYDRO CONSULTING ENGINEERS · BETTS ASSOCIATES CONSULTING ENGINEERS · BETTS GEO CONSULTING ENGINEERS

Client: Taylor Wimpey

Project title:
Glen Dimplex
Stoney Lane

Drawing title:
Preliminary Retaining Layout

Scale: for the original size of A0

Drawn by: NR | Checked by: | Passed by: | Date: Apr' 2025

Drawing status:
Technical Due Diligence

Job No:	Drawing No: Project	Origin	Volume	Level	Type	Discip.	Number	Revision:
TAY143	GDX	BET	ZZ	XX	DR	C	0002	P08

6-7 Old Marsh Farm Barns, Welsh Road, Sealand, Flintshire, CH5 2LY
enquiries@betts-associates.co.uk
Chester 01244 288178

STONEY LANE

RENWICK AVENUE

Road 5TH

Road 4

Road 2

Road 1

Material Change

Material Change Raised Table

Position of Existing 355mm Gas Main

CF

Und

EP

29

35

37

47

53

59

12

20

138

139

LEGEND

- Site Boundary
- FFL 134.65 — Proposed Finished Floor Level
- +(133.70) — Existing Boundary Ground Level
- 16.500 — Proposed Road / Driveway Contour - Major (0.50m interval)
- 16.450 — Proposed Road / Driveway Contour - Minor (0.05m interval)
- ACO — Private Drainage (ACO Channel & Gully)
- 1 in 13 — Proposed Drive / Path Gradient & Direction
- 1 in 10 — Proposed Garden Gradient & Direction
- +17.100 — Proposed Spot Level
- Proposed Earthwork Batter
- (S) — Proposed Steps *(300mm going, 150mm rising)*
- STEP+450 — Stepped Foundation
- AC — Underbuild - Measured from FFL -150mm to PGL
- 3C — Tanking - Measured from FFL -150mm to PGL
- 3C — Stepped DPC - Measured from FFL -150mm to PGL

Retaining construction details to be provided by developer.

- FOE - 0.150m — Flag on Edge (up to 450mm) - *Retained height shown*
- RET - 0.500m — Masonry Retaining Wall (over 450mm) - *Retained height shown*

Notes

1. Planning layout ref. Taylor Wimpey - 25053-VIM_2026-07-29
2. Topographical survey provided by 'Geographical Engineering Operations', ref 'G24104 Stoney Lane, Whiston Cross', Dated March 2024.
3. Road detail, levels and layout are subject to local authority section 38 Highways approval.

Proposed Finished Levels
The levels indicated on this plan are indicative (*+/-500mm*) and subject to change following detailed levels design.

NORTH Indicative

Sheet layout
Scale: 1:2000

St Edmund Arrowsmith Catholic Centre For Learning

Proposed Electric Sub-Station

Foul Pump Station

Mark	Date	Details	By	Chk
P08	24.08.26	Minor amendment to Notes	CP	
P07	19.08.26	Updated with new layout & revised external levels	CP	
P06	19.01.26	Scale bar shown	TR	
P05	05.12.25	Amended to suit new layout	NR	
P04	15.10.25	Amended to suit layout dated: 09.10.25	TR	NR
P03	02.10.25	Road 4 levels changed	TR	NR
P02	25.09.25	Amended to suit latest layout	TR	NR
P01	11.04.25	Preliminary issue for review	TR	xx

Revision History

Drawing originator:

BETTS HYDRO CONSULTING ENGINEERS · BETTS ASSOCIATES CONSULTING ENGINEERS · BETTS GEO CONSULTING GEOLOGISTS

Client: Taylor Wimpey

Project title:
Glen Dimplex
Stoney Lane

Drawing title:
Preliminary Retaining Layout

Scale: for the original size of A0

Drawn by: NR | Checked by: | Passed by: | Date: Apr' 2025

Drawing status:
Technical Due Diligence

Job No:	Drawing No: Project	Origin	Volume	Level	Type	Discip.	Number	Revision:
TAY143	GDX	BET	ZZ	XX	DR	C	0003	P08

6 -7 Old Hoach Farm Barns, Welsh Road, Sealand, Flintshire, CH5 2LY
enquiries@betts-associates.co.uk
Chester 01244 288178

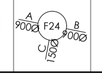
Surface Water

MH No.	DIAGRAM	MANHOLE DIMENSION (mm)	MANHOLE TYPE	COVER TYPE	COVER LEVEL (m)	INVERT LEVEL (m)	DEPTH TO SOFFIT (m)	EASTING (m)	NORTHING (m)
S1		1350Ø	Type C	B125	60.797	59.213	1.434	347945.194	391628.292
S2		1350Ø	Type C	B125	60.635	59.089	1.396	347941.921	391610.063
S3		1800Ø	Type C	D400	60.389	58.748	1.341	347931.180	391583.485
S4		1500Ø	Type C	D400	60.203	58.558	1.270	347905.708	391593.748
S5		1350Ø	Type C	D400	59.955	58.702	0.952	347887.069	391642.825
S6		2400Ø	Type C	D400	60.130	58.088	1.292	347878.280	391604.799
S7		2100Ø	Type C	D400	59.628	57.950	0.928	347857.494	391553.515
S8		2100Ø	Type C	D400	59.584	57.934	0.900	347860.046	391547.707
S9		2100Ø	Type C	D400	59.679	57.873	1.056	347882.811	391538.561
S10		2100Ø	Type C	D400	59.777	57.697	1.330	347947.445	391512.593
S11		1500Ø	Type B	D400	61.146	58.414	2.282	348118.621	391574.685
S12		1500Ø	Type C	D400	60.824	59.149	1.224	348017.411	391615.435
S13		1500Ø	Type C	D400	60.776	58.975	1.351	348023.976	391609.685
S14		1500Ø	Type B	D400	60.649	58.637	1.562	348040.478	391606.148
S15		1800Ø	Type B	D400	60.490	58.252	1.789	348058.369	391598.944
S16		2100Ø	Type B	D400	61.791	58.133	2.908	348160.138	391490.862
S17		2100Ø	Type B	D400	60.742	57.984	2.008	348104.767	391513.234
S18		2100Ø	Type B	D400	60.323	57.853	1.720	348056.250	391532.836
S19		2100Ø	Type C	D400	60.208	58.000	1.458	347959.786	391571.810
S20		2100Ø	Type C	D400	59.972	57.849	1.373	348015.516	391549.294
S21		2700Ø	Type B	D400	60.242	57.796	1.695	348035.180	391541.349
S22		---	HEADWALL		59.683	57.760	1.173	348029.837	391528.020
S23		---	HEADWALL		59.683	57.683	1.250	348018.331	391499.471
S24		1200Ø	Unknown	D400	60.271	58.672	1.373	348135.710	391410.594
S25		1200Ø	Unknown	D400	61.506	60.081	1.200	348158.094	391472.702
S26		1500Ø	Type B	D400	60.587	58.301	1.836	348144.008	391433.619
S27		2100Ø	Type B	D400	60.472	57.990	1.732	348140.169	391435.162

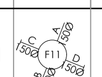
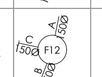
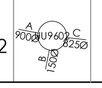
Surface Water

MH No.	DIAGRAM	MANHOLE DIMENSION (mm)	MANHOLE TYPE	COVER TYPE	COVER LEVEL (m)	INVERT LEVEL (m)	DEPTH TO SOFFIT (m)	EASTING (m)	NORTHING (m)
S28		2100Ø	Type C	D400	60.033	57.865	1.417	348093.698	391453.833
S29		2100Ø	Type C	D400	59.787	57.711	1.326	348036.303	391476.892
S30		2700Ø	Type B	D400	60.089	57.648	1.691	348012.998	391486.256
S31		2700Ø	Type B	D400	60.074	57.585	2.190	347989.644	391495.638
S32		1350Ø	Type B	D400	59.529	57.106	2.198	347978.493	391468.039
S33		1350Ø	Type B	D400	59.549	57.056	2.268	347986.213	391464.920

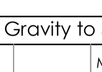
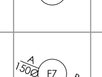
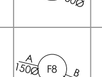
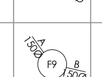
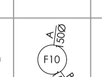
Foul Gravity to Stoney Road (**FW Network 1**)

MH No.	DIAGRAM	MANHOLE DIMENSION (mm)	MANHOLE TYPE	COVER TYPE	COVER LEVEL (m)	INVERT LEVEL (m)	DEPTH TO SOFFIT (m)	EASTING (m)	NORTHING (m)
F20		1350Ø	Type C	D400	59.633	58.596	0.888	347856.362	391557.193
F21		1350Ø	Type C	D400	59.894	58.347	1.397	347868.609	391587.926
F22		1350Ø	Type B	D400	60.167	58.181	1.836	347875.557	391608.835
F23		1200Ø	Type B	D400	60.025	57.972	1.904	347882.660	391635.779
F24		1800Ø	Type B	D400	59.938	57.104	1.934	347885.699	391651.144

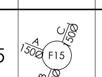
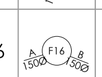
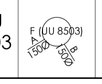
Foul Gravity to Stoney Road (**FW Network 3**)

MH No.	DIAGRAM	MANHOLE DIMENSION (mm)	MANHOLE TYPE	COVER TYPE	COVER LEVEL (m)	INVERT LEVEL (m)	DEPTH TO SOFFIT (m)	EASTING (m)	NORTHING (m)
F11		1350Ø	Type C	D400	60.368	58.786	1.432	347935.954	391588.988
F12		1200Ø	Type B	B125	60.616	58.635	1.832	347943.186	391607.781
F13		1200Ø	Type B	B125	60.781	58.464	2.166	347947.736	391630.019
F14		1200Ø	Type B	B125	60.989	58.364	2.475	347960.958	391631.644
UU 9602		1800Ø	Type B	D400	60.750	57.580	2.270	347961.836	391636.086

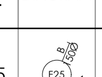
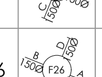
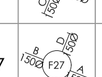
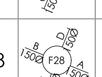
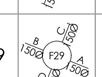
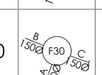
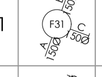
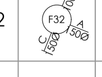
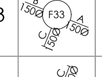
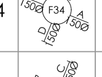
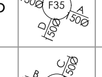
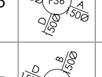
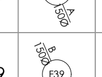
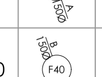
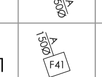
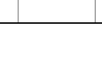
Foul Gravity to Stoney Road (**FW Network 4**)

MH No.	DIAGRAM	MANHOLE DIMENSION (mm)	MANHOLE TYPE	COVER TYPE	COVER LEVEL (m)	INVERT LEVEL (m)	DEPTH TO SOFFIT (m)	EASTING (m)	NORTHING (m)
F6		1350Ø	Type C	D400	61.242	59.699	1.392	348126.950	391574.366
F7		1350Ø	Type C	D400	60.680	59.399	1.131	348085.154	391591.202
F8		1350Ø	Type C	D400	60.624	59.099	1.376	348043.358	391608.039
F9		1200Ø	Type B	D400	60.803	58.962	1.691	348023.407	391612.539
F10		1200Ø	Type B	D400	60.892	58.907	1.836	348018.563	391619.334
UU 0601		1800Ø	Type B	D400	61.030	58.167	2.038	348019.759	391628.983

Foul Gravity to Cumber Lane (**FW Network 2**)

MH No.	DIAGRAM	MANHOLE DIMENSION (mm)	MANHOLE TYPE	COVER TYPE	COVER LEVEL (m)	INVERT LEVEL (m)	DEPTH TO SOFFIT (m)	EASTING (m)	NORTHING (m)
F15		1350Ø	Type C	D400	59.943	58.685	1.108	347915.703	391522.531
F16		1350Ø	Type C	D400	59.551	58.245	1.156	347861.434	391544.469
F17		1200Ø	Unknown	B125	59.684	58.195	1.339	347855.109	391542.585
F18		1200Ø	Unknown	B125	59.250	58.024	1.076	347846.582	391521.479
F19		1350Ø	Type C	B125	58.885	57.837	0.898	347823.490	391530.809
UU 8503		1350Ø	Type C	D400	58.563	57.770	0.643	347818.840	391538.396

Foul to Pumping Station - Rising Main to Foul Gravity to Cumber Lane (**FW Network 2**)

MH No.	DIAGRAM	MANHOLE DIMENSION (mm)	MANHOLE TYPE	COVER TYPE	COVER LEVEL (m)	INVERT LEVEL (m)	DEPTH TO SOFFIT (m)	EASTING (m)	NORTHING (m)
F25		1350Ø	Type C	D400	60.044	58.786	1.108	347979.040	391566.997
F26		1200Ø	Type B	D400	59.988	57.589	2.248	348019.082	391550.819
F27		1200Ø	Type B	D400	60.286	57.309	2.827	348053.689	391536.837
F28		1200Ø	Type A	D400	60.760	56.863	3.747	348108.605	391514.649
F29		1200Ø	Type A	D400	61.151	56.628	4.373	348137.639	391502.919
F30		1200Ø	Type A	D400	61.921	56.417	5.353	348163.608	391492.427
F31		1200Ø	Type A	D400	61.196	56.171	4.874	348152.504	391461.619
F32		1350Ø	Type C	D400	59.866	58.761	0.955	347964.497	391502.806
F33		1350Ø	Type C	D400	60.090	58.524	1.415	347993.663	391491.015
F34		1350Ø	Type C	D400	59.805	58.207	1.449	348032.831	391475.182
F35		1350Ø	Type B	D400	59.983	57.770	2.063	348086.723	391453.395
F36		1350Ø	Type B	D400	60.227	57.540	2.536	348114.981	391441.972
F37		1200Ø	Type A	D400	60.488	55.928	4.409	348141.553	391431.230
F38		1200Ø	Type A	B125	60.209	55.657	4.403	348129.519	391397.209
F39		1500Ø	Pen-Stock	D400	59.600	55.417	4.033	348142.199	391367.939
F40		TBC	Wet Well	D400	59.600	55.395	4.055	348143.133	391365.193
F41		1650 x1850	Valve Chamber	D400	59.600	55.368	4.082	348144.289	391361.797

NOTES

a. These Manhole Schedules are for guidance purposes only and NOT to be used for pricing and ordering. The 1:20 Manhole Construction Details are to be used ONLY when approval has been obtained from the Statutory Undertaker.

b. These Manhole Schedules only indicate main drainage runs; refer to the approved 1:20 Manhole Construction Details for locations of incoming connections from gullies and domestic drainage for construction purposes.

c. The co-ordinates indicated on these Manhole Schedules relate to the intersection of the main drainage runs and not the centre of the manhole. Please refer to the 1:20 Manhole Construction Details for this information.

d. Should any discrepancies be identified between the 1:20 Manhole Construction Details and the Manhole Schedules these should be reported to both the Developer's Engineer and Betts Associates prior to any construction taking place.

e. Should any discrepancies be identified between the Main Drainage Layout and the Domestic Drainage Layout these should be reported to both the Developer's Engineer and Betts Associates prior to any construction taking place.

f. The contractor shall check all existing drainage levels and points of connection to existing public sewers before site start and the design engineer notified immediately of any discrepancy against levels provided to inform the design.

Notes

1. Planning layout ref, Taylor Wimpey - 25053-VIM_2026-07-29
2. Topographical survey provided by 'Geographical Engineering Operations', ref 'G24104 Stoney Lane, Whiston Cross', Dated March 2024.
3. Road detail, levels and layout are subject to local authority section 38 Highways approval.

Mark	Date	Details	By	Chk
P04	19.08.26	Updated with new layout	CP	
P03	05.12.25	Amended to suit new planning layout	NR	
P02	15.10.25	Amended to suit layout dated: 09.10.25	TR	NR
P01	02.10.25	Preliminary issue for review	TR	NR

Revision history

Drawing originator:

BETTS HYDRO CONSULTING ENGINEERS · BETTS ASSOCIATES CONSULTING ENGINEERS · BETTS GEO CONSULTING ENGINEERS

Client: Taylor Wimpey

Project title:

Glen Dimplex
Stoney Lane

Drawing title:

Manhole Schedules

Scale: NTS for the original size of A1

Drawn by: TR | Checked by: NR | Passed by: | Date: Oct' 2025

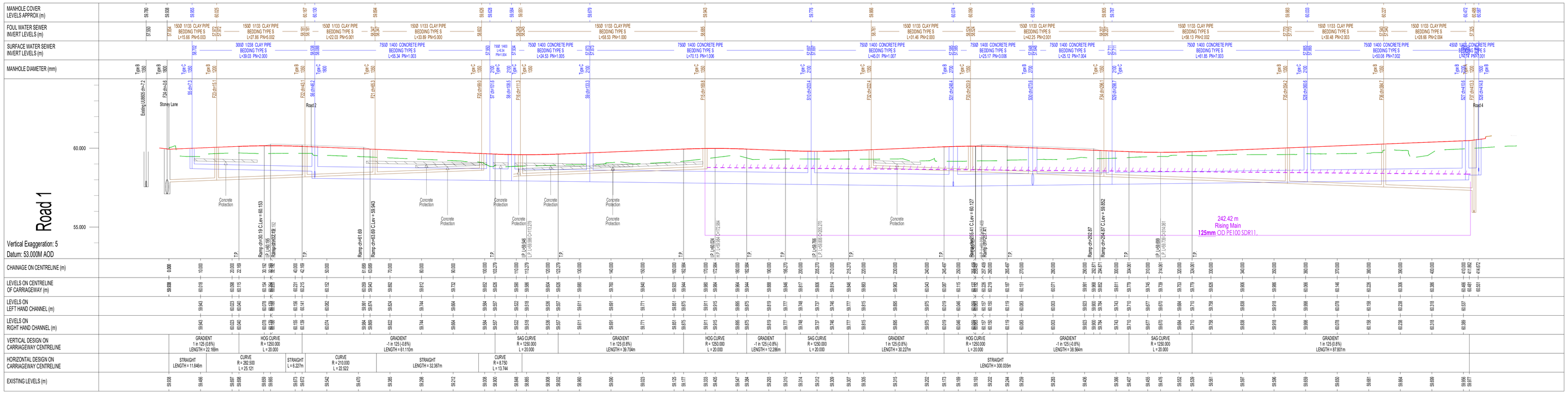
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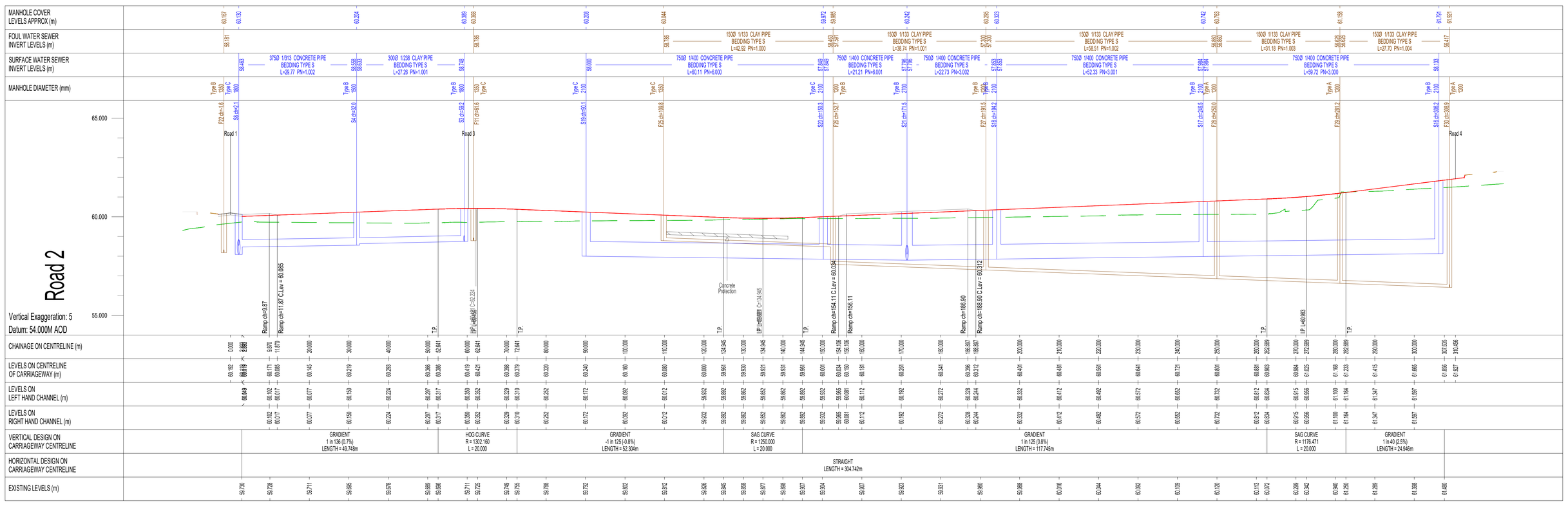
Technical Due Diligence

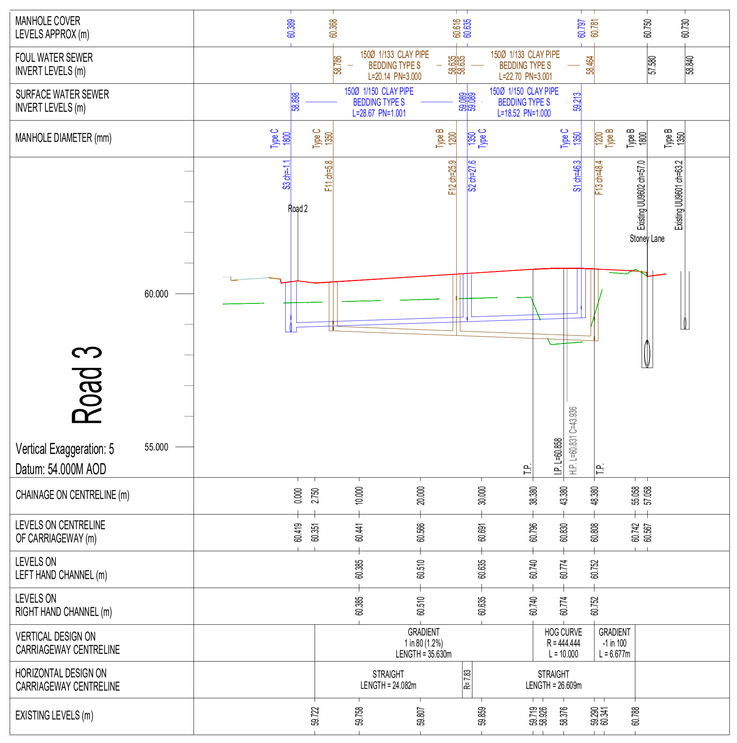
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TAY143	GDX	BET	ZZ	XX	DR	C	0004	P03

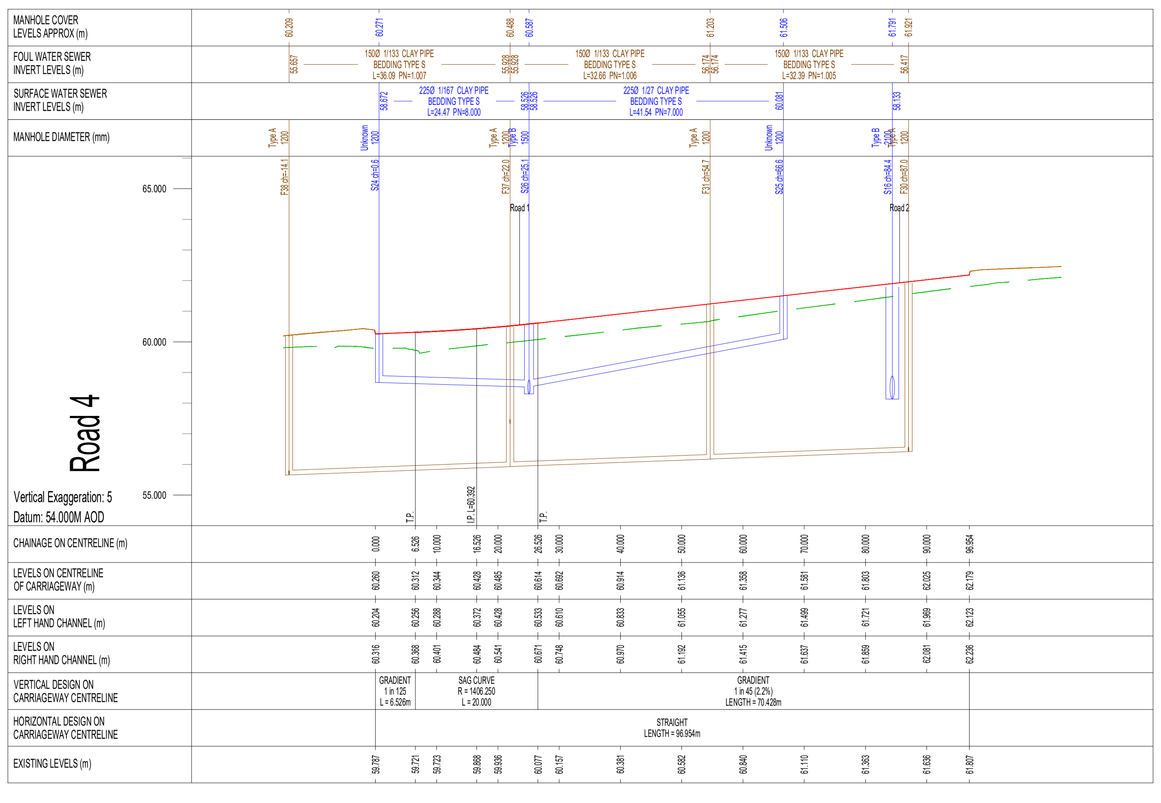
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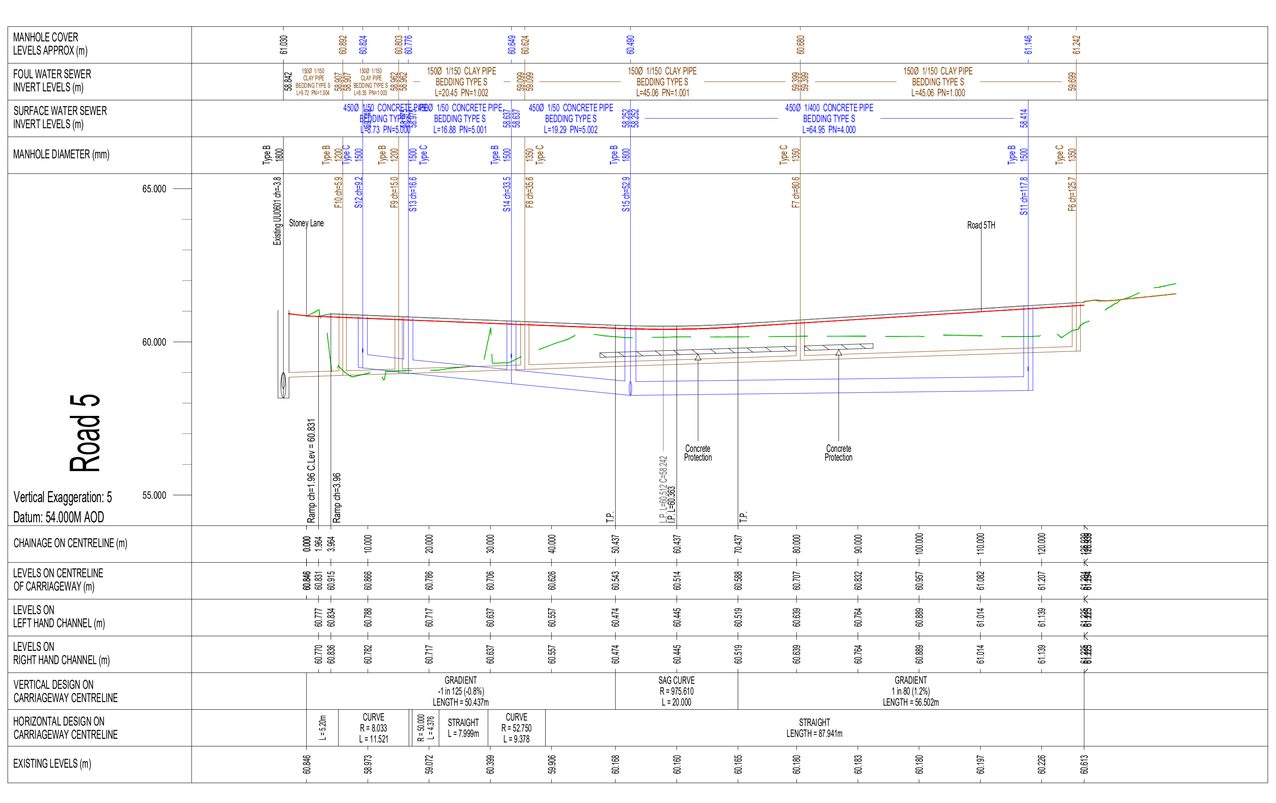
6 -7 Old Marsh Farm Barns, Welsh Road, Sealand, Flintshire, CH5 2LY
enquiries@betts-associates.co.uk
Chester 01244 288178

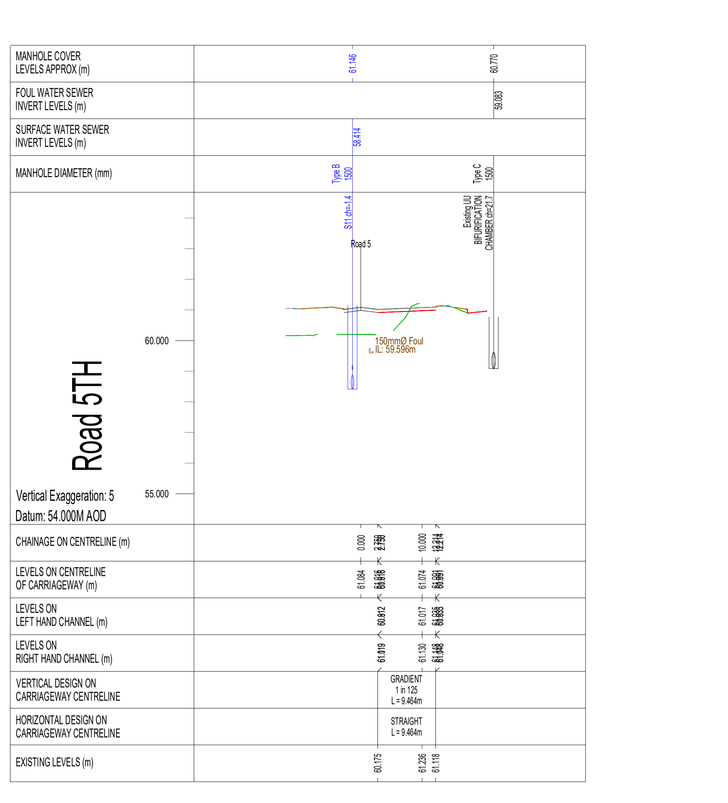












Legend

- Existing Ground Level
- Proposed Ground Level
- Proposed Foul Water Sewer
- Proposed Surface Water Sewer
- Proposed Ordinary Watercourse Culvert
- Existing Ordinary Watercourse Culvert
- Existing Combined Sewer
- Existing Highways Sewer

Notes

1. This drawing is to be read in conjunction with the standard details, the layouts, schedules and specifications for the development.
2. A +1% gradient represents a rise of 1m in 100m.
3. Left and right hand channels are on the left and right hand side respectively, when standing at zero chainage and looking along the road.
4. A level at any point 'x' m from the start of a vertical curve is given by the formula:-

   $$\text{level@'x'=level@ start of curve} + \frac{ax}{100} - \frac{(a-b)x^2}{200}$$

   where 'a' and 'b' are the gradients at the start and end of the curve respectively and having the algebraic signs +/-.
5. Pipe sizes are stated in millimetres and levels are shown in metres A.O.D.
6. All pipes to have flexible joints with granular bedding (class s) unless stated otherwise. where 150mm concrete bed and surround is specified the concrete must be broken at the joint positions by the insertion of a 'flexcell' collar.
7. Connections to existing sewers are to be soffit to soffit unless noted otherwise.
8. All vitrified CLAYs to be extra strength to B.S. 65. 1991.
9. 'MV' is equal to the rate of change of gradient and is calculated from the formula:-

   $$MV = 100 * \frac{(A-B)}{L}$$

   Where A and B are as in note 4 above.
10. Existing levels to be confirmed on site prior to commencement of works.
11. All CONC.s to be class 'M'.
12. Refer to Betts Associates drainage layout drawing **TAY143-101** for further drainage notes.

Notes

1. Planning layout ref, Taylor Wimpey - 25053-VIM_2026-07-29
2. Topographical survey provided by "Geographical Engineering Operations", ref 'G24104 Stoney Lane, Whiston Cross', Dated March 2024.
3. Road detail, levels and layout are subject to local authority section 38 Highways approval.

Mark	Date	Details	By	Chk
P05	19.08.26	Updated with new layout		CP
P04	19.01.26	Scale bar shown		TR
P03	05.12.25	Amended to suit new planning layout		NR
P02	15.10.25	Amended to suit layout dated: 09.10.25		TR NR
P01	02.10.25	Preliminary issue for review		TR NR

Revision history

Drawing originator:

BETTS HYDRO CONSULTING ENGINEERS
BETTS ASSOCIATES CONSULTING ENGINEERS
BETTS GEO CONSULTING ENGINEERS

Client:

Taylor Wimpey

Project title:

Glen Dimplex
Stoney Lane

Drawing title:

Longsections

Scale: 1:500H 1:100V for the original size of A0

Drawn by: TR | Checked by: NR | Passed by: | Date: Oct' 2025

Drawing status:

Technical Due Diligence

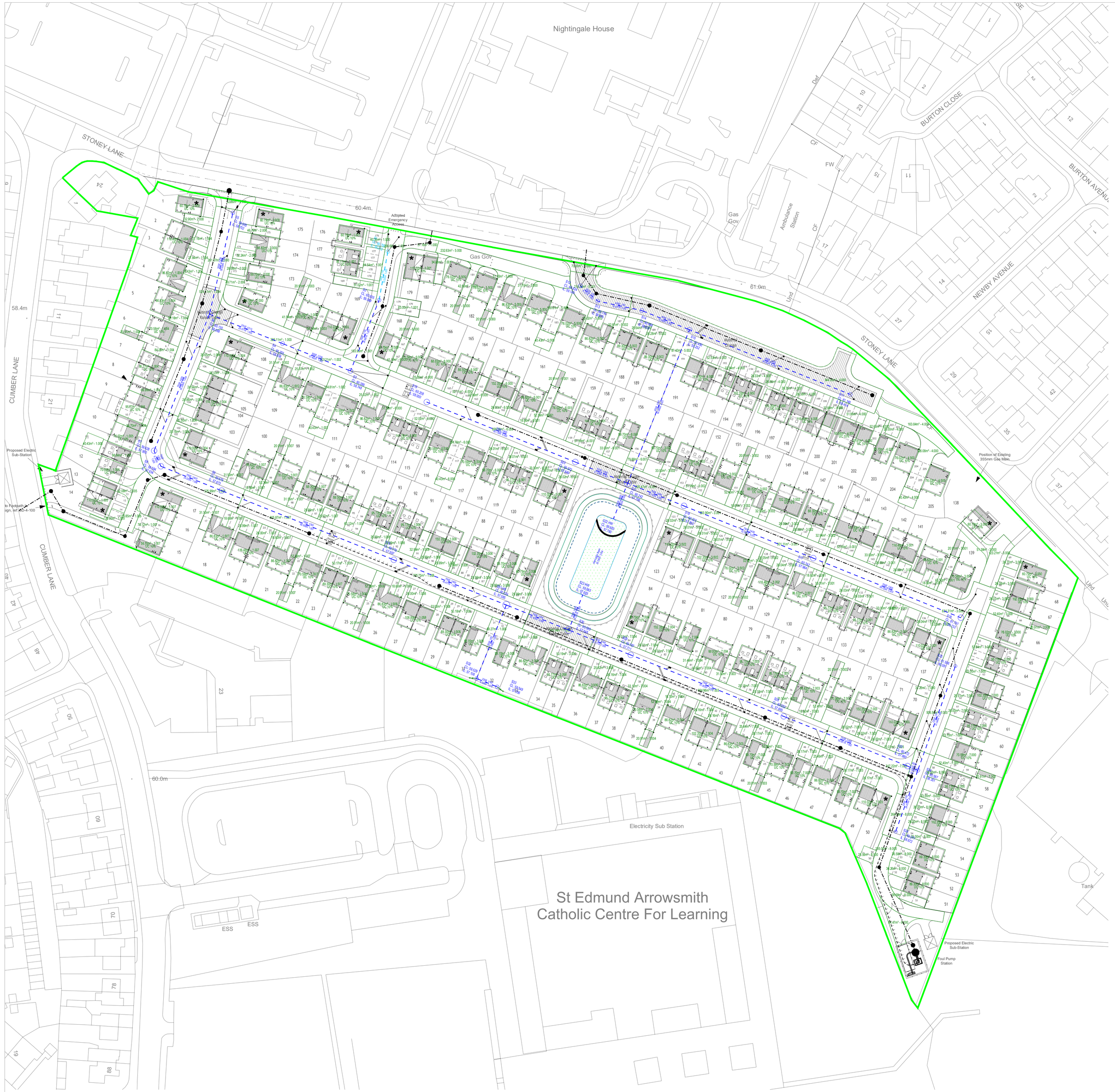
Job No:	Drawing No: Project	Originator	Volume	Level	Type	Discipline	Number	Revision
TAY143	GDX	BET	XX	ZZ	DR	C	0005	P05

Do not scale this drawing

6 -7 Old Model Farm Barns, Wrexham Road, Saltney, Flintshire, CH5 2LY
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APPENDIX C – PROPOSED DRAINAGE CATCHMENT PLAN (BETTS ASSOCIATES)

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Manhole No.	Pipe No.	Private IMP	Private UC	Total IMP + UC
S2	1.000	97.532	0.000	97.532
S3	1.001	890.736	26.658	917.394
S4	1.002	845.165	31.481	876.646
S6	1.003	605.690	18.060	623.750
S7	1.004	1955.398	94.698	2050.096
S8	1.005	593.923	25.663	619.586
S8	1.006	525.990	0.000	525.990
S10	1.007	1857.340	96.118	1953.458
S31	1.008	1912.228	70.919	1983.147
S6	2.000	863.347	32.890	896.237
S17	3.000	1408.667	39.572	1448.239
S18	3.001	1910.056	90.068	2000.124
S21	3.002	1479.638	95.541	1575.179
S31	3.006	764.422	55.196	819.618
S15	4.000	2425.172	81.648	2506.819
S13	5.000	1011.083	39.089	1050.172
S13	5.001	218.548	0.000	218.548
S15	5.002	462.366	26.543	488.909
S20	6.000	2019.071	69.279	2088.350
S21	6.001	1224.078	62.979	1287.057
S25	7.000	978.413	26.871	1005.284
S27	7.002	368.126	0.000	368.126
S29	7.003	2515.374	109.466	2624.840
S30	7.004	1246.323	66.519	1312.841
S26	8.000	1241.675	37.673	1279.348
Totals:		29420.360	1196.929	30617.289

Notes

1. Planning layout ref.
   Taylor Wimpey - 25053-VIM_2026-07-29
2. Topographical survey provided by 'Geographical Engineering Operations', ref 'G24104 Stoney Lane, Whiston Cross', Dated March 2024.
3. Road detail, levels and layout are subject to local authority section 38 Highways approval.

Mark	Date	Details	By	Chk
P02	20.08.26	Updated with current site Layout	CP	
P01	23.12.25	Preliminary issue for review	NR	

Revision history

Drawing originator:

BETTS HYDRO CONSULTING ENGINEERS
BETTS ASSOCIATES CONSULTING ENGINEERS
BETTS GEO CONSULTING ENGINEERS

Client:

Taylor Wimpey

Project title:

Glen Dimplex
Stoney Lane

Drawing title:

Impermeable Areas Plan

Scale: As Shown for the original size of A1

Drawn by: NR | Checked by: | Passed by: | Date: Dec' 2025

Drawing status:

Technical Due Diligence

Job No:	Drawing No: Project	Origin.	Volume	Level	Type	Discip.	Number	Revision:
TAY143	GDX	BET	ZZ	XX	DR	C	0006	P02

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enquiries@betts-associates.co.uk
Chester 01244 288178

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APPENDIX D – HYRAULIC CALCULATIONS & DRAINAGE NETWORK DETAILS

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PRELIMINARY SURFACE WATER DRAINAGE NETWORK DETAILS

Site at Former Glen Dimplex, Stoney Lane, Whiston

For

Taylor Wimpey



Rev. 1.0

20th August 2026

FORMER GLEN DIMPLEX, STONEY LANE, WHISTON

Drainage Network Details

20th August 2026

Issue no.	Rev. 1.0			
Date:	20th Aug 2026			
Prepared By:	Chris Pickles			
Checked By:	Richard Nicholas			
Authorised By:	Robert Ankers			

Betts Associates Ltd
Old Marsh Farm Barns
Welsh Road
Sealand
Flintshire
CH5 2LY

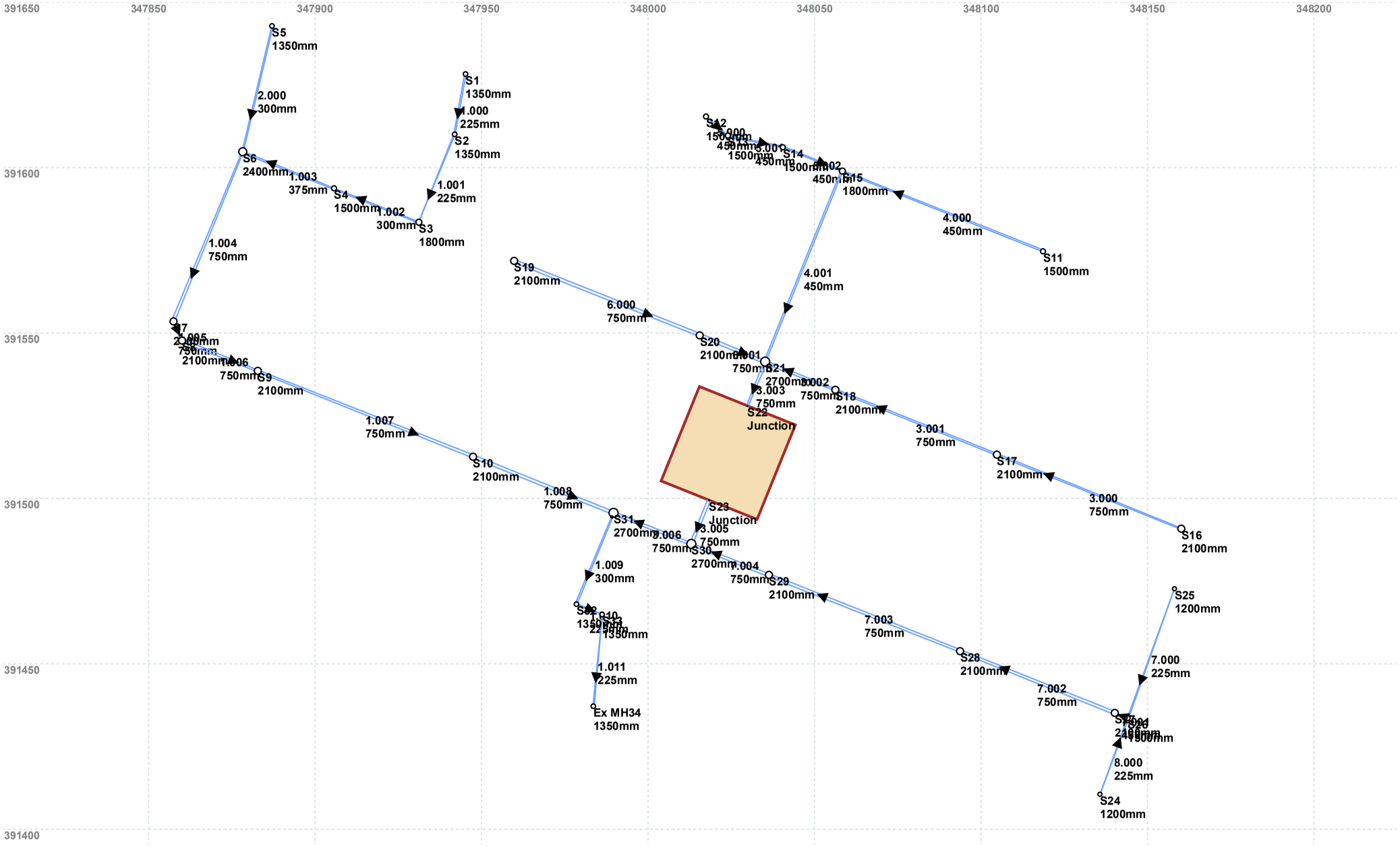
Tel no. 01244 288178
Project no. CAS02

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Surface Water System Details
Plan of proposed Surface Drainage Network
Simulation Settings
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Link Details
Pipeline Schedules
Manhole Schedules
Flow Controls
Storage Structures

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Simulation Results for the 1yr Return Period
Simulation Results for the 2yr Return Period
Simulation Results for the 30yr Return Period
Simulation Results for the 100yr Return Period
Simulation Results for the 100yr Return Period + 45% Climate Change
Simulation Results for the 200yr Return Period

BETTS ASSOCIATES CONSULTING ENGINEERS	Betts Associates Ltd Unit 6, Old Marsh Farm Barns, Sealand, Deeside CH5 2LY	File: TAY143 - Preliminary Drainage Details - P01 - Augu Network: Chris Pickles Aug 2026	Page 1 Preliminary Surface Water Drainage Network



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Simulation Settings

Rainfall Methodology	FEH-22	Skip Steady State	x	1 year (l/s)	42.2
Rainfall Events	Singular	Drain Down Time (mins)	1440	2 year (l/s)	42.4
Summer CV	1.000	Additional Storage (m³/ha)	0.0	30 year (l/s)	42.4
Winter CV	1.000	Starting Level (m)		100 year (l/s)	42.4
Analysis Speed	Detailed	Check Discharge Rate(s)	✓	Check Discharge Volume	x

Storm Durations

15	30	60	120	180	240	360	480	600	720	960	1440

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1	0	0	0
2	0	0	0
30	0	0	0
100	0	0	0
100	45	0	0
200	0	0	0

Pre-development Discharge Rate

Site Makeup	Greenfield	SPR	0.10	Betterment (%)	0
Greenfield Method	IH124	Region	1	QBar	
Positively Drained Area (ha)		Growth Factor 1 year	0.85	Q 1 year (l/s)	
SAAR (mm)		Growth Factor 30 year	1.95	Q 30 year (l/s)	
Soil Index	1	Growth Factor 100 year	2.48	Q 100 year (l/s)	

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Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)	Invert Level (m)
S1	0.010	5.00	60.797	1350	347945.194	391628.292	1.659	59.138
S2	0.092	5.00	60.635	1350	347941.921	391610.063	1.621	59.014
S3	0.088	5.00	60.389	1800	347931.180	391583.485	1.641	58.748
S4	0.062	5.00	60.203	1500	347905.708	391593.748	1.645	58.558
S5	0.090	5.00	59.955	1350	347887.069	391642.825	1.253	58.702
S6	0.205	5.00	60.130	2400	347878.280	391604.799	2.042	58.088
S7	0.062	5.00	59.628	2100	347857.494	391553.515	1.678	57.950
S8	0.053	5.00	59.584	2100	347860.047	391547.707	1.650	57.934
S9	0.195	5.00	59.679	2100	347882.811	391538.561	1.806	57.873
S10	0.198	5.00	59.777	2100	347947.445	391512.593	2.080	57.697
S16	0.145	5.00	61.791	2100	348160.138	391490.862	3.658	58.133
S17	0.200	5.00	60.742	2100	348104.767	391513.234	2.758	57.984
S18	0.158	5.00	60.323	2100	348056.250	391532.836	2.470	57.853
S11	0.251	5.00	61.146	1500	348118.621	391574.685	2.732	58.414
S12	0.105	5.00	60.824	1500	348017.411	391615.435	1.675	59.149
S13	0.022	5.00	60.776	1500	348023.976	391609.685	1.801	58.975
S14	0.049	5.00	60.649	1500	348040.478	391606.148	2.012	58.637
S15			60.490	1800	348058.369	391598.944	2.238	58.252
S19	0.209	5.00	60.208	2100	347959.786	391571.810	2.208	58.000
S20	0.129	5.00	59.972	2100	348015.516	391549.294	2.123	57.849
S21			60.242	2700	348035.180	391541.349	2.446	57.796
S22			59.683		348029.837	391528.020	1.924	57.759
S23		5.00	59.683		348018.331	391499.471	2.000	57.683
S25	0.101	5.00	61.506	1200	348158.094	391472.702	1.425	60.081
S24	0.128	5.00	60.271	1200	348135.710	391410.594	1.599	58.672
S26			60.587	1500	348144.008	391433.619	2.286	58.301
S27	0.037	5.00	60.472	2100	348140.169	391435.162	2.482	57.990
S28	0.262	5.00	60.033	2100	348093.698	391453.833	2.168	57.865
S29	0.131	5.00	59.787	2100	348036.303	391476.892	2.076	57.711
S30	0.082	5.00	60.089	2700	348012.998	391486.256	2.441	57.648
S31			60.074	2700	347989.644	391495.638	2.489	57.585
S32			59.529	1350	347978.493	391468.039	2.423	57.106
S33			59.549	1350	347986.213	391464.920	2.493	57.056
Ex MH34			58.500	1350	347983.573	391437.196	1.540	56.960

Links (Input)

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	S1	S2	18.520	0.600	59.138	59.014	0.124	149.4	225	5.29	38.8
1.001	S2	S3	28.667	0.600	59.014	58.823	0.191	150.1	225	5.74	37.4
1.002	S3	S4	27.462	0.600	58.748	58.633	0.115	238.8	300	6.19	36.2
1.003	S4	S6	29.571	0.600	58.558	58.463	0.095	311.3	375	6.67	34.9
2.000	S5	S6	39.028	0.600	58.702	58.538	0.164	238.0	300	5.64	37.7
1.004	S6	S7	55.336	0.600	58.088	57.950	0.138	401.0	750	7.34	33.3
1.005	S7	S8	6.345	0.600	57.950	57.934	0.016	396.6	750	7.41	33.1
1.006	S8	S9	24.533	0.600	57.934	57.873	0.061	402.2	750	7.71	32.4
1.007	S9	S10	69.656	0.600	57.873	57.697	0.176	395.8	750	8.53	30.7
1.008	S10	S31	45.477	0.600	57.697	57.585	0.112	406.0	750	9.08	29.7
3.000	S16	S17	59.720	0.600	58.133	57.984	0.149	400.8	750	5.72	37.5
3.001	S17	S18	52.327	0.600	57.984	57.853	0.131	399.4	750	6.34	35.8
3.002	S18	S21	22.725	0.600	57.853	57.796	0.057	398.7	750	6.61	35.1
4.000	S11	S15	64.952	0.600	58.414	58.252	0.162	400.9	450	6.07	36.5
5.000	S12	S13	8.727	0.600	59.149	58.975	0.174	50.2	450	5.05	39.5

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Links (Input)

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
5.001	S13	S14	16.877	0.600	58.975	58.637	0.338	49.9	450	5.15	39.2
5.002	S14	S15	19.286	0.600	58.637	58.252	0.385	50.1	450	5.26	38.8
4.001	S15	S21	62.089	0.600	58.252	58.096	0.156	398.0	450	7.09	33.8
6.000	S19	S20	60.106	0.600	58.000	57.849	0.151	398.1	750	5.72	37.5
6.001	S20	S21	21.208	0.600	57.849	57.796	0.053	400.2	750	5.97	36.8
3.003	S21	S22	14.360	0.600	57.796	57.760	0.036	398.9	750	7.27	33.4
3.005	S23	S30	14.251	0.600	57.683	57.648	0.035	407.2	750	5.17	39.1
7.000	S25	S26	41.544	0.600	60.081	58.526	1.555	26.7	225	5.27	38.8
8.000	S24	S26	24.475	0.600	58.672	58.526	0.146	167.6	225	5.41	38.4
7.001	S26	S27	4.138	0.600	58.301	58.290	0.011	376.2	450	5.47	38.2
7.002	S27	S28	50.081	0.600	57.990	57.865	0.125	400.6	750	6.07	36.5
7.003	S28	S29	61.853	0.600	57.865	57.711	0.154	401.6	750	6.81	34.5
7.004	S29	S30	25.117	0.600	57.711	57.648	0.063	398.7	750	7.11	33.8
3.006	S30	S31	25.168	0.600	57.648	57.585	0.063	399.5	750	7.41	33.1
1.009	S31	S32	29.766	0.600	57.585	57.106	0.479	62.1	300	9.33	29.3
1.010	S32	S33	8.326	0.600	57.106	57.056	0.050	166.5	225	9.47	29.0
1.011	S33	Ex MH34	27.850	0.600	57.056	56.960	0.096	290.1	225	10.08	28.0

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.000	18.520	149.4	225	Circular	60.797	59.138	1.434	60.635	59.014	1.396
1.001	28.667	150.1	225	Circular	60.635	59.014	1.396	60.389	58.823	1.341
1.002	27.462	238.8	300	Circular	60.389	58.748	1.341	60.203	58.633	1.270
1.003	29.571	311.3	375	Circular	60.203	58.558	1.270	60.130	58.463	1.292
2.000	39.028	238.0	300	Circular	59.955	58.702	0.953	60.130	58.538	1.292
1.004	55.336	401.0	750	Circular	60.130	58.088	1.292	59.628	57.950	0.928
1.005	6.345	396.6	750	Circular	59.628	57.950	0.928	59.584	57.934	0.900
1.006	24.533	402.2	750	Circular	59.584	57.934	0.900	59.679	57.873	1.056
1.007	69.656	395.8	750	Circular	59.679	57.873	1.056	59.777	57.697	1.330
1.008	45.477	406.0	750	Circular	59.777	57.697	1.330	60.074	57.585	1.739
3.000	59.720	400.8	750	Circular	61.791	58.133	2.908	60.742	57.984	2.008
3.001	52.327	399.4	750	Circular	60.742	57.984	2.008	60.323	57.853	1.720
3.002	22.725	398.7	750	Circular	60.323	57.853	1.720	60.242	57.796	1.696
4.000	64.952	400.9	450	Circular	61.146	58.414	2.282	60.490	58.252	1.788

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.000	S1	1350	Manhole	Adoptable	S2	1350	Manhole	Adoptable
1.001	S2	1350	Manhole	Adoptable	S3	1800	Manhole	Adoptable
1.002	S3	1800	Manhole	Adoptable	S4	1500	Manhole	Adoptable
1.003	S4	1500	Manhole	Adoptable	S6	2400	Manhole	Adoptable
2.000	S5	1350	Manhole	Adoptable	S6	2400	Manhole	Adoptable
1.004	S6	2400	Manhole	Adoptable	S7	2100	Manhole	Adoptable
1.005	S7	2100	Manhole	Adoptable	S8	2100	Manhole	Adoptable
1.006	S8	2100	Manhole	Adoptable	S9	2100	Manhole	Adoptable
1.007	S9	2100	Manhole	Adoptable	S10	2100	Manhole	Adoptable
1.008	S10	2100	Manhole	Adoptable	S31	2700	Manhole	Adoptable
3.000	S16	2100	Manhole	Adoptable	S17	2100	Manhole	Adoptable
3.001	S17	2100	Manhole	Adoptable	S18	2100	Manhole	Adoptable
3.002	S18	2100	Manhole	Adoptable	S21	2700	Manhole	Adoptable
4.000	S11	1500	Manhole	Adoptable	S15	1800	Manhole	Adoptable

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Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
5.000	8.727	50.2	450	Circular	60.824	59.149	1.225	60.776	58.975	1.351
5.001	16.877	49.9	450	Circular	60.776	58.975	1.351	60.649	58.637	1.562
5.002	19.286	50.1	450	Circular	60.649	58.637	1.562	60.490	58.252	1.788
4.001	62.089	398.0	450	Circular	60.490	58.252	1.788	60.242	58.096	1.696
6.000	60.106	398.1	750	Circular	60.208	58.000	1.458	59.972	57.849	1.373
6.001	21.208	400.2	750	Circular	59.972	57.849	1.373	60.242	57.796	1.696
3.003	14.360	398.9	750	Circular	60.242	57.796	1.696	59.683	57.760	1.173
3.005	14.251	407.2	750	Circular	59.683	57.683	1.250	60.089	57.648	1.691
7.000	41.544	26.7	225	Circular	61.506	60.081	1.200	60.587	58.526	1.836
8.000	24.475	167.6	225	Circular	60.271	58.672	1.374	60.587	58.526	1.836
7.001	4.138	376.2	450	Circular	60.587	58.301	1.836	60.472	58.290	1.732
7.002	50.081	400.6	750	Circular	60.472	57.990	1.732	60.033	57.865	1.418
7.003	61.853	401.6	750	Circular	60.033	57.865	1.418	59.787	57.711	1.326
7.004	25.117	398.7	750	Circular	59.787	57.711	1.326	60.089	57.648	1.691
3.006	25.168	399.5	750	Circular	60.089	57.648	1.691	60.074	57.585	1.739
1.009	29.766	62.1	300	Circular	60.074	57.585	2.189	59.529	57.106	2.123
1.010	8.326	166.5	225	Circular	59.529	57.106	2.198	59.549	57.056	2.268
1.011	27.850	290.1	225	Circular	59.549	57.056	2.268	58.500	56.960	1.315

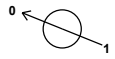
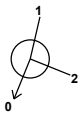
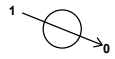
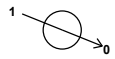
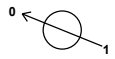
Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
5.000	S12	1500	Manhole	Adoptable	S13	1500	Manhole	Adoptable
5.001	S13	1500	Manhole	Adoptable	S14	1500	Manhole	Adoptable
5.002	S14	1500	Manhole	Adoptable	S15	1800	Manhole	Adoptable
4.001	S15	1800	Manhole	Adoptable	S21	2700	Manhole	Adoptable
6.000	S19	2100	Manhole	Adoptable	S20	2100	Manhole	Adoptable
6.001	S20	2100	Manhole	Adoptable	S21	2700	Manhole	Adoptable
3.003	S21	2700	Manhole	Adoptable	S22		Junction	
3.005	S23		Junction		S30	2700	Manhole	Adoptable
7.000	S25	1200	Manhole	Adoptable	S26	1500	Manhole	Adoptable
8.000	S24	1200	Manhole	Adoptable	S26	1500	Manhole	Adoptable
7.001	S26	1500	Manhole	Adoptable	S27	2100	Manhole	Adoptable
7.002	S27	2100	Manhole	Adoptable	S28	2100	Manhole	Adoptable
7.003	S28	2100	Manhole	Adoptable	S29	2100	Manhole	Adoptable
7.004	S29	2100	Manhole	Adoptable	S30	2700	Manhole	Adoptable
3.006	S30	2700	Manhole	Adoptable	S31	2700	Manhole	Adoptable
1.009	S31	2700	Manhole	Adoptable	S32	1350	Manhole	Adoptable
1.010	S32	1350	Manhole	Adoptable	S33	1350	Manhole	Adoptable
1.011	S33	1350	Manhole	Adoptable	Ex MH34	1350	Manhole	Adoptable

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections		Link	IL (m)	Dia (mm)
S1	347945.194	391628.292	60.797	1.659	1350		0	1.000	59.138	225
S2	347941.921	391610.063	60.635	1.621	1350		1	1.000	59.014	225
							0	1.001	59.014	225

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Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
S3	347931.180	391583.485	60.389	1.641	1800	 1	1.001	58.823	225
						0	1.002	58.748	300
S4	347905.708	391593.748	60.203	1.645	1500	 1	1.002	58.633	300
						0	1.003	58.558	375
S5	347887.069	391642.825	59.955	1.253	1350	 0	2.000	58.702	300
S6	347878.280	391604.799	60.130	2.042	2400	 1	2.000	58.538	300
						2	1.003	58.463	375
						0	1.004	58.088	750
S7	347857.494	391553.515	59.628	1.678	2100	 1	1.004	57.950	750
						0	1.005	57.950	750
S8	347860.047	391547.707	59.584	1.650	2100	 1	1.005	57.934	750
						0	1.006	57.934	750
S9	347882.811	391538.561	59.679	1.806	2100	 1	1.006	57.873	750
						0	1.007	57.873	750
S10	347947.445	391512.593	59.777	2.080	2100	 1	1.007	57.697	750
						0	1.008	57.697	750
S16	348160.138	391490.862	61.791	3.658	2100	 0	3.000	58.133	750
S17	348104.767	391513.234	60.742	2.758	2100	 1	3.000	57.984	750
						0	3.001	57.984	750
S18	348056.250	391532.836	60.323	2.470	2100	 1	3.001	57.853	750
						0	3.002	57.853	750
S11	348118.621	391574.685	61.146	2.732	1500	 0	4.000	58.414	450
S12	348017.411	391615.435	60.824	1.675	1500	 0	5.000	59.149	450

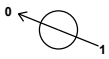
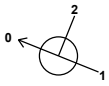
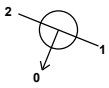
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Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
S13	348023.976	391609.685	60.776	1.801	1500	1	5.000	58.975	450
						0	5.001	58.975	450
S14	348040.478	391606.148	60.649	2.012	1500	1	5.001	58.637	450
						0	5.002	58.637	450
S15	348058.369	391598.944	60.490	2.238	1800	1	5.002	58.252	450
						2	4.000	58.252	450
						0	4.001	58.252	450
S19	347959.786	391571.810	60.208	2.208	2100	0	6.000	58.000	750
S20	348015.516	391549.294	59.972	2.123	2100	1	6.000	57.849	750
						0	6.001	57.849	750
S21	348035.180	391541.349	60.242	2.446	2700	1	6.001	57.796	750
						2	4.001	58.096	450
						3	3.002	57.796	750
						0	3.003	57.796	750
S22	348029.837	391528.020	59.683	1.924		1	3.003	57.760	750
S23	348018.331	391499.471	59.683	2.000		0	3.005	57.683	750
S25	348158.094	391472.702	61.506	1.425	1200	0	7.000	60.081	225
S24	348135.710	391410.594	60.271	1.599	1200	0	8.000	58.672	225
S26	348144.008	391433.619	60.587	2.286	1500	1	8.000	58.526	225
						2	7.000	58.526	225
						0	7.001	58.301	450
S27	348140.169	391435.162	60.472	2.482	2100	1	7.001	58.290	450
						0	7.002	57.990	750
S28	348093.698	391453.833	60.033	2.168	2100	1	7.002	57.865	750
						0	7.003	57.865	750

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Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
S29	348036.303	391476.892	59.787	2.076	2100	1	7.003	57.711	750
									
						0	7.004	57.711	750
S30	348012.998	391486.256	60.089	2.441	2700	1	7.004	57.648	750
							2	3.005	57.648	750
						0	3.006	57.648	750
S31	347989.644	391495.638	60.074	2.489	2700	1	3.006	57.585	750
							2	1.008	57.585	750
						0	1.009	57.585	300
S32	347978.493	391468.039	59.529	2.423	1350	1	1.009	57.106	300
									
						0	1.010	57.106	225
S33	347986.213	391464.920	59.549	2.493	1350	1	1.010	57.056	225
									
						0	1.011	57.056	225
Ex MH34	347983.573	391437.196	58.500	1.540	1350	1	1.011	56.960	225
									

Node S31 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	x	Sump Available	✓
Invert Level (m)	57.585	Product Number	CTL-SHE-0263-4240-1900-4240
Design Depth (m)	1.900	Min Outlet Diameter (m)	0.300
Design Flow (l/s)	42.4	Min Node Diameter (mm)	2400

Node S23 Flow through Pond Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Main Channel Length (m)	30.425
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	57.683	Main Channel Slope (1:X)	400.0
Safety Factor	2.0	Time to half empty (mins)	300	Main Channel n	0.035

Inlets

S22

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	355.7	0.0	0.600	511.8	0.0	1.200	688.8	0.0	1.800	886.1	0.0
0.100	379.9	0.0	0.700	539.9	0.0	1.300	720.3	0.0	1.900	921.0	0.0
0.200	405.2	0.0	0.800	568.6	0.0	1.400	752.3	0.0	2.000	956.4	0.0
0.300	431.0	0.0	0.900	597.8	0.0	1.500	784.9	0.0			
0.400	457.4	0.0	1.000	627.6	0.0	1.600	818.1	0.0			
0.500	484.3	0.0	1.100	657.9	0.0	1.700	851.8	0.0			

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Results for 1 year Critical Storm Duration. Lowest mass balance: 99.98%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	S1	11	59.164	0.026	1.2	0.0371	0.0000	OK
15 minute summer	S2	11	59.100	0.086	12.9	0.1233	0.0000	OK
15 minute summer	S3	11	58.870	0.122	23.5	0.3115	0.0000	OK
15 minute summer	S4	11	58.697	0.139	31.1	0.2453	0.0000	OK
15 minute summer	S5	11	58.783	0.081	11.4	0.1155	0.0000	OK
15 minute summer	S6	11	58.254	0.166	67.1	0.7515	0.0000	OK
15 minute summer	S7	12	58.155	0.205	74.9	0.7110	0.0000	OK
15 minute summer	S8	12	58.130	0.196	78.0	0.6779	0.0000	OK
180 minute summer	S9	120	58.073	0.200	40.9	0.6919	0.0000	OK
180 minute summer	S10	120	58.073	0.376	50.1	1.3024	0.0000	OK
15 minute summer	S16	11	58.219	0.086	18.5	0.2970	0.0000	OK
15 minute summer	S17	11	58.112	0.128	42.8	0.4421	0.0000	OK
180 minute summer	S18	120	58.074	0.221	24.0	0.7641	0.0000	OK
15 minute summer	S11	10	58.548	0.134	32.0	0.2366	0.0000	OK
15 minute summer	S12	10	59.204	0.055	13.4	0.0972	0.0000	OK
15 minute summer	S13	10	59.033	0.058	16.1	0.1021	0.0000	OK
15 minute summer	S14	10	58.703	0.066	22.2	0.1172	0.0000	OK
15 minute summer	S15	12	58.426	0.174	54.1	0.4424	0.0000	OK
15 minute summer	S19	11	58.102	0.102	26.7	0.3534	0.0000	OK
180 minute summer	S20	120	58.074	0.225	16.2	0.7782	0.0000	OK
180 minute summer	S21	120	58.074	0.278	54.3	1.5902	0.0000	OK
180 minute summer	S22	120	58.074	0.315	50.9	0.0000	0.0000	OK
180 minute summer	S23	120	58.074	0.391	36.3	0.0000	0.0000	OK
15 minute summer	S25	10	60.135	0.054	12.8	0.0614	0.0000	OK
15 minute summer	S24	10	58.775	0.103	16.3	0.1162	0.0000	OK
15 minute summer	S26	10	58.433	0.132	28.6	0.2336	0.0000	OK

Link Event (Outflow)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	S1	1.000	S2	1.2	0.156	0.028	0.1527	
15 minute summer	S2	1.001	S3	12.6	0.922	0.298	0.3919	
15 minute summer	S3	1.002	S4	23.5	0.898	0.328	0.7190	
15 minute summer	S4	1.003	S6	31.0	0.891	0.275	1.0289	
15 minute summer	S5	2.000	S6	11.1	0.740	0.155	0.5854	
15 minute summer	S6	1.004	S7	67.4	0.806	0.110	4.6382	
15 minute summer	S7	1.005	S8	72.7	0.770	0.118	0.5991	
15 minute summer	S8	1.006	S9	78.8	0.852	0.128	2.2704	
15 minute summer	S9	1.007	S10	100.2	0.892	0.162	7.9088	
15 minute summer	S10	1.008	S31	110.4	0.669	0.181	8.4516	
15 minute summer	S16	3.000	S17	17.8	0.474	0.029	2.3066	
15 minute summer	S17	3.001	S18	40.9	0.647	0.066	3.5926	
15 minute summer	S18	3.002	S21	53.9	0.568	0.087	2.3827	
15 minute summer	S11	4.000	S15	32.1	0.736	0.200	3.0402	
15 minute summer	S12	5.000	S13	13.3	1.166	0.029	0.0998	
15 minute summer	S13	5.001	S14	16.0	1.218	0.035	0.2221	
15 minute summer	S14	5.002	S15	22.0	0.869	0.048	0.6711	
15 minute summer	S15	4.001	S21	49.0	0.949	0.304	3.2093	
15 minute summer	S19	6.000	S20	25.8	0.568	0.042	3.6225	
15 minute summer	S20	6.001	S21	35.0	0.442	0.057	2.2054	
15 minute summer	S21	3.003	S22	135.8	1.190	0.220	1.6454	
15 minute summer	S22	Flow through Pond	S23	99.3	0.158	0.002	93.9126	
15 minute summer	S23	3.005	S30	-134.7	-1.471	-0.221	2.3826	
15 minute summer	S25	7.000	S26	12.6	1.727	0.124	0.3024	
15 minute summer	S24	8.000	S26	16.0	0.938	0.400	0.4187	
15 minute summer	S26	7.001	S27	28.5	0.808	0.172	0.1459	

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Results for 1 year Critical Storm Duration. Lowest mass balance: 99.98%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	S27	11	58.105	0.115	33.0	0.3983	0.0000	OK
180 minute summer	S28	124	58.073	0.208	25.3	0.7221	0.0000	OK
180 minute summer	S29	124	58.073	0.362	29.9	1.2544	0.0000	OK
180 minute summer	S30	120	58.073	0.425	30.2	2.4358	0.0000	OK
180 minute summer	S31	120	58.073	0.488	44.5	2.7944	0.0000	SURCHARGED
180 minute summer	S32	124	57.413	0.307	41.1	0.4400	0.0000	SURCHARGED
180 minute summer	S33	124	57.332	0.276	41.1	0.3945	0.0000	SURCHARGED
180 minute summer	Ex MH34	124	57.130	0.170	41.1	0.0000	0.0000	OK

Link Event (Outflow)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	S27	7.002	S28	33.0	0.593	0.054	2.8030	
15 minute summer	S28	7.003	S29	65.0	0.801	0.106	5.2960	
15 minute summer	S29	7.004	S30	73.2	0.711	0.119	3.9529	
15 minute summer	S30	3.006	S31	-77.2	-0.443	-0.125	5.1031	
180 minute summer	S31	1.009	S32	41.1	0.979	0.291	1.3954	
180 minute summer	S32	1.010	S33	41.1	1.034	1.023	0.3311	
180 minute summer	S33	1.011	Ex MH34	41.1	1.068	1.356	1.0020	436.9

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Results for 2 year Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	S1	10	59.168	0.030	1.7	0.0431	0.0000	OK
15 minute summer	S2	11	59.117	0.103	17.7	0.1478	0.0000	OK
15 minute summer	S3	11	58.895	0.147	32.5	0.3753	0.0000	OK
15 minute summer	S4	11	58.724	0.166	42.8	0.2936	0.0000	OK
15 minute summer	S5	11	58.798	0.096	15.7	0.1367	0.0000	OK
15 minute summer	S6	11	58.286	0.198	92.5	0.8961	0.0000	OK
15 minute summer	S7	12	58.197	0.247	103.3	0.8539	0.0000	OK
15 minute summer	S8	12	58.169	0.235	107.5	0.8134	0.0000	OK
180 minute summer	S9	124	58.161	0.288	51.1	0.9980	0.0000	OK
180 minute summer	S10	124	58.161	0.464	58.5	1.6064	0.0000	OK
15 minute summer	S16	11	58.233	0.100	25.4	0.3457	0.0000	OK
180 minute summer	S17	128	58.162	0.178	20.7	0.6165	0.0000	OK
180 minute summer	S18	128	58.162	0.309	30.2	1.0687	0.0000	OK
15 minute summer	S11	10	58.572	0.158	44.0	0.2795	0.0000	OK
15 minute summer	S12	10	59.214	0.065	18.4	0.1146	0.0000	OK
15 minute summer	S13	10	59.043	0.068	22.1	0.1198	0.0000	OK
15 minute summer	S14	10	58.715	0.078	30.6	0.1370	0.0000	OK
15 minute summer	S15	12	58.461	0.209	74.5	0.5322	0.0000	OK
180 minute summer	S19	124	58.162	0.162	12.6	0.5608	0.0000	OK
180 minute summer	S20	124	58.161	0.312	20.3	1.0823	0.0000	OK
180 minute summer	S21	128	58.161	0.365	65.5	2.0912	0.0000	OK
180 minute summer	S22	124	58.161	0.402	60.7	0.0000	0.0000	OK
180 minute summer	S23	124	58.161	0.478	43.2	0.0000	0.0000	OK
15 minute summer	S25	10	60.145	0.064	17.6	0.0725	0.0000	OK
15 minute summer	S24	10	58.797	0.125	22.4	0.1409	0.0000	OK
15 minute summer	S26	10	58.458	0.157	39.3	0.2765	0.0000	OK

Link Event (Outflow)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	S1	1.000	S2	1.6	0.167	0.039	0.1936	
15 minute summer	S2	1.001	S3	17.4	1.002	0.410	0.4971	
15 minute summer	S3	1.002	S4	32.4	0.981	0.453	0.9083	
15 minute summer	S4	1.003	S6	42.8	0.974	0.380	1.3015	
15 minute summer	S5	2.000	S6	15.3	0.810	0.214	0.7393	
15 minute summer	S6	1.004	S7	92.9	0.860	0.151	6.0154	
15 minute summer	S7	1.005	S8	100.1	0.822	0.162	0.7727	
15 minute summer	S8	1.006	S9	108.6	0.910	0.177	2.9307	
15 minute summer	S9	1.007	S10	138.2	0.937	0.223	10.3887	
15 minute summer	S10	1.008	S31	153.9	0.735	0.252	11.1295	
15 minute summer	S16	3.000	S17	24.5	0.519	0.040	2.9033	
15 minute summer	S17	3.001	S18	57.1	0.685	0.093	4.7673	
15 minute summer	S18	3.002	S21	75.9	0.595	0.123	3.1413	
15 minute summer	S11	4.000	S15	44.1	0.788	0.275	3.8901	
15 minute summer	S12	5.000	S13	18.3	1.264	0.040	0.1264	
15 minute summer	S13	5.001	S14	22.0	1.328	0.048	0.2793	
15 minute summer	S14	5.002	S15	30.3	0.910	0.066	0.8595	
15 minute summer	S15	4.001	S21	68.5	1.042	0.426	4.0849	
15 minute summer	S19	6.000	S20	35.5	0.591	0.058	4.8397	
15 minute summer	S20	6.001	S21	48.5	0.455	0.079	2.9091	
15 minute summer	S21	3.003	S22	192.0	1.308	0.312	2.1094	
15 minute winter	S22	Flow through Pond	S23	107.2	0.159	0.002	128.8610	
15 minute summer	S23	3.005	S30	-203.8	-1.574	-0.334	3.1603	
15 minute summer	S25	7.000	S26	17.3	1.891	0.172	0.3808	
15 minute summer	S24	8.000	S26	22.0	1.013	0.549	0.5331	
15 minute summer	S26	7.001	S27	39.1	0.881	0.236	0.1840	

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Results for 2 year Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
180 minute summer	S27	124	58.162	0.172	16.0	0.5950	0.0000	OK
180 minute summer	S28	124	58.161	0.296	31.8	1.0264	0.0000	OK
180 minute summer	S29	124	58.161	0.450	33.5	1.5584	0.0000	OK
180 minute summer	S30	124	58.161	0.513	32.5	2.9366	0.0000	OK
180 minute summer	S31	124	58.161	0.576	50.3	3.2964	0.0000	SURCHARGED
180 minute summer	S32	128	57.427	0.321	42.0	0.4590	0.0000	SURCHARGED
180 minute summer	S33	128	57.341	0.285	42.0	0.4082	0.0000	SURCHARGED
180 minute summer	Ex MH34	128	57.132	0.172	42.0	0.0000	0.0000	OK

Link Event (Outflow)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	S27	7.002	S28	45.5	0.647	0.074	3.5505	
15 minute summer	S28	7.003	S29	90.1	0.850	0.147	8.9565	
15 minute summer	S29	7.004	S30	101.0	0.719	0.164	5.3418	
15 minute summer	S30	3.006	S31	-106.2	-0.509	-0.172	6.5299	
180 minute summer	S31	1.009	S32	42.0	0.976	0.298	1.4009	
180 minute summer	S32	1.010	S33	42.0	1.057	1.046	0.3311	
180 minute summer	S33	1.011	Ex MH34	42.0	1.089	1.386	1.0066	548.2

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Results for 30 year Critical Storm Duration. Lowest mass balance: 99.93%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	S1	10	59.194	0.056	3.8	0.0795	0.0000	OK
15 minute summer	S2	11	59.194	0.180	38.4	0.2575	0.0000	OK
15 minute summer	S3	11	59.004	0.256	71.7	0.6511	0.0000	OK
15 minute summer	S4	11	58.829	0.271	94.3	0.4783	0.0000	OK
15 minute summer	S5	10	58.852	0.150	34.8	0.2149	0.0000	OK
120 minute winter	S6	118	58.604	0.516	59.7	2.3324	0.0000	OK
120 minute winter	S7	118	58.604	0.654	63.5	2.2644	0.0000	OK
120 minute winter	S8	118	58.604	0.670	62.4	2.3197	0.0000	OK
120 minute winter	S9	118	58.603	0.730	79.8	2.5303	0.0000	OK
120 minute winter	S10	118	58.604	0.907	90.4	3.1406	0.0000	SURCHARGED
120 minute winter	S16	118	58.605	0.472	15.8	1.6365	0.0000	OK
120 minute winter	S17	120	58.604	0.620	36.6	2.1487	0.0000	OK
120 minute winter	S18	118	58.604	0.751	43.3	2.6019	0.0000	SURCHARGED
15 minute summer	S11	11	58.670	0.256	97.3	0.4532	0.0000	OK
15 minute summer	S12	10	59.249	0.100	40.8	0.1762	0.0000	OK
15 minute summer	S13	10	59.079	0.104	49.1	0.1829	0.0000	OK
15 minute summer	S14	10	58.752	0.115	67.8	0.2032	0.0000	OK
120 minute winter	S15	118	58.604	0.352	46.6	0.8963	0.0000	OK
120 minute winter	S19	118	58.605	0.605	22.8	2.0951	0.0000	OK
120 minute winter	S20	118	58.604	0.755	30.1	2.6166	0.0000	SURCHARGED
120 minute winter	S21	118	58.604	0.808	100.3	4.6283	0.0000	SURCHARGED
120 minute winter	S22	118	58.605	0.845	88.2	0.0000	0.0000	OK
120 minute winter	S23	118	58.604	0.921	79.8	0.0000	0.0000	SURCHARGED
15 minute summer	S25	10	60.180	0.099	39.0	0.1120	0.0000	OK
15 minute summer	S24	10	58.957	0.285	49.7	0.3226	0.0000	SURCHARGED
120 minute winter	S26	118	58.604	0.303	25.0	0.5360	0.0000	OK

Link Event (Outflow)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	S1	1.000	S2	3.9	0.207	0.091	0.3855	
15 minute summer	S2	1.001	S3	38.5	1.136	0.908	0.9783	
15 minute summer	S3	1.002	S4	71.1	1.217	0.994	1.5951	
15 minute summer	S4	1.003	S6	94.3	1.219	0.836	2.2826	
15 minute summer	S5	2.000	S6	34.1	1.004	0.475	1.3239	
15 minute summer	S6	1.004	S7	202.6	0.986	0.330	11.7219	
15 minute summer	S7	1.005	S8	217.9	0.936	0.353	1.6177	
15 minute summer	S8	1.006	S9	232.3	1.001	0.379	6.9080	
15 minute summer	S9	1.007	S10	285.3	1.036	0.461	24.7266	
15 minute summer	S10	1.008	S31	318.9	0.924	0.522	19.2694	
15 minute summer	S16	3.000	S17	54.6	0.624	0.089	10.6349	
15 minute summer	S17	3.001	S18	114.9	0.745	0.187	13.9024	
15 minute summer	S18	3.002	S21	160.5	0.661	0.260	7.4244	
15 minute summer	S11	4.000	S15	95.1	0.922	0.593	7.3373	
15 minute summer	S12	5.000	S13	40.6	1.518	0.089	0.2336	
15 minute summer	S13	5.001	S14	48.8	1.646	0.106	0.5012	
15 minute summer	S14	5.002	S15	67.4	1.144	0.147	1.5819	
15 minute summer	S15	4.001	S21	152.6	1.302	0.947	7.2386	
15 minute summer	S19	6.000	S20	70.1	0.634	0.114	15.9958	
15 minute summer	S20	6.001	S21	107.7	0.509	0.175	6.9076	
15 minute summer	S21	3.003	S22	418.3	1.660	0.679	5.0445	
15 minute summer	S22	Flow through Pond	S23	197.8	0.153	0.004	266.5284	
15 minute summer	S23	3.005	S30	-456.0	-2.057	-0.748	5.9251	
15 minute summer	S25	7.000	S26	38.5	2.341	0.381	0.6836	
15 minute summer	S24	8.000	S26	48.5	1.239	1.212	0.9111	
15 minute summer	S26	7.001	S27	86.6	1.111	0.522	0.3227	

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Results for 30 year Critical Storm Duration. Lowest mass balance: 99.93%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
120 minute winter	S27	118	58.604	0.614	29.0	2.1278	0.0000	OK
120 minute winter	S28	118	58.604	0.739	52.0	2.5606	0.0000	OK
120 minute winter	S29	118	58.604	0.893	53.9	3.0938	0.0000	SURCHARGED
120 minute winter	S30	118	58.604	0.956	77.7	5.4748	0.0000	SURCHARGED
120 minute winter	S31	118	58.604	1.019	77.4	5.8341	0.0000	SURCHARGED
15 minute winter	S32	48	57.431	0.325	42.3	0.4658	0.0000	SURCHARGED
60 minute summer	S33	185	57.345	0.289	42.3	0.4131	0.0000	SURCHARGED
60 minute summer	Ex MH34	185	57.132	0.172	42.3	0.0000	0.0000	OK

Link Event (Outflow)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	S27	7.002	S28	100.3	0.736	0.163	13.1905	
15 minute summer	S28	7.003	S29	191.3	0.953	0.312	21.7733	
15 minute summer	S29	7.004	S30	207.1	0.845	0.336	10.3068	
15 minute summer	S30	3.006	S31	-259.4	-0.748	-0.421	10.8750	
120 minute winter	S31	1.009	S32	42.3	0.980	0.300	1.4029	
15 minute winter	S32	1.010	S33	42.3	1.065	1.054	0.3311	
60 minute summer	S33	1.011	Ex MH34	42.3	1.097	1.397	1.0083	830.3

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Results for 100 year Critical Storm Duration. Lowest mass balance: 99.86%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	S1	11	59.317	0.179	5.3	0.2563	0.0000	OK
15 minute summer	S2	11	59.314	0.300	44.1	0.4298	0.0000	SURCHARGED
15 minute summer	S3	11	59.068	0.320	84.6	0.8133	0.0000	SURCHARGED
120 minute winter	S4	118	58.881	0.323	33.9	0.5709	0.0000	OK
120 minute winter	S5	118	58.881	0.179	12.1	0.2559	0.0000	OK
120 minute winter	S6	120	58.881	0.793	73.7	3.5858	0.0000	SURCHARGED
120 minute winter	S7	118	58.881	0.931	72.2	3.2250	0.0000	SURCHARGED
120 minute winter	S8	118	58.881	0.947	69.9	3.2806	0.0000	SURCHARGED
120 minute winter	S9	118	58.881	1.008	90.9	3.4925	0.0000	SURCHARGED
120 minute winter	S10	118	58.882	1.185	104.2	4.1036	0.0000	SURCHARGED
120 minute winter	S16	120	58.884	0.751	19.6	2.5999	0.0000	SURCHARGED
120 minute winter	S17	120	58.883	0.899	40.9	3.1134	0.0000	SURCHARGED
120 minute winter	S18	120	58.883	1.030	47.5	3.5663	0.0000	SURCHARGED
120 minute winter	S11	120	58.881	0.467	33.9	0.8251	0.0000	SURCHARGED
15 minute summer	S12	10	59.261	0.112	50.4	0.1986	0.0000	OK
15 minute summer	S13	10	59.091	0.116	60.7	0.2055	0.0000	OK
120 minute winter	S14	120	58.882	0.245	23.8	0.4324	0.0000	OK
120 minute winter	S15	118	58.883	0.631	57.7	1.6055	0.0000	SURCHARGED
120 minute winter	S19	120	58.882	0.882	28.2	3.0562	0.0000	SURCHARGED
120 minute winter	S20	120	58.882	1.033	36.3	3.5800	0.0000	SURCHARGED
120 minute winter	S21	120	58.882	1.086	115.6	6.2212	0.0000	SURCHARGED
120 minute winter	S22	120	58.883	1.124	107.7	0.0000	0.0000	OK
120 minute winter	S23	120	58.883	1.200	120.4	0.0000	0.0000	SURCHARGED
15 minute summer	S25	10	60.193	0.112	48.3	0.1271	0.0000	OK
15 minute summer	S24	10	59.101	0.429	61.4	0.4848	0.0000	SURCHARGED
120 minute winter	S26	120	58.882	0.581	30.9	1.0270	0.0000	SURCHARGED

Link Event (Outflow)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	S1	1.000	S2	7.6	0.312	0.179	0.6821	
15 minute summer	S2	1.001	S3	44.4	1.179	1.049	1.1401	
15 minute summer	S3	1.002	S4	84.2	1.240	1.176	1.7740	
15 minute summer	S4	1.003	S6	111.9	1.280	0.992	2.5701	
15 minute summer	S5	2.000	S6	42.1	1.064	0.587	1.5452	
15 minute summer	S6	1.004	S7	243.8	1.012	0.397	15.7238	
15 minute summer	S7	1.005	S8	261.2	0.959	0.423	2.1422	
15 minute summer	S8	1.006	S9	277.3	1.017	0.452	8.8852	
15 minute summer	S9	1.007	S10	336.6	1.052	0.544	28.6114	
15 minute summer	S10	1.008	S31	388.2	0.979	0.636	20.0154	
15 minute summer	S16	3.000	S17	67.5	0.649	0.110	15.8198	
15 minute summer	S17	3.001	S18	138.5	0.741	0.225	18.2402	
15 minute summer	S18	3.002	S21	196.0	0.693	0.318	9.1029	
15 minute summer	S11	4.000	S15	114.9	0.954	0.716	8.8988	
15 minute summer	S12	5.000	S13	50.2	1.586	0.110	0.2763	
15 minute summer	S13	5.001	S14	60.3	1.736	0.132	0.5868	
15 minute summer	S14	5.002	S15	83.3	1.185	0.182	1.8299	
15 minute summer	S15	4.001	S21	184.5	1.361	1.146	8.2670	
15 minute summer	S19	6.000	S20	85.1	0.649	0.138	20.5758	
15 minute summer	S20	6.001	S21	135.5	0.533	0.220	8.4863	
15 minute summer	S21	3.003	S22	486.5	1.741	0.790	6.0207	
15 minute summer	S22	Flow through Pond	S23	-248.9	0.164	-0.005	332.2716	
15 minute summer	S23	3.005	S30	-518.5	-2.034	-0.850	6.2722	
15 minute summer	S25	7.000	S26	47.7	2.468	0.472	0.8033	
15 minute summer	S24	8.000	S26	60.1	1.514	1.502	0.9436	
15 minute summer	S26	7.001	S27	107.4	1.189	0.648	0.3736	

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Results for 100 year Critical Storm Duration. Lowest mass balance: 99.86%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
120 minute winter	S27	120	58.882	0.892	35.9	3.0905	0.0000	SURCHARGED
120 minute winter	S28	120	58.882	1.017	62.9	3.5215	0.0000	SURCHARGED
120 minute winter	S29	118	58.882	1.171	66.2	4.0555	0.0000	SURCHARGED
120 minute winter	S30	120	58.882	1.234	122.2	7.0651	0.0000	SURCHARGED
120 minute winter	S31	118	58.882	1.297	97.2	7.4254	0.0000	SURCHARGED
30 minute summer	S32	180	57.431	0.325	42.3	0.4658	0.0000	SURCHARGED
30 minute summer	S33	180	57.345	0.289	42.3	0.4131	0.0000	SURCHARGED
30 minute summer	Ex MH34	180	57.132	0.172	42.3	0.0000	0.0000	OK

Link Event (Outflow)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	S27	7.002	S28	121.1	0.747	0.197	17.0813	
15 minute summer	S28	7.003	S29	224.3	0.972	0.365	25.4732	
15 minute summer	S29	7.004	S30	242.2	0.880	0.393	11.0536	
15 minute summer	S30	3.006	S31	-306.3	-0.790	-0.497	11.0770	
720 minute summer	S31	1.009	S32	42.3	0.964	0.300	1.4029	
30 minute winter	S32	1.010	S33	42.3	1.065	1.054	0.3311	
30 minute summer	S33	1.011	Ex MH34	42.3	1.097	1.397	1.0083	834.4

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Results for 100 year +45% CC Critical Storm Duration. Lowest mass balance: 99.64%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	S1	11	59.962	0.824	7.3	1.1790	0.0000	SURCHARGED
15 minute summer	S2	11	59.961	0.947	65.6	1.3550	0.0000	SURCHARGED
30 minute summer	S3	20	59.515	0.767	112.6	1.9512	0.0000	SURCHARGED
180 minute winter	S4	176	59.507	0.949	35.6	1.6776	0.0000	SURCHARGED
180 minute winter	S5	176	59.507	0.805	12.7	1.1524	0.0000	SURCHARGED
180 minute winter	S6	176	59.507	1.419	76.8	6.4209	0.0000	SURCHARGED
180 minute winter	S7	176	59.507	1.557	73.2	5.3943	0.0000	FLOOD RISK
180 minute winter	S8	176	59.507	1.573	73.2	5.4497	0.0000	FLOOD RISK
180 minute winter	S9	176	59.507	1.634	98.4	5.6610	0.0000	FLOOD RISK
180 minute winter	S10	176	59.507	1.810	124.8	6.2706	0.0000	FLOOD RISK
180 minute winter	S16	180	59.507	1.374	20.5	4.7608	0.0000	SURCHARGED
180 minute winter	S17	180	59.507	1.523	43.2	5.2767	0.0000	SURCHARGED
180 minute winter	S18	180	59.508	1.655	62.4	5.7313	0.0000	SURCHARGED
180 minute winter	S11	176	59.507	1.093	35.6	1.9321	0.0000	SURCHARGED
180 minute winter	S12	176	59.507	0.358	14.9	0.6331	0.0000	OK
180 minute winter	S13	176	59.507	0.532	18.0	0.9407	0.0000	SURCHARGED
180 minute winter	S14	176	59.507	0.870	25.2	1.5380	0.0000	SURCHARGED
180 minute winter	S15	176	59.507	1.255	57.5	3.1947	0.0000	SURCHARGED
180 minute winter	S19	180	59.508	1.508	29.6	5.2221	0.0000	SURCHARGED
180 minute winter	S20	180	59.508	1.659	45.0	5.7456	0.0000	SURCHARGED
180 minute winter	S21	180	59.508	1.712	152.9	9.8010	0.0000	SURCHARGED
180 minute winter	S22	180	59.508	1.749	161.9	0.0000	0.0000	OK
180 minute winter	S23	180	59.508	1.825	172.3	0.0000	0.0000	FLOOD RISK
15 minute summer	S25	10	60.224	0.143	69.9	0.1616	0.0000	OK
15 minute summer	S24	10	59.562	0.890	89.0	1.0064	0.0000	SURCHARGED
180 minute winter	S26	180	59.507	1.206	32.4	2.1317	0.0000	SURCHARGED

Link Event (Outflow)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	S1	1.000	S2	15.7	0.465	0.371	0.7366	
15 minute summer	S2	1.001	S3	64.1	1.611	1.513	1.1401	
15 minute summer	S3	1.002	S4	121.1	1.720	1.692	1.9339	
15 minute summer	S4	1.003	S6	162.1	1.501	1.437	3.2616	
15 minute summer	S5	2.000	S6	61.0	1.177	0.850	2.7483	
15 minute summer	S6	1.004	S7	327.3	1.061	0.533	24.3545	
15 minute summer	S7	1.005	S8	330.1	0.987	0.534	2.7926	
15 minute summer	S8	1.006	S9	340.8	1.029	0.555	10.7975	
15 minute summer	S9	1.007	S10	453.0	1.070	0.732	30.6570	
15 minute summer	S10	1.008	S31	548.6	1.247	0.898	20.0154	
30 minute summer	S16	3.000	S17	88.8	0.632	0.144	26.2840	
15 minute summer	S17	3.001	S18	170.5	0.741	0.277	23.0302	
15 minute summer	S18	3.002	S21	252.3	0.738	0.409	10.0017	
15 minute summer	S11	4.000	S15	176.9	1.117	1.103	10.2912	
15 minute summer	S12	5.000	S13	72.8	1.802	0.159	0.3707	
15 minute summer	S13	5.001	S14	87.8	1.865	0.191	1.4177	
15 minute summer	S14	5.002	S15	117.1	1.253	0.256	2.7857	
15 minute summer	S15	4.001	S21	272.1	1.744	1.689	9.8376	
15 minute summer	S19	6.000	S20	131.0	0.637	0.212	26.4539	
15 minute summer	S20	6.001	S21	202.8	0.585	0.330	9.3341	
15 minute summer	S21	3.003	S22	707.1	1.941	1.148	6.3201	
15 minute summer	S22	Flow through Pond	S23	-497.1	0.159	-0.011	526.4492	
30 minute summer	S23	3.005	S30	-829.3	-1.884	-1.360	6.2722	
15 minute summer	S25	7.000	S26	69.2	2.681	0.685	1.0754	
15 minute summer	S24	8.000	S26	87.5	2.201	2.187	0.9636	
15 minute summer	S26	7.001	S27	156.1	1.353	0.942	0.6556	

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Results for 100 year +45% CC Critical Storm Duration. Lowest mass balance: 99.64%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
180 minute winter	S27	180	59.507	1.517	35.0	5.2563	0.0000	SURCHARGED
180 minute winter	S28	180	59.507	1.642	67.9	5.6894	0.0000	SURCHARGED
180 minute winter	S29	180	59.508	1.797	85.1	6.2232	0.0000	FLOOD RISK
180 minute winter	S30	180	59.508	1.860	175.2	10.6480	0.0000	SURCHARGED
180 minute winter	S31	180	59.507	1.922	123.0	11.0067	0.0000	SURCHARGED
180 minute summer	S32	648	57.431	0.325	42.3	0.4658	0.0000	SURCHARGED
30 minute winter	S33	348	57.345	0.289	42.3	0.4131	0.0000	SURCHARGED
30 minute winter	Ex MH34	348	57.132	0.172	42.3	0.0000	0.0000	OK

Link Event (Outflow)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	S27	7.002	S28	164.1	0.758	0.267	22.0417	
15 minute summer	S28	7.003	S29	298.6	1.008	0.486	27.2228	
15 minute summer	S29	7.004	S30	333.3	0.945	0.541	11.0545	
30 minute summer	S30	3.006	S31	-497.3	-1.130	-0.808	11.0770	
60 minute summer	S31	1.009	S32	42.3	1.004	0.300	1.4029	
480 minute summer	S32	1.010	S33	42.3	1.065	1.054	0.3311	
30 minute winter	S33	1.011	Ex MH34	42.3	1.097	1.397	1.0083	1211.5

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Results for 200 year Critical Storm Duration. Lowest mass balance: 99.81%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	S1	11	59.477	0.339	5.3	0.4858	0.0000	SURCHARGED
15 minute summer	S2	11	59.467	0.453	51.9	0.6488	0.0000	SURCHARGED
15 minute summer	S3	11	59.142	0.394	95.5	1.0037	0.0000	SURCHARGED
180 minute winter	S4	176	59.077	0.519	27.8	0.9167	0.0000	SURCHARGED
180 minute winter	S5	176	59.077	0.375	9.9	0.5362	0.0000	SURCHARGED
180 minute winter	S6	176	59.077	0.989	60.3	4.4731	0.0000	SURCHARGED
180 minute winter	S7	176	59.077	1.127	59.8	3.9033	0.0000	SURCHARGED
180 minute winter	S8	176	59.077	1.143	58.4	3.9587	0.0000	SURCHARGED
180 minute winter	S9	176	59.077	1.204	76.1	4.1701	0.0000	SURCHARGED
180 minute winter	S10	176	59.077	1.380	89.3	4.7802	0.0000	SURCHARGED
180 minute winter	S16	176	59.077	0.944	16.0	3.2711	0.0000	SURCHARGED
180 minute winter	S17	176	59.077	1.093	30.9	3.7871	0.0000	SURCHARGED
180 minute winter	S18	176	59.077	1.224	36.3	4.2410	0.0000	SURCHARGED
180 minute winter	S11	176	59.078	0.664	27.7	1.1725	0.0000	SURCHARGED
15 minute summer	S12	10	59.269	0.120	56.5	0.2121	0.0000	OK
15 minute summer	S13	10	59.099	0.124	68.1	0.2192	0.0000	OK
180 minute winter	S14	176	59.077	0.440	19.4	0.7778	0.0000	OK
180 minute winter	S15	176	59.077	0.825	47.1	2.1004	0.0000	SURCHARGED
180 minute winter	S19	176	59.077	1.077	23.1	3.7320	0.0000	SURCHARGED
180 minute winter	S20	176	59.077	1.228	30.0	4.2550	0.0000	SURCHARGED
180 minute winter	S21	176	59.077	1.281	92.5	7.3369	0.0000	SURCHARGED
180 minute winter	S22	176	59.077	1.318	93.8	0.0000	0.0000	OK
180 minute winter	S23	176	59.077	1.394	103.2	0.0000	0.0000	SURCHARGED
15 minute summer	S25	10	60.202	0.120	54.1	0.1363	0.0000	OK
15 minute summer	S24	10	59.224	0.552	68.8	0.6239	0.0000	SURCHARGED
180 minute winter	S26	176	59.077	0.776	25.2	1.3718	0.0000	SURCHARGED

Link Event (Outflow)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	S1	1.000	S2	11.3	0.361	0.265	0.7366	
15 minute summer	S2	1.001	S3	50.5	1.269	1.192	1.1401	
15 minute summer	S3	1.002	S4	94.9	1.350	1.326	1.8784	
15 minute summer	S4	1.003	S6	125.7	1.321	1.115	2.7763	
15 minute summer	S5	2.000	S6	47.2	1.098	0.658	1.6777	
15 minute summer	S6	1.004	S7	269.5	1.030	0.438	18.7699	
15 minute summer	S7	1.005	S8	283.2	0.965	0.458	2.4665	
15 minute summer	S8	1.006	S9	297.7	1.015	0.485	10.0085	
15 minute summer	S9	1.007	S10	361.2	1.054	0.584	30.0519	
15 minute summer	S10	1.008	S31	419.8	0.993	0.688	20.0154	
15 minute summer	S16	3.000	S17	74.4	0.658	0.121	19.4429	
15 minute summer	S17	3.001	S18	150.2	0.745	0.244	20.6900	
15 minute summer	S18	3.002	S21	217.0	0.711	0.352	9.8074	
15 minute summer	S11	4.000	S15	124.6	0.968	0.776	9.9076	
15 minute summer	S12	5.000	S13	56.3	1.623	0.123	0.3027	
15 minute summer	S13	5.001	S14	67.7	1.788	0.148	0.6394	
15 minute summer	S14	5.002	S15	93.4	1.214	0.204	1.9099	
15 minute summer	S15	4.001	S21	204.7	1.390	1.271	8.6526	
15 minute summer	S19	6.000	S20	99.2	0.657	0.161	23.4871	
15 minute summer	S20	6.001	S21	146.0	0.543	0.237	9.1567	
15 minute summer	S21	3.003	S22	549.5	1.818	0.892	6.3201	
15 minute summer	S22	Flow through Pond	S23	-289.0	0.177	-0.006	377.0437	
15 minute summer	S23	3.005	S30	-583.6	-2.170	-0.957	6.2722	
15 minute summer	S25	7.000	S26	53.4	2.535	0.529	0.8760	
15 minute summer	S24	8.000	S26	67.6	1.699	1.688	0.9556	
15 minute summer	S26	7.001	S27	120.5	1.235	0.727	0.4033	

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Results for 200 year Critical Storm Duration. Lowest mass balance: 99.81%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
180 minute winter	S27	176	59.077	1.087	29.0	3.7664	0.0000	SURCHARGED
180 minute winter	S28	176	59.077	1.212	50.4	4.1992	0.0000	SURCHARGED
180 minute winter	S29	176	59.077	1.366	55.6	4.7327	0.0000	SURCHARGED
180 minute winter	S30	176	59.077	1.429	104.8	8.1839	0.0000	SURCHARGED
180 minute winter	S31	176	59.077	1.492	85.8	8.5434	0.0000	SURCHARGED
30 minute summer	S32	223	57.431	0.325	42.3	0.4658	0.0000	SURCHARGED
60 minute winter	S33	337	57.345	0.289	42.3	0.4131	0.0000	SURCHARGED
60 minute summer	Ex MH34	337	57.132	0.172	42.3	0.0000	0.0000	OK

Link Event (Outflow)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	S27	7.002	S28	132.5	0.750	0.216	19.4166	
15 minute summer	S28	7.003	S29	245.2	0.985	0.399	26.7074	
15 minute summer	S29	7.004	S30	266.0	0.892	0.432	11.0545	
15 minute summer	S30	3.006	S31	-343.5	-0.805	-0.558	11.0770	
30 minute winter	S31	1.009	S32	42.3	1.075	0.300	1.4029	
30 minute summer	S32	1.010	S33	42.3	1.065	1.054	0.3311	
60 minute summer	S33	1.011	Ex MH34	42.3	1.097	1.397	1.0083	1178.2

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APPENDIX E – EXCEEDANCE FLOW ROUTING PLAN (BETTS ASSOCIATES)

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LEGEND

- Site Boundary
- FFL 134.65 — Proposed Finished Floor Level
- Proposed Surface Water Sewer
- Proposed Gully Connection
- Proposed Foul Water Sewer
- Flood Flow Exceedance Low Points

Flood Exceedance Event (1 in 800 Year)

This plan illustrates flood exceedance routing and ponding based on the proposed ground levels under the simulated 1 in 800 year storm event, as detailed in Doc: TAY143-GDX-BET-ZZ-XX-RP-C-0013- P01-Exceedance Event Network Details.

The simulation results show manhole cover exceedance and flooding at the following location: S7 (~14m³). This plan provides a visual representation of the associated flood volumes for exceedance.

The simulation includes the operation of the proposed below-ground drainage system and identifies the point at which it is first exceeded. Exceedance flows are contained within the proposed carriageway, directed away from both proposed and existing dwellings. There is no flooding of the proposed dwellings in this extreme storm event.

Notes

1. Planning layout ref. Taylor Wimpey - 25053-1000H- Site Layout_2025-10-09 .
2. Topographical survey provided by 'GEO_ref 'G24104 - Stoney Lane, Prescot Topographical and Utility Survey', Dated March 2024.
3. Road detail, levels and layout are subject to local authority section 38 Highways approval.

0 5 10 20 30 40 50m

SCALE 1:500

Mark	Date	Details	By	Che
P03	20.08.26	Updated with current Site Layout	CP	
P02	26.03.26	Up-Flo filter indicated	CP	
P01	23.03.26	Preliminary issue for review	CP	

Revision history

Drawing originator:

BETTS HYDRO CONSULTING ENGINEERS · BETTS ASSOCIATES CONSULTING ENGINEERS · BETTS GEO CONSULTING ENGINEERS

Client: Taylor Wimpey

Project title: Glen Dimplex, Stoney Lane

Drawing title: Flood Exceedance Routing

Scale: 1:500 for the original size of A0

Drawn by: CP | Checked by: - | Passed by: - | Date: Apr' 2025

Drawing status:

Job No:	Drawing No: Project	Origin	Volume	Level	Type	Discip	Number	Revision:
TAY143	GDX	BET	ZZ	XX	DR	C	0008	P03

Do not scale this drawing

6-7 Old Horeh Farm Barns, Welsh Road, Sealand, Flintshire, CH5 2LY
enquiries@betts-associates.co.uk
Chester 01244 288178

Simulation Settings

Rainfall Methodology	FEH-22	Skip Steady State	x	1 year (l/s)	42.2
Rainfall Events	Singular	Drain Down Time (mins)	1440	2 year (l/s)	42.4
Summer CV	1.000	Additional Storage (m³/ha)	0.0	30 year (l/s)	42.4
Winter CV	1.000	Starting Level (m)		100 year (l/s)	42.4
Analysis Speed	Detailed	Check Discharge Rate(s)	✓	Check Discharge Volume	x

Storm Durations

15	30	60	120	180	240	360	480	600	720	960	1440

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
800	0	0	0

Pre-development Discharge Rate

Site Makeup	Greenfield	SPR	0.10	Betterment (%)	0
Greenfield Method	IH124	Region	1	QBar	
Positively Drained Area (ha)		Growth Factor 1 year	0.85	Q 1 year (l/s)	
SAAR (mm)		Growth Factor 30 year	1.95	Q 30 year (l/s)	
Soil Index	1	Growth Factor 100 year	2.48	Q 100 year (l/s)	

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Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)	Invert Level (m)
S1	0.010	5.00	60.797	1350	347945.194	391628.292	1.659	59.138
S2	0.092	5.00	60.635	1350	347941.921	391610.063	1.621	59.014
S3	0.088	5.00	60.389	1800	347931.180	391583.485	1.641	58.748
S4	0.062	5.00	60.203	1500	347905.708	391593.748	1.645	58.558
S5	0.090	5.00	59.955	1350	347887.069	391642.825	1.253	58.702
S6	0.205	5.00	60.130	2400	347878.280	391604.799	2.042	58.088
S7	0.062	5.00	59.628	2100	347857.494	391553.515	1.678	57.950
S8	0.053	5.00	59.584	2100	347860.047	391547.707	1.650	57.934
S9	0.195	5.00	59.679	2100	347882.811	391538.561	1.806	57.873
S10	0.198	5.00	59.777	2100	347947.445	391512.593	2.080	57.697
S16	0.145	5.00	61.791	2100	348160.138	391490.862	3.658	58.133
S17	0.200	5.00	60.742	2100	348104.767	391513.234	2.758	57.984
S18	0.158	5.00	60.323	2100	348056.250	391532.836	2.470	57.853
S11	0.251	5.00	61.146	1500	348118.621	391574.685	2.732	58.414
S12	0.105	5.00	60.824	1500	348017.411	391615.435	1.675	59.149
S13	0.022	5.00	60.776	1500	348023.976	391609.685	1.801	58.975
S14	0.049	5.00	60.649	1500	348040.478	391606.148	2.012	58.637
S15			60.490	1800	348058.369	391598.944	2.238	58.252
S19	0.209	5.00	60.208	2100	347959.786	391571.810	2.208	58.000
S20	0.129	5.00	59.972	2100	348015.516	391549.294	2.123	57.849
S21			60.242	2700	348035.180	391541.349	2.446	57.796
S22			59.683		348029.837	391528.020	1.924	57.759
S23		5.00	59.683		348018.331	391499.471	2.000	57.683
S25	0.101	5.00	61.506	1200	348158.094	391472.702	1.425	60.081
S24	0.128	5.00	60.271	1200	348135.710	391410.594	1.599	58.672
S26			60.587	1500	348144.008	391433.619	2.286	58.301
S27	0.037	5.00	60.472	2100	348140.169	391435.162	2.482	57.990
S28	0.262	5.00	60.033	2100	348093.698	391453.833	2.168	57.865
S29	0.131	5.00	59.787	2100	348036.303	391476.892	2.076	57.711
S30	0.082	5.00	60.089	2700	348012.998	391486.256	2.441	57.648
S31			60.074	2700	347989.644	391495.638	2.489	57.585
S32			59.529	1350	347978.493	391468.039	2.423	57.106
S33			59.549	1350	347986.213	391464.920	2.493	57.056
Ex MH34			58.500	1350	347983.573	391437.196	1.540	56.960

Links (Input)

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	S1	S2	18.520	0.600	59.138	59.014	0.124	149.4	225	5.29	38.8
1.001	S2	S3	28.667	0.600	59.014	58.823	0.191	150.1	225	5.74	37.4
1.002	S3	S4	27.462	0.600	58.748	58.633	0.115	238.8	300	6.19	36.2
1.003	S4	S6	29.571	0.600	58.558	58.463	0.095	311.3	375	6.67	34.9
2.000	S5	S6	39.028	0.600	58.702	58.538	0.164	238.0	300	5.64	37.7
1.004	S6	S7	55.336	0.600	58.088	57.950	0.138	401.0	750	7.34	33.3
1.005	S7	S8	6.345	0.600	57.950	57.934	0.016	396.6	750	7.41	33.1
1.006	S8	S9	24.533	0.600	57.934	57.873	0.061	402.2	750	7.71	32.4
1.007	S9	S10	69.656	0.600	57.873	57.697	0.176	395.8	750	8.53	30.7
1.008	S10	S31	45.477	0.600	57.697	57.585	0.112	406.0	750	9.08	29.7
3.000	S16	S17	59.720	0.600	58.133	57.984	0.149	400.8	750	5.72	37.5
3.001	S17	S18	52.327	0.600	57.984	57.853	0.131	399.4	750	6.34	35.8
3.002	S18	S21	22.725	0.600	57.853	57.796	0.057	398.7	750	6.61	35.1
4.000	S11	S15	64.952	0.600	58.414	58.252	0.162	400.9	450	6.07	36.5
5.000	S12	S13	8.727	0.600	59.149	58.975	0.174	50.2	450	5.05	39.5

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Links (Input)

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
5.001	S13	S14	16.877	0.600	58.975	58.637	0.338	49.9	450	5.15	39.2
5.002	S14	S15	19.286	0.600	58.637	58.252	0.385	50.1	450	5.26	38.8
4.001	S15	S21	62.089	0.600	58.252	58.096	0.156	398.0	450	7.09	33.8
6.000	S19	S20	60.106	0.600	58.000	57.849	0.151	398.1	750	5.72	37.5
6.001	S20	S21	21.208	0.600	57.849	57.796	0.053	400.2	750	5.97	36.8
3.003	S21	S22	14.360	0.600	57.796	57.760	0.036	398.9	750	7.27	33.4
3.005	S23	S30	14.251	0.600	57.683	57.648	0.035	407.2	750	5.17	39.1
7.000	S25	S26	41.544	0.600	60.081	58.526	1.555	26.7	225	5.27	38.8
8.000	S24	S26	24.475	0.600	58.672	58.526	0.146	167.6	225	5.41	38.4
7.001	S26	S27	4.138	0.600	58.301	58.290	0.011	376.2	450	5.47	38.2
7.002	S27	S28	50.081	0.600	57.990	57.865	0.125	400.6	750	6.07	36.5
7.003	S28	S29	61.853	0.600	57.865	57.711	0.154	401.6	750	6.81	34.5
7.004	S29	S30	25.117	0.600	57.711	57.648	0.063	398.7	750	7.11	33.8
3.006	S30	S31	25.168	0.600	57.648	57.585	0.063	399.5	750	7.41	33.1
1.009	S31	S32	29.766	0.600	57.585	57.106	0.479	62.1	300	9.33	29.3
1.010	S32	S33	8.326	0.600	57.106	57.056	0.050	166.5	225	9.47	29.0
1.011	S33	Ex MH34	27.850	0.600	57.056	56.960	0.096	290.1	225	10.08	28.0

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.000	18.520	149.4	225	Circular	60.797	59.138	1.434	60.635	59.014	1.396
1.001	28.667	150.1	225	Circular	60.635	59.014	1.396	60.389	58.823	1.341
1.002	27.462	238.8	300	Circular	60.389	58.748	1.341	60.203	58.633	1.270
1.003	29.571	311.3	375	Circular	60.203	58.558	1.270	60.130	58.463	1.292
2.000	39.028	238.0	300	Circular	59.955	58.702	0.953	60.130	58.538	1.292
1.004	55.336	401.0	750	Circular	60.130	58.088	1.292	59.628	57.950	0.928
1.005	6.345	396.6	750	Circular	59.628	57.950	0.928	59.584	57.934	0.900
1.006	24.533	402.2	750	Circular	59.584	57.934	0.900	59.679	57.873	1.056
1.007	69.656	395.8	750	Circular	59.679	57.873	1.056	59.777	57.697	1.330
1.008	45.477	406.0	750	Circular	59.777	57.697	1.330	60.074	57.585	1.739
3.000	59.720	400.8	750	Circular	61.791	58.133	2.908	60.742	57.984	2.008
3.001	52.327	399.4	750	Circular	60.742	57.984	2.008	60.323	57.853	1.720
3.002	22.725	398.7	750	Circular	60.323	57.853	1.720	60.242	57.796	1.696
4.000	64.952	400.9	450	Circular	61.146	58.414	2.282	60.490	58.252	1.788

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.000	S1	1350	Manhole	Adoptable	S2	1350	Manhole	Adoptable
1.001	S2	1350	Manhole	Adoptable	S3	1800	Manhole	Adoptable
1.002	S3	1800	Manhole	Adoptable	S4	1500	Manhole	Adoptable
1.003	S4	1500	Manhole	Adoptable	S6	2400	Manhole	Adoptable
2.000	S5	1350	Manhole	Adoptable	S6	2400	Manhole	Adoptable
1.004	S6	2400	Manhole	Adoptable	S7	2100	Manhole	Adoptable
1.005	S7	2100	Manhole	Adoptable	S8	2100	Manhole	Adoptable
1.006	S8	2100	Manhole	Adoptable	S9	2100	Manhole	Adoptable
1.007	S9	2100	Manhole	Adoptable	S10	2100	Manhole	Adoptable
1.008	S10	2100	Manhole	Adoptable	S31	2700	Manhole	Adoptable
3.000	S16	2100	Manhole	Adoptable	S17	2100	Manhole	Adoptable
3.001	S17	2100	Manhole	Adoptable	S18	2100	Manhole	Adoptable
3.002	S18	2100	Manhole	Adoptable	S21	2700	Manhole	Adoptable
4.000	S11	1500	Manhole	Adoptable	S15	1800	Manhole	Adoptable

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Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
5.000	8.727	50.2	450	Circular	60.824	59.149	1.225	60.776	58.975	1.351
5.001	16.877	49.9	450	Circular	60.776	58.975	1.351	60.649	58.637	1.562
5.002	19.286	50.1	450	Circular	60.649	58.637	1.562	60.490	58.252	1.788
4.001	62.089	398.0	450	Circular	60.490	58.252	1.788	60.242	58.096	1.696
6.000	60.106	398.1	750	Circular	60.208	58.000	1.458	59.972	57.849	1.373
6.001	21.208	400.2	750	Circular	59.972	57.849	1.373	60.242	57.796	1.696
3.003	14.360	398.9	750	Circular	60.242	57.796	1.696	59.683	57.760	1.173
3.005	14.251	407.2	750	Circular	59.683	57.683	1.250	60.089	57.648	1.691
7.000	41.544	26.7	225	Circular	61.506	60.081	1.200	60.587	58.526	1.836
8.000	24.475	167.6	225	Circular	60.271	58.672	1.374	60.587	58.526	1.836
7.001	4.138	376.2	450	Circular	60.587	58.301	1.836	60.472	58.290	1.732
7.002	50.081	400.6	750	Circular	60.472	57.990	1.732	60.033	57.865	1.418
7.003	61.853	401.6	750	Circular	60.033	57.865	1.418	59.787	57.711	1.326
7.004	25.117	398.7	750	Circular	59.787	57.711	1.326	60.089	57.648	1.691
3.006	25.168	399.5	750	Circular	60.089	57.648	1.691	60.074	57.585	1.739
1.009	29.766	62.1	300	Circular	60.074	57.585	2.189	59.529	57.106	2.123
1.010	8.326	166.5	225	Circular	59.529	57.106	2.198	59.549	57.056	2.268
1.011	27.850	290.1	225	Circular	59.549	57.056	2.268	58.500	56.960	1.315

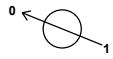
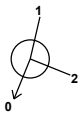
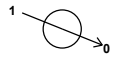
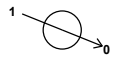
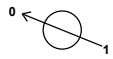
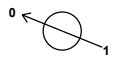
Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
5.000	S12	1500	Manhole	Adoptable	S13	1500	Manhole	Adoptable
5.001	S13	1500	Manhole	Adoptable	S14	1500	Manhole	Adoptable
5.002	S14	1500	Manhole	Adoptable	S15	1800	Manhole	Adoptable
4.001	S15	1800	Manhole	Adoptable	S21	2700	Manhole	Adoptable
6.000	S19	2100	Manhole	Adoptable	S20	2100	Manhole	Adoptable
6.001	S20	2100	Manhole	Adoptable	S21	2700	Manhole	Adoptable
3.003	S21	2700	Manhole	Adoptable	S22		Junction	
3.005	S23		Junction		S30	2700	Manhole	Adoptable
7.000	S25	1200	Manhole	Adoptable	S26	1500	Manhole	Adoptable
8.000	S24	1200	Manhole	Adoptable	S26	1500	Manhole	Adoptable
7.001	S26	1500	Manhole	Adoptable	S27	2100	Manhole	Adoptable
7.002	S27	2100	Manhole	Adoptable	S28	2100	Manhole	Adoptable
7.003	S28	2100	Manhole	Adoptable	S29	2100	Manhole	Adoptable
7.004	S29	2100	Manhole	Adoptable	S30	2700	Manhole	Adoptable
3.006	S30	2700	Manhole	Adoptable	S31	2700	Manhole	Adoptable
1.009	S31	2700	Manhole	Adoptable	S32	1350	Manhole	Adoptable
1.010	S32	1350	Manhole	Adoptable	S33	1350	Manhole	Adoptable
1.011	S33	1350	Manhole	Adoptable	Ex MH34	1350	Manhole	Adoptable

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections		Link	IL (m)	Dia (mm)
S1	347945.194	391628.292	60.797	1.659	1350		0	1.000	59.138	225
S2	347941.921	391610.063	60.635	1.621	1350		1 0	1.000 1.001	59.014 59.014	225 225

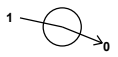
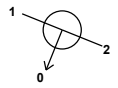
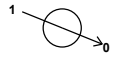
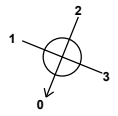
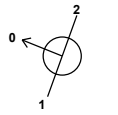
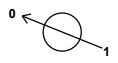
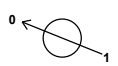
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Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections		Link	IL (m)	Dia (mm)
S3	347931.180	391583.485	60.389	1.641	1800		1	1.001	58.823	225
							0	1.002	58.748	300
S4	347905.708	391593.748	60.203	1.645	1500		1	1.002	58.633	300
							0	1.003	58.558	375
S5	347887.069	391642.825	59.955	1.253	1350		0	2.000	58.702	300
S6	347878.280	391604.799	60.130	2.042	2400		1	2.000	58.538	300
							2	1.003	58.463	375
							0	1.004	58.088	750
S7	347857.494	391553.515	59.628	1.678	2100		1	1.004	57.950	750
							0	1.005	57.950	750
S8	347860.047	391547.707	59.584	1.650	2100		1	1.005	57.934	750
							0	1.006	57.934	750
S9	347882.811	391538.561	59.679	1.806	2100		1	1.006	57.873	750
							0	1.007	57.873	750
S10	347947.445	391512.593	59.777	2.080	2100		1	1.007	57.697	750
							0	1.008	57.697	750
S16	348160.138	391490.862	61.791	3.658	2100		0	3.000	58.133	750
S17	348104.767	391513.234	60.742	2.758	2100		1	3.000	57.984	750
							0	3.001	57.984	750
S18	348056.250	391532.836	60.323	2.470	2100		1	3.001	57.853	750
							0	3.002	57.853	750
S11	348118.621	391574.685	61.146	2.732	1500		0	4.000	58.414	450
S12	348017.411	391615.435	60.824	1.675	1500		0	5.000	59.149	450

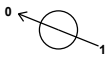
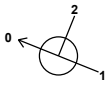
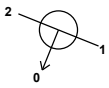
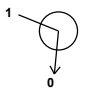
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Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
S13	348023.976	391609.685	60.776	1.801	1500	 1	5.000	58.975	450
						0	5.001	58.975	450
S14	348040.478	391606.148	60.649	2.012	1500	 1	5.001	58.637	450
						0	5.002	58.637	450
S15	348058.369	391598.944	60.490	2.238	1800	1	5.002	58.252	450
						 2	4.000	58.252	450
						0	4.001	58.252	450
S19	347959.786	391571.810	60.208	2.208	2100				
						0	6.000	58.000	750
S20	348015.516	391549.294	59.972	2.123	2100	 1	6.000	57.849	750
						0	6.001	57.849	750
S21	348035.180	391541.349	60.242	2.446	2700	 1	6.001	57.796	750
						2	4.001	58.096	450
						3	3.002	57.796	750
						0	3.003	57.796	750
S22	348029.837	391528.020	59.683	1.924		 1	3.003	57.760	750
S23	348018.331	391499.471	59.683	2.000					
						0	3.005	57.683	750
S25	348158.094	391472.702	61.506	1.425	1200				
						0	7.000	60.081	225
S24	348135.710	391410.594	60.271	1.599	1200				
						0	8.000	58.672	225
S26	348144.008	391433.619	60.587	2.286	1500	 1	8.000	58.526	225
						2	7.000	58.526	225
						0	7.001	58.301	450
S27	348140.169	391435.162	60.472	2.482	2100	 1	7.001	58.290	450
						0	7.002	57.990	750
S28	348093.698	391453.833	60.033	2.168	2100	 1	7.002	57.865	750
						0	7.003	57.865	750

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Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
S29	348036.303	391476.892	59.787	2.076	2100		1	7.003	57.711	750
							0	7.004	57.711	750
S30	348012.998	391486.256	60.089	2.441	2700		1	7.004	57.648	750
							2	3.005	57.648	750
							0	3.006	57.648	750
S31	347989.644	391495.638	60.074	2.489	2700		1	3.006	57.585	750
							2	1.008	57.585	750
							0	1.009	57.585	300
S32	347978.493	391468.039	59.529	2.423	1350		1	1.009	57.106	300
							0	1.010	57.106	225
S33	347986.213	391464.920	59.549	2.493	1350		1	1.010	57.056	225
							0	1.011	57.056	225
Ex MH34	347983.573	391437.196	58.500	1.540	1350		1	1.011	56.960	225

Node S31 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	x	Sump Available	✓
Invert Level (m)	57.585	Product Number	CTL-SHE-0263-4240-1900-4240
Design Depth (m)	1.900	Min Outlet Diameter (m)	0.300
Design Flow (l/s)	42.4	Min Node Diameter (mm)	2400

Node S23 Flow through Pond Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Main Channel Length (m)	30.425
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	57.683	Main Channel Slope (1:X)	400.0
Safety Factor	2.0	Time to half empty (mins)	340	Main Channel n	0.035

Inlets

S22

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	355.7	0.0	0.600	511.8	0.0	1.200	688.8	0.0	1.800	886.1	0.0
0.100	379.9	0.0	0.700	539.9	0.0	1.300	720.3	0.0	1.900	921.0	0.0
0.200	405.2	0.0	0.800	568.6	0.0	1.400	752.3	0.0	2.000	956.4	0.0
0.300	431.0	0.0	0.900	597.8	0.0	1.500	784.9	0.0			
0.400	457.4	0.0	1.000	627.6	0.0	1.600	818.1	0.0			
0.500	484.3	0.0	1.100	657.9	0.0	1.700	851.8	0.0			

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Results for 800 year Critical Storm Duration. Lowest mass balance: 99.67%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	S1	11	59.912	0.774	8.3	1.1074	0.0000	SURCHARGED
15 minute summer	S2	11	59.911	0.897	64.5	1.2836	0.0000	SURCHARGED
240 minute winter	S3	224	59.585	0.837	22.6	2.1303	0.0000	SURCHARGED
240 minute winter	S4	224	59.584	1.026	30.0	1.8138	0.0000	SURCHARGED
240 minute winter	S5	232	59.584	0.882	10.7	1.2623	0.0000	SURCHARGED
240 minute winter	S6	224	59.584	1.496	64.4	6.7684	0.0000	SURCHARGED
240 minute winter	S7	232	59.584	1.634	60.9	5.6602	0.0000	FLOOD RISK
240 minute winter	S8	224	59.584	1.650	65.2	5.7156	11.3135	FLOOD
240 minute winter	S9	228	59.584	1.711	84.9	5.9282	0.0000	FLOOD RISK
240 minute winter	S10	228	59.585	1.888	105.7	6.5417	0.0000	FLOOD RISK
240 minute winter	S16	228	59.588	1.455	17.3	5.0388	0.0000	SURCHARGED
240 minute winter	S17	228	59.587	1.603	38.7	5.5542	0.0000	SURCHARGED
240 minute winter	S18	228	59.587	1.734	55.7	6.0082	0.0000	SURCHARGED
240 minute winter	S11	228	59.588	1.174	29.9	2.0746	0.0000	SURCHARGED
240 minute winter	S12	228	59.588	0.439	12.5	0.7757	0.0000	OK
240 minute winter	S13	228	59.588	0.613	15.1	1.0831	0.0000	SURCHARGED
240 minute winter	S14	228	59.588	0.951	20.9	1.6803	0.0000	SURCHARGED
240 minute winter	S15	228	59.588	1.336	46.9	3.3998	0.0000	SURCHARGED
240 minute winter	S19	228	59.588	1.588	24.9	5.4992	0.0000	SURCHARGED
240 minute winter	S20	228	59.588	1.739	38.8	6.0224	0.0000	SURCHARGED
240 minute winter	S21	228	59.588	1.792	133.4	10.2583	0.0000	SURCHARGED
240 minute winter	S22	228	59.588	1.828	132.5	0.0000	0.0000	OK
240 minute winter	S23	228	59.587	1.904	141.1	0.0000	0.0000	FLOOD RISK
15 minute summer	S25	10	60.222	0.141	68.3	0.1590	0.0000	OK
240 minute winter	S24	228	59.588	0.916	15.3	1.0359	0.0000	SURCHARGED
240 minute winter	S26	228	59.587	1.286	27.3	2.2730	0.0000	SURCHARGED

Link Event (Outflow)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	S1	1.000	S2	14.1	0.477	0.331	0.7366	
15 minute summer	S2	1.001	S3	62.7	1.577	1.481	1.1401	
15 minute summer	S3	1.002	S4	118.6	1.684	1.656	1.9339	
15 minute summer	S4	1.003	S6	158.7	1.474	1.407	3.2616	
15 minute summer	S5	2.000	S6	59.7	1.171	0.832	2.4624	
15 minute summer	S6	1.004	S7	321.1	1.059	0.523	24.3545	
15 minute summer	S7	1.005	S8	325.3	0.984	0.526	2.7926	
15 minute summer	S8	1.006	S9	336.7	1.028	0.549	10.7975	
30 minute summer	S9	1.007	S10	419.2	0.953	0.678	30.6570	
30 minute summer	S10	1.008	S31	532.3	1.210	0.872	20.0154	
15 minute summer	S16	3.000	S17	85.4	0.677	0.139	26.0587	
15 minute summer	S17	3.001	S18	168.4	0.743	0.274	23.0302	
15 minute summer	S18	3.002	S21	248.5	0.738	0.403	10.0017	
15 minute summer	S11	4.000	S15	175.7	1.109	1.095	10.2912	
15 minute summer	S12	5.000	S13	71.2	1.792	0.156	0.3649	
15 minute summer	S13	5.001	S14	86.2	1.855	0.188	1.2923	
15 minute summer	S14	5.002	S15	113.5	1.250	0.248	2.6482	
15 minute summer	S15	4.001	S21	267.1	1.715	1.658	9.8376	
15 minute summer	S19	6.000	S20	127.5	0.643	0.207	26.4539	
15 minute summer	S20	6.001	S21	198.1	0.584	0.322	9.3341	
15 minute summer	S21	3.003	S22	700.9	1.967	1.138	6.3201	
15 minute summer	S22	Flow through Pond	S23	-464.8	0.160	-0.010	509.6441	
30 minute summer	S23	3.005	S30	-831.1	-1.889	-1.363	6.2722	
15 minute summer	S25	7.000	S26	67.6	2.669	0.669	1.0522	
15 minute summer	S24	8.000	S26	85.6	2.153	2.139	0.9636	
15 minute summer	S26	7.001	S27	152.7	1.342	0.921	0.6556	

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Results for 800 year Critical Storm Duration. Lowest mass balance: 99.67%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
240 minute winter	S27	228	59.587	1.597	29.1	5.5331	0.0000	SURCHARGED
240 minute winter	S28	228	59.587	1.722	58.3	5.9658	0.0000	SURCHARGED
240 minute winter	S29	228	59.587	1.876	72.4	6.4992	0.0000	FLOOD RISK
240 minute winter	S30	228	59.587	1.939	143.6	11.1037	0.0000	SURCHARGED
240 minute winter	S31	228	59.586	2.001	104.1	11.4598	0.0000	SURCHARGED
600 minute summer	S32	1035	57.431	0.325	42.3	0.4658	0.0000	SURCHARGED
600 minute summer	S33	1035	57.345	0.289	42.3	0.4131	0.0000	SURCHARGED
60 minute summer	Ex MH34	481	57.132	0.172	42.3	0.0000	0.0000	OK

Link Event (Outflow)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	S27	7.002	S28	161.2	0.759	0.262	22.0417	
15 minute summer	S28	7.003	S29	294.3	1.006	0.479	27.2228	
15 minute summer	S29	7.004	S30	328.9	0.940	0.534	11.0545	
30 minute summer	S30	3.006	S31	-477.2	-1.084	-0.775	11.0770	
120 minute summer	S31	1.009	S32	42.3	0.982	0.300	1.4029	
60 minute winter	S32	1.010	S33	42.3	1.065	1.054	0.3311	
60 minute summer	S33	1.011	Ex MH34	42.3	1.097	1.397	1.0083	1512.7

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APPENDIX F – WATER QUALITY ASSESSMENT (SIMPLE INDEX APPROACH)

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Water quality management assessment - CIRIA SuDS Manual 'Simplified Index Approach' - Existing

Pollution hazard indices from Table 26.2 'Pollution hazard indices for different land use classifications'

Mitigation indices from Table 26.3 'Indicative SuDS mitigation indices for discharges to surfae waters'

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Description of area being served	Ref. no.	Category	Pollution type	Hazard index	Treatment Stage and Component: Primary	Secondary	Tertiary	Total SuDS mitigation index	Assessment criteria	Acceptable (y/n)
Main Factory/ Manufacturing Areas , Delivery Yards & Chemical Hadling Zones	001	Sites with heavy pollution... industrial sites; sites where chemicals and fuels are delivered, handled, stored, used or manufactured (CIRIA Table 26.2 - High)	Pollution hazard level	High						
			Total suspended solids (TSS)	0.8				0.00	0.80	n
			Metals	0.8				0.00	0.20	n
			Hydrocarbons	0.9				0.00	0.05	n
Internal Service Roads, Hardstanding & Delivery Approaches	002	Commercial yard and delivery areas, non-residential car parking with frequent change... all roads except low traffic roads (CIRIA Table 26.2 - Medium)	Pollution hazard level	Medium						
			Total suspended solids (TSS)	0.7				0.00	0.70	n
			Metals	0.6				0.00	0.60	n
			Hydrocarbons	0.7				0.00	0.70	n
Staff / Visitor Car Parking Areas	003	Non-residential car parking with infrequent change (eg offices) ie < 300 traffic movements/day (CIRIA Table 26.2 - Low)	Pollution hazard level	Low						
			Total suspended solids (TSS)	0.5				0.00	0.50	n
			Metals	0.4				0.00	0.40	n
			Hydrocarbons	0.4				0.00	0.40	n
Factory / Building Roofs	004	Other roofs (typically commercial/industrial roofs) (CIRIA Table 26.2 - Low). Note: potential for metal leaching from	Pollution hazard level	Low						
			Total suspended solids (TSS)	0.3				0.00	0.30	n
			Metals	0.2				0.00	0.20	n
			Hydrocarbons	0.05				0.00	0.05	n

Water quality management assessment - CIRIA SuDS Manual 'Simplified Index Approach' - Proposed

Pollution hazard indices from Table 26.2 'Pollution hazard indices for different land use classifications'

Mitigation indices from Table 26.3 'Indicative SuDS mitigation indices for discharges to surfae waters'

Former Glen Dimplex
Whiston
v1.0 HYD1128

BETTS HYDRO
CONSULTING ENGINEERS

Description of area being served	Ref. no.	Category	Pollution type	Hazard index	Treatment Stage and Component: Primary	Secondary		Tertiary		Total SuDS mitigation index	Assessment criteria	Acceptable (y/n)
Roof area	001	Residential roofs	Pollution hazard level	Very low	Filter Drain	Detention Basin	(factored by 0.5)					
			Total suspended solids (TSS)	0.2	0.40	0.50	0.25			0.65	0.20	y
			Metals	0.2	0.40	0.50	0.25			0.65	0.20	y
			Hydrocarbons	0.05	0.40	0.60	0.30			0.70	0.05	y
Domestic Driveways	002	Individual property driveways, residential car parks, low traffic roads (eg cul de sacs, homezones and general access roads) and non-residential car parking with infrequent change (eg schools, offices) ie < 300 traffic movements/day	Pollution hazard level	Low	Filter Drain	Detention Basin	(factored by 0.5)					
			Total suspended solids (TSS)	0.5	0.40	0.50	0.25			0.65	0.50	y
			Metals	0.4	0.40	0.50	0.25			0.65	0.40	y
			Hydrocarbons	0.4	0.40	0.60	0.30			0.70	0.40	y
Private/Adoptable Estate Roads	003	Individual property driveways, residential car parks, low traffic roads (eg cul de sacs, homezones and general access roads) and non-residential car parking with infrequent change (eg schools, offices) ie < 300 traffic movements/day	Pollution hazard level	Low	Detention Basin							
			Total suspended solids (TSS)	0.5	0.50					0.50	0.50	y
			Metals	0.4	0.50					0.50	0.40	y
			Hydrocarbons	0.4	0.50					0.50	0.40	y

APPENDIX G – SUDS MAINTENANCE & MANAGEMENT PLAN

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24th August 2026

BETTS HYDRO
CONSULTING ENGINEERS

SUDS MAINTENANCE AND MANAGEMENT PLAN

SITE: FORMER GLEN DIMPLEX, STONEY LANE, WHISTON

We have been asked to prepare an outline Sustainable Drainage Systems Maintenance and Management Plan to support the proposed development at the site above. The purpose of this statement is to identify the typical requirements in accordance with CIRIA (2015) for maintenance and management of the drainage infrastructure that has been proposed (see *Appendix A*). The Preliminary Drainage Layout, prepared by Betts Associates, has been appended to this statement for completeness (see *Appendix A* for further details).

In terms of the proposed surface water management infrastructure, source control will be provided via a filter drain and an interception drain. Conveyance will be provided by a below ground pipe network, utilising oversized pipework (900mm diameter) to assist with attenuation. Stormwater storage generated in the events up to and including the 1 in 100yr plus 45% climate change allowance event will be catered for by an attenuation basin. An interception drain is also proposed along the southern site boundary, to intercept potential exceedance flows entering or leaving the site from adjacent land. The specific means of attenuation and conveyance are to be confirmed at the detailed design stage.

The proposed drainage infrastructure will be offered to United Utilities or a NAV for adoption. The adoptee should be inspecting any assets regularly, preferably during and after heavy rainfall to check effective operation.

The following section will consider the typical maintenance and management techniques recommended for the types of drainage infrastructure included within the Preliminary Drainage Layout. Regular inspection and maintenance is required to ensure the effective long-term operation of all proposed components. Maintenance responsibility for systems should be placed with a responsible organisation.

Regular inspection and maintenance of drainage systems are important for their effective and continued operation. Maintenance activities can be broadly defined as regular, occasional, and remedial maintenance. The proposed maintenance regime for the surface water drainage infrastructure should follow typical guidance for management and maintenance, guidance can also be sought from the CIRIA 753 SuDS Manual where appropriate. Guidance on the operation and maintenance requirements that may be appropriate are outlined subsequently; this is not exhaustive, and some actions may not always be required.

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Head Office Betts Associates Ltd

www.betts-associates.co.uk

PIPEWORK AND MANHOLES

Below ground pipework and manholes should be routinely monitored to ensure they are operating safely and sustainably. The pipework should be inspected routinely, and any defects repaired as and when required.

FILTER DRAIN

As shown on the Preliminary Drainage Layout (Appendix A), the Filter Drain is located to the front of properties, parallel to the back of footway, and is designed to collect surface water run-off from adjacent drives and roof areas. Owing to the presence of ground contamination across the site, the Filter Drain is fully lined with an impermeable membrane; run-off passes through the surrounding granular filter media into a Terram-wrapped perforated pipe at the base of the drain before conveyance to the proposed surface water network. Maintenance activities should take care not to damage the impermeable lining. Regular and ongoing maintenance is required for the filter drain to ensure that it continues to operate to the design performance standards. Detailed specifications and frequencies should be provided for the required maintenance, along with annual costs and any potential machinery necessary to undertake maintenance. Different designs will have different operational and maintenance requirements (to be confirmed at the detailed design stage). The typical requirements set out in **Table 1** below are as recommended within The SuDS Manual.

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Table 1: Recommended Maintenance Routines for Filter Drains (CIRIA, 2015)

Regular Maintenance	***Frequency***
Remove litter and debris	Monthly
Cut grass/vegetation on top of the filter drain and side slopes	Monthly (during growing season), or as required
Inspect inlets, outlets, control structures and pipework for blockages and physical damage, clear/repair as required	Monthly
Occasional Maintenance	***Frequency***
Remove sediment and debris from the surface of the filter media	As required, following inspection
Rehabilitate surface and upper filter media where clogging is identified	As required
Remedial Actions	***Frequency***
Repair erosion or damage to side slopes	As required
Reconstruct/replace filter media where infiltration performance has significantly reduced	As required (likely to be infrequent)
Monitoring	***Frequency***
Initial inspection	Monthly (for three months post-installation)
Inspect for evidence of poor operation, ponding, or weed growth – if required, take remedial action	Every 3 months (48hr following large storms for first 6 months)
Monitor silt accumulation rates and establish appropriate maintenance frequencies	Annually

INTERCEPTION DRAIN

As shown on the Preliminary Drainage Layout (Appendix A), the Interception Drain is located to the rear of proposed gardens, along the southern site boundary, and comprises a series of catch pits connected by perforated pipework laid within granular fill and wrapped in a permeable geotextile, with an impermeable membrane lining the trench. The interception drain, proposed along the southern site boundary to manage potential exceedance flows entering or leaving the site from adjacent land, will require regular and ongoing maintenance to ensure it continues to operate to the design performance standards. Detailed specifications and frequencies should be provided for the required maintenance, along with annual costs and any potential machinery necessary to undertake maintenance. Different designs will have different operational and maintenance requirements (to be confirmed at the detailed design stage). The typical requirements set out in **Table 2** below are as recommended within The SuDS Manual.

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Table 2: Recommended Maintenance Routines for Interception Drain (CIRIA, 2015)

Regular Maintenance	***Frequency***
Remove litter and debris	Monthly
Inspect inlets, outlets and overflows for blockages, clear as required	Monthly
Inspect for evidence of physical damage along the drain alignment	Monthly
Manage vegetation along the drain corridor	Monthly (during growing season), or as required
Occasional Maintenance	***Frequency***
Inspect silt accumulation rates and establish appropriate removal frequencies	Every 3 months, or as required
Remove sediment from inlets and outlets	Annually, or as required
Remedial Actions	***Frequency***
Repair erosion or other damage along the drain	As required
Repair/rehabilitate inlets, outlets and overflows	As required
Relevel uneven sections and reinstate design levels/falls	As required

ATTENUATION BASIN

As shown on the Preliminary Drainage Layout (Appendix A), the attenuation basin is designed with a base level of 57.383 mAOD and a top of bank level of 59.383 mAOD, providing a 300mm freeboard and a temporary maximum storage volume of 1,003.09 m^3. Outflow from the basin is controlled via a Hydro International HydroBrake® Optimum flow control device (Ref. S30), restricting discharge to 42.4 l/s to the private surface water sewer. Regular and ongoing maintenance is required for the attenuation basin to ensure that it continues to operate to the design performance standards. Detailed specifications and frequencies should be provided for the required maintenance, along with annual costs and any potential machinery necessary to undertake maintenance. Different designs will have different operational and maintenance requirements (to be confirmed at the detailed design stage). This will need to be designed to cater for the extreme storm event volumes up to and including the 100yr return period event with 45% allowance for climate change. The requirements set out in **Table 3** below refer to the recommendations in The SuDS Manual for maintenance of attenuation basins.

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Table 3: Recommended Maintenance Routines for Attenuation Basins (CIRIA, 2015)

Regular Maintenance	***Frequency***
Remove litter and debris	Monthly
Manage vegetation and remove nuisance plans (inc. cutting grass for spillways/access routes)	Monthly (during growing season), or as required
Cut grass – meadow grass in and around basin	Half yearly (spring – before nesting season, and autumn)
Inspect inlets, outlets and overflows for blockages, and clear as required	Monthly
Inspect banksides, structures, pipework etc for evidence of physical damage	Monthly
Inspect inlets and facility surface for silt accumulation: establish appropriate silt removal frequencies	Monthly (for first year), then annually/as required
Check any penstocks and other mechanical devices	Annually
Tidy all dead growth before start of growing season	Annually
Remove sediment from inlets, outlets and forebay	Annually (or as required)
Manage wetland plants in outlet pool – where provided	Annually
Occasional Maintenance	***Frequency***
Reseed areas of poor vegetation growth	As required
Prune and trim any trees and remove cuttings	Every 2 years, or as required
Remove sediment from inlets, outlets, forebay and main basin where required	Every 5 years, or as required (likely to be minimal where effective upstream source control is provided)
Remedial Actions	***Frequency***
Repair erosion or other damage by reseeding or re-turfing	As required

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Realignment of rip-rap	As required
Repair/rehabilitation of inlets, outlets, and overflows	As required
Relevel uneven surfaces and reinstate design levels	As required

HYDROBRAKE FLOW CONTROL DEVICES

As shown on the Preliminary Drainage Layout (Appendix A), a Hydro International HydroBrake® Optimum (Ref. S30, cover level 60.074 mAOD, invert level 57.585 mAOD) is proposed to control outflow from the attenuation basin, restricting discharge to 42.4 l/s. Generally, Hydrobrake devices require little maintenance and have a design life greater than that of the upstream drainage infrastructure. Should the device get blocked, then the main chamber would flood and depending on the specific Hydrobrake product being installed, most come equipped with by-pass doors (or similar) to allow the device to be accessed and drained manually to provide appropriate access for maintenance to be undertaken. In terms of management, the typical routines for maintenance are for inlets, outlets, and overflows to be inspected regularly to prevent blockages and be cleared where needed. Sediment can be removed from inlets and outlets when required and any inlets and outlets can be repaired if damage is picked up in the regular inspections.

I trust you will find the above and attached are of assistance. If you however have any queries or require further information, please do not hesitate to contact me.

Yours sincerely,

Graduate Flood Risk Analyst
BETTS HYDRO

APPENDED
Appendix A – Preliminary Drainage Layout (Betts Associates)

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APPENDIX A – PRELIMINARY DRAINAGE LAYOUT (BETTS ASSOCIATES)

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Drainage Strategy - Foul water

The proposed foul water drainage strategy for the development is divided into four separate drainage networks, each designed to discharge to the existing United Utilities public sewerage system.

Network 1
Network 1 comprises a gravity drainage system located within the north-west corner of the site. This network is designed to connect to the existing combined sewer within Stoney Lane, upstream of existing United Utilities manhole reference 8604.

Connection Manhole Details:

MH Ref: F24 (Proposed)
Cover Level (CL): 59.938 mAOD
Invert Level (IL): 57.853 mAOD (150mm Ø – proposed foul connection)
Invert Level (IL): 57.104 mAOD (900mm Ø – existing sewer)

Network 2
Network 2 serves the majority of the site and drains to a proposed pumping station located adjacent to **Plot 51** in the southern corner of the site. The associated rising main is wholly contained within the development and discharges to proposed manhole **F15**.

The ultimate discharge point is to an Existing United Utilities foul water manhole Ref. 8503, located within the site boundary. The existing downstream connection to the United Utilities combined sewer (MH Ref. 8501) within Cumber Lane is to remain and shall continue to serve the development as a foul water discharge point.

Connection Manhole Details:

MH Ref: 8503
Cover Level (CL): 58.518 mAOD
Invert Level (IL): 57.77 mAOD (150mm Ø - existing sewer)

Network 3
Network 3 comprises a gravity drainage system located within the northern part of the site, adjacent to Plot 180. This network is designed to connect to the existing United Utilities combined sewer within Stoney Lane via existing manhole reference UU9602.

Connection Manhole Details:

MH Ref: 9602 (Existing)
Cover Level (CL): 60.75 mAOD
Invert Level (IL): 58.330 mAOD (150mm Ø – proposed foul connection)
Invert Level (IL): 57.580 mAOD (900mm Ø – existing sewer)

Network 4
Network 4 comprises a gravity drainage system located within the northern part of the site, within Road 3, serving Plots 184–205. This network is designed to connect to the existing United Utilities combined sewer within Stoney Lane via existing manhole reference UU0601.

Connection Manhole Details:

MH Ref: 0601 (Existing)
Cover Level (CL): 61.03 mAOD
Invert Level (IL): 58.842 mAOD (150mm Ø – proposed foul connection)
Invert Level (IL): 58.167 mAOD (825mm Ø – existing sewer)

Overall, the proposed foul water drainage strategy utilises a combination of gravity drainage and a single adoptable pumping station to serve the development. Foul flows discharge to existing United Utilities foul and combined sewerage infrastructure via four separate connection points, with all new foul sewers and associated infrastructure designed in accordance with the relevant United Utilities and Sewers for Adoption requirements.

Drainage Strategy - Surface water

Surface water runoff generated by the proposed development will discharge to the existing on-site culverted watercourse via a new manhole reference **S33**, located along the southern site boundary, at a restricted discharge rate of **42.4 l/s**.

The surface water drainage network has been designed to accommodate the 1 in 30 year storm event, with additional attenuation provided by an online attenuation basin to manage the 1 in 100 year event plus 45% allowance for climate change.

Connection Manhole Details:
MH Ref: **S33** (Proposed)
Cover Level (CL): 59.549 mAOD
Invert Level (IL): 57.056 mAOD (225 mm Ø)

Proposed Foul Water Connection (F24 Proposed) Network 1

A new online manhole is proposed on the existing United Utilities 900mm Ø combined water sewer within Stoney Lane. The proposed development shall connect to the existing public foul water sewer via a 150mm Ø soffit to soffit connection.

MH Ref: F24
Cover Level (CL): 59.938 mAOD
Invert Level (IL): **57.853** mAOD *(150mm Ø – proposed foul connection)*
Invert Level (IL): 57.104 mAOD *(900mm Ø – existing sewer)*

Proposed Foul Water Connection (9602 Existing) Network 3

A new connection to existing manhole Ref 9602 is proposed, this United Utilities combined sewer is located within Stoney Lane. The proposed development shall connect to the existing public combined sewer via a 150mm Ø soffit to soffit connection.

MH Ref: **9602**
Cover Level (CL): 60.75 mAOD
Invert Level (IL): **58.330** mAOD *(150mm Ø – proposed foul connection)*
Invert Level (IL): 57.580 mAOD *(900mm Ø – existing sewer)*

Proposed Foul Water Connection (0601 Existing) Network 4

A new connection to existing manhole Ref 0601 is proposed, this United Utilities combined sewer is located within Stoney Lane. The proposed development shall connect to the existing public combined sewer via a 150mm Ø soffit to soffit connection.

MH Ref: **9602**
Cover Level (CL): 61.03 mAOD
Invert Level (IL): **58.842** mAOD *(150mm Ø – proposed foul connection)*
Invert Level (IL): 58.167 mAOD *(825mm Ø – existing sewer)*

Proposed Finished Levels
The levels indicated on this plan are indicative (+/-500mm) and subject to change following detailed levels design.

Proposed Filter Drain
Filter drain located to front of properties, parallel to the back of footway. Designed to collect surface water runoff from adjacent drives and roof areas. Surface water runoff is filtered through the surrounding granular stone and conveyed via perforated pipework to the proposed surface water drainage network.

Proposed Interception Drain
Interception drain located to rear of proposed gardens, along site boundary. Designed to intercept surface water runoff from adjacent land and prevent uncontrolled flows entering or leaving the development.

Proposed Foul Water Connection (8503 Existing) Network 2

Existing United Utilities foul water manhole to be retained and rebuilt/made good as necessary. The existing downstream connection to the United Utilities combined sewer (MH Ref. 8501) within Cumber Lane is to remain and shall continue to serve the development as a foul water discharge point.

MH Ref: **8503 Existing**
Cover Level (CL): 58.518 mAOD
Invert Level (IL): **57.77** mAOD *(150mm Ø)*

Foul Water Rising Main
The proposed foul water rising main will be routed through the site within the proposed road network and will discharge to proposed manhole F15. From this point, flows will continue via gravity to the existing Foul Water Manhole Ref. 8503, ultimately discharging to the existing combined sewer within Cumber Lane.

Rising Main Length: Approx. 320m
Termination Manhole: F15

Flow Control Chamber Manhole S31 HB
Hydro International HydroBrake Optimum
SHE-0263-4240-1900-4240
Design head = 1.900 m
Restricted discharge max. = 42.4 l/sec
Flow control orifice size 263mm
Cover level: 60.074 mAOD
Invert level: 57.585 mAOD

Proposed Diversion
Minor diversion works proposed to accommodate proposed site layout.

Proposed Surface Water Connection (S33)
A New manhole is to be constructed online of the existing on site culverted watercourse.

MH Ref: **S32** (Proposed)
Cover Level (CL): 59.549 mAOD
Invert Level (IL): 57.056 mAOD (225 mm Ø)

Attenuation Basin
To attenuate flows up to 1:100 year storm + 45% CC

Base Level:	57.383 m
Top of Bank Level:	59.383 m
Freeboard:	300 mm
Temp maximum storage volume:	1003.09 m³

Proposed Finished Levels
The levels indicated on this plan are indicative (+/-500mm) and subject to change following detailed levels design.

Proposed Interception Drain
Interception drain located to rear of proposed gardens, along site boundary. Designed to intercept surface water runoff from adjacent land and prevent uncontrolled flows entering or leaving the development.

Proposed Filter Drain
Filter drain located to front of properties, parallel to the back of footway. Designed to collect surface water runoff from adjacent drives and roof areas. Surface water runoff is filtered through the surrounding granular stone and conveyed via perforated pipework to the proposed surface water drainage network.

Proposed Interception Drain
Interception drain located to rear of proposed gardens, along site boundary. Designed to intercept surface water runoff from adjacent land and prevent uncontrolled flows entering or leaving the development.

Foul Water Rising Main
The proposed foul water rising main will be routed through the site within the proposed road network and will discharge to proposed manhole F15. From this point, flows will continue via gravity to the existing Foul Water Manhole Ref. 8503, ultimately discharging to the existing combined sewer within Cumber Lane.

Rising Main Length: Approx. 320m
Termination Manhole: F15

Foul Water Pumping Station
Proposed foul water pumping station serving the southern catchment of the development. Flows shall be conveyed via a proposed rising main to manhole F15, before continuing by gravity through the foul water network to existing United Utilities manhole Ref. 8503 and the existing combined sewer within Cumber Lane.

Existing Culverted Watercourse
Culverted Watercourse.

Existing Culverted Watercourse
Culverted Watercourse.

SW02 Buried Under Grass

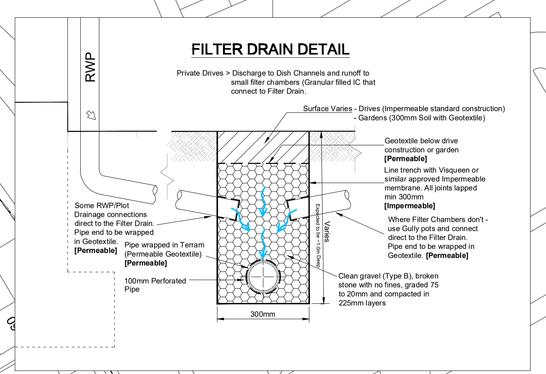
SW03 Buried under grass but exposed

SW04 Buried Under Grass. Line Comes in on T not bend so can not CCTV to outfall.

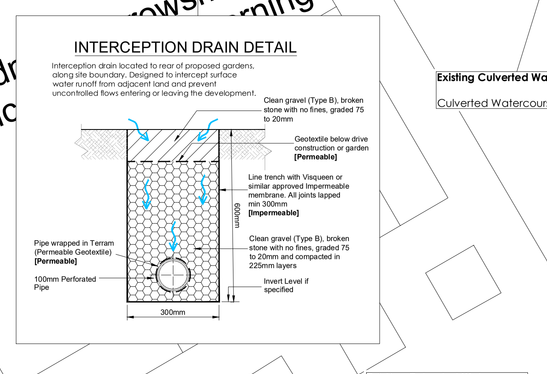
SW00 Buried Under Grass
CL:58.23m

Proposed Finished Levels
The levels indicated on this plan are indicative (+/-500mm) and subject to change following detailed levels design.

FILTER DRAIN DETAIL



INTERCEPTION DRAIN DETAIL



Legend

- Development boundary
- Proposed Adoptable Surface Water Sewer
- Highway Sewer & Manhole
- Highway Gully & Connection Pipe Work
- Proposed Adoptable Foul Water Sewer
- Proposed Adoptable Foul Water Rising Main
- Proposed Interception Drain
- Proposed Sewer Easement *(3m from Centre line)*
- Existing Public Foul Water Sewer
- Existing Public Surface Water Sewer
- Existing Public Combined Sewer
- Existing Ordinary Watercourse Culvert
- FFL 134.65 — Proposed Finished Floor Level
- +133.70 — Existing Boundary Ground Level
- +17.100 — Proposed Spot Level
- Proposed Earthwork Batter
- 4C — Underbuild - Measured from FFL to PGL
- 3C — Tanking - Measured from FFL to PGL
- FOE - 0.150m — Flag on Edge (up to 450mm)
- RET - 0.500m — Masonry Retaining Wall (over 450mm)

Notes

1. Planning layout ref.
Taylor Wimpey - 25053-VIM_2026-07-29
2. Topographical survey provided by 'Geographical Engineering Operations', ref 'G24104 Stoney Lane, Whiston Cross', Dated March 2024.
3. Road detail, levels and layout are subject to local authority section 38 Highways approval.

Notes

1. The use of any other flow control devices not associated with the Hydro International HydroBrake Optimum references provided may constitute a flood risk.
2. Drainage design and construction is in accordance with Design and Construction Guidance 2020 (DCG) and the requirements of the statutory undertaker.
3. Tolerances in pipe laying to be in accordance with Design and Construction Guidance 2020 (DCG).
4. For pipes 150-450mm dia. all rocker pipes to be in accordance with Design and Construction Guidance 2020 (DCG).
5. Engineering bricks shall not contain frogs or holes.
6. Brickwork to manholes to be English bond.
7. Where pipes are surrounded in concrete, flexibility is to be maintained at pipe joints by the use of a suitable compressible material eg. "FLexcell" or "Fibreboard".
8. All manhole covers and frames must comply with BS EN124, covers in roads to be grade D400 and be 150mm deep. manhole covers in car parking areas and drives to be grade B125, whilst landscaped areas may be grade A15.
9. Clayware pipes to be 65 extra strength quality "Hepseal" or similar approved.
10. Granolithic benching to manholes to be 40mm minimum thickness.
11. Precast concrete chamber rings to be reinforced.
12. The slope of benching in all cases should be 1 in 30.
13. Manholes shall not incorporate double square or double oblique channel junctions in their inverts.
14. All incoming pipes shall be surrounded with 150mm of concrete to the face of the collar of the first flexible joint and the outgoing pipe shall also be surrounded to within 50mm of the first flexible joint and a compressible filler used as a former between the concrete surround and downstream pipe collar.
15. All underground services to be confirmed by contractor prior to commencement on site, any discrepancies to be reported to engineer.
16. Private sewers not located in roads to be class F granular bed and surround as per standard details.
17. Sewers located under adopted roads to be class s granular bed and surround (more than 1.2m cover.)
18. Sewers located under private roads and car parking bays to be class f granular bed and surround as per standard details unless adopted, then provide class s (if more than 1.2m cover).
19. Private sewers with less than 0.6m of cover to be concrete surrounded as class Z on standard details.
20. Adopted sewers with less than 1.2m cover, provide class Z concrete bed and surround. concrete haunching may be suitable for large diameter storage sewers, guidance must be sought from adopting authority prior to use.
21. Road gullies to be pcc and trapped with 150mm ST4 concrete surround.
22. No deep or wide rooted trees to be planted within close proximity of the proposed and existing public sewer system.
23. Pipes less than 300mm dia. to be Polypipe UPVC unless otherwise stated.

NHBC Standards
Effective from 1st January 2025

IMPORTANT** - Invert levels at proposed points of connection are **to be confirmed prior** to any works commencing on site as onsite drainage and slab levels may be affected

P13 24.08.26	Minor amendment to notes	CP
P12 19.08.26	Updated with new layout and additional SUDs	CP
P11 26.03.26	Up-Fix filter indicated	CP
P10 23.03.26	Updated with additional notes & existing assets	CP
P09 19.01.26	Scale bar shown	TR
P08 05.12.25	Proposed discharge rate amended	CP
P07 05.12.25	Amended to suit new planning layout	NR
P06 15.10.25	Amended to suit layout dated: 09.10.25	TR NR
P05 02.10.25	Cellular storage removed & rising main shown	TR NR
P04 25.09.25	Amended to suit latest layout	TR NR
P03 11.04.25	Plots 13 and 14 FFL changed	NR
P02 07.04.25	Drainage strategy amended, pond removed, tank added, pipes downsized.	NR
P01 04.04.25	Preliminary issue for review	NR xx
Mark | Date	Details	By | Chk

Revision history

Drawing originator:

BETTS HYDRO CONSULTING ENGINEERS · BETTS ASSOCIATES CONSULTING ENGINEERS · BETTS GEO CONSULTING ENGINEERS

Client: Taylor Wimpey

Project title:

Glen Dimplex
Stoney Lane

Drawing title:

Preliminary Drainage Layout

Scale: 1:500 for the original size of A0

Drawn by: CP | Checked by: - | Passed by: - | Date: Apr 2025

Drawing status:

For Planning

Job No:	Drawing No: Project	Origin	Volume	Level	Type	Discip	Number	Revision:
TAY143	GDX	BET	ZZ	XX	DR	C	0001	P13

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APPENDIX H – EXISTING SERVICES PLAN

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Existing Culverted Watercourse

Existing culverted watercourse crossing site, North to South.
Position identified from historical documents. CCTV Survey confirms this length is redundant and blocked with concrete; no active flow route identified.

Culverted Watercourse Diversion

CCTV investigations undertaken on 17/07/2026 by Quinn Utilities have confirmed that the existing culvert/watercourse shown crossing the site is redundant and does not provide an active flow route through the site.

The CCTV survey identified the former culvert connection as being obstructed by concrete/hardened material, with the survey abandoned at the obstruction due to 100% cross-sectional area loss. The CCTV investigation and associated survey plan indicate that the culvert has previously been taken out of use and does not form part of the existing active watercourse network.

On this basis, no diversion or replacement of the existing culvert is proposed as part of the development. The proposed drainage layout has therefore been designed on the basis that the redundant culvert does not convey flows through the site.

CCTV Survey Information

This drawing is to be read in conjunction with the following CCTV investigation information:

- **M3382 Taylor Wimpey Glen Dimplex Stoney Lane Whiston 17 07 26.** CCTV Survey Report prepared by Quinn Utilities, dated 17/07/2026.
- **M3382 Taylor Wimpey Glen Dimplex CCTV Plan 17 07 26.** CCTV survey plan showing the investigated drainage network and identified obstructions.

The above CCTV information has been used to establish the status and connectivity of the existing culverted drainage infrastructure within the site.

Existing Culverted Watercourse

Existing culverted watercourse alignment identified from historical documents. CCTV Survey confirms this length is redundant and blocked with concrete. No active flow route identified; no diversion works proposed.

Existing Culverted Watercourse

Culverted Watercourse.

Mark	Date	Details	By	Chk
C	24.08.26	Notes on ex-culvert added following CCTV	CP	
B	03.07.26	Manhole UU9401 cover & invert confirmed	CP	
A	17.03.26	First issue	CP	

Revision history

Drawing originator:

BETTS HYDRO CONSULTING ENGINEERS | BETTS ASSOCIATES CONSULTING ENGINEERS | BETTS GEO CONSULTING ENGINEERS

Client:

Taylor Wimpey

Project title:

Glen Dimplex
Stoney Lane

Drawing title:

Existing Services Layout

Scale:	for the original size of A0				
Drawn By: CP	Checked by:	Passed by:	Date: March 2026		
Drawing status:					

Job No:	Drawing No: Project	Origin	Volume	Level	Type	Discip	Number	Revision:
TAY143	GDX	BET	ZZ	XX	DR	C	001	C

Do not scale this drawing

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APPENDIX I – GI REPORT

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Phase I and II Geoenvironmental Site Assessment

Site: Glen Dimplex, Prescot
Reference: 17-500-R1-2
Date: June 24



e3p

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Registered in England
CRN: 08725262

QUALITY ASSURANCE

Report reference	17-500-R1-2

REV REF:	DESCRIPTION	AUTHOR	CHECKED	AUTHORISED	DATE
R1-1	First issue	ID	MW	SC	22/05/24
R1-2	Updated Site History and Contaminant Sources (Munitions Works)	MW	SC	SC	06/06/24

This report has been prepared for the sole benefit, use, and information of the client. The liability of Environmental Engineering Partnership Limited T/A E3P with respect to the information contained in the report will not extend to any third party. This report has been prepared by the qualified persons as listed below.

WRITTEN BY	QUALIFICATIONS	POSITION
Iona Diack	BSc (Hons), FGS	Consultant

REVIEWED BY	QUALIFICATIONS	POSITION
Mark Wilson	BSc (Hons) Ind, FGS, MIEnvSc	Senior Consultant

AUTHORISED BY	QUALIFICATIONS	POSITION
Stephanie Cox	BSc (Hons), FGS, PIEMA, MIEnvSci, CEnv	Director

EXECUTIVE SUMMARY

Site Address	Glen Dimplex Home Appliances Ltd, Stoney Lane, Rainhill, Prescot, L35 2XW
Grid Reference	E 348017 N 391531
Site Area	5.96 Ha.
Proposed Development	At present, a proposed development plan has not been decided, however it is assumed the redevelopment will comprise residential dwellings with associated private gardens, roadways and associated infrastructure.
Current Site Use	The site is an irregularly shaped parcel of land situated to the south of Stoney Lane in Rainhill, Prescot. Presently, the site is occupied by the Glen Dimplex Home Appliances manufacturing factory, which predominantly comprises a large active factory structure with associated smaller buildings and infrastructure, including a gas governor to the north and two electricity substations to the west and south. Surrounding the main factory structure, a service road is present to the south and the west, connecting to Stoney Lane at the north. An associated area of hardstanding car parking is noted at the east of the site. Small areas of soft cover landscaping (managed grasses) are noted at the north and east of the structure, with sporadic semi-mature trees towards the northern boundary.
Site History	Following a review of pertinent Ordnance Survey mapping circa 1850, the site appears to be utilised as vacant agricultural land with a small dwelling situated at the centre of the southern boundary. A roadway leading to the dwelling is running parallel to the southern boundary. A well is noted adjacent to the dwelling at the southern boundary. Several segmenting tree-lined field boundaries are present, with the site comprising seven smaller fields. Two small ponds are recorded; one situated at the northern boundary towards the east, with another pond situated towards the centre of the southern boundary. Historical mapping was unavailable between 1907 and 1925. However, records held by Heritage Gateway indicates a factory had been developed on the site, and that it was being used as a Munitions Works during the First World War (1914-1918) and up until at least 1925 (likely for the manufacturing of military based explosives and propellants). Minor changes were noted in the mapping with significant changes noted in mapping circa 1925, where the site was completely redeveloped and now comprises an Iron Foundry with associated railway sidings across the site. The works structures consisted of two large structures segmented by a railway siding traversing east to west through the centre of the site. Multiple small outbuildings were noted along the western sector of the main factory structure and the outbuilding situated to the south of the main factory structure is assumed to be associated with the railway sidings. Subsequent mapping circa 1927 identified minor compositional changes to the main factory structure with a tank situated towards the south. Following mapping dated 1937, the site was renamed to Rainhill Stove works, with minor compositional changes to the structure noted. Records held by Heritage Gateway indicates the factory was repurposed as a Munitions Works during the Second World War (1939-1945), again likely for the manufacturing of military based explosives and propellants.

Site History *Continued…*	Alterations continued to the main factory structure identified in mapping circa 1954 with the main factory structures now recorded as one large structure, with the former segmenting sidings removed. Additional outbuildings were constructed towards the northeast of the site, with an electricity substation noted at the northwest of the main factory structure and a small pond noted at the southern boundary adjacent to the sidings towards the east. By 1978, all railway and tramway sidings were removed with a segmenting boundary noted at the eastern sector of the site, separating the area from the main works structure. It is assumed this is the construction of the car parking area. Minor expansions of the main factory structure were noted in following mapping, but predominantly the present day composition was first noted in aerial imaging dated 2000.

ENVIRONMENTAL SETTING

Geology	Superficial Geology	Glacial Till (Majority of site) – CLAY, SAND, and GRAVEL Glaciofluvial Deposits (Southeast) – SAND and GRAVEL
	Bedrock Geology	Kinnerton Sandstone Formation (Majority of site) – SANDSTONE Chester Formation (East) - SANDSTONE
	Faults	The nearest geological fault is located on-site (Cronton Fault) traversing northwest to southeast through the eastern sector of the site, with a downthrow to the east.
Geomorphology	Based on the initial geological assessment, a review of available topographic data and pertinent mapping, E3P has undertaken a preliminary geomorphological evaluation of the landform and its possible mechanism for formation. Based upon a review of historical mapping and topographical contours, it would appear that the placement and upfilling of material will have formed the current site level plateau prior to the construction of the historical development. It is possible that the historical level raising has resulted in a greater thickness of Made Ground overlying the natural glacial till and glaciofluvial deposits, and potentially underwent earthworks to create a development platform for the main factory structure present.	
Hydrogeology	A Secondary (undifferentiated) aquifer and Secondary A aquifer (East) has been recorded on-site in the superficial geology with a Principal aquifer in the bedrock geology. An active groundwater abstraction licence is recorded within 50m of the site located 16 m SE, pertaining to Elis UK Ltd and used for laundry purposes.	
Hydrology	No surface water features are located within 100 m of the site boundary. Due to the local topography, it is unlikely that any shallow groundwater will be present. The site is located within Flood Zone 1 - no risk of flooding.	

Utility Locations	A full ground penetrating radar (GPR) and utility survey has been undertaken by Geo UK Ltd in March 2024. The survey identified electricity cables surrounding the main factory structure and feeding into the two on-site electricity substations. Two gas governors and associated pipework were identified along the northern boundary and fed into a polystyrene manufacturing plant and the northwest corner of the main factory structure. Water and sewerage mains and telecommunication cables were also identified surrounding the main factory structure and feeding into the surrounding smaller structures.
Landfill Sites and Waste Sites	No landfill sites (current or historic) are located within 250 m of the site. The site has undergone significant historical development and ground working, the Made Ground associated with the landmark development may produce hazardous ground gases such as methane and carbon dioxide.
Radon	Radon Class 1 - less than 1% of homes are estimated to be at or above the Action Level. No radon protection measures required.
Unexploded Ordnance	Low risk UXO area - no further works required. Records held by Heritage Gateway indicates the site had previously been used as Munitions Works during the First World War (1914-1918), up until at least 1925; and again during the Second World War (1939-1945). Though the type of munitions manufactured at the site is currently unknown, given the operational years during the First and Second World Wars, it is likely that military based explosives and propellants were manufactured at the site.
Per- and Poly-Fluorinated Substances (PFAS) and Perfluorooctanoic Acid (PFOA)	Due to current and/or historical processes on the site, the site has been identified to be a potential risk of PFAS/PFOA and further risk assessment will be required.
Hazardous Installations	The following hazardous installations have been identified on-site which have the potential to affect the proposed development: Electricity substation, Gas and Governors.

E3P PRELIMINARY GROUND INVESTIGATION

Preliminary Ground Investigation Works	E3P has completed a preliminary intrusive ground investigation comprising: • 10 x window sample boreholes, • 2 x Cable Percussive Boreholes, • Construction of environmental monitoring installations; • 2 no. rounds of groundwater sampling; and • 4 no. rounds of ground gas monitoring.
Ground Conditions	**Made Ground – 0.00 m bgl to 3.50 m bgl** Made Ground deposits were encountered within all exploratory hole locations to depths of between 0.00 m and in excess of 3.00 m bgl although, in general, Made Ground was encountered to a depth of less than 1.50 m bgl.

Ground Conditions
Continued…

Made Ground deposits were varied across the site, however all generally comprised concrete in the upper 300 mm in the majority of locations. The exception of this was WS104–WS106 which encountered asphalt within the upper 150 mm of the boreholes as they were situated in the car park.

Typically, the concrete or asphalt was underlain by a slightly clayey sandy gravel, with gravel of brick, concrete, mudstone, limestone, coal and slag with rare fragments of glass, plastic, and timber in some locations. These deposits were encountered from 0.15–0.80 m bgl, and were typically overlaying a reworked gravelly clay, with gravel of brick, sandstone, mudstone and in rare instances coal to a maximum proven depth of 3.00 m bgl (CP102).

Hydrocarbon odours were noted within six locations, situated across the site within the Made Ground deposits. The depths the hydrocarbon odour was encountered ranged from 0.50–1.90 m bgl (WS106) and was typically noted within a reworked very gravelly clay with gravel of sandstone, mudstone, concrete, ash, and slag.

Superficial Deposits – 3.50 m bgl to 4.44 m bgl
Superficial deposits were encountered within all exploratory locations, with the superficial deposits varying across the site. The most common stratum recorded was an orangish brown sandy gravelly CLAY with gravel of sandstone, mudstone, and instances of coal and quartz. Typically, the CLAY was locally interbedded with an orange very clayey fine to medium SAND from 0.70–4.44 m bgl.

In five locations, a very sandy CLAY with pockets of orange fine to medium SAND was noted, which was typically towards the east, with the exception of WS107 which recorded this stratum from 0.90–4.00 m bgl.

In CP102, a band of SAND and GRAVEL approximately 500 mm thick was recorded from 3.00–3.50 m bgl, with gravel of sandstone. This was in turn underlain by the orange-brown mottled sandy gravelly CLAY from 3.50–9.00 m bgl. A rare band of clayey fine to medium SAND with pockets of grey CLAY was noted in WS103, from 1.40–3.00 m bgl.

Bedrock – 4.00 m bgl to 9.37 m bgl
The bedrock geology was encountered between 4.00–9.37 m bgl during the preliminary ground investigation as highly weathered SANDSTONE recovered as a red very gravelly medium to coarse SAND.

Generally, bedrock was encountered at shallower depths (<5.00 m bgl) towards the north of the site, in WS107 and WS109, deepening to 9.00 m bgl towards the south of the site (CP101 and CP102).

Groundwater
Groundwater strikes were encountered as seepages in two locations at depths from 1.00–7.00 m bgl.
During the monitoring programme, groundwater was recorded at depths ranging from 0.60 m to 5.47 m bgl.

CONTAMINATED LAND ASSESSMENT

Initial Conceptual Site Model

Human Health

Sources

- Historical Iron Foundry (PL1, PL2, PL3, PL4, PL6, PL7, PL8) - Heavy Metals (Spent Oxides), Non-Volatile Polycyclic Aromatic Hydrocarbons (PAHs), Asbestos Containing Materials (ACM) (Former Structure), Total Petroleum Hydrocarbons (TPHs), Volatile Organic Compounds (VOCs), Semi Volatile Organic Compounds (SVOCs), Sulphates (slag, clinker, ashy deposits).
- Historical Munitions Works (PL1, PL2, PL3, PL4, PL6, PL7, PL8, PL9) - Heavy Metals & Metal Compounds, Inorganic Compounds, Explosive Compounds and Propellants (inc. TNT, RDX, HMX, Tetryl, PETN, Nitroguanidine, Nitroglycerine and Picric Acid), Acids, Organic Solvents, TPHs and VOCs; Accidental Detonation of Explosive Compounds and Propellants.
- Made Ground (PL1, PL2, PL3, PL4, PL6, PL7, PL8) - Heavy Metals, Non-Volatile PAHs, ACM, TPHs, VOCs, SVOCs, Sulphates (slag, clinker, ashy deposits).
- Historical Railway/Tramway Sidings (PL1, PL2, PL3, PL6, PL8) - Heavy Metals, Non-Volatile PAHs, TPHs, VOCs (Degreasers, Oil lubricants), SVOCs, Sulphates (ashy deposits).
- Historical & Current Oven Manufacturing Factory (PL1, PL2, PL3, PL4, PL6, PL7, PL8) - Heavy Metals, Non-Volatile PAHs, ACM (Fabric of Structures), TPHs, VOCs (Coatings, Solvents, Slurry Waste, Acids), SVOCs, PFAS/PFOA (Coatings).
- Electricity Substations (Pre 1970) (PL1, PL2) - Polychlorinated biphenyl (PCBs).
- Historical Infilled Ponds (centre south, southeast and northeast) (PL1, PL2, PL3, PL7) - Heavy Metals, Non-Volatile PAHs, ACM, Organic Compounds.

Controlled Waters

Sources

- Historical Munitions Works (PL2, PL5) –Explosive Compounds and Propellants, Acids, Solvents, low end TPHs, VOCs.
- Historical & Current Oven Manufacturing Factory (PL2, PL5) – low-end TPHs VOCs, SVOCs, PFAS/PFOA.

Ground Gas

Sources

- Substantial Made Ground associated with Historical Iron Foundry, Historical Railway/Tramway Sidings, Historical and Current Oven Manufacturing Factory, and Historical Infilled Ponds (PL4)– Methane, Carbon Dioxide.

	• Volatile Contaminants associated with Historical Iron Foundry, Historical Munitions Works, Made Ground deposits, Historical Railway/Tramway Sidings, and Historical and Current Oven Manufacturing Factory (PL4) - Volatile Vapours.
Initial Conceptual Site Model *Continued...*	**Receptors** • Groundworkers and Site Personnel • Future End Users • Underlying Secondary A Superficial Aquifer and Principal Bedrock Aquifer
Human Health	**Inorganic Heavy Metals** • Three instances of exceedances of inorganic heavy metals (Arsenic, Lead and Nickel) were identified within the Made Ground deposits in the upper 1.30 m bgl of the ground, predominantly towards the north of the site. • The identified elevated concentrations of heavy metalloid compounds have primary exposure pathways related to dermal contact and ingestion of soils (PL2), and consumption of homegrown vegetables (PL1). **Volatile Organic Compounds (VOCs)** • Localised areas of elevated Trichloroethene (TCE), Dichloroethene (cis 1,2-Dichloroethene, and Trans 1,2-Dichloroethene), and Vinyl Chloride have been identified within soils in three locations (WS101 to WS103) across the southern boundary of the site, directly to the south of the main factory structure. It is noted that WS102 and WS103 are located within the immediate vicinity of the enamel slurry waste storage area, located to the southeast of the main factory structure. As such, the enamel slurry waste storage area may be the potential source of these exceedances. • These elevated compounds present a primary exposure pathway linked to the potential volatilisation to indoor air risk (PL4), in addition to exposure pathways of dermal contact and ingestion of soils (PL2) and consumption of homegrown vegetables (PL1) within impacted areas. • Further investigation and subsequent testing is recommended in order to determine the spatial extent of the VOC contamination identified within the soils across the southern boundary of the site and to understand whether leaching had occurred into the underlying natural strata, particularly in WS101 and WS103 where exceedances were only recorded within Made Ground Deposits. • If the enamel slurry waste storage area is deemed to be the source, removal of the impacted material is recommended to mitigate any further migration and degradation of TCE into further areas of the site. Subject to the findings of further phases of intrusive ground investigation, further assessment in the form of a Detailed Quantitative Risk Assessment (DQRA) may also be required.

Human Health *Continued…*	**Asbestos** • No asbestos contamination was identified within any samples submitted for laboratory testing, however the fabric of the current main factory structure is known to contain asbestos throughout. • Following demolition of the main factory structure, further investigation and subsequent testing is recommended in order to obtain representative soil samples of the underlying strata and determine whether the underlying soils are impacted with asbestos. • If Asbestos fibres are encountered, a primary exposure pathway of inhalation of fibres (PL3) would be presented to site personnel and end users. • Impacted soils should be managed according to the asbestos risk mitigation conceptual site model.
Controlled Waters	**Sources** • Historically, the site has been subjected to extensive infilling and a number of industrial uses including an Iron Foundry and Oven Manufacturing Factory which, at the time of writing the report is still present and active. • Chemical by-products of manufacturing processes and compounds within the Made Ground may have subsequently leached down into underlying ground and contaminated groundwater both within Made Ground and natural superficial deposits. • Widespread Trichloroethene (TCE), Dichloroethene (cis 1,2-Dichloroethene, and Trans 1,2-Dichloroethene), and Vinyl Chloride contamination and localised heavy metal exceedances have been identified in the groundwater analysis at the site. • It is noted that where there are exceedances of VOCs in soils, exceedances in groundwater were often recorded. Therefore, it is considered that there is a likely on-site source of contamination which may be leaching across the site. • A plume of Trichloroethene (TCE), Dichloroethene variants, and Vinyl Chloride has been identified within groundwater monitoring data, extending from WS107 towards the northwestern entrance of the site, through to CP102 towards the southeast of the factory. It is noted that concentrations of VOCs were significantly higher in deeper groundwater monitoring wells, which suggests the plume is formed of DNAPL. **Pathways** • The site is underlain by a mixed geology, generally cohesive clay in the south of the site with discrete areas of interbedded cohesive and granular materials towards the north. The granular deposits will afford less protection to the underlying Principal aquifer in the bedrock in comparison to the remainder of the site, where generally clay deposits are anticipated to, or proven in excess of 5.00 m in areas.

Controlled Waters *Continued…*	• Towards the northern sector of the site, bedrock was encountered at lesser depths (<5.00 m bgl), which further increases the risk of vertical migration of compounds towards the underlying bedrock aquifer as a result of cohesive material is not present within suitable quantities to afford protection to the underlying aquifer. **Receptor** • Principal Bedrock Aquifer and Source Protection Zone 3. • Given the significantly elevated concentrations of the VOC impact within both shallow and the deeper groundwater wells in the south of the site, the principal aquifer is deemed to be at a high risk. • No environmental monitoring wells have been advanced into the principal aquifer (bedrock) and so, it is not yet proven whether the source-pathway-receptor linkage is complete. Without samples of the principal aquifer, the extent, if any, of VOC impact cannot be proven.
Ground Gas	**Sources** • Historically, the site has been subjected to extensive infilling and a number of industrial uses including an Iron Factory and Oven Manufacturing Factory which, at the time of writing the report is still present and active. • Chemical by-products of manufacturing processes and compounds within the Made Ground may have subsequently leached down into underlying ground and contaminated both Made Ground and natural superficial deposits. • Three historically infilled ponds were formerly present towards the centre south, southeast and northeast boundaries, which are potential sources of ground gases. • Widespread VOC (Trichloroethene, Dichloroethene and Vinyl Chloride) contamination impact have been identified in the soil analysis towards the south. **Pathways** • The site is underlain predominantly by cohesive clay with discrete areas of interbedded cohesive and granular materials towards the north. The granular deposits will facilitate in the migration of ground gas across the site from on-site sources including MADE GROUND deposits, historically infilled ponds and known VOC impacts. **Assessment** • Based on the initial ground gas monitoring data, the site classifies in variable categories with the majority of site situated within Characteristic Situation 1 (CS1).

Ground Gas *Continued…*	• There are two noted areas falling within Characteristic Situation 2 (CS2), and a further two areas falling within Characteristic Situation 3 (CS3). • As a precautionary measure, it is recommended that the whole site should be categorised within CS2, which will require basic gas protection measures, with any proposed plots within the area of CS3 classification potentially requiring further precautions. • Further environmental monitoring wells are required within the footprint of the main factory structure in addition to further ground gas monitoring regimes under lower pressure conditions and further falling and rising pressure events due to elevated readings and known VOC impacted soils and groundwater. • With regards to the elevated volatile contaminants identified within soils and groundwater across the southern boundary of the site, vapour resistant membranes may be required to be installed during the build phase for any proposed buildings situated within the immediate vicinity of the impacted soils. **Radon** • A Radon Class 1 has been applied to the site, therefore no radon protective measures are required in the construction of residential dwellings.
Potable Water Infrastructure	Based upon chemical soil analysis and depth of Made Ground, it is considered likely a barrier pipe will be required. This will be confirmed following a UKWIR pipeline assessment as post remedial site condition may vary from the present.

GEOTECHNICAL ASSESSMENT

Underground Obstructions & Subterranean hazards	In the northern part of the site in WS108, a notable concrete obstruction was identified within the Made Ground. These findings suggest the presence of remnants from a previous platform associated with historical railway sidings. As part of the process of creating a suitable development platform, all subterranean obstructions will need to be excavated and removed beneath new structures and infrastructure. This will facilitate the construction of the proposed plots as intended.
Allowable Bearing Capacity	Based upon the ABC data, suitable materials for founding have been identified at 1.00 m bgl to 2.00 m bgl within the natural firm to very stiff CLAY in WS102, WS105, WS107 and WS109, with all other locations containing Made Ground exceeding 1.40 m bgl. The ABC ranges from 52 kN/m^2 –155 kN/m^2 from 1.00–1.45 m bgl within the aforementioned locations. Within three other locations, a suitable ABC was identified at 2.00 m bgl, in the firm to very stiff gravelly CLAY in WS104 and WS110, and in the dense clayey fine to medium SAND in WS106. The ABC ranges from 75 kN/m^2 –301 kN/m^2 from 2.00–2.45 m bgl within the aforementioned locations.

Allowable Bearing Capacity *Continued…*	Towards the south of the site, the remaining four exploratory hole locations (WS101, WS103, CP101 and CP102), reached a material considered a suitable ABC at 3.00 m bgl, in either the firm to very stiff gravelly CLAY or the dense SAND & GRAVEL, with CP101 recorded at 4.00 m bgl due to extensive MADE GROUND. The ABC ranges from 170 kN/m^2 –435 kN/m^2 from 3.00–4.45 m bgl within the aforementioned locations.
Foundation Options	Several foundation options should be considered for residential development on confirmed soil mechanics, cost, and construction feasibility. In this instance, it is thought that the following foundation options for low-rise housing: • Shallow strip foundations bearing on the firm to very stiff gravelly clay at 1.45 m bgl; • Reinforced trench fill to support reinforced strip foundations should be considered where the target bearing stratum is greater than 1.50 m below the proposed level and in areas of softer variable ground and/or potential tree influence • Driven pile foundations within areas of extensive MADE GROUND (> 2.50 m bgl) or anomalies. Within the site, there are areas of variable ground conditions that will preclude the use of a shallow spread foundation. This includes the footprint of the main factory structure and outbuildings, where extensive Made Ground deposits are anticipated. Therefore, consideration should be given to the use of Ground Improvement by Vibro Stone Column to ensure the treatment achieves a suitable design ABC to support a doubly reinforced strip foundation or construction of piled foundations.
Foundations Near Trees	Foundation depths within the conjectured influence of former, existing or proposed trees will need to be deepened to ensure that structural loading bears within the underlying target founding stratum, which cannot be subject to volumetric instability associated with fluctuation in moisture content.
Heave Precautions Near Trees	Given that the underlying clay is of low volume change potential, heave precautions will not be required to the internal face of a foundation less than 1.50 m in depth. Heave precautions will be required to the underside of floor slabs (where there is no 200 mm void) and pile ground beams are required within the modelled influencing distance of trees.
Building Floor Slabs	Ground-bearing floor slabs are not considered viable given the anticipated depths of Made Ground > 600 mm and shallow cohesive soils.
Soakaway Drainage	The Made Ground and underlying granular soils are cohesive in nature and impacted by low-level inorganic and volatile organic compounds which would preclude the use of infiltration drainage systems.
Sulphate Assessment	Concrete classification will be DS1, AC-1s in accordance with soil chemical analysis of sulphate data. Concrete design should be completed in accordance with this classification. Further intrusive ground investigation required to confirm areas not investigated.
Highway & Infrastructure Construction	Unsuitable materials are potentially present within areas of the infilled ponds. Where a proposed highway or infrastructure is to be constructed in these areas, remediation works will be required to ensure the site is engineered to a suitable geotechnical design specification. Further investigation is required to confirm underlying material within the vicinity of infilled ponds.

CBR Design %	Granular soils can be re-engineered to ensure 5% within the subgrade during favourable climatic conditions. Natural clay soils will provide a CBR in the order of 3–5% during drier climatic periods. However, if water is allowed to shed onto the formation, the CBR will reduce to < 2%, which will require specialist engineering of the subgrade.
Civil Engineering Excavations	Extensive obstructions are anticipated within the footprint of the main factory structure with known obstructions encountered within WS108 (north of the main factory structure).
Waste Characterisation	Any material that is to be disposed off-site should undergo assessment using Technical Guidance WM3: *Waste Classification – Guidance on the classification and assessment of waste*. This can be done upon request and in line with the Environment Agency sampling frequencies.

RECOMMENDATIONS

Based on the findings of the Geoenvironmental site assessment and the various conclusions drawn, the following additional works are recommended to be completed in due course:

- Further intrusive ground investigation, including delineation of VOC impacted soils and groundwater and determination of any potential PFAS/PFOA, Explosive Compounds and Propellant contamination;
- Further intrusive ground investigation of inaccessible areas (main factory structure and outbuildings);
- Human Health Detailed Quantitative Risk Assessment (DQRA) of VOC impacted soils (subject to findings of further phases of intrusive ground investigation);
- Controlled Waters DQRA of VOC DNAPL plume;
- Plot-specific foundation schedule (upon receipt of the final development levels);
- Geotechnical Design Report (GDR), including settlement analysis;
- Geotechnical Earthworks Specification (infrastructure);
- Remediation and enabling works strategy; and
- Specification for Mitigation of Hazardous Ground Gases & Verification Plan.

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17-500-001 – Site Location Plan
17-500-003 – Historical Features Plan
17-500-004 – Site Features Plan
17-500-005 – Exploratory Hole Location Plan
17-500-006 – Depth of Made Ground Plan
17-500-009 – Depth to Founding Strata Plan
17-500-010 – Human Health Conceptual Site Model
17-500-012 – Depth to Bedrock Plan
17-500-015 – Development Constraints Plan
17-500-018 – Contamination Issues Plan (Groundwater)
17-500-026 – Contamination Issues Plan (Human Health)
17-500-027 – Controlled Waters Conceptual Site Model
17-500-028 – Utility Survey Plan
17-500-029 – Groundwater Flow Plan

1. INTRODUCTION

1.1. BACKGROUND

Glen Dimplex Homes Appliances Ltd (the client) has commissioned E3P to undertake a Phase I and II Geoenvironmental Site Assessment at the Glen Dimplex Factory, Stoney Lane, Rainhill, Prescot, L35 2XW.

This report is required to determine potential contaminated land liabilities, remediation requirements and geotechnical engineering works that will be required as part of the proposed development for a low-rise residential development.

1.2. PROPOSED DEVELOPMENT

At present, a proposed development plan has not been decided, however it is assumed the redevelopment will comprise residential dwellings with associated private gardens, roadways and associated infrastructure.

At the time of writing this report, the proposed development is potentially subject to change and will be updated following significant changes.

1.3. OBJECTIVES AND SCOPE

The objectives of the geoenvironmental investigation are as follows:

- Review historical plans, geology, hydrogeology, site sensitivity, floodplain issues, mining records and any local authority information available to complete a desk study in line with Environment Agency (EA) document Land Contamination: Risk Management (LCRM) (updated June 2023).
- Undertake a phase of sampling and analysis to provide an overview of the environmental issues identified.
- Assess the implications of any potential environmental risks, liabilities and development constraints associated with the site concerning the site's future use and off-site receptors.
- Assess the geotechnical information and provide recommendations concerning foundations, pavement construction and floor slabs.
- Assess the coal mining-related information and provide recommendations regarding any future treatment; and,
- Provide recommendations regarding future works required.

1.4. SOURCES OF INFORMATION

Background information was sought from the following sources:

- Groundsure Enviro+Geo Insight Search Reference GS-APN-DM7-KX2-GEA;
- Historical mapping dated 1893 to 2017. A selection of historical maps is reproduced in APPENDIX VI;

- Online planning records held by Knowsley Metropolitan Borough Council and St Helens Metropolitan Borough Council;
- Consultations with representatives of Knowsley Metropolitan Borough Council and St Helens Metropolitan Borough Council;
- Consultations with representatives of the Coal Authority;
- Magic Map Groundwater Vulnerability Map;
- Radon: Guidance on protective measures for new buildings (BRE Document BR 211, 2007);
- British Geological Survey Map;
- Groundsure IO database;
- https://zeticauxo.com/downloads-and-resources/risk-maps/;
- https://www.heritagegateway.org.uk;
- https://flood-map-for-planning.service.gov.uk; and
- Environment Data - Catchment Data Explorer

1.5. SCOPE OF WORKS

The scope of works includes the elements included in Table 1.

Table 1 Scope of Works

PRELIMINARY REPORTING
Phase 1 Geoenvironmental Assessment
PRELIMINARY GROUND INVESTIGATION
Design of suitable preliminary ground investigation;
Window sample probeholes with the construction of environmental monitoring installations;
Deep cable percussive boreholes with the construction of groundwater monitoring installations; and
Soil and groundwater sampling.
TESTING AND MONITORING
In-situ geotechnical testing;
Chemical and geotechnical analysis;
Groundwater monitoring; and
Ground gas monitoring.

ASSESSMENT AND REPORTING

- Factual and interpretative reporting;
- Contamination risk assessment and conceptual site model; and
- Geotechnical assessment and interpretation.

1.6. LIMITATIONS

The limitations of this report are presented in APPENDIX I.

1.7. RISK CLASSIFICATION

The description of risk classification and the likely action required as set out in CIRIA C552 are included in APPENDIX III.

1.8. CONFIDENTIALITY

E3P has prepared this report solely for the use of the client and those parties with whom a warranty agreement has been executed or with whom an assignment has been agreed. Should any third party wish to use or rely upon the report's contents, written approval must be sought from E3P; a charge may be levied against such consent.

2. SITE SETTING

2.1. SITE DETAILS

Table 2 Site Details

Site Address	Glen Dimplex Home Appliances Ltd, Stoney Lane, Rainhill, Prescot, L35 2XW
National Grid Reference	E 348017 N 391531
Site Area	5.96 Ha.
Site Ownership	Glen Dimplex Home Appliances Ltd.

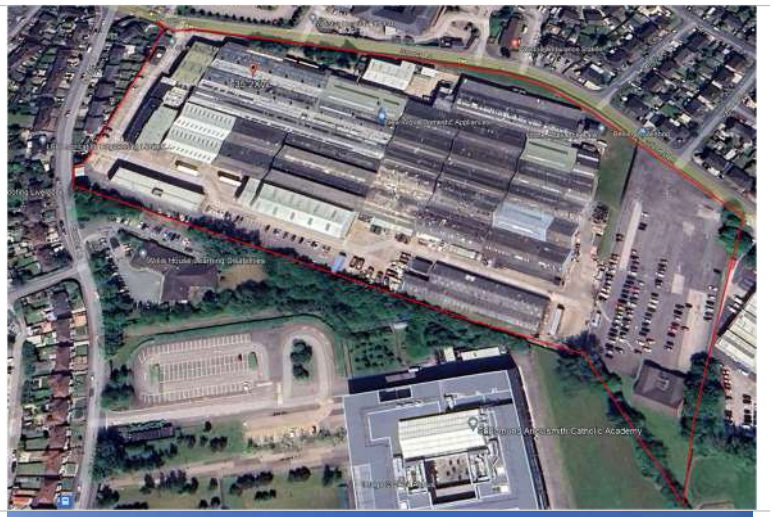
The Glossary presented in APPENDIX II defines all acronyms used within this report.

A site location map is presented as Drawing 17-500-001 in APPENDIX IV.

2.2. CURRENT SITE USE

A site walkover was completed by an E3P representative on 18th March 2024, with the full details included in Table 3. Site features are presented as Drawing 17-500-004 in APPENDIX IV, and site photographs are presented in APPENDIX V.

Table 3 Site Description

FEATURE	DESCRIPTION	PHOTOGRAPHIC EVIDENCE
Occupancy/Use	The site is an active oven manufacturing factory with an associated employee car park to the east. Primarily, the site comprises a large singular storey industrial structure with small outbuilding along the southern and northern boundaries. Presently, the site is active with heavy haulage deliveries and exports, however it is known that decommission of the factory will commence circa July 2024.	
Structures	A large structure is present occupying the majority of the site, with multiple small structures noted to the north, south, and west of the structure. Small substructures including two electricity substations and gas houses are recorded across the periphery of the site.	

FEATURE	DESCRIPTION	PHOTOGRAPHIC EVIDENCE
Retaining Structures	Small retaining structures were noted in the small area of landscaping towards the east of the main factory structure. Further retaining walls were noted along the northern boundary adjacent to Stoney Lane to the north of the structure.	
Access	Surrounding the main factory structure, a service road is present to the south and the west, connecting to Stoney Lane at the north. Access for both pedestrians and vehicles can be gained at the northwest off Stoney Lane in Prescot. The access is restricted with security adjacent at the northwest, which is manned 24 hours.	

FEATURE	DESCRIPTION	PHOTOGRAPHIC EVIDENCE
Slope	Minor slopes were identified particularly at the northern boundary and towards the west at the soft cover adjacent to the structure. A small retaining structure is noted at the southern face adjacent to the building.	
Vegetation/Ecology	No significant instances of vegetation/ecology were noted with the exception of small areas of soft cover landscaping (managed grasses) are noted at the north and east of the structure, with semi sporadic semi-mature trees towards the northern boundary.	

FEATURE	DESCRIPTION	PHOTOGRAPHIC EVIDENCE
Hazardous Material Storage	An enamel slurry waste storage area was recorded to the southeast of the main factory structure both in an above ground waste skip pictured to the right, and in a below ground storage tank. Two large above ground oil storage containers were noted to the west of the structure, with all containers identified in good condition with no sign of damage. Further instances of hazardous material storage is anticipated within the factory. However, this has not been confirmed at the time of the walkover as a full survey of the factory interior has not been completed.	 

FEATURE	DESCRIPTION	PHOTOGRAPHIC EVIDENCE
Asbestos-Containing Material (ACM)	No evidence of ACM was noted across the majority of the site during the site walkover. Anecdotal information from site personnel indicated asbestos sheeting roof was present. Due to the age of the building, asbestos containing material is expected throughout the fabric of the building. A pre-demolition asbestos survey will be required within all existing buildings within the site boundary.	
Polychlorinated Biphenyls (PCBs)	Two electricity substation have been identified on-site towards the northwest and south, both of which were present prior to 1970. Therefore, it is considered likely PCBs are contained within the vicinity of these substations.	

FEATURE	DESCRIPTION	PHOTOGRAPHIC EVIDENCE
Volatile Organic Compounds (VOCs)	An active polystyrene manufacturing plant was noted with large imports of polystyrene recorded at the northern boundary adjacent to the structure. This presents a potential source of VOCs within the vicinity of the polystyrene manufacturing plant (northern boundary), however all instances of polystyrene were well stored with all surrounding areas covered in hardstanding. It is understood the polystyrene manufacturing plant was constructed in 2006, and that during the site walkover, no evidence of above or below ground storage tanks of VOCs were identified. However, as access to the plant was restricted due to its active nature, the presence of storage tanks within the plants interior cannot be fully discounted at this time.	
PFAS/PFOA	It is understood that the site has operated as a Stove Works and oven manufacturing factory since 1937. This presents a potential source of PFAS/PFOA within the vicinity of the main factory structure, as PFAS/PFOA based products may have been utilised in the manufacturing process (e.g. non-stick coatings). During the site walkover, no evidence of above or below ground storage tanks of PFAS/PFOA were identified. However, as access to the main factory structure was restricted due to its active nature, the presence of storage tanks within the factory's interior cannot be fully discounted at this time.	

FEATURE	DESCRIPTION	PHOTOGRAPHIC EVIDENCE
Waste Storage	Non-hazardous waste storage was present in large containers to the south of the main factory structure adjacent to the two small outbuildings. Some localised areas of fly tipped material was noted across the site however none appeared hazardous.	
Drainage & Utilities	During the site walkover, multiple instances of manholes and drainage covers were noted across the site within the roadways surrounding the main factory structure. Further instances of services are anticipated across the site due to the active nature including low–high voltage electricity cables, gas mains, clean water, and telecommunications cables connecting the structure to the adjacent roadways. A full GPR and utility survey has been undertaken by Geo UK Ltd in March 2024 and is presented as Drawing 17-500-028 in APPENDIX IV. The survey identified electricity cables surrounding the main factory structure and feeding into the two on-site electricity substations. Two gas governors and associated pipework were identified along the northern boundary and fed into the polystyrene manufacturing plant and northwest corner of the main factory structure. Water and sewerage mains and telecommunication cables were also identified surrounding the main factory structure and feeding into the surrounding smaller structures. Due to the site being an active oven manufacturing factory, the utility survey was not able to access the interior of the main factory structure or surrounding small structures.	

2.3. SURROUNDING AREA

The immediate surrounding area land uses are summarised in Table 4.

Table 4 Surrounding Land Uses

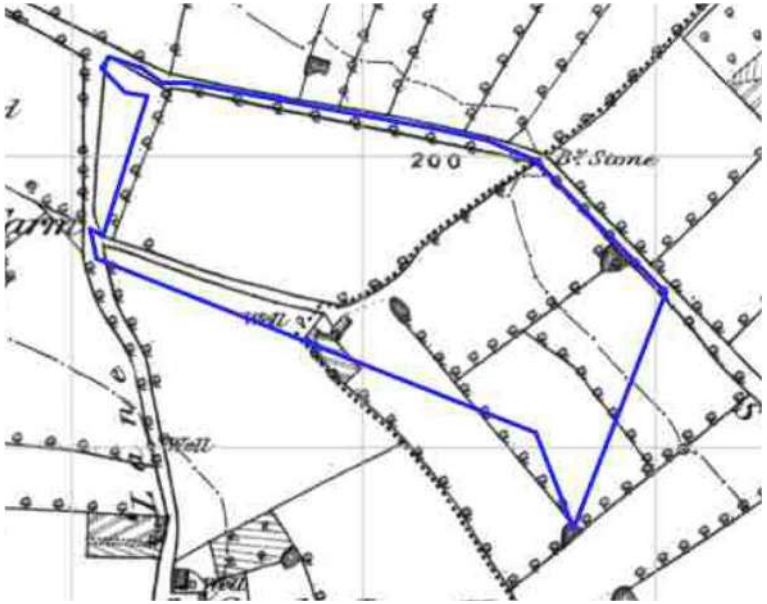
DIRECTION	LAND USE
North	Whiston Hospital, Whiston Ambulance Station, Residential units.
East	Elis (Laundry Service), Residential units.
South	Willis House Learning Disabilities, St Edmund Arrowsmith Catholic Academy
West	Residential units

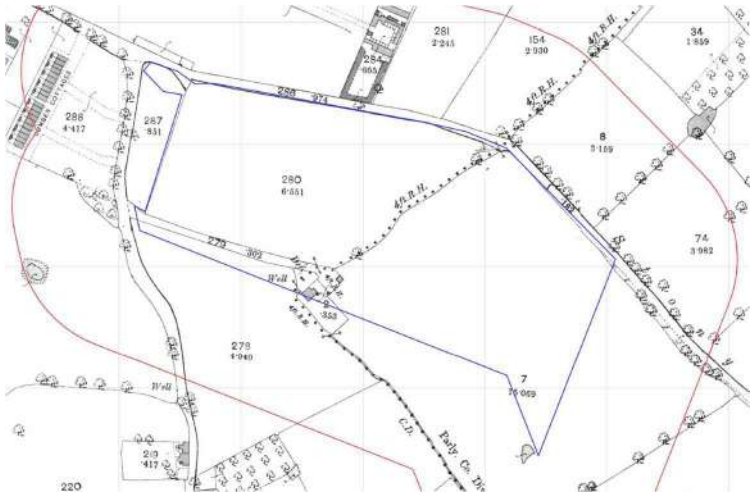
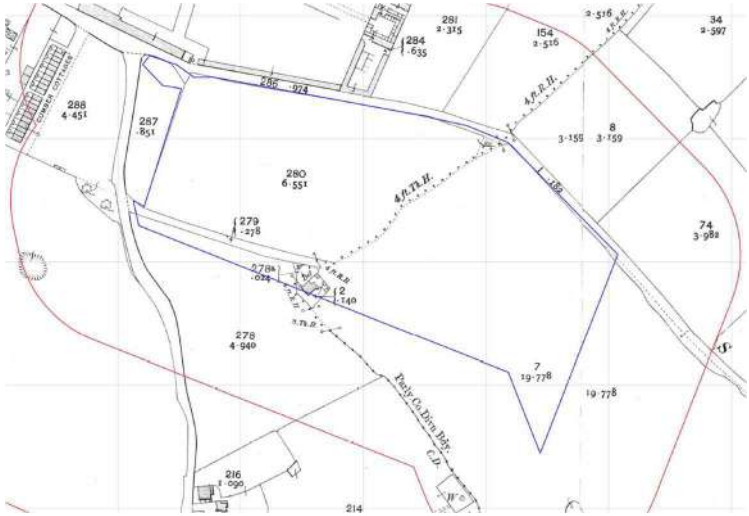
3. SITE HISTORY

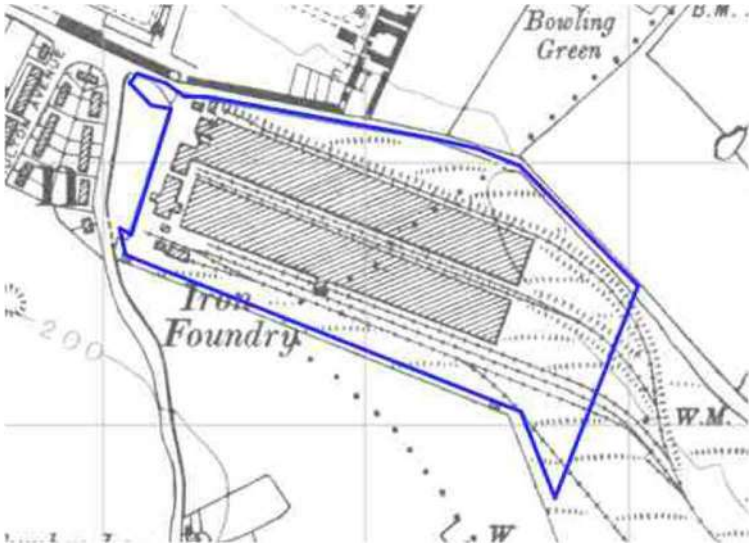
3.1. ON-SITE HISTORICAL DEVELOPMENT

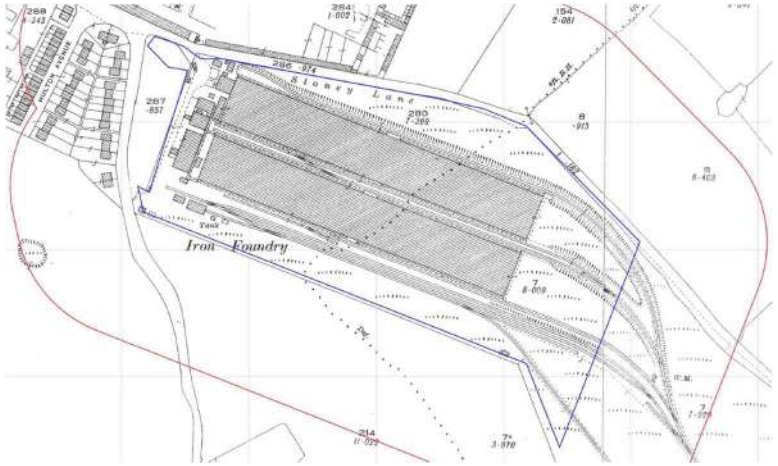
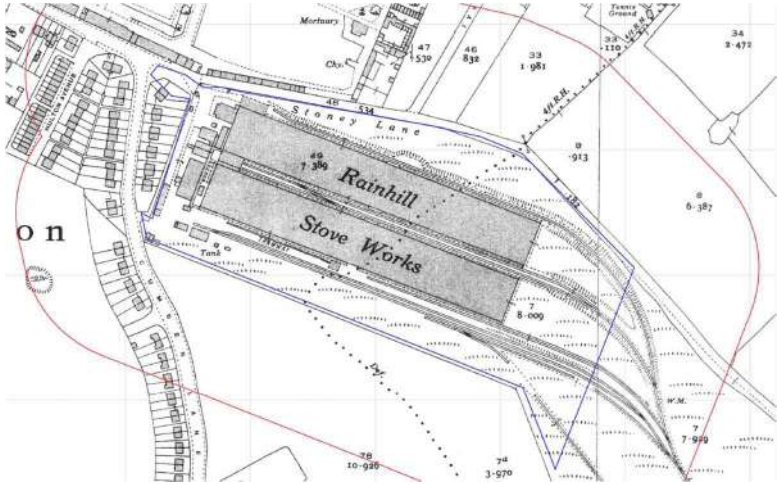
A review of historical mapping and historical aerial imagery pertinent to the site is summarised in Table 5. In addition, historical site features are presented in Drawing No 17-500-003 in APPENDIX IV.

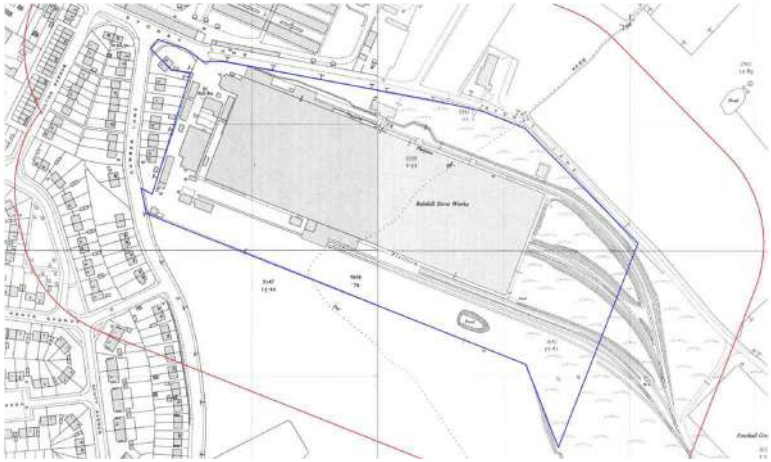
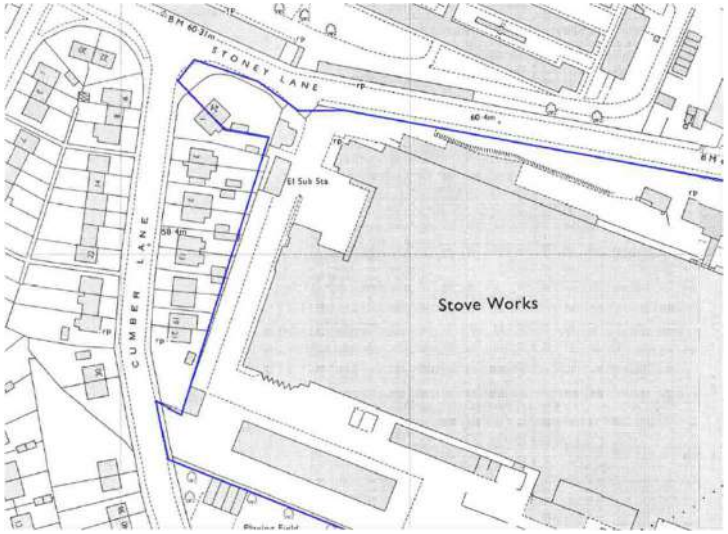
Table 5 Historical Development

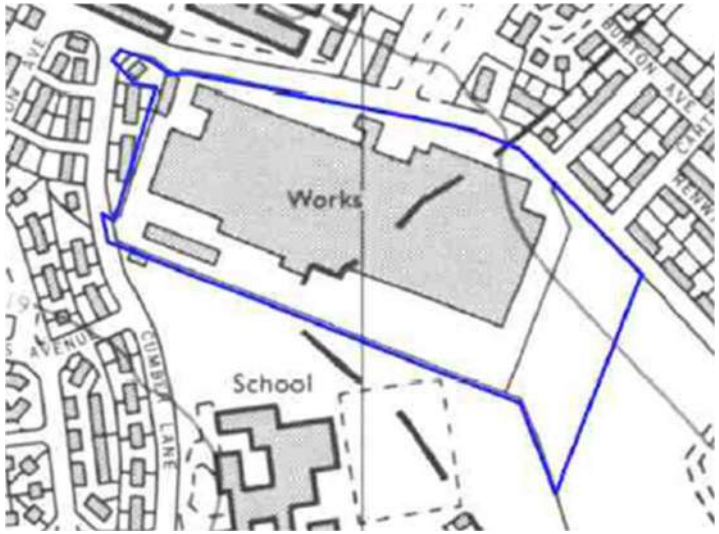
MAP EDITION	HISTORICAL LAND USE	HISTORICAL MAP EXCERPT
1850 1:10,560	The site appears to be utilised as vacant agricultural land with a small dwelling situated at the centre of the southern boundary. A roadway leading to the dwelling is running parallel to the southern boundary. A well is noted adjacent to the dwelling at the southern boundary. Several segmenting tree-lined field boundaries are present, with the site comprising seven smaller fields. Two small ponds are recorded at the northern boundary towards the east, with another pond situated towards the centre of the southern boundary. A topographical gradient is noted towards the northeast of the site, suggesting natural geomorphology was variable.	

MAP EDITION	HISTORICAL LAND USE	HISTORICAL MAP EXCERPT
1892 1:2,500	The majority of the field boundaries have been removed. A small site boundary is noted at the north-western most point of the site, with a small portion noted entering at the centre of the northern boundary. The field boundary traversing through the centre of the site is now noted as a small hedge-lined road traversing from the south towards the northeast, continuing off-site. The two small ponds recorded at the northern boundary towards the east, and towards the centre of the southern boundary are no longer recorded. No other notable features have been identified.	
1907 1:2,500	One of the wells present towards the south has been removed. The hedge-lined road is now remarked as a Hedge Track. No other notable features have been identified.	

MAP EDITION	HISTORICAL LAND USE	HISTORICAL MAP EXCERPT
1914-1925	Historical mapping was unavailable between 1907 and 1925. However, records held by Heritage Gateway indicates a factory had been developed on the site, and that it was being used as a Munitions Works during the First World War (1914-1918) and up until at least 1925 (likely for the manufacturing of military based explosives and propellants).	
1925 1:10,560	The site has been completely redeveloped and comprises an Iron Foundry with associated railway sidings across the site. The Iron Foundry consists of two large structures separated by a railway siding traversing east to west through the centre of the site. Multiple small outbuildings are noted along the western sector of the main factory structures. The outbuilding situated to the south of the main factory structure is assumed to be associated with the railway sidings. Cuttings are noted at the northern boundary, north of the structure, with further cuttings noted adjacent to railway sidings towards the eastern and southern boundaries. Railway sidings are noted entering the site at the eastern boundary, branching off to the south, centre of, and north of the main foundry building.	

MAP EDITION	HISTORICAL LAND USE	HISTORICAL MAP EXCERPT
1927 1:2,500	A tank is noted at the southern boundary adjacent to the railway sidings to the south of the structure. No other significant changes have been identified.	
1937 1:2,500	The site is now named Rainhill Stove Works. A small extension to the structure at the northeast of the works structure is noted. Changes to the cutting at the centre of the northern works structure is noted now protruding further north than previous mapping. The sidings to the south are now noted as tramway sidings, with a small portion of the branch traversing southeast removed.	
1939-1945	Records held by Heritage Gateway indicates the factory was repurposed as a Munitions Works during the Second World War (1939-1945), again likely for the manufacturing of military based explosives and propellants.	

MAP EDITION	HISTORICAL LAND USE	HISTORICAL MAP EXCERPT
1954-1955 1:1,250	The site now comprises one large structure, with the sidings previously noted segmenting the two structures removed. Additional outbuildings have been constructed towards the northeast of the site with an electricity substation noted to the northwest of the main factory structure. A small pond is noted at the southern boundary adjacent to the sidings towards the east. The tank previously recorded at the southwestern boundary has been removed with a new tank recorded present at the southeastern corner of the main factory structure. Two platforms at the north and south of the main factory structure are noted.	
1972-1975 1:1,250	The separated outbuildings previously noted along the western boundary have either been removed or incorporated into the main factory structure. An additional connecting structure is noted at the central northern point of the main factory structure. The structure at the southwestern sector of the site is noted as extended. *Other sectors of the site are not available within historical mapping.*	

MAP EDITION	HISTORICAL LAND USE	HISTORICAL MAP EXCERPT
1978 1:10,000	All railway and tramway sidings present in previous mapping have now been removed. A County Parish boundary is noted segmenting the site through the centre of the site. A segmenting boundary is noted at the eastern sector of the site, separating the area from the main works structure. It is assumed this is the construction of the car parking area.	
1990 1:10,000	Small compositional changes to the main factory structure have been identified, with expansions noted towards the northern and southeastern sector of the main factory structure. Additional structures are noted at the southeastern and southern sectors of the site. Further boundaries segmenting the western sector of the site are noted.	

MAP EDITION	HISTORICAL LAND USE	HISTORICAL MAP EXCERPT
2000 Aerial Imaging	A roadway surrounding the main factory structure connecting to Stoney Lane to the north traversing south and west along the structure is noted. An associated car parking area to the east of the site is identified. Localised areas of soft standing landscaping are noted surrounding the main factory structure. No other significant changes have been identified.	
2024 Aerial Imaging	No significant changes from previous mapping have been identified. Present day site composition is displayed.	

3.2. SUMMARY OF ON-SITE HISTORICAL DEVELOPMENT

The following summary points have been highlighted after a detailed review of the historical mapping series.

3.2.1. POTENTIAL HISTORICAL CONTAMINATION ISSUES

- Iron Foundry – Heavy Metals, Non-volatile Polycyclic Aromatic Hydrocarbons (PAHs), Total Petroleum Hydrocarbons (TPHs), Sulphates (Slag, Ash, Dust).
- Munitions Works – Heavy Metals & Metal Compounds (Silver, Lead, Magnesium, Mercury Fulminate); Inorganic Compounds (Nitrite, Nitrate, Sulphate Ions, Ammonium Nitrate, Sodium/Potassium Nitrate, Sodium Sulphite, Sodium/Potassium/Ammonium Perchlorate); Primary Explosive Compounds (Silver Azide, Lead Azide, Lead Styphnate, Tetrazene); Secondary Explosive Compounds (TNT (2,4,6-Trinitrotoluene), RDX (Cyclotrimethylene Trinitramine), HMX (Cyclotetramethylene Tetranitramine), Tetryl (Trinitrophenylmethylnitramine), PETN (Pentaerythritol tetranitrate), Nitroguanidine, Nitroglycerine, Nitrocellulose, Picric acid (2,4,6-trinitrophenol) and Ammonium Picrate; Propellants (solid – single, double or triple base, and composite; or liquid); Acids (nitric, sulphuric and acetic), Organic Solvents (acetone, ether, ethanol, cyclohexanone, diethyl ether, ethyl carbonate, and triacetin), TPHs (including unsymmetrical dimethylhydrazine, polyisobutylene (PIB) and hydroxy-terminated polybutadiene (HPTB)), and Volatile Organic Compounds (VOCs) (including Hexamine, Toluene, Mononitrotoluene, Dinitrotoluene, Polymers, Glycerine, Phenol, Anilines, Aldehydes, Organic Esters, Acetic Anhydride, Guanidine Nitrate, Dicyanodiamide, diphenylamine, isopropyl nitrite and nitrate, ethyl centralite, and glycerine).
- Stove Works - Heavy Metals, Non-volatile PAHs, TPHs, Sulphates (Slag, Ash, Dust), PFAS/PFOA (Coatings).
- Historical Tanks – Volatile Compounds (TPHs, Volatile Organic Compounds - VOCs)
- Historical Electricity Sub Station – Polychlorinated Biphenyls (PCBs)
- Historical Railway/Tramway Sidings – Heavy Metals, Non-volatile PAHs, TPHs, Sulphates (Ashy deposits)
- Made Ground – Heavy Metals, Non-volatile PAHs, TPHs, Asbestos Containing Materials (ACM)
- Historical Infilled Ponds – Heavy Metals, Non-volatile PAHs, TPHs, Organic Compounds, ACM.

3.2.2. POTENTIAL HISTORICAL GEOTECHNICAL ISSUES

- Historical Development (Made Ground and Obstructions) – Significant (likely reinforced) concrete floor slabs in main factory structure footprint.
- Historical Railway/Tramway Sidings and associated platforms (Made Ground and Obstructions) – iron and concrete floors with deeper Made Ground fill expected in these areas.
- Historical Infilled Ponds (centre south, southeast and northeast) – Soft organic deposits with detritus materials.

3.3. OFF-SITE HISTORICAL DEVELOPMENT

A review of potentially contaminative uses identified on historical Ordnance Survey maps within a 100 m radius of the site is summarised in
Table 6.

Table 6 Surrounding Historical Development

SURROUNDING FEATURE	DISTANCE	DATES	DIRECTION
Unspecified Workhouse Then: Poor Law Institution Then: Whiston County Hospital Then: Whiston Hospital	3 m	Pre 1891 – Pre 1906 Pre 1906 – Pre 1947 Pre 1947–Pre 1966 Pre 1966–Present	Northwest
Electricity Sub Station Then: No longer present	30 m	Pre 1955 – Pre 1964 Pre 1964 - Present	Northwest
Unspecified Tank Then: No longer present	35 m	Pre 1984 – Pre 1993 Pre 1993 - Present	Southeast
Unspecified Pit Then: No longer present	76 m	Pre 1906 – Pre 1955 Pre 1955 - Present	West
Electricity Sub Station Then: No longer present	81 m	Pre 1984 – Pre 1993 Pre 1993 - Present	Southeast
Electricity Sub Station Then: No longer present	93 m	Pre 1973 – Pre 1993 Pre 1993 - Present	Northeast

3.4. PLANNING HISTORY

E3P has reviewed online planning records held by Knowsley Metropolitan Borough Council and St Helens Metropolitan Borough Council, and environmentally pertinent information has been obtained for the site, outlined within Table 7 below.

Table 7 Planning History

PLANNING REFERENCE	PLANNING APPLICATION	PERTINENT DOCUMENTS
95/00211/APP	Installation of Tank for storage of liquid oxygen.	None Provided (1995)
97/00304/APP	Construction of vehicular access from Stoney Lane.	None Provided (1997)
02/00052/FUL	Erection of extension to south side of factory for storage facilities.	None Provided (2002)
06/00093/FUL	Erection of Industrial Building for manufacture of Polystyrene, erection of boiler house and associated water tower.	None Provided (2006)

3.5. ANECDOTAL INFORMATION

A web-based search of the subject site has recovered the following photographs, courtesy of Britain From Above:

Table 8 Summary of Anecdotal Information

PLATE EPR000530 – BRITAIN FROM ABOVE 1935	
PLATE EPR000532 – BRITAIN FROM ABOVE 1935	

3.6. PREVIOUS REPORTS

No previous reports have been submitted to E3P for review.

4. ENVIRONMENTAL SETTING

4.1. GEOLOGY

The British Geological Survey (BGS) map (Sheet 097) for the site (1:50,000, Solid and Drift editions) and online records indicate the area is underlain by the geological sequence presented in Table 9.

Table 9 Summary of Underlying Geology

GEOLOGICAL UNIT	CLASSIFICATION	DESCRIPTION	AQUIFER CLASSIFICATION
Superficial	Glacial Till (majority of site)	SAND, CLAY and GRAVEL	Secondary undifferentiated
	Glaciofluvial Deposits (Southeast)	SAND and GRAVEL	Secondary A Aquifer
Bedrock	Kinnerton Sandstone Formation (Majority)	SANDSTONE	Principal Aquifer
	Chester Formation (Eastern)	SANDSTONE	

E3P has reviewed the BGS database, which identified several boreholes in close proximity, from which to compare the published geology above.

The borehole logs are summarised in Table 10 below.

Table 10 Summary of BGS Borehole Records

LOCATION	DEPTH	MADE GROUND	SUPERFICIAL	BEDROCK
21 m SW	2.10 m	1.00 m	Firm to Stiff CLAY > 1.0 m	Not encountered
26 m W	6.00 m	1.20 m	Soft to Stiff CLAY > 1.20 m	Not encountered
70 m SE	10.97 m	0.38 m	Soft to Stiff CLAY >0.38 m	Not encountered

The BGS mapping also identifies the location of faults, as presented in Table 11.

Table 11 Faulting

LOCATION	DESCRIPTION
On-site (eastern sector – Cronton Fault)	Fault Inferred / Northwest to Southeast, downthrow to East
69 m NW	Fault Observed / Northwest to Southeast

4.2. HYDROGEOLOGY

The Groundsure report indicates that the site is located within a Groundwater Source Protection Zone 3. Furthermore, there is an active groundwater abstraction point located 16 m SE of the site, pertaining to Elis UK Ltd and used for laundry purposes.

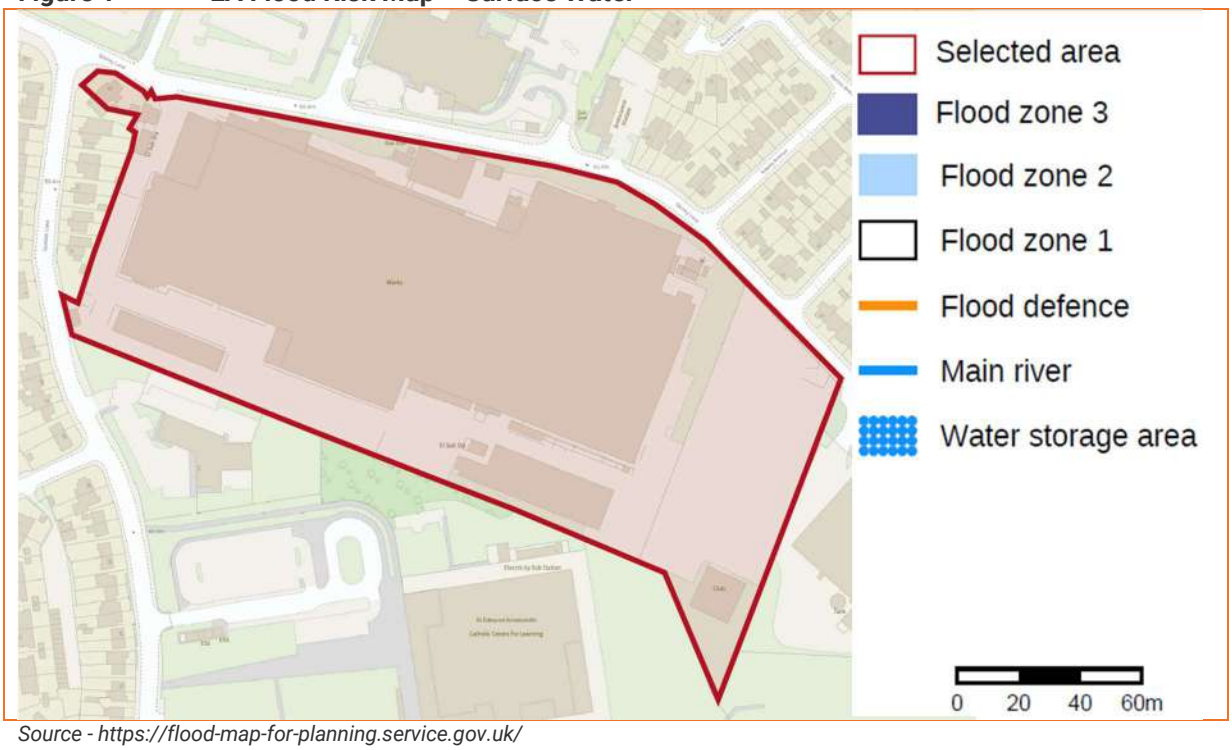
Following a review of the site's historical and present-day mapping, a well was identified historically in the southern sector of the area adjacent to historical farm buildings (Drawing 17-500-004, APPENDIX IV).

4.3. HYDROLOGY

No surface water features are located within 50 m of the site boundary. The closest surface water feature is an unnamed inland river situated 138 m south of site.

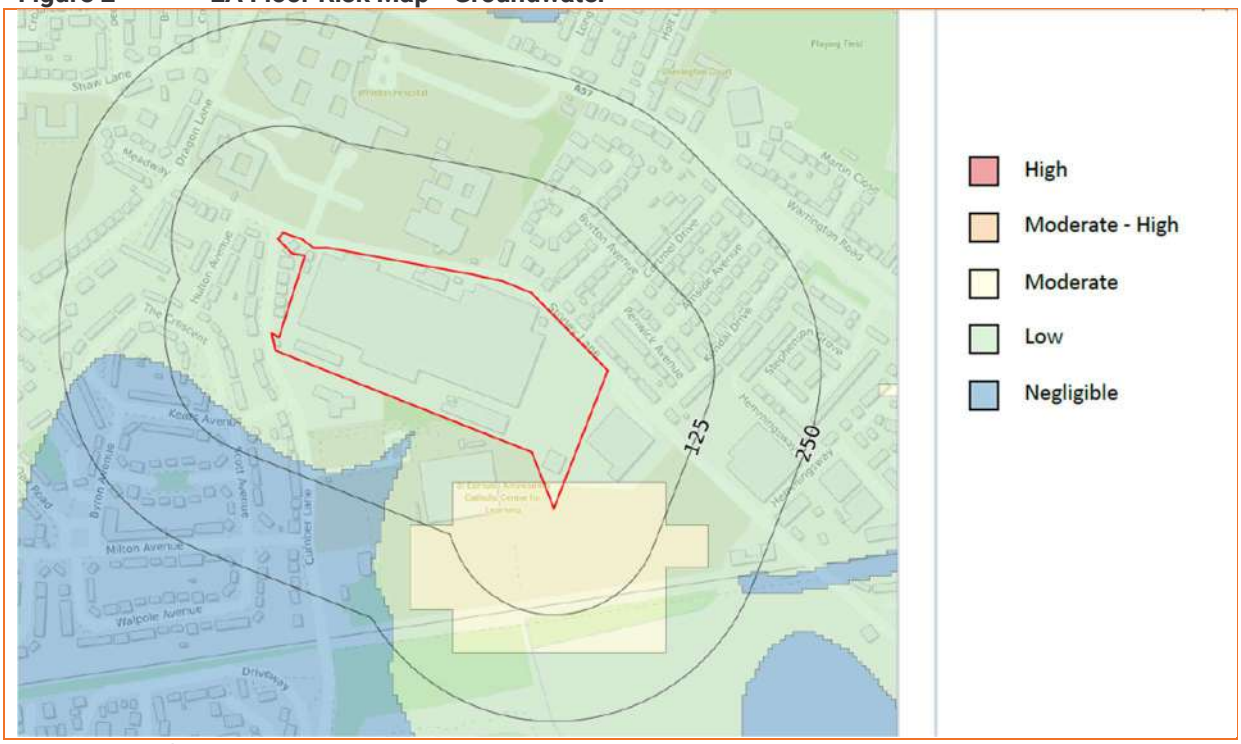
The site is predominantly located within a currently defined "Flood Risk Zone 1", defined as land assessed as having less than 1 in 1,000 annual probability of river or sea flooding (< 0.1%) and, as such, is considered to be unaffected by river flooding. In addition, the Groundsure report states there is a limited potential for groundwater flooding at the majority of the site, with discrete areas at the southeast at a moderate risk. The Environment Agency (EA) Flood Risk Maps for the site is presented in Figure 1 and Groundsure Groundwater Flooding Map in Figure 2.

Figure 1 EA Flood Risk Map – Surface Water



Source - https://flood-map-for-planning.service.gov.uk/

Figure 2 EA Floor Risk Map - Groundwater



Source – Groundsure mapping

4.4. RADON RISK POTENTIAL

The Groundsure report indicates the site is situated in an area where less than 1% of homes are above the "Action Level" and that the BGS reports that radon protective measures are not necessary for the construction of new dwellings or extensions.

4.5. LANDFILL SITES

No active or historical landfill or waste sites have been recorded within 1 km of the site boundary.

4.6. WASTE MANAGEMENT LICENSES AND ENVIRONMENTAL PERMITS

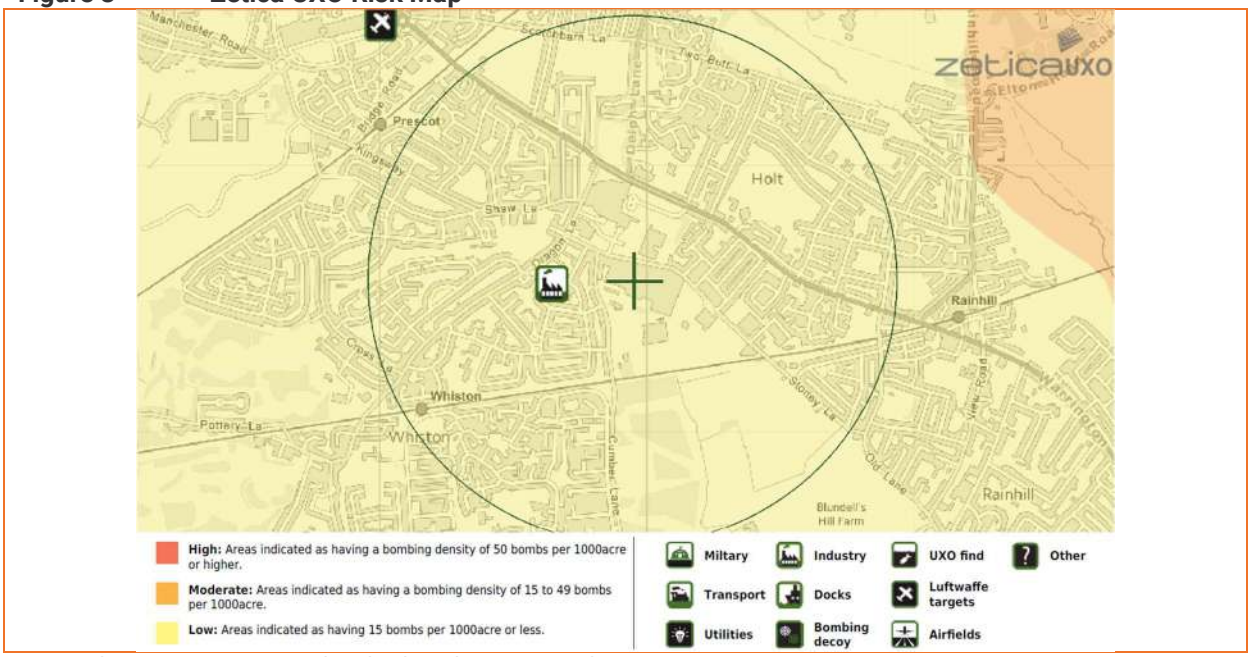
No Waste Management Licenses or Environmental Permits have been identified in the environmental database for the site and surrounding area.

A singular waste exemption is recorded within 100 m of the site (42 m SE), categorised as storage of waste exemption, in a secure place, not on a farm.

4.7. UNEXPLODED ORDNANCE

The regional unexploded bomb risk map from Zetica (2014) indicates that the site is in an area at a low risk from possible unexploded ordnance (UXO) resulting from the Second World War. The Zetica UXO Risk Map is presented in Figure 3.

Figure 3 Zetica UXO Risk Map



Source - https://zeticauxo.com/downloads-and-resources/risk-maps/

Records held by Heritage Gateway indicates the site had previously been used as Munitions Works during the First World War (1914-1918) and up until at least 1925; and again during the Second World War (1939-1945). Though the type of munitions manufactured at the site is currently unknown, given the operational years during the First and Second World Wars, it is likely that military based explosives and propellants were manufactured at the site.

4.8. INDUSTRIAL LAND USES

The site is located within a predominantly industrial area; therefore several industrial land uses have been identified within a 100 m radius of the site, summarised in Table 12.

Table 12 Industrial Land Uses

INDUSTRIAL LAND USE	DISTANCE	DIRECTION	STATUS
Gas Governor	28 m	Northeast	Active
Electricity Substation	29 m	South	Active
Whiston Ambulance Station	32 m	Northeast	Active
Tank	40 m	Southeast	Active
Electricity Substation	82 m	Southeast	Active
Mabley Electrical Services	84 m	Southwest	Active
Electricity Substation	97 m	Northeast	Active

4.9. SITE SENSITIVITY ASSESSMENT

The site is assessed to be located within a “Moderate/High” sensitivity setting, as discussed in Table 13.

Table 13 Site Sensitivity Assessment

SENSITIVITY PROFILE	DISCUSSION	RATING
Groundwater Source Protection Zone or Drinking Water Safeguard Zone	The site is situated within a Groundwater Source Protection Zone 3 – Therefore is considered high sensitivity underlying aquifers.	High
Distance to the Closest Groundwater Abstraction Point	An active groundwater abstraction point is noted 16 m SE from the site, pertaining to Elis UK Ltd and used for laundry purposes.	High
Aquifer Classification in Superficial Deposits	The majority of the site is situated within a secondary undifferentiated superficial aquifer, with the eastern sector of the site underlain by a secondary A superficial aquifer.	Moderate
Aquifer Classification in Bedrock	The site is underlain by a principal bedrock aquifer.	High
Is the Site Underlain by Low-Permeability Superficial Deposits to Depths in Excess of 10 m?	Based upon nearby BGS boreholes the underlying superficial deposits are likely to comprise low permeability clay soils to depths in excess of 5 m, which may reduce the potential for mobile phase contaminants to migrate towards the bedrock aquifer. Towards the eastern sector of the site, high permeability granular deposits are anticipated which will afford less protection to the underlying bedrock aquifer.	Moderate
Is the Site Located Within 50 m of a Surface Watercourse?	The risk to surface water is negligible, given the absence of a viable receptor within influencing distance of the site.	Low
Sensitive Land Uses	The site is situated within an SSSI Impact Risk Zone however, the proposed development does not fall within the type of development requiring consultation.	Low
Sensitive Ecological Receptors	None Identified.	Low
OVERALL SITE ENVIRONMENTAL SENSITIVITY		**Moderate/High**

4.10. REGULATORY DATABASE

The information summarised in Table 14 has been obtained from a commercially available environmental database. The summary table only includes records from within 250 m of the subject site and is not otherwise detailed in the report.

Table 14 Summary of Environmental Data

RECORD	ENTRIES WITHIN 250 M	DETAILS
Contaminated Land Register Entries and Notices	0	None Identified
Authorised Industrial Processes (IPC/IPPC/LAPPC)	1	On-site - Glen Dimplex Home Appliances Ltd– Licensed Pollutant Release (Part B) – Current Permit (Coating Processes).
Fuel Stations Entries	0	None Identified
Licensed Radioactive Substances	1	92 m NW - St Helens and Knowsley Hospital Trust - Effective
Enforcements, Prohibitions or Prosecutions	0	None Identified
Discharge Consents	0	None Identified

RECORD	ENTRIES WITHIN 250 M	DETAILS
Pollution Incidents	0	None Identified
Consents Issued Under the Planning (Hazardous Substances) Act 1990	0	None Identified
Control of Major Accident Hazard (COMAH) Sites	0	None Identified

5. PRELIMINARY MINING ASSESSMENT

5.1. COAL MINING

The Coal Authority (CA) mapping and records indicate that the site is in an area that may be affected by coal mining.

A CA mining report was obtained (Ref: 51003408185001) dated February 2024.

The CA operates a risk-based approach to assessing potential instability issues associated with future land development located within the predefined CA consultation areas. This risk-based approach subdivides the potential risk into "low" and "high" risk categories.

The risk categories can be defined as:

Low-Risk Sites – Deemed to be land where coal mining has taken place, however, it was at such depth not to pose a risk to new development, and it, therefore, contains no known recorded risks and as such, no further assessment is required.

For low-risk sites, the CA categorically states:

If your proposed development is within the Development Low Risk Area, there is no need for you to submit any coal mining information with your planning application and The Coal Authority will not be consulted by the LPA. The LPA will include our Standing Advice as an informative note within the decision notice.

High-Risk Sites – Deemed to be landholdings located within an area known to contain legacy risks that include:

- Mine entries (shaft or adit);
- Shallow coal workings (recorded and probable);
- Workable coal seam outcrops;
- Mine gas sites and areas;
- Recorded coal-mining-related hazards;
- Geological features (fissures and break lines); and
- Former surface mining sites (sometimes using historical opencast extraction methods).

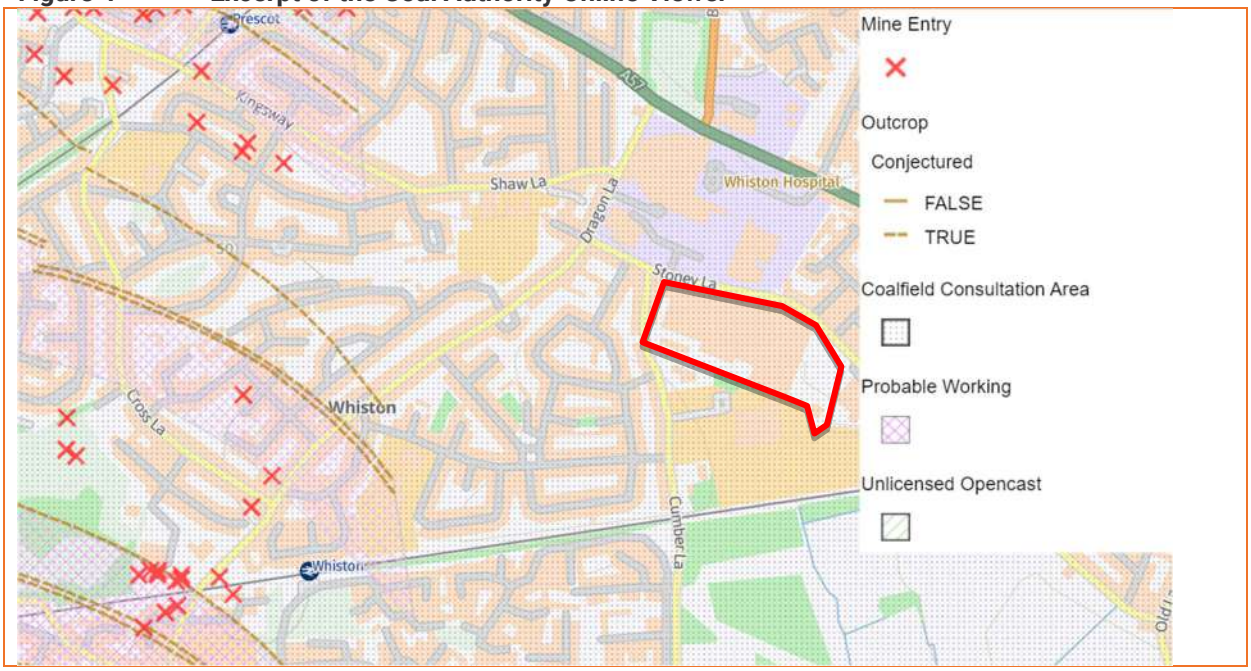
5.2. COAL MINING INFORMATION

Prior to the enactment of the Coal Mines Regulation Act (1872), which came into force on the 1st of January 1883, there was no statutory requirement to record the extent of abandoned mine workings and as such the CA has no knowledge of extensive workings throughout the UK Coal Fields where shallow workings are present at a depth that could result in a subsidence event in the future (through successive cavitation) associated with failure of support mechanism.

Determining if a site may have unrecorded or recorded coal mine workings requires the consideration of a wide range of information, and E3P has completed a review of relevant information in relation to potential coal mining activities.

In the first instance, E3P has reviewed the Coal Authority Online Viewer, and an excerpt of this is presented in Figure 4. This map shows that the site does not lie within a high-risk development area. No recorded coal seams are present on-site; the closest worked coal seam is located approximately 530 m to the west, which dip down away from the site.

Figure 4 Excerpt of the Coal Authority Online Viewer



As the site is within an area affected by coal mining, E3P has obtained a Consultant Coal Mining Report for the site (ref: 51003408185001), which is presented in APPENDIX XIII.

Table 15 provides a summary of pertinent coal mining information within this report.

Table 15 Coal Mining Information

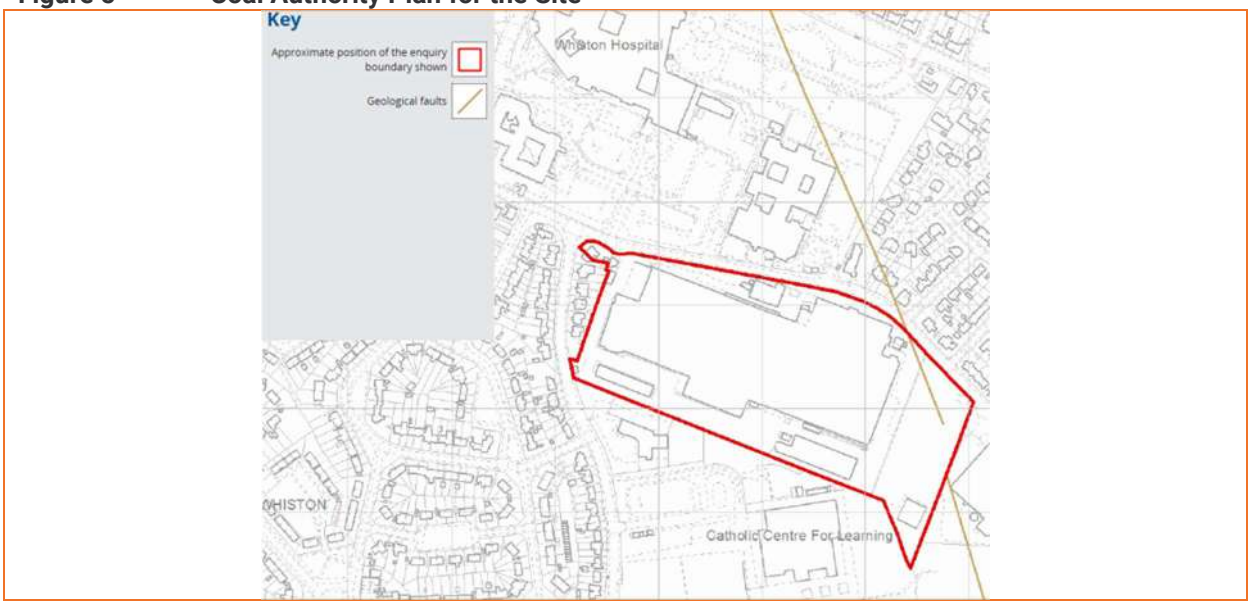
SOURCES OF INFORMATION	SUMMARY
Known Past Underground Mining	No past mining is recorded
Probable Unrecorded workings	No
Spine Roadways at Shallow Depth	No spine roadways recorded at shallow depths.
Mine Entries within 100 m of the Site	None recorded within 100 m of the site boundary.
Mine Abandonment plans	No
Known outcrops	No outcrops recorded
Faults / Fissures	Through the eastern sector of the site (Cronton Fault), traversing northwest to southeast, with a downthrow to the east.
Opencast mines	None recorded within 500 m of the site boundary.

SOURCES OF INFORMATION	SUMMARY
Coal Authority Managed Tips	None recorded within 500 m of the site boundary.
Remediated Sites	None recorded within 50 m of the site boundary.
Coal Mining Subsidence	The Coal Authority has not received a damage notice or claim for the subject property, or any property within 50 metres of the enquiry boundary, since 31 October 1994. There is no current Stop Notice delaying the start of remedial works or repairs to the property. The Coal Authority is not aware of any request having been made to carry out preventive works before coal is worked under section 33 of the Coal Mining Subsidence Act 1991.
Mine Gas	None recorded within 500 m of the enquiry boundary.
Mine Water	None recorded within 500 m of the enquiry boundary.
Future Underground Mining	None recorded
British Geological Survey Mapping	A review of 1:10,000 geological mapping indicates no recorded coal seams are present on-site, with the closest worked coal seam located approximately 530 m to the west, which dips down away from the site.
Review of Coal Authority Archive	No CA archives/mine abandonment plans are made available.
Historical Ordnance Survey Mapping	A review of historical Ordnance Survey Mapping did not identify any coal mining associated features within 500 m of the site boundaries. As no recorded coal outcrops have been recorded within the boundary of, or in immediate proximity to the site, no further assessment is likely required.
Historical Ground Investigations	E3P has not been provided with any historical ground investigation reports.

5.3. COAL AUTHORITY PLAN

The Coal Authority plan referenced: MR-LARGE-PLOT-51003408185001-1709132950870 shows there are no hazardous mining associated features within the vicinity of the site as illustrated in Figure 5.

Figure 5 Coal Authority Plan for the Site



5.4. COAL MINING GEOLOGY

Figure 6 is a photograph of the 1:63,360 plan for the site, which shows a geological fault (Cronton Fault) traversing northwest to southeast through the eastern sector of the site, with a downthrow to the east.

No coal outcrops are recorded within an influencing distance to the site, with all known worked seams situated > 500 m to the west of the site within the Pennine Middle Coal Measures.

Figure 6 Photograph of the 1:63,360 Plan for the Site



5.5. MINE ABANDONMENT PLANS

Mine abandonment plans are not currently available for the site.

5.6. OPEN CAST MINING

There are no records of open-cast mining related to the site.

5.7. PRELIMINARY MINE GAS ASSESSMENT

If coal mining is present below the site, this may be a potential source of ground gas that could pose a risk to site end users. A preliminary mine gas assessment is provided in Table 16.

Table 16 Preliminary Mine Gas Assessment

SCENARIO	DISCUSSION	RATING
Are there known coal seams beneath the Site?	No – no known seams are recorded below the site.	Low
Are there coal seams within 150 m of the top of the bedrock?	No – no known seams are recorded below the site.	Low

SCENARIO	DISCUSSION	RATING
Are there any known workings below the Site?	No – no known seams are recorded below the site.	Low
Are the underlying superficial deposits impermeable?	Yes – the site is anticipated to be underlain by impermeable cohesive deposits. However, the eastern sector is anticipated to be underlain by granular deposits, and shallow bedrock deposits are anticipated to be present at depths ranging from 4.00–10.00 m bgl.	Moderate (High in eastern sector only)
Are there any mine entrances within the site boundary or within 50 m of the Site?	No – the closest mine entrance is situated greater than 150 m from site.	Low
Are there any faults below the Site or in close proximity?	Yes – there is a fault (Cronton Fault) traversing northwest to southeast through the eastern sector of the site, with a downthrow to the east.	High
Is there any records of mine gas emission on or within 50 m of the Site	No	Low
Is there any record of historical mine stabilisation works?.	No	High
Evidence of rising groundwater in flooded mine workings?	Not known	Moderate
OVERALL, MINE GAS RISK (IF MODERATE/ HIGH, THEN FURTHER ASSESSMENT IS REQUIRED)		Low to Moderate
Conclusions: The site is not underlain by any known coal seams or situated within immediate proximity of any coal workings at a shallow depth. Overall the potential source of ground gases are considered negligible. **No further assessment is required.**		

5.8. COAL MINING RISK ASSESSMENT

This risk assessment comprises a desk-based review of all available information on coal mining issues that are relevant to the application site deemed to be located within a high-risk area. This includes:

- Interpretation of information to identify and assess the risks to the proposed development from coal mining legacy, including the cumulative impact of issues;
- Setting out appropriate mitigation measures to address the coal mining legacy issues affecting the site, including any necessary remedial works and/or demonstrate how coal mining issues have influenced the proposed development; and
- Demonstrating to the local planning authority that the application site is, or can be made, safe and stable to meet the requirements of national planning policy with regard to development on unstable land.

The coal mining risk assessment is summarised in Table 17.

Table 17 Summary of Coal Mining Risk Assessment

COAL MINING RISK ASSESSMENT	YES/NO	RISK ASSESSMENT
Recorded Underground Coal Mining at Shallow Depth (< 30 m)	No	Low
Recorded Underground Coal Mining at Shallow Depth (> 30 m)	No	Low
Evidence of Unrecorded Surface Extraction of Coal Outcrop	No	Low
Unrecorded Underground Coal Mining at Shallow Depth (< 30 m)	No	Low
Mine Entries (Shaft/Adits)	No	Low
Coal Mining Geology – Fractures/Fissures	No	Low
Recorded Gas Emissions	No	Low
Recorded Mining Surface Hazard	No	Low
Surface Mining (Opencast)	No	Very Low/Low

Based on a continuation of the current site use and the redevelopment of the site for residential end use, there is considered to be a low risk associated coal mining activity.

6. PRELIMINARY GEOTECHNICAL ASSESSMENT

6.1. GEOTECHNICAL DATA

Geotechnical data presented within a commercially available environmental database is summarised in Table 18.

Table 18 Summary of Geotechnical Data

HAZARD	DESIGNATION
Shrink-Swell Clay	Very low risk
Landslides	Very low risk
Ground Dissolution	No hazard
Compressible Ground	No hazard
Collapsible Deposits	Very low risk
Running Sand	Very low risk

6.2. ARTIFICIAL LANDFORM AND GEOMORPHOLOGY

Based on the initial geological assessment, a review of available topographic data and pertinent mapping, E3P has undertaken a preliminary geomorphological evaluation of the landform and its possible mechanism for formation.

Based upon a review of historical mapping and topographical contours, it would appear that the placement and upfilling of material will have formed the current site level plateau prior to the construction of the historical development.

It is possible that the historical level raising has resulted in a greater thickness of Made Ground overlying the natural glacial till and glaciofluvial deposits, and potentially underwent earthworks to create a development platform for the factory present.

Figure 7 Surface Lidar Data



6.3. GROUND CAVITIES AND SINK HOLES

Information within the Groundsure Report states the site is within an area of no hazard to very low hazard from rock solubility. No sources indicative of geotechnical hazards including ground cavities and sink holes have been identified on-site, or within the immediate vicinity.

6.4. PRELIMINARY GEOTECHNICAL ASSESSMENT

Based on the desk-study information, the following geotechnical assessment has been made:

- Given the predominantly developed nature of the site, it is likely there will be substantial Made Ground fill deposits and obstructions. Existing buildings will require demolition, with all relict foundations grubbing out before the proposed development's construction.
- Three historically infilled ponds were formerly present towards the centre south, southeast and northeast boundaries, which are potential sources of alluvial deposits, silts and possible organic peat deposits, and localised greater depths of Made Ground. An investigation will be required to assess these and undertake in-situ geotechnical testing to determine the potential foundation solution for any proposed plots in these areas.
- The site contains no topographical variances due to the developed nature of the site. Therefore, significant earthworks are unlikely to be required for the proposed redevelopment.
- Nearby geology and BGS boreholes suggest that shallow bedrock may be present, potentially at depths ranging from 4.00–10.00 m bgl.
- A geological fault (Cronton Fault) is recorded traversing northwest to southeast through the eastern sector of the site, with a downthrow to the east, which potentially presents a geotechnical risk in these areas.

7. INITIAL CONCEPTUAL SITE MODEL

Under EA LCRM (updated June 2023) and BSI 10175 (Code of Practice for Investigation of Potentially Contaminated Land), and BS EN ISO 21365:2021 (Soil Quality – Conceptual models for potentially contaminated sites), E3P has developed a Tier 1 risk assessment comprising an initial conceptual site model (CSM) to identify potential contamination sources, migration pathways and receptors within the study area. An initial screening of the on and potential off-site sources of contamination has been undertaken in Table 19, with the more detailed initial CSM included overleaf as Table 20.

Table 19 Initial Contaminant Source Screening

SOURCE	SOIL	GROUNDWATER	GROUND GAS
ON-SITE			
Historical Iron Foundry (inc. Tanks)	Heavy Metals (Spent Oxides), Non-Volatile PAHs, ACM, TPHs, VOCs SVOCs, Sulphates (slag, clinker, ashy deposits)	TPHs, VOCs	Volatile vapours, Carbon Dioxide, Methane
Historical Munitions Works	Heavy Metals & Metal Compounds, Inorganic Compounds, Explosive Compounds and Propellants (inc. TNT, RDX, HMX, Tetryl, PETN, Nitroguanidine, Nitroglycerine and Picric Acid), Acids, Organic Solvents, TPHs, VOCs	Primary and Secondary Explosive Compounds and Propellants, Acids, Organic Solvents, TPHs, VOCs	Volatile Vapours
Made Ground	Heavy Metals, Non-Volatile PAHs, ACM, TPHs, VOCs, SVOCs Sulphates (slag, clinker, ashy deposits	TPHs, VOCs, SVOCs	Volatile vapours, Carbon Dioxide, Methane
Railway/Tramway Sidings	Heavy Metals, Non-Volatile PAHs, TPHs, VOCs, Sulphates (slag, clinker, ashy deposits	TPHs, VOCs,	Volatile vapours, Carbon Dioxide, Methane
Historical & Current Oven Manufacturing Factory (inc. Tanks)	Heavy Metals, Non-Volatile PAHs, ACM, TPHs, VOCs, SVOCs, PFAS/PFOA	TPHs, VOCs, SVOCs, PFAS/PFOA	Volatile vapours, Carbon Dioxide, Methane
Electricity Substations	PCBs	Unlikely	Unlikely
Historical Infilled Ponds (centre south, southeast and northeast)	Heavy Metals, Non-Volatile PAHs, ACM, Organic Compounds	Unlikely	Organic Deposits (Carbon Dioxide, Methane)
OFF-SITE			
Whiston Hospital	Heavy Metals, Non-Volatile PAHs, TPHs, VOCs	Unlikely	Unlikely

After reviewing all environmentally pertinent information and the potential contaminant sources, the following initial conceptual site model has been developed for the site.

Table 20 Initial Conceptual Model

CONTAMINANT RISK			LIKELIHOOD	SEVERITY	LEVEL OF RISK	JUSTIFICATION
SOURCES	**MIGRATION PATHWAYS**	**RECEPTORS**				
HUMAN HEALTH						
Iron Foundry, Made Ground, Railway / Tramway Sidings, Oven Manufacturing Factory and Historical Infilled Ponds Metals, Non-Volatile PAHs, Sulphates (slag, clinker, ashy deposits) **Electricity Substations** PCBs **Munitions Works,** Heavy Metals and Metal Compounds, Inorganic Compounds, Explosive Compounds and Propellants, Acids, Organic Solvents, TPHs, VOCs **Oven Manufacturing Factory** PFAS/PFOA	Accidental ingestion and/or dermal contact with contaminated soil and/or leachate. **PL1/PL2** Inhalation of contaminated dust. **PL3**	Human Health – construction workers	Low likelihood	Medium	Moderate/Low	The initial CSM has identified contaminants of concern as above assessment criteria. Site personnel have a greater chance of coming into contact with contaminated soils. Intrusive ground investigation and assessment to determine the potential extent of any contamination will be required.
		Human Health – end users	Low likelihood	Medium	Moderate/Low	

CONTAMINANT RISK			LIKELIHOOD	SEVERITY	LEVEL OF RISK	JUSTIFICATION
SOURCES	**MIGRATION PATHWAYS**	**RECEPTORS**				
Tanks (Iron Foundry / Oven Manufacturing Factory) and Made Ground Volatile PAHs (naphthalene), TPHs, VOCs **Munitions Works,** Explosive Compounds and Propellants, Organic Solvents, TPHs, VOCs	Inhalation of vapours. **PL4** Migration through permeable strata and preferential pathways.	Human Health – end users Human Health – Off-site receptors	Likely	Medium	Moderate	Based upon the historical mapping and initial site walkover, the presence of fuel and chemical storage tanks has been identified, which may be a significant source of volatile PAHs, TPHs and VOCs. The site's historical use as a Munitions Works may also be a significant source of Explosive Compounds, Propellants, and Organic Solvents. Intrusive ground investigation and assessment will be required to determine the level of mitigation measures and/or remediation.
Made Ground, Iron Foundry/Munitions Works/Oven Manufacturing Factory and Historical Infilled Ponds Asbestos (Asbestos containing materials (ACM) and loose fibres)	Inhalation (of fibres). Construction works disturbing bound material and releasing fibres. **PL3**	Human Health – construction workers, end land users, and users of adjacent sites	Likely	Medium	Moderate	Risk of inhalation of fibres during Ground Investigation and construction works. Disturbance of ACMs and dust derivatives from construction would increase risk to adjacent sites. Intrusive ground investigation will be required to determine the presence of ACMs and develop appropriate mitigation measures.

CONTAMINANT RISK			LIKELIHOOD	SEVERITY	LEVEL OF RISK	JUSTIFICATION
SOURCES	**MIGRATION PATHWAYS**	**RECEPTORS**				
Iron Foundry, Made Ground and Railway/Tramway Sidings Sulphates (slag, clinker, ashy deposits) **Munitions Works** Acids, Sulphates	Sulphate attack on concrete. **PL6**	Building concrete	Likely	Medium	Moderate/Low	Due to the presence of Made Ground on the site, the potential for sulphate in ashy deposits is high. The site's historical use as a Munitions Works may also be a significant source of Acids and Sulphates; both of which may impact the proposed building concrete. Intrusive ground investigation will be required to assess the concrete classification.
Iron Foundry, Made Ground, Oven Manufacturing Factory and Historical Infilled Ponds Organic contaminants (hydrocarbons and solvents) **Munitions Works** Explosive Compounds and Propellants (Nitroglycerine and Picric Acid), Organic Compounds, Acids	Ingestion of tainted water supply. **PL7**	Human Health – End Users Water pipeline	Low likelihood	Medium	Moderate	Likely probability as significant contamination is anticipated at pipeline depth across the west and centre of the site (0.75–1.35 m). Explosive Compounds and Propellants (Nitroglycerine and Picric Acid) may be capable of permeating plastic water supply pipes. An intrusive ground investigation to confirm the presence of any contaminants is required.

CONTAMINANT RISK			LIKELIHOOD	SEVERITY	LEVEL OF RISK	JUSTIFICATION
SOURCES	**MIGRATION PATHWAYS**	**RECEPTORS**				
Iron Foundry, Munitions Works, Made Ground, Railway/Tramway Sidings and Oven Manufacturing Factory Phytotoxic contaminants	Direct contact (plant uptake). **PL8**	Flora	Low likelihood	Medium	Moderate/Low	Likely probability as contamination is considered possible, which may be taken up by flora in soft landscaping/gardens. An intrusive ground investigation to confirm the presence of any contaminants is required.
Munitions Works Explosive Compounds and Propellants	Accidental Detonation. **PL9**	Human Health – construction workers, end land users, and users of adjacent sites Buildings and Structures	Low likelihood	High	Moderate/High	Although the overall probability is low, due to site's historical use as a Munitions Works, there may be a significant source of Explosive Compounds and Propellants on-site which presents a potential unacceptable risk to receptors via accidental detonation. Recommended mitigation measures should include explosive ordnance safety and awareness briefings and site safety inductions during all ground investigations and remediation works. Safe working practices and sampling procedures should be implemented. Transport of samples for off-site analysis may be regulated by the Road Transport (Carriage of Explosives) Regulation 1989. Authorisation from HM Inspector of Explosives may also be required for certain investigative or redevelopment works including sampling and laboratory analysis.

CONTAMINANT RISK			LIKELIHOOD	SEVERITY	LEVEL OF RISK	JUSTIFICATION
SOURCES	**MIGRATION PATHWAYS**	**RECEPTORS**				
CONTROLLED WATERS						
Iron Foundry, Made Ground, Railway / Tramway Sidings, Oven Manufacturing Factory and Historical Infilled Ponds TPHs, VOCs, SVOCs **Munitions Works,** Primary and Secondary Explosive Compounds and Propellants, Acids, Organic Solvents, TPHs, VOCs **Oven Manufacturing Factory** PFAS/PFOA	Leaching of contaminants from Made Ground through infiltration and percolation of rainwater. **PL5**	Controlled waters, underlying Principal Aquifer	Likely	High	High	Based upon the historical mapping and initial site walkover, the presence of fuel and chemical storage tanks has been identified, which may be a significant source of TPHs, VOCs and SVOCs. The site's historical use as a Munitions Works may also be a significant source of Explosive Compounds and Propellants, Acids and Organic Solvents; all of which may impact the underlying Principal Aquifer. The current development and associated hardstanding will assist in reducing the leachate produced from contaminated soils, and therefore reduce the impact to groundwater. An intrusive ground investigation to confirm the presence of any contaminants within groundwater is required.
		Infrastructure and services	Likely	High	High	The development of proposed estate roads (hardstanding and drainage) will reduce the leachate produced from contaminated soils. Infrastructure and services shall be designed to resist chemical attack and ingress. An intrusive ground investigation to confirm the presence of any contaminants within groundwater is required.

CONTAMINANT RISK			LIKELIHOOD	SEVERITY	LEVEL OF RISK	JUSTIFICATION
SOURCES	**MIGRATION PATHWAYS**	**RECEPTORS**				
Groundwater TPHs, VOCs, SVOCs, Explosive Compounds and Propellants, Acids, Organic Solvents, PFAS/PFOA	Contact with contaminated groundwater. **PL2**	Human Health – site personnel	Unlikely	Low	Low	Shallow groundwater is not anticipated on-site and is assumed if present would be significantly lower than the construction level.
	Contaminants leached from the Made Ground and from off-site sources may be mobilised to greater distances through advective flow. **PL5**	Human Health – end users	Low likelihood	Medium	Moderate	Impacted groundwater could transport contaminants vertically and horizontally through permeable strata. However, the site works will not exacerbate this, and site work will be undertaken above the water table. Groundwater will need to be considered for surrounding developments.
GROUND GAS						
Ground gases Methane and Carbon Dioxide in the Made Ground Volatile Vapours associated with Tanks and Munition Works	Inhalation of ground gas. **PL4** Accumulation of ground gas in confined spaces (asphyxiation or explosion)	Human Health – site personnel	Low likelihood	Medium	Moderate/Low	Ground gases may migrate through permeable strata to enter proposed buildings. A period of ground gas monitoring will be required to determine the gas regime for the site.
		Human Health – end users	Low likelihood	Medium	Moderate/Low	
		Infrastructure and services	Low likelihood	Medium	Moderate/Low	
Radon	Inhalation of ground gas. **PL4** Accumulation of ground gas in confined spaces (carcinogenic)	Human Health – site personnel	Unlikely	Low	Very low	Radon mapping has identified the site is not within an area at risk from radon. No radon mitigation measures will be required.
		Human Health – end users	Unlikely	Low	Very low	

CONTAMINANT RISK			LIKELIHOOD	SEVERITY	LEVEL OF RISK	JUSTIFICATION
SOURCES	MIGRATION PATHWAYS	RECEPTORS				

Main exposure pathways:
PL1 = soil ingestion, PL2 = dermal contact and ingestion, PL3 = dust inhalation; PL4 = Vapour/Gas Inhalation; PL5 = Vertical / Lateral Migration; PL6 = Corrosion of concrete; PL7=Tainting of water supply; PL8 = Uptake by plants. PL9 = Accidental Detonation.

Level of Risk	
Very Low	
Low	
Low/Moderate	
Moderate	
Moderate/High	
High	

8. E3P PRELIMINARY GROUND INVESTIGATION

8.1. GENERAL OVERVIEW

A preliminary intrusive ground investigation has been designed based on the findings of the desk study, with exploratory holes advanced to target specific potential contaminant sources summarised in Section 7.0. The investigation has also been used to collect geotechnical information to assist in the design and construction of the proposed development.

Exploratory fieldwork was completed between 19th and 21st March 2024. The works are summarised in Table 21.

8.2. LIMITATIONS OF THE INVESTIGATION

As the Glen Dimplex Homes Appliances Manufacturing Factory was still active, additional considerations of exploratory hole locations were required to take account for live services, active traffic routes, and for the insurance of public safety. This rendered a large proportion of the site inaccessible, including within the footprint of the main factory structure comprising the majority of the site.

A borehole was preliminarily situated adjacent to the electricity substation towards the southern boundary of the site to test for the potential presence of PCB compounds. However, multiple live 11kV cables not recorded within statutory service plans, and an earthing mat to the south of the substation were detected during GPR surveying and utility clearance. Therefore, a sufficient easement (>5.00 m) was imposed and subsequently the borehole was moved approximately 6.00 m north from the substation. This limits the likelihood of PCBs being detected due to the significantly low mobility of the compounds and are more likely to be present within the footprint of, and immediate vicinity (>1.00 m) of the electricity substation.

8.3. SCOPE OF INVESTIGATION

A summary of the fieldwork completed are included in Table 21.

Table 21 Summary of Fieldwork

POTENTIAL SOURCE/RATIONALE	LOCATION HOLE	TYPE	MAXIMUM DEPTH (M BGL)	MONITORING WELLS RESPONSE ZONE (M BGL)
General Ground Conditions Including the Presence/Nature of Obstructions	WS101	Window Sample Borehole	5.45	1.00–1.50
	WS102		5.16	2.00–4.00
	WS104		4.42	1.30–3.30
	WS105		3.40	1.00–3.00
	WS106		4.44	0.50–1.90
	WS107		4.24	1.00–4.00
	WS110		3.40	0.50–1.00
Electricity Substation (PCBs)	WS103		5.45	0.50–1.40
Proximity to Polystyrene Manufacturing Plant	WS108		1.74	0.50–1.00
	WS109		4.31	1.00–4.00
Investigation of Deeper Soil Horizons	CP101	Cable Percussive Borehole	9.09	3.00–7.50
	CP102		9.37	3.50–9.00

Window sample boreholes were advanced to undertake in-situ detailed geotechnical testing, obtain environmental samples and install groundwater and ground gas monitoring wells.

Cable Percussive boreholes were advanced to investigate deeper strata, undertake in-situ detailed geotechnical testing, obtain environmental samples and install deep groundwater and ground gas monitoring wells.

The sampling locations are illustrated in Drawing 17-500-005 (APPENDIX IV). The ground conditions encountered are indicated on the logs, which are provided in APPENDIX VII.

The locations were surveyed by GPS to Ordnance Survey with an accuracy of < 10 mm.

Return visits were made to monitor installations for groundwater level and gas concentrations. In addition, selected wells were purged and samples of groundwater recovered for chemical analysis.

8.4. IN-SITU STANDARD PENETRATION TESTING (SPT)

In-situ geotechnical testing was conducted using the standard penetration test (SPT) and, where the ground is granular, a 60° cone (SPT(C)) was used instead of the sampling tube. The results are shown in the borehole logs in APPENDIX VII, presented in Table 40 and discussed in Section 11.0.

8.5. LABORATORY ANALYSIS

Selected soil samples were submitted for a range of chemical and geotechnical analysis, summarised in Table 22.

Table 22 Summary of Laboratory Analysis

CHEMICAL ANALYSIS
Metals;
pH, total sulphate, water-soluble sulphate (2:1 extract);
Sulphide;
Cyanide;
Phenols;
Total and speciated polycyclic aromatic hydrocarbons (PAHs);
Asbestos identification and quantification;
Speciated and banded total petroleum hydrocarbons (TPHs);
Total Organic Carbon (TOC);
Volatile Organic Compounds (VOCs);
Semi-Volatile Organic Compounds (SVOCs); and
Polychlorinated biphenyls (PCBs).

GEOTECHNICAL ANALYSIS

- Moisture content;
- Atterberg limits determinations;
- Particle size distribution (PSD);
- Single-stage triaxial tests;
- Multi-stage triaxial tests; and,
- Consolidation.

8.6. STORAGE, PRESERVATION AND TRANSPORT OF SAMPLES

Measures taken to ensure the quality and integrity of the collected samples, from collection to receipt of the samples by the laboratory, are summarised in Table 23.

Table 23 Sample Integrity Information

SUBJECT	CHEMICAL SAMPLING	
Storage	**Soil**	**Groundwater**
	Glass jars supplied by the laboratory were used for the collection of soil samples to be analysed for SVOCs, VOCs, and in a singular instance PCBs. Plastic tubs were used to collect soil samples for metals analysis, and asbestos screening.	Glass vials supplied by the laboratory were used for the collection of samples to be analysed for VOCs. Samples to be analysed for lower volatility compounds were stored in laboratory-prepared glass jars.
Preservation	Soil and groundwater sample containers were filled to minimise headspace prior to sealing and stored at a low temperature within cool boxes with cooling aids to minimise the loss of volatile contaminants and reduce microbial activity during the collection of samples.	
Sample Integrity	**Soil**	**Groundwater**
	Dedicated disposable nitrile gloves were worn and changed between sample collections to prevent cross-contamination.	Groundwater samples were collected using dedicated plastic tubing, which was changed between monitoring well locations to prevent cross-contamination.
Transport	Samples were stored and shipped in dedicated sample boxes provided by the laboratory. Sample details were recorded on the laboratory chain of custody form enclosed with the samples prior to dispatch. Scheduling information for the samples was confirmed with the laboratory via email.	

Chemical analysis has been undertaken by an accredited laboratory with the testing results summarised and discussed in Section 10 and the testing certificates included in APPENDIX VIII.

Geotechnical samples were collected as required per location immediately after excavation, labelled and sealed to minimise moisture loss. The geotechnical samples were collected and couriered by a dedicated courier to an accredited geotechnical testing laboratory. The testing results are summarised and discussed in Section 11 and the testing certificates included in APPENDIX IX.

9. GROUND AND GROUNDWATER CONDITIONS

9.1. SUMMARY OF GROUND CONDITIONS

The preliminary ground investigation generally confirms the published geology and identifies the strata set out in Table 24.

Table 24 Summary of Strata

HOLE	DEPTH TO STRATUM (M BGL)						
	MADE GROUND	SANDY CLAY	CLAYEY F-M SAND	CLAY WITH SAND POCKETS	SAND WITH CLAY POCKETS	SAND AND GRAVEL	BEDROCK
WS101	0.00–1.70	3.00–4.10	1.70–3.00	4.10–5.45	–	–	–
WS102	0.00–0.70	0.70–5.16	–	–	–	–	–
WS103	0.00–1.40	3.00–5.45	–	–	1.40–3.00	–	–
WS104	0.00–1.30	1.60–4.42	1.30–1.60	–	–	–	–
WS105	0.00–0.60	–	–	0.60–3.40	–	–	–
WS106	0.00–1.90	–	2.00–4.44	1.90–2.00	–	–	–
WS107	0.00–0.70	–	0.70–0.90	0.90–4.00	–	–	4.00–4.24
WS108	0.00–1.74	–	–	–	–	–	–
WS109	0.00–0.90	–	0.90–4.00	–	–	–	4.00–4.31
WS110	0.00–1.10	2.20–3.40	–	1.10–2.20	–	–	–
CP101	0.00–2.70	2.70–8.70	–	–	–	–	8.70–9.09
CP102	0.00–3.00	3.50–9.00	–	–	–	3.00–3.50	9.00–9.37

9.2. MADE GROUND

Made Ground deposits were encountered within all exploratory hole locations to depths of between 0.00 m and in excess of 3.00 m bgl although, in general, Made Ground was encountered to a depth of less than 1.50 m bgl.

Made Ground deposits were varied across the site, however all generally comprised concrete in the upper 300 mm in the majority of locations. The exception of this was WS104–WS106 which encountered asphalt within the upper 150 mm of the boreholes as they were situated in the car park.

Typically, the concrete or asphalt was underlain by a slightly clayey sandy gravel, with gravel of brick, concrete, mudstone, limestone, coal and slag with rare fragments of glass, plastic, and timber in some locations. These deposits were encountered from 0.15–0.80 m bgl, and were typically overlaying a reworked gravelly clay, with gravel of brick, sandstone, mudstone and in rare instances coal to a maximum proven depth of 3.00 m bgl (CP102).

Hydrocarbon odours were noted within six locations (summarised in

Table 26), situated across the site within the Made Ground deposits. The depths the hydrocarbon odour was encountered ranged from 0.50–1.90 m bgl (WS106) and was typically noted within a reworked very gravelly clay with gravel of sandstone, mudstone, concrete, ash, and slag.

A Depth of Made Ground Plan is presented as Drawing 17-500-006 in APPENDIX IV.

9.3. SUPERFICIAL DEPOSITS

Superficial deposits were encountered within all exploratory locations, with the superficial deposits varying across the site. The most common stratum recorded was an orangish brown sandy gravelly CLAY with gravel of sandstone, mudstone, and instances of coal and quartz. Typically, the CLAY was locally interbedded with an orange very clayey fine to medium SAND from 0.70–4.44 m bgl.

In five locations, a very sandy CLAY with pockets of orange fine to medium SAND was noted, which was typically towards the east, with the exception of WS107 which recorded this stratum from 0.90–4.00 m bgl.

In CP102, a band of SAND and GRAVEL approximately 500 mm thick was recorded from 3.00–3.50 m bgl, with gravel of sandstone. This was in turn underlain by the orange-brown mottled sandy gravelly CLAY from 3.50–9.00 m bgl.

A rare band of clayey fine to medium SAND with pockets of grey CLAY was noted in WS103, from 1.40–3.00 m bgl.

9.4. BEDROCK GEOLOGY

The bedrock geology was encountered between 4.00–9.37 m bgl during the preliminary ground investigation as highly weathered SANDSTONE recovered as a red very gravelly medium to coarse SAND.

Generally, bedrock was encountered at shallower depths (<5.00 m bgl) towards the north of the site, in WS107 and WS109, deepening to 9.00.m bgl towards the south of the site (CP101 and CP102).

A Depth to Bedrock Plan is presented as Drawing 17-500-012 in APPENDIX IV.

9.5. GROUNDWATER

Groundwater strikes were encountered as seepages. The depth of the seepages are shown on the exploratory hole records in APPENDIX VII and are summarised in Table 25.

Table 25 Summary of Groundwater Strikes

LOCATION	DEPTH TO STRIKE (M)	NOTES
WS104	1.00	Seepage
CP101	3.50	Seepage
CP101	7.00	Seepage

Monitoring was undertaken using an electronic dip meter to record the depth to groundwater, if present in environmental monitoring wells. These results are summarised in Table 34.

9.6. VISUAL AND OLFACTORY EVIDENCE OF CONTAMINATION

Visual and olfactory evidence of potential contamination has been identified during the preliminary ground investigation and these are summarised in Table 26.

Table 26 Summary of Visual and Olfactory Evidence of Contamination

LOCATION	DEPTH (M)	STRATUM	NOTES
WS101	1.20–1.70	MADE GROUND	Slight Hydrocarbon Odour

LOCATION	DEPTH (M)	STRATUM	NOTES
WS102	0.50–0.70	MADE GROUND	Slag and ash inclusions
WS102	0.70–1.30	Natural CLAY	Strong Hydrocarbon Odour
WS103	0.70–1.40	Natural SAND	Strong Hydrocarbon Odour
WS105	0.15–0.60	MADE GROUND	Slag
WS106	0.30–0.70	MADE GROUND	Slag and ash inclusions
WS106	0.70–1.90	MADE GROUND	Slight Hydrocarbon Odour, slag and ash inclusions.
WS110	0.10–1.10	MADE GROUND	Strong Hydrocarbon Odour

9.7. OBSTRUCTIONS

Obstructions were identified in several locations across the site, with their positions summarised in Table 27, marked on the Development Constraints Plan (Drawing 17-500-015, APPENDIX IV).

Table 27 Summary of Obstructions

LOCATION	DEPTH (M)	STRATUM	NOTES
WS108	1.74	Made Ground	Potential Concrete Slab

10. TIER 2 QUALITATIVE CONTAMINATED LAND RISK ASSESSMENT

E3P has undertaken a Tier 2 qualitative land risk assessment with respect to human health, controlled waters and ground gas to determine if any potential contaminants within the underlying soils and groundwater pose an unacceptable level of risk to the identified receptors.

10.1. SAMPLE ANALYSIS POPULATION

Table 28 summarises the chemical analysis testing scheduled.

It is noted that analysis for PFAS/PFOA, Explosive Compounds and Propellants has not been undertaken at this stage of intrusive ground investigation due to restricted access to the main factory structure's interior (i.e. where the potential sources may be located). Analysis for PFAS/PFOA, Explosive Compounds and Propellants in soils and groundwater will be undertaken during further stages of intrusive ground investigation once access to the interior of the main factory structure can be obtained.

Table 28 Summary of Testing Schedule

TYPE OF SAMPLE	NO. OF SAMPLES	DETERMINANDS
MADE GROUND: Ash and Clinker	8	Speciated PAH, pH, total metals, asbestos ID, TOC, Banded TPHs
	3	Leachable metals and PAHs
MADE GROUND: Hydrocarbon Odours	6	VOCs, SVOCs.
Natural CLAY	4	Speciated PAH, total metals, Banded TPHs
Natural SAND	1	Speciated PAH, total metals, Banded TPHs, VOCs, SVOCs

10.2. HUMAN HEALTH RISK ASSESSMENT

At Tier 2 stage, the long term (chronic) human health toxicity of the soil has been assessed by comparing the on-site concentrations of organic and inorganic compounds with reference values published in LQM/CIEH S4UL (S4UL3267).

Where Tier 2 screening values are not provided by LQM, other screening values have been used and these are referenced in Table 29.

The Tier 2 screening values for residential with plant uptake have been utilised for this assessment due to the proposed development being a residential end use. To remain conservative at an early stage, the screening values based on a 1% SOM have been utilised for this assessment.

The results of the comparison have been summarised in Table 29.

Table 29 Summary of Inorganic and Hydrocarbon Toxicity Assessment for a Residential End Use (with plant uptake)

DETERMINANT	UNIT	GAC	N	MC	LOC. OF EX	PL	ASSESSMENT
Arsenic	mg/kg	37	13	67	WS110 0.70 m	1	Further Action
Cadmium	mg/kg	11	13	0.65	N/A	1	No Further Action
Chromium (VI)	mg/kg	6.0	13	< 0.50	N/A	1	No Further Action
Lead	mg/kg	200**	13	690	WS108 1.30 m	1	Further Action
Mercury	mg/kg	1.2	13	0.27	N/A	4	No Further Action
Nickel	mg/kg	130	13	170	WS110 0.70 m	1	Further Action
Selenium	mg/kg	250	13	1.1	N/A	1	No Further Action
Copper	mg/kg	2400	13	280	N/A	1	No Further Action
Zinc	mg/kg	3700	13	330	N/A	1	No Further Action
Cyanide – Total	mg/kg	791	13	<0.50	N/A	1	No Further Action
Phenols – Total	mg/kg	120	6	< 0.1	N/A	1	No Further Action
Asbestos	Fibres	NFD	6	NFD	N/A	3	No Further Action
Naphthalene	mg/kg	2.3	13	0.53	N/A	4	No Further Action
Acenaphthylene	mg/kg	170	13	<0.10	N/A	2	No Further Action
Acenaphthene	mg/kg	210	13	<0.10	N/A	1	No Further Action
Fluorene	mg/kg	170	13	<0.10	N/A	1	No Further Action
Phenanthrene	mg/kg	95	13	1.20	N/A	2	No Further Action
Anthracene	mg/kg	2400	13	0.30	N/A	2	No Further Action
Fluoranthene	mg/kg	280	13	1.9	N/A	2	No Further Action
Pyrene	mg/kg	620	13	1.6	N/A	2	No Further Action
Benzo(a)Anthracene	mg/kg	7.2	13	0.77	N/A	2	No Further Action
Chrysene	mg/kg	15	13	0.78	N/A	2	No Further Action
Benzo(b)Fluoranthene	mg/kg	2.6	13	1.1	N/A	2	No Further Action
Benzo(k)Fluoranthene	mg/kg	77	13	0.42	N/A	2	No Further Action
Benzo(a)Pyrene	mg/kg	2.2	13	0.78	N/A	2	No Further Action
Indeno(123-cd)Pyrene	mg/kg	27	13	0.50	N/A	2	No Further Action
Dibenzo(a,h)Anthracene	mg/kg	0.24	13	0.14	N/A	2	No Further Action
Benzo(ghi)Perylene	mg/kg	320	13	0.21	N/A	2	No Further Action
TPH C6-C8 (aliphatic)*	mg/kg	100	13	< 1.0	N/A	4	No Further Action
TPH C8-C10 (aliphatic)*	mg/kg	27	20	< 1.0	N/A	4	No Further Action
TPH C10-C12 (aromatic)*	mg/kg	74	20	3.9	N/A	4	No Further Action
TPH C12-C16 (aromatic)*	mg/kg	140	20	25	N/A	4	No Further Action
TPH C16-C21 (aromatic)*	mg/kg	260	20	160	N/A	1	No Further Action
TPH C21-C35 (aromatic)*	mg/kg	1100	20	170	N/A	1	No Further Action
Total PCBs	mg/kg	-	1	< 0.10	N/A	1	No Further Action
Trichloroethene (TCE)	mg/kg	0.0016	5	1.1	WS101 1.30 m WS102 0.90 m WS102 1.40 m WS103 0.80 m WS103 0.60 m	4	Further Action
cis 1,2-Dichloroethene	mg/kg	0.11***	5	4.6	WS102 0.90 m WS102 1.40 m WS103 0.80 m WS103 0.60 m	4	Further Action
Trans 1,2-Dichloroethene	mg/kg	0.19***	5	0.12	WS102 0.90 m WS103 0.80 m	4	Further Action
1,1-Dichloroethene	mg/kg	2.4***	5	0.0035	N/A	4	No Further Action
Vinyl Chloride	mg/kg	0.00064	5	0.017	WS102 0.90 m WS102 1.40 m	4	Further Action
Ethylbenzene	mg/kg	47	5	0.0031	N/A	4	No Further Action
Toluene	mg/kg	130	5	0.0034	N/A	4	No Further Action
o-Xylene	mg/kg	60	5	0.0021	N/A	4	No Further Action

Notes
PL1 = soil ingestion, PL2 = dermal contact and ingestion, PL3 = dust inhalation; PL4 = Vapour/Gas Inhalation

Abbreviations: GAC = general assessment criteria, N = number of samples, MC = maximum concentration; Loc of Ex = location of exceedance; PL = Contaminant Pathway; NFD = no fibres detected.

The pathway noted in the table is the primary pathway, however it may not be the only pathway of that contaminant

* The Tier 2 GAC for the hydrocarbon fraction is derived from the CIEH assessment for petroleum hydrocarbons Criteria Working Group (CWG) for both aliphatic and aromatic compounds. E3P has utilised the Tier 2 values for aliphatic compounds for the volatile and semi volatile fractions (C5-C12) and the Tier 2 values for aromatic compound for the non-volatile fractions (C12-C35). The comparison of a total (aliphatic/aromatic) compounds to an individual fraction is considered to be a conservative approach and satisfactory for the protection of human health.
**The Tier 2 GAC for lead has been taken from CL:AIRE C4SL.
*** The Tier 2 GAC for Dichloroethene (cis 1,2-Dichloroethene, Trans 1,2-Dichloroethene and 1,1-Dichloroethene) has been taken from CL:AIRE GAC.

Referring to Table 29, the result of this direct comparison indicates that the data exceeds the screening criteria for a residential end use for the following contaminants:

Inorganics

- Arsenic
- Lead
- Nickel

Organics

- Trichloroethene (TCE)
- cis 1,2-Dichloroethene
- Trans 1,2-Dichloroethene
- Vinyl Chloride

The soil in WS103 was tested for PCBs due to the proximity to an electricity substation. No PCBs exceeding the GAC screening values were recorded, however due to live services the samples were taken >5.00 m from the electricity substation. Therefore, due to the low mobility of PCB compounds, further investigation and testing of soils within the footprint of the substation are recommended following decommission of live services.

Significant concentrations of VOCs were identified in both the natural and MADE GROUND samples within the soils towards the south of site submitted for chemical analysis.

10.2.1. EXPOSURE PATHWAYS

The main exposure pathways based on the Tier 2 exceedances are:

- Soil ingestion (PL1);
- Vapour inhalation (indoor) (PL4);
- Dermal contact and ingestion (PL2); and
- Consumption of homegrown vegetables (PL1)

10.2.2. HUMAN HEALTH RISK ASSESSMENT AND MITIGATION

Inorganic Heavy Metals

All of the identified elevated concentrations have primary exposure pathways related to dermal contact and ingestion of soils (PL2), inhalation of particulate (PL3) and consumption of homegrown vegetables (PL1). All three instances of exceedances of inorganic heavy metals were identified within the Made Ground deposits in the upper 1.30 m bgl of the ground, predominantly towards the north of the site. Further investigation following the demolition of the structure is required to understand the potential extent of exceedances of inorganic heavy metals to infer a suitable mitigation measure.

Based on the present known exceedances of the GACs and risks to chronic human health associated with the elevated concentrations of inorganic heavy metal compounds, these can be mitigated through the installation of a suitable cover system in all proposed private gardens, landscaping and public open space to remove any potential for direct exposure to impacted soils.

The specific design and installation process for the appropriate cover systems will be clearly defined within the site remediation and enabling works strategy.

Volatile Organic Compounds (VOCs)

Localised areas of elevated Trichloroethene (TCE), Dichloroethene (cis 1,2-Dichloroethene, and Trans 1,2-Dichloroethene), and Vinyl Chloride have been identified within soils in three locations (WS101 to WS103) across the southern boundary of the site, directly to the south of the main factory structure. It is noted that WS102 and WS103 are located within the immediate vicinity of the enamel slurry waste storage area, located to the southeast of the main factory structure. As such, the enamel slurry waste storage area may be the potential source of these exceedances.

These elevated compounds present a primary exposure pathway linked to the potential volatilisation to indoor air risk, in addition to exposure pathways of dermal contact and ingestion of soils (PL2) and consumption of homegrown vegetables (PL1) within impacted areas.

Furthermore, the identified VOC exceedances are known to be highly mobile, presenting a risk of further migration of Trichloroethene (TCE) which is known to subsequently degrade into Dichloroethene (cis 1,2-Dichloroethene and Trans 1,2-Dichloroethene), and Vinyl Chloride. As the final degradation product (Vinyl Chloride) has only been identified within WS102, it is assumed at this stage of testing that WS102 is the likely source of TCE, which is subsequently migrating to WS101 and WS103, which is further degrading into Dichloroethene in the latter location.

Further investigation and subsequent testing will be required in order to determine the spatial extent of the VOC contamination identified within the soils across the southern boundary of the site and to understand whether leaching has occurred into the underlying natural strata, particularly in WS101 and WS103 where exceedances were only recorded within Made Ground Deposits.

If the enamel slurry waste storage area is deemed to be the source, removal of the impacted material is required to mitigate any further migration and degradation of TCE into further areas of the site.

Subject to the findings of further phases of intrusive ground investigation, further assessment in the form of a Detailed Quantitative Risk Assessment (DQRA) may also be required.

Asbestos

No asbestos contamination was identified within any samples submitted for laboratory testing; however the fabric of the current main factory structure is known to contain asbestos throughout.

Following demolition of the main factory structure, further investigation and subsequent testing is recommended in order to obtain representative soil samples of the underlying strata and determine whether the underlying soils are impacted with asbestos.

If Asbestos fibres are encountered, a primary exposure pathway of inhalation of fibres (PL3) would be presented to site personnel and end users. Impacted soils should be managed according to the asbestos risk mitigation conceptual site model shown in Figure 8.

Figure 8 Asbestos Risk Mitigation Conceptual Site Model



Notes
ND None Detect
0.001% Soils may contain ≤ 0.001% asbestos using composite testing to ensure there is no potential risk to human health. This value is present within areas where there may be a short-term low-level exposure of soils containing trace asbestos fibres by construction workers where an appropriate level of asbestos management is employed (dust suppression)
0.1% Soils at a depth of >1.00 m bgl may contain <0.1% asbestos using composite testing where they will not be likely to be disturbed in the future and will therefore be in an area of low sensitivity. Risk assessment completed in accordance with Asbestos JIWG risk assessment tools.
Undefined- this will be dependent upon soils encountered during earthworks, which may be placed at these depths to ensure no potential risk to human health.

PFAS/PFOA

The site is considered to be at a moderate risk from PFAS/PFOA contamination, due to the sites historical and current use as an oven manufacturing factory.

Due to the active nature of the site and the limited volume of material available to be collected from individual exploratory hole locations, PFAS/PFOA testing within the soils could not be completed during this phase of intrusive ground investigation.

Further investigation and subsequent testing will be required to confirm the presence or absence of PFAS/PFOA compounds within both the soils and groundwater within the footprint of the main factory structure.

PFAS/PFOA poses a significant human health risk if found to be present, which will require further sampling of soil and groundwater to understand the potential extent of compounds if found to be present within any ground materials on-site.

Explosive Compounds and Propellants

The site is considered to be at a moderate risk of contamination from Explosive Compounds and Propellants, due to the sites historical use as a Munitions Works during the First and Second World Wars.

Due to the active nature of the site and the limited volume of material available to be collected from individual exploratory hole locations, testing for Explosive Compounds and Propellants within the soils could not be completed during this phase of intrusive ground investigation.

Further investigation and subsequent testing will be required to confirm the presence or absence of Explosive Compounds and Propellants within both the soils and groundwater within the footprint of the main factory structure.

Explosive Compounds and Propellants poses a significant human health risk if found to be present, which will require further sampling of soil and groundwater to understand the potential extent of compounds if found to be present within any ground materials on-site.

Safe working practices and sampling procedures are essential for the analysis of soils from explosive sites. If contamination is anticipated to be significant, transport of samples for off-site analysis may be regulated by the Road Transport (Carriage of Explosives) Regulation 1989. Authorisation from HM Inspector of Explosives may also be required for certain investigative or redevelopment works including sampling and laboratory analysis.

Natural Strata

Chemical analysis of the natural clay superficial deposits has identified these soils to be acceptable for use as subsoil within the proposed garden areas; however, further chemical samples will be required in areas not investigated to meet regulatory sampling frequency. There are no suitable sources of topsoil available on the site.

A Human Health Contamination Issues Plan is presented as Drawing 17-500-026 in APPENDIX IV.

10.3. CONTROLLED WATERS RISK ASSESSMENT

E3P has undertaken a controlled waters risk assessment for the site based on the consideration of the conceptual site model and the sensitive receptors which are summarised in Table 30.

Table 30 Controlled Waters Conceptual Model and Sensitivity Profile

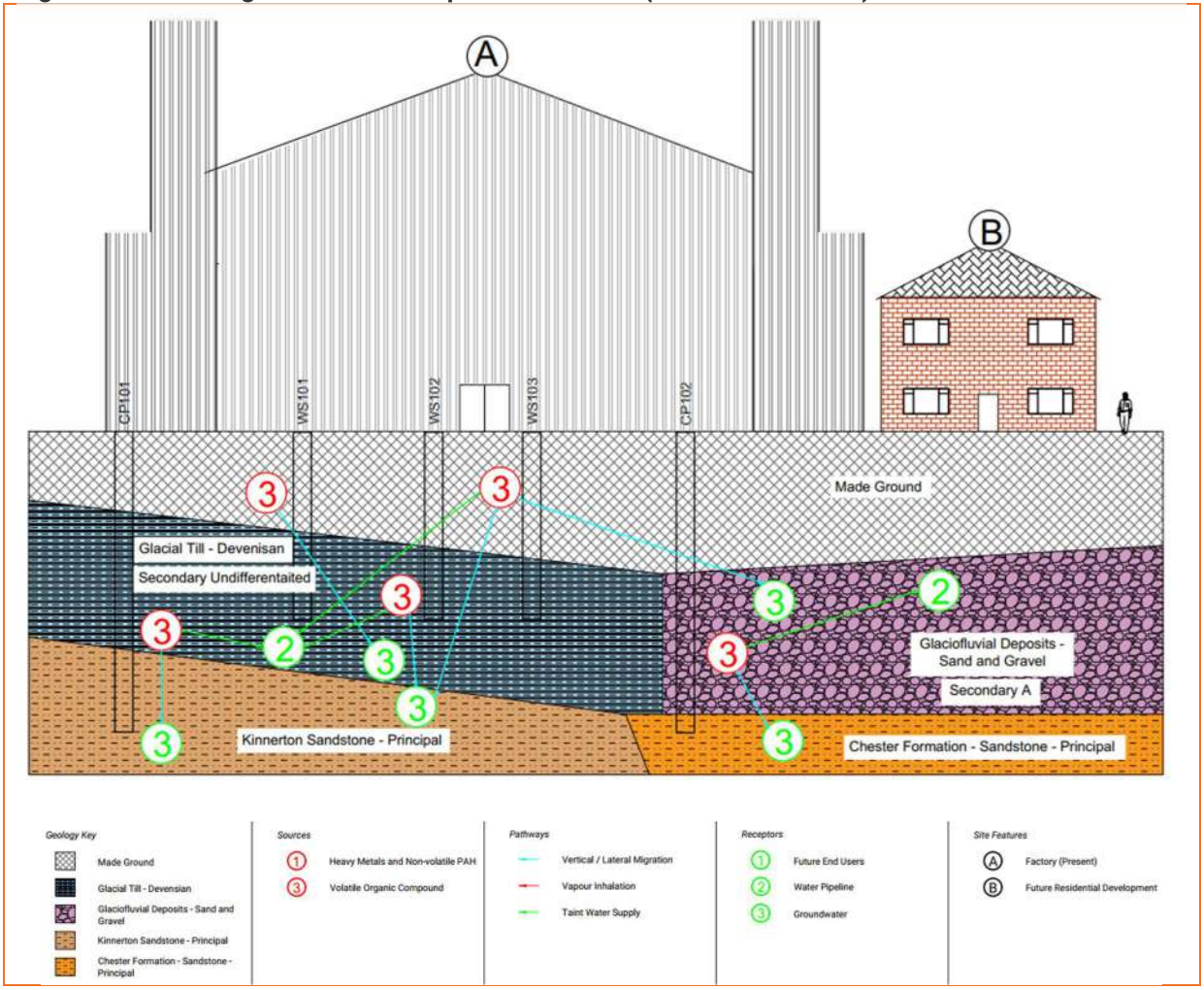
DISCUSSION	SENSITIVITY RATING
Contaminant Source	
MADE GROUND Heavy metal and VOC contamination has been identified within Made Ground infill materials, with the heavy metals recorded towards the north and VOCs identified towards the south. Variable Made Ground with high-level (predominantly low-solubility in water; LQM/CIEH 2014) VOC impact is present throughout the Made Ground which has subsequently leached into underlying natural deposits to a depth of 1.40 m bgl.	**High**

DISCUSSION		SENSITIVITY RATING
OVEN FACTORY The oven manufacturing factory is situated in the centre of the site and a known enamel slurry waste storage area is located towards the southeast of the site, adjacent to WS103. Due to the industrial usage of the site, significant potential sources of VOCs and SVOCs are anticipated which may leach into the underlying ground within areas of below ground tanks.		**High**
Pathway		
Vertical Migration The majority of the site is underlain by low permeability superficial deposits which will offer some protection to the underlying aquifer and inhibit vertical migration of any contaminants towards the underlying principal aquifer. However, towards the north of the site, shallow bedrock (<5.00 m bgl) was encountered, therefore these areas are at increased risk of vertical migration as a sufficient clay aquitard is not present to afford protection to the underlying principal aquifer.		**High**
Lateral migration Lateral migration of contaminants is considered possible due to the presence of granular alluvium deposits across the site. However, the majority of identified deposits consist of low permeability CLAY therefore reducing the overall likelihood of lateral migration.		**Medium**
Receptor		
Aquifer Classification in Superficial Deposits	Secondary Undifferentiated aquifer and Secondary A aquifer (eastern sector)	**Medium**
Aquifer Classification in Bedrock	Principal aquifer	**High**
Groundwater Source Protection Zone or Drinking Water Safeguard Zone	The site is situated within a Source Protection Zone 3 – therefore the total area needed to support the abstraction or discharge from the protected groundwater source.	**High**
Distance to the Closest Groundwater Abstraction Point	An active groundwater abstraction point located 16 m SE of the site, pertaining to Elis UK Ltd and used for laundry purposes. This increases the sensitivity of the underlying aquifer.	**High**
Is the site Located Within 50 m of a Surface Watercourse?	No surface watercourses are situated within 50 m of the site boundary.	**Low**

The ICSM developed within the context of the site setting has viable pollutant pathway, which would be the downward migration of potentially mobile phase-soluble contaminants towards the underlying principal aquifer.

In addition to above, E3P has developed a diagrammatic controlled waters conceptual model which considers the factors in Table 30. This is presented as Drawing 17-500-027 in APPENDIX IV and a snapshot is included in Figure 9.

Figure 9 Diagrammatic Conceptual Site Model (Controlled Waters)



The Tier 2 assessment in line with LCRM (2023) has included a comparison of leachate analysis from samples of the Made Ground and groundwater samples to drinking water standards (DWS).

DWS will be viewed as a priority given the highly sensitive underlying aquifer and the lack of surface receptors in proximity for EQS, however where there are no regulatory guidance values for DWS, the EQS thresholds will be utilised in their absence.

These are presented in Table 31.

Water samples were obtained utilising a bailer. During the second water sampling visit, a full bailer was inspected for light non-aqueous phase liquid (LNAPL) or dense non-aqueous phase liquids (DNAPL) due to the identified volatile organic compound contamination identified towards the south of the site within soils. However, no visible indicators of LNAPL/DNAPL were identified from the sampled environmental monitoring wells.

Table 31 Comparison of Groundwater and Leachate Analysis with Tier 2 Screening Levels

DETERMINAND	UNIT	DWS [3,4]	NO. OF GW SAMPLES	MAX CONC. IN GROUNDWATER	LOCATION OF EXCEEDANCE	NO. OF LEACHATE SAMPLES	MAX CONC. IN LEACHATE	LOCATION OF EXCEEDANCE	ASSESSMENT
Arsenic	µg/l	10	8	3.6	N/A	3	5.2	N/A	No Further Action
Cadmium	µg/l	5	8	0.31	N/A	3	0.51	N/A	No Further Action
Chromium (VI)	µg/l	–	8	< 20	N/A	3	< 20	N/A	No Further Action
Chromium (III)	µg/l	50	8	0.89	N/A	3	10	N/A	No Further Action
Copper	µg/l	2000	8	2.6	N/A	3	15	N/A	No Further Action
Total Cyanide	µg/l	50	8	< 0.0050	N/A	3	< 0.0050	N/A	No Further Action
Lead	µg/l	10	8	< 0.50	N/A	3	4.8	N/A	No Further Action
Mercury	µg/l	1.0	8	< 0.010	N/A	3	< 0.05	N/A	No Further Action
Nickel	µg/l	20	8	29	CP101	3	7.9	N/A	Further Action
Selenium	µg/l	10	8	1.3	N/A	3	1.7	N/A	No Further Action
Zinc	µg/l	–	8	13	N/A	3	14	N/A	No Further Action
pH	–	6–9	8	5.7	CP101	3	8.0	N/A	Further Action
Polycyclic Aromatic Hydrocarbons									
Naphthalene	µg/l	10*	8	< 0.50	N/A	3	< 0.010	N/A	No Further Action
Anthracene	µg/l	10*	8	< 0.50	N/A	3	< 0.010	N/A	No Further Action
Benzo[b]fluoranthene	µg/l	10*	8	< 0.50	N/A	3	< 0.010	N/A	No Further Action
Benzo[k]fluoranthene	µg/l	10*	8	< 0.50	N/A	3	< 0.010	N/A	No Further Action
Benzo(a)pyrene	µg/l	10*	8	< 0.50	N/A	3	< 0.010	N/A	No Further Action
Indeno(123-cd)pyrene	µg/l	10*	8	< 0.50	N/A	3	< 0.010	N/A	No Further Action
Fluoranthene	µg/l	10*	8	< 0.50	N/A	3	< 0.010	N/A	No Further Action
Benzo(ghi)perylene	µg/l	10*	8	< 0.50	N/A	3	< 0.010	N/A	No Further Action
Aromatic Hydrocarbon									
TPH C5-C7 (benzene)	µg/l	1	8	8.0	WS102	3	< 0.10	N/A	Further Action
TPH C7-C8 (toluene)	µg/l	700	8	18	N/A	3	< 0.10	N/A	No Further Action
TPH C8-C10	µg/l	300	8	< 0.10	N/A	3	< 0.10	N/A	No Further Action

DETERMINAND	UNIT	DWS [3,4]	NO. OF GW SAMPLES	MAX CONC. IN GROUNDWATER	LOCATION OF EXCEEDANCE	NO. OF LEACHATE SAMPLES	MAX CONC. IN LEACHATE	LOCATION OF EXCEEDANCE	ASSESSMENT
(xylene)									
TPH C10-C12 (naphthalene)	µg/l	90	8	< 5.0	N/A	3	< 0.10	N/A	No Further Action
TPH C12-C16	µg/l	90	8	< 0.10	N/A	3	< 0.10	N/A	No Further Action
TPH C16-C35	µg/l	90	8	< 0.10	N/A	3	< 0.10	N/A	No Further Action
Aliphatic Hydrocarbon									
TPH C5-C6	µg/l	1000[5]	8	< 0.10	N/A	3	< 0.10	N/A	No Further Action
TPH C6-C8	µg/l	1000[5]	8	< 0.10	N/A	3	< 0.10	N/A	No Further Action
TPH C8-C10	µg/l	300	8	< 0.10	N/A	3	< 0.10	N/A	No Further Action
TPH C10-C12	µg/l	300	8	< 0.10	N/A	3	< 0.10	N/A	No Further Action
TPH C12-C16	µg/l	300	8	< 0.10	N/A	3	< 0.10	N/A	No Further Action
TPH C16-C21	µg/l	300**	8	< 0.10	N/A	3	< 0.10	N/A	No Further Action
TPH C21-C35	µg/l	300**	8	< 0.10	N/A	3	< 0.10	N/A	No Further Action
Volatile Organic Compounds									
Tetrachloroethene	µg/l	10	8	5.3	N/A	–	–	–	No Further Action
Trichloroethene (TCE)	µg/l	10	8	>10 000	WS102 WS103 WS107 CP101 CP102	–	–	–	Further Action
Trichlorobenzene	µg/l	–	8	< 10	–	–	–	–	No Further Action
Trichloromethane	µg/l	–	8	< 1.0	N/A	–	–	–	No Further Action
Dichloromethane	µg/l	200	8	< 1.0	N/A	–	–	–	No Further Action
Cis 1,2-Dichloroethene	µg/l	–	8	> 10 000	WS102 WS103 WS107	–	–	–	Further Action

DETERMINAND	UNIT	DWS [3,4]	NO. OF GW SAMPLES	MAX CONC. IN GROUNDWATER	LOCATION OF EXCEEDANCE	NO. OF LEACHATE SAMPLES	MAX CONC. IN LEACHATE	LOCATION OF EXCEEDANCE	ASSESSMENT
					CP101 CP102				
Trans 1,2-Dichloroethene	µg/l	–	8	150	WS102 CP102	–	–	–	**Further Action**
1,1-Dichloroethene	µg/l	–	8	27	WS102 CP102	–	–	–	**Further Action**
Vinyl Chloride	µg/l	0.3	8	>10 000	WS102 WS103 WS107 CP102	–	–	–	**Further Action**

10.3.1. CONTROLLED WATER RISK ASSESSMENT AND MITIGATION

This comparison indicates that the data exceeds the DWS values for the following inorganic compounds:

- Nickel;
- pH;
- TPH C5-C7 (Benzene);
- Trichloroethene (TCE);
- Cis 1,2-Dichloroethene;
- Trans 1,2-Dichloroethene;
- 1,1-Dichloroethene; and
- Vinyl chloride.

In relation to the elevated Nickel and pH, these were only found to be elevated against DWS thresholds in CP101 groundwater samples.

No exceedances of the DWS thresholds were identified within any of the tested leachate samples.

In relation to the VOC exceedances, Table 32 provides a summary. Where multiple data from a singular well groundwater monitoring data has been obtained (WS102, WS107, CP101), the largest concentration over the two visits has been recorded below.

Table 32 Summary of Elevated Contaminants in Groundwater

CONTAMINANT	CONTAMINANT SOURCE				
	WS102 (µG/L)	WS103 (µG/L)	WS107 (µG/L)	CP101 (µG/L)	CP102 (µG/L)
TPH C5–C7 (Benzene)	8	–	–	–	–
Trichloroethene (TCE)	>10, 000	27	20	2.1	6900
1,1-Dichloroethene	18	–	–	–	27
Trans 1,2-Dichloroethene	190	–	–	–	73
Cis 1,2-Dichloroethene	>10, 000	38	12	3.7	9600
Vinyl Chloride	6100	3.4	1.3	–	400

PFAS/PFOA

The site is considered to be at a moderate risk from PFAS/PFOA contamination, due to the sites historical and current use as an oven manufacturing factory.

Due to the active nature of the site and the limited volume of groundwater available to be collected within individual exploratory hole locations, PFAS/PFOA testing of the groundwater could not be completed during this phase of intrusive ground investigation.

Further investigation and subsequent testing will be required to confirm the presence or absence of PFAS/PFOA compounds within both the soils and groundwater within the footprint of the main factory structure.

PFAS/PFOA poses a significant risk to controlled waters if found to be present, which will require further sampling of soil and groundwater to understand the potential extent of compounds if found to be present within any ground materials on-site.

Explosive Compounds and Propellants

The site is considered to be at a moderate risk of contamination from Explosive Compounds and Propellants, due to the sites historical use as a Munitions Works during the First and Second World Wars.

Explosive Compounds and Propellants are generally only sparingly soluble in water and therefore of fairly low mobility. However, nitroglycerine is more soluble in water, may be significantly more mobile and may migrate considerable distances from the source of contamination. The lack of mobility in the majority of particulate explosive compounds and propellants (TNT, RDX, HMX, Tetryl, etc) may mean that absorbed materials provide an on-going source of groundwater contamination owing to desorption and continuous leaching during rainfall, though this will be reduced due to the presence of hardstanding across the majority of site.

Due to the active nature of the site and the limited volume of groundwater available to be collected within individual exploratory hole locations,, testing for Explosive Compounds and Propellants within the soils could not be completed during this phase of intrusive ground investigation.

Further investigation and subsequent testing will be required to confirm the presence or absence of Explosive Compounds and Propellants within both the soils and groundwater within the footprint of the main factory structure.

Explosive Compounds and Propellants pose a significant risk to controlled waters if found to be present, which will require further sampling of soil and groundwater to understand the potential extent of compounds if found to be present within any ground materials on-site.

10.3.2. DISCUSSION OF CONTROLLED WATERS RISK ASSESSMENT

Historically, the site has been subjected to extensive infilling and a number of industrial uses including an Iron Foundry and Oven Manufacturing Factory which, at the time of writing the report is still present and active. Chemical by-products of manufacturing processes and compounds within the Made Ground may have subsequently leached down into underlying ground and contaminated groundwater both within Made Ground and natural superficial deposits.

The site is underlain by a mixed geology, generally cohesive clay in the south of the site with discrete areas of interbedded cohesive and granular materials towards the north. The granular deposits will afford less protection to the underlying principal aquifer in the bedrock in comparison to the remainder of the site, where generally clay deposits are anticipated to, or proven in excess of 5.00 m in areas. Furthermore, towards the northern sector of the site, bedrock was encountered at lesser depths (<5.00 m bgl), which further increases the risk of vertical migration of compounds towards the underlying bedrock aquifer as a result of cohesive material is not present within suitable quantities to afford protection to the underlying aquifer.

The site is also situated within a Source Protection Zone 3, which further increases the sensitivity of the underlying aquifer. Overall, it is deemed the Principal Bedrock Aquifer is deemed to be at a high risk to on-site contamination, particularly in the north of the site, as extensive sources of contamination and potential pathways (vertical migration) have been established.

Widespread Trichloroethene (TCE), Dichloroethene (cis 1,2-Dichloroethene, and Trans 1,2-Dichloroethene), and Vinyl Chloride contamination and localised heavy metal exceedances have been identified in the groundwater analysis at the site.

It is noted that where there are exceedances of VOCs in soils, exceedances in groundwater were often recorded. Therefore, it is considered that there is a likely on-site source of contamination which may be leaching across the site and into the underlying groundwater, and subsequently the principal aquifer.

Based upon the significantly higher concentrations of VOCs recorded within two sets of groundwater samples within WS102, and in addition to a larger number of different compounds recorded, WS102 is considered the most likely point-source of contamination which is subsequently leaching into the surrounding areas. Based upon the location of WS102, and the identified visual/olfactory impact within both the natural and MADE GROUND deposits, it is assumed the contamination is leaching from the main factory structure and the enamel slurry waste storage area located to the north / northeast of the borehole.

A plume of Trichloroethene (TCE), Dichloroethene variants, and Vinyl Chloride has been identified within groundwater monitoring data, extending from WS107 towards the northwestern entrance of the site, through to CP102 towards the southeast of the factory. No groundwater samples were obtained from WS101, as the environmental monitoring well did not contain enough groundwater for laboratory testing, however as exceedances of the known Trichloroethene, Dichloroethene variants, and Vinyl Chloride were identified within the soil testing, it is considered likely groundwater within the vicinity of WS101 will be contaminated with the aforementioned VOCs. It is noted that concentrations of VOCs were significantly higher in deeper groundwater monitoring wells, which suggests the plume is formed of DNAPL.

A Groundwater Contamination Issues Plan is presented as Drawing 17-500-018 in APPENDIX IV.

The groundwater flow plan (Drawing 17-500-029) shows that, in general, groundwater is flowing in a south-westerly direction. When consulting the cross section plans of the site (APPENDIX IV) it can be seen that groundwater levels range between 58.00 m AOD in the northeast and 54.00 m AOD in the southwest. At present, the cross sections show that the groundwater flows through both Made Ground and natural deposits at the site, particularly in the south of the site. This is potentially allowing for the dispersion of the identified elevated contaminants within the groundwater.

The site is currently an industrial factory building, with extensive hardstanding surface cover, rainfall is currently being intercepted which limits the potential for additional mobilisation of the identified contaminants.

The proposed development will create hardstanding cover across the site, thus reducing the amount of infiltration generated. This will in turn, reduce the amount of contaminants present in leachate off the site and reduce the risk further to the underlying aquifer. Given that the majority of the site is underlain by low permeability clay, the leaching of contaminants in this sector will be significantly reduced as the Made Ground will be contained beneath the impermeable surface covering, with the exception of garden areas, and above the natural clay aquitard.

Principal Aquifer

Site wide Trichloroethene (TCE), Dichloroethene variants, and Vinyl Chloride impact has been identified with the soils and groundwaters across the site.

The Tier 2 assessment has identified multiple exceedances of VOCs and a localised TPH (Benzene) in the groundwater samples. To remove the risk of vertical migration into the aquifer, a process of hotspot removal and/or treatment may be applied during remediation works within the locations where the elevated VOCs have been identified (WS102, WS103, WS107, CP101, CP102). As a result of this exercise, the source and further leaching potential of the soil would be removed.

The Tier 2 assessment shows elevated VOCs, against DWS values, on a site wide basis. These contaminants may leach vertically through soils, into the underlying aquifer which is recorded at depths <10.00 m bgl. Specialist remediation works and deep groundwater monitoring wells will be required in order to treat the DNAPL plume. A Controlled Waters DQRA is also recommended.

Given the significantly elevated concentrations of the VOC impact within both shallow and the deeper groundwater wells (CP101, CP102) in the south of the site, stabilisation of material may be required to stabilise the impacted soils and ensure no long-term risk to the wider environs.

It must be noted that no environmental monitoring wells have been advanced into the principal aquifer (bedrock) and so, it is not yet proven whether the source-pathway-receptor linkage is complete. Without samples of the principal aquifer, the extent, if any, of VOC impact cannot be proven.

10.4. GROUND GAS RISK ASSESSMENT

10.4.1. RATIONALE

Hazardous ground gas qualitative risk assessment is based on a conceptual site model (CSM) similar to that used for soil and groundwater contamination sources (i.e., source-pathway-receptor pollutant linkages).

The risk can be assessed based on knowledge of the ground conditions and CSM and a measure of hazardous gas concentrations and gas flow at the site within monitoring standpipes.

10.4.2. GROUND CONDITIONS

Made Ground

Made Ground deposits were encountered within all exploratory hole locations to depths of between 0.00 m and in excess of 3.00 m bgl although, in general, Made Ground was encountered to a depth of less than 1.50 m bgl.

Typically, the concrete or asphalt was underlain by a slightly clayey sandy gravel, with gravel of brick, concrete, mudstone, limestone, coal and slag with rare fragments of glass, plastic, and timber in some locations. These deposits were encountered from 0.15–0.80 m bgl, and were typically overlaying a reworked gravelly clay, with gravel of brick, sandstone, mudstone and in rare instances coal to a maximum proven depth of 3.00 m bgl (CP102).

Hydrocarbon odours were noted within six locations, situated across the site within the Made Ground deposits. The depths the hydrocarbon odour was encountered ranged from 0.50–1.90 m bgl (WS106) and was typically noted within a reworked very gravelly clay with gravel of sandstone, mudstone, concrete, ash, and rare instances of slag.

Superficial Strata

Superficial deposits were encountered within all exploratory locations, with the superficial deposits varying across the site. The most common stratum recorded was an orangish brown sandy gravelly CLAY with gravel of sandstone, mudstone, and instances of coal and quartz. Typically, the CLAY was locally interbedded with an orange very clayey fine to medium SAND from 0.70–4.44 m bgl.

In five locations, a very sandy CLAY with pockets of orange fine to medium SAND was noted, which was typically towards the east, with the exception of WS107 which recorded this stratum from 0.90–4.00 m bgl.

In CP102, a band of SAND and GRAVEL approximately 500 mm thick was recorded from 3.00–3.50 m bgl, with gravel of sandstone. This was in turn underlain by the orange-brown mottled sandy gravelly CLAY from 3.50–9.00 m bgl. A rare band of clayey fine to medium SAND with pockets of grey CLAY was noted in WS103, from 1.40–3.00 m bgl.

Bedrock Strata

The bedrock geology was encountered between 4.00–9.37 m bgl during the preliminary ground investigation as highly weathered SANDSTONE recovered as a red very gravelly medium to coarse SAND.

Generally, bedrock was encountered at shallower depths (<5.00 m bgl) towards the north of the site, in WS109 and WS109, deepening to 9.00.m bgl towards the south of the site.

The site is situated within a coal mining reporting area, but not within a development high risk zone.

Groundwater

Groundwater strikes were encountered as seepages in two locations at depths from 1.00–7.00 m bgl. During the monitoring programme, groundwater was recorded at depths ranging from 0.60 m to 5.47 m bgl.

10.4.3. SOURCES AND PATHWAYS OF GROUND GAS

Based on the CSM, the following potential sources and pathways of ground gas have been identified:

- Made Ground;
- Three infilled ponds within the site boundary;
- No landfills have been identified within 250 m of the site and the site is not in an area affected by Radon;
- VOC impacted soils and groundwater - potential sources of volatile vapours as dichlorination (degradation) of compounds occurs.

There is potential for localised ground gas migration in proximity of the identified sources, albeit reduced by predominantly low permeability strata.

The CIRIA C665 guidance on gas risk assessment includes recommendations for periods and frequencies for monitoring visits. These recommendations take into account the nature of the proposed development and the likely generation potential of the source.

The proposed development comprises private residential properties, which would be classified as a Type A development (high sensitivity) in accordance with BS8485:2015+A1:2019. However, it is considered that the likely generation potential of the identified gas sources (taking into account the likelihood of future increases in gas generation) would be best classified as high.

Therefore, within the context of the proposed residential end-use and ground gas generation potential, the gas assessment requires twelve visits over nine months, with at least two sets of readings at low or falling atmospheric pressure. However, as this is a preliminary investigation, four visits over one month have been conducted to form an initial assessment of gas risk prior to the decommission of the factory.

10.4.4. GROUND GAS RISK ASSESSMENT METHODOLOGY

The potential impact on the development from ground gases has been assessed with reference to standards and guidelines published in:

- CIRIA Report 665 – Assessing risks posed by hazardous ground gases to buildings (2007)
- BS8485:2015+A1:2019 – Code of Practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings

BS8485 provides guidance on the level of gas protection requirements based upon the characteristic situation (CS) and the proposed development based on building type.

Therefore, in accordance with BS8485, based on the measured flow rates and hazardous gas concentrations, individual hazardous gas flow rates (Q_{hg}) shall be derived for each monitoring point, from which the site characteristic hazardous gas flow rate (Q_{hgs}), and then the Characteristic Situation (CS) can be determined.

The following equation should be utilised:

$$Q_{hg} = q\left(\frac{C_{hg}}{100}\right)$$

Where:
q is the measured flow rate (in litres per hour) of combined gases from the monitoring standpipe
C_{hg} is the measured hazardous gas concentration (in percentage volume/volume).

The subsequent derived gas screening value (GSV) should be the maximum Q_{hg} (flow rate x concentration as a percentage volume) for all the monitoring events.

A 'worst case check' may be carried out using the maximum recorded flow in any hole with the maximum concentration in any hole to present the plausible worst case conditions. Adoption of the worst case Q_{hg} requires thorough justification and reference to the CSM.

The final derived GSV can then be used to characterise the site as summarised in Table 33.

Table 33 Site Characterisation by GSV (BS8485:2015)

CS	HAZARD POTENTIAL	GSV (L/HR) FOR METHANE AND CARBON DIOXIDE	ADDITIONAL FACTORS
CS1	Very Low	< 0.07	Typically <1% methane concentration and <5% carbon dioxide concentration (otherwise consider an increase to CS2)
CS2	Low	< 0.70	Typical measured flow rate <70 l/h (otherwise consider an increase to CS3)
CS3	Moderate	< 3.5	N/A
CS4	Moderate to High	< 15	N/A
CS5	High	< 70	N/A
CS6	Very High	> 70	N/A

Notes
1) *The CS is equivalent to the characteristic GSV in CIRIA C665.*
2) *The worst-case ground gas regime identified on the site, either methane or carbon dioxide, at the worst-case temporal conditions that the site may be expected to encounter should be considered.*
3) *Gas Screening Value is the Borehole Gas Volume Flow Rate, in litres per hour, multiplied by the concentration in the air stream of the particular gas being considered.*
4) *The Gas Screening Value thresholds should not generally be exceeded without the completion of a detailed ground gas risk assessment taking into account site-specific conditions.*

10.4.5. MONITORING METHODOLOGY

Concentrations of methane (CH_4), carbon dioxide (CO_2) and oxygen (O_2) were measured using a calibrated infrared gas analyser (GFM435) with gas flow rates measured using an integrated flow meter.

Gas measurements were recorded for a minimum of 300 seconds (5 minutes) at each location, increasing to 600 seconds if elevated concentrations identified, at which point the maximum concentration of CH_4 and CO_2, together with the lowest concentration of O_2 were recorded.

In addition, during the third and fourth monitoring rounds, concentrations of VOC gases were also measured using a Minirae 3000 Photo Ionisation Detector (PID) Monitor calibrated to Isobutylene.

The results of the ground gas monitoring are presented in Table 34.

In addition to the raw data, the results for each individual standpipe have been assessed with reference to guidance provided in BS8485:2015. Based on the initial peak measured flow rates and hazardous gas concentrations, individual hazardous gas flow rates (Q_{hg}) have been derived for each monitoring point, from which an individual Characteristic Situation (CS) can ultimately be determined.

10.4.6. SUMMARY OF MONITORING RESULTS

Table 34 presents of the ground gas and groundwater monitoring results to date.

Table 34 Summary of Ground Gas Monitoring Results

WELL	DATE	CH_4 INITIAL (%V/V)	CH_4 STEADY (%V/V)	CH_4 GSV (l/hr)	CO_2 INITIAL (%V/V)	CO_2 STEADY (%V/V)	CO_2 GSV (l/hr)	O_2 (%V/V)	VOCs PEAK (PPM)	VOCs STEADY (PPM)	ATMOS (mb)	ATMOS. DYNAMIC	FLOW (l/hr)	RESPONSE ZONE (m bgl)	DEPTH TO BASE (m bgl)	DEPTH TO WATER (m bgl)
WS101	04/04/24	0.1	0.1	0.0001	0.3	0.3	0.0003	20.4	-	-	991	Steady	0.1	1.00–1.50	1.51	1.14
	11/04/24	0.1	0.1	0.0001	0.1	0.1	0.0001	20.4	-	-	1016	Rising	0.1		1.50	1.02
	23/04/24	0.1	0.1	0.0002	0.1	0.1	0.0002	20.3	0	0	1016	Falling	0.1		1.50	1.22
	03/05/24	0.1	0.1	0.0002	0.1	0.1	0.0002	20.5	0	0	997	Steady	0.2		1.50	1.33
WS102	04/04/24	0.1	0.1	0.0001	0.1	0.1	0.0001	20.5	-	-	992	Steady	0.1	2.00–4.00	4.01	0.62
	11/04/24	0.1	0.1	0.0001	0.3	0.2	0.0003	18.6	-	-	1017	Rising	0.1		4.00	3.52
	23/04/24	0.1	0.1	0.0001	0.1	0.1	0.0001	20.4	0	0	1017	Falling	0.1		4.00	3.32
	03/05/24	0.1	0.1	0.0004	0.2	0.1	0.0008	20.1	0	0	1017	Steady	0.4		4.00	3.08
WS103	04/04/24	2.7	0.1	0.0054	3.4	1.0	0.0068	17.6	-	-	992	Steady	0.2	0.50–1.40	1.63	1.47
	11/04/24	0.1	0.1	0.0001	0.3	0.3	0.0003	20.4	-	-	1016	Rising	0.1		1.62	1.09
	23/04/24	0.1	0.1	0.0001	0.3	0.3	0.0003	20.5	0.7	0.6	1016	Falling	0.1		1.62	1.17
	03/05/24	0.1	0.1	0.0001	0.5	0.4	0.0005	20.1	0	0	997	Steady	0.1		1.62	1.52
WS104	04/04/24	0.1	0.1	0.0001	0.1	0.1	0.0001	20.6	-	-	991	Steady	0.1	1.30–3.30	2.78	0.95
	11/04/24	0.1	0.1	0.0001	0.1	0.1	0.0001	20.7	-	-	1016	Rising	0.1		2.85	0.93
	23/04/24	0.1	0.1	0.0001	0.2	0.1	0.0002	20.4	0	0	1016	Falling	0.1		2.85	2.35
	03/05/24	0.1	0.1	0.0001	0.1	0.1	0.0001	20.4	0	0	998	Steady	0.1		2.85	2.45
WS105	04/04/24	1.9	0.3	0.0019	1.2	0.7	0.0012	16.9	-	-	991	Steady	0.1	1.00–3.00	2.88	2.71
	11/04/24	0.1	0.1	0.0001	0.1	0.1	0.0001	20.6	-	-	1017	Rising	0.1		2.88	2.64
	23/04/24	0.1	0.1	0.0001	0.4	0.3	0.0004	20.2	0	0	1019	Falling	0.1		2.88	2.72
	03/05/24	0.1	0.1	0.0001	0.2	0.1	0.0002	20.4	0	0	998	Steady	0.1		2.88	2.78
WS106	04/04/24	0.1	0.1	0.0001	0.8	0.8	0.0008	10.3	-	-	991	Steady	0.1	0.50–1.90	2.17	2.13
	11/04/24	0.1	0.1	0.0001	0.4	0.4	0.0004	17.5	-	-	1016	Rising	0.1		2.15	2.11
	23/04/24	0.1	0.1	0.0001	1.4	0.9	0.0014	16.6	0	0	1017	Falling	0.1		2.15	Dry
	03/05/24	0.1	0.1	0.0001	0.7	0.4	0.0007	19.6	0	0	996	Steady	0.1		2.15	Dry
WS107	04/04/24	0.1	0.1	0.0001	1.5	1.5	0.0015	12.3	-	-	992	Steady	0.1	1.00–4.00	3.98	2.72
	11/04/24	0.1	0.1	0.0001	17.0	1.7	0.0170	12.7	-	-	1016	Rising	0.1		3.99	2.73
	23/04/24	0.1	0.1	0.0001	0.1	0.1	0.0001	20.6	0	0	1016	Falling	0.1		3.99	2.81
	03/05/24	0.1	0.1	0.0001	0.1	0.1	0.0001	20.6	0	0	998	Steady	0.1		3.99	2.78
WS108	04/04/24	0.1	0.1	0.0001	0.1	0.1	0.0001	15.5	-	-	992	Steady	0.1	0.50–1.00	1.01	0.79
	11/04/24	0.1	0.1	0.0001	0.1	0.1	0.0001	20.0	-	-	1016	Rising	0.1		1.02	0.80

WELL	DATE	CH_4 INITIAL (%V/V)	CH_4 STEADY (%V/V)	CH_4 GSV (l/hr)	CO_2 INITIAL (%V/V)	CO_2 STEADY (%V/V)	CO_2 GSV (l/hr)	O_2 (%V/V)	VOCs PEAK (PPM)	VOCs STEADY (PPM)	ATMOS (mb)	ATMOS. DYNAMIC	FLOW (l/hr)	RESPONSE ZONE (m bgl)	DEPTH TO BASE (m bgl)	DEPTH TO WATER (m bgl)
	23/04/24	0.1	0.1	0.0001	0.1	0.1	0.0001	19.7	0	0	1015	Falling	0.1		1.02	0.98
	03/05/24	0.1	0.1	0.0001	0.1	0.1	0.0001	19.9	0	0	998	Steady	0.1		1.02	0.95
WS109	04/04/24	0.1	0.1	0.0001	2.0	2.0	0.0020	6.5	-	-	992	Steady	0.1	1.00–4.00	3.99	3.95
	11/04/24	6	1.2	0.0060	2.6	2.6	0.0026	4.5	-	-	1016	Rising	0.1		3.98	3.86
	23/04/24	0.1	0.1	0.0001	2.4	2.4	0.0024	10.9	0	0	1016	Falling	0.1		3.98	3.78
	03/05/24	0.1	0.1	0.0001	2.7	2.7	0.0027	4.1	0	0	996	Steady	0.1		3.98	3.89
WS110	04/04/24	0.1	0.1	0.0001	1.2	1.1	0.0012	15.8	-	-	992	Steady	0.1	0.50–1.00	1.12	0.99
	11/04/24	0.1	0.1	0.0001	0.4	0.4	0.0004	20.0	-	-	1016	Rising	0.1		1.11	0.97
	23/04/24	0.1	0.1	0.0001	1.5	1.5	0.0015	14.7	0	0	1016	Falling	0.1		1.11	Dry
	03/05/24	0.1	0.1	0.0001	1.6	1.6	0.0016	16.7	0	0	995	Steady	0.1		1.11	Dry
CP101	04/04/24	0.1	0.1	0.0001	0.2	0.2	0.0002	20.5	-	-	992	Steady	0.1	3.00–7.50	7.17	2.38
	11/04/24	0.1	0.1	0.0001	0.1	0.1	0.0001	20.5	-	-	1016	Rising	0.1		7.18	5.47
	23/04/24	0.1	0.1	0.0001	0.1	0.1	0.0001	20.4	0	0	1016	Falling	0.1		7.18	3.99
	03/05/24	0.1	0.1	0.0001	0.2	0.1	0.0002	20.5	0	0	995	Steady	0.1		7.18	3.14
CP102	04/04/24	0.1	0.1	0.0001	0.1	0.1	0.0001	18.1	-	-	992	Steady	0.1	3.50–9.00	7.22	4.60
	11/04/24	0.1	0.1	0.0000	0.1	0.1	0.0001	20.5	-	-	1017	Rising	0.1		7.22	4.60
	23/04/24	0.1	0.1	0.0000	0.1	0.1	0.0001	20.2	0	0	1016	Falling	0.1		7.82	4.02
	03/05/24	0.1	0.1	0.0001	0.1	0.1	0.0001	20.4	0	0	996	Steady	0.1		7.82	4.60

Notes

CIRIA Characteristic Situation		Q_{hg}		
	CS1	*<0.07*	*Typical Max CO2 <5 % Typical Max CH4 <1 %*	*Values in BOLD exceed CS1 Thresholds*
	CS2	*<0.7*	*Flow rate not to exceed 70 l/hr otherwise consider increase to CS3*	*Values in BLUE denote water above level of response zone (flooded)*
	CS3	*<3.5*		
	CS4	*<15*	*Quantitative Risk Assessment required to evaluate scope of protective measures*	

10.4.7. GROUNDWATER

The water level within several of the monitoring wells was recorded to be above the top of the response zone (flooded) on a number of occasions, as summarised in Table 35, thus rendering some of the monitoring data unreliable. Therefore, each time a flooded well was encountered, the well was bailed and left to re-equilibrate. Wells were re-monitored after a period of 20–30 minutes.

Table 35 Flooded Monitoring Well Data

WELL	VISIT 1 04/04/2024	VISIT 2 11/04/2024
WS102	Y	-
WS104	Y	Y
CP101	Y	-

Within remaining monitoring wells, groundwater levels were variable across monitoring wells and visits. Therefore, it is considered likely groundwater flow is present within the upper 2.00 m bgl of the ground within the site.

10.4.8. BAROMETRIC PRESSURE

Visits 1 and 4 were undertaken during a period of steady low pressure, with a recorded low of 992 mbar.

Visit 2 was undertaken during a period of rising high pressure, with a recorded high of 1017 mbar.

Visit 3 was undertaken during a period of falling high pressure with a recorded high of 1016 mbar.

It is therefore considered that the visits have been undertaken over representative conditions.

10.4.9. GAS FLOW

Throughout the monitoring period, the majority of flow rates were recorded to be 0.1 l/hr (limit of detection of the analyser).

However, elevated flow rates were recorded within WS101 and WS102 during visit 4, which were recorded at 0.2 l/hr and 0.4 l/hr, respectively. Additionally, elevated flow rates were recorded during visit 1 within WS103, recorded at 0.2 l/hr.

Both elevated flow rates instances were recorded during steady low pressure events.

10.4.10. GAS CONCENTRATIONS

The majority of maximum methane value recorded within the monitoring wells was 0.1% v/v (limit of detection of the analyser). However, elevated initial flow readings were noted within WS103 and WS105 during visit 1 with peak readings of 2.7% v/v and 1.9% v/v, respectively.

The highest initial methane value was recorded within WS109 during visit 2 with peak flow recorded at 6.0% v/v and steady flow readings at 1.7% v/v.

Carbon dioxide concentrations were recorded at concentrations ranging from 0.1% v/v to 3.4% v/v. A peak initial flow reading of 17 % v/v was recorded within WS107 during visit 2, however the steady flow dropped to 1.7% v/v due to low subsequent readings.

10.4.11. RADON RISK

The site is in an area where less than 1% of homes are above the Radon Action Level, therefore, no radon protection measures are required for any proposed new dwellings.

All sites registered from 1st December 2022 onwards will have been assessed against the updated radon maps by NHBC and will be required to have radon protection measures installed in accordance with the updated mapping.

Figure 10 indicates that based on the less than 1% area observed, the site falls under a Radon Potential Class of 1 within the User Guide for the HPA-BGS Joint Radon Potential Dataset for Great Britain (Ref: IR/11/044, dated 2011). A Radon potential class of 1 indicates that the site is not within a radon affected area, which requires no radon protective measures as illustrated in Figure 11.

Figure 10 Radon Affected Area Potential Class

Radon Potential Class*	Is the property in a Radon Affected Area?	Additional information
1	No	The property is in a Lower probability radon area (less than 1% of homes are estimated to be at or above the Action Level). The property is not in a radon affected area.
2	Yes	The property is in an Intermediate probability radon area (1 to 3% of homes are estimated to be at or above the Action Level). The property is in a radon affected area.
3	Yes	The property is an Intermediate probability radon area (3 to 5% of homes are estimated to be at or above the Action Level). The property is in a radon affected area.
4	Yes	The property is in an Intermediate probability radon area (5 to 10% of homes are estimated to be at or above the Action Level). The property is in a radon affected area.
5	Yes	The property is in a Higher probability radon area (10 to 30% of homes are estimated to be at or above the Action Level). The property is in a radon affected area.
6	Yes	The property is in a Higher probability radon area (more than 30% of homes are estimated to be at or above the Action Level). The property is in a radon affected area.

*The Radon Potential Class number should not be included in answers.

Source: User Guide for the HPA-BGS Joint Radon Potential Dataset for Great Britain (Ref: IR/11/044, dated 2011)

Figure 11 Radon Affected Area Measures Required

Radon Potential Class*	What level of radon protective measures are required for new buildings in England and Wales?	What level of radon protective measures are required for new dwellings in Scotland?
1	None**	None**
2	None	Stage 1
3	Basic	Stage 1
4	Basic	Stage 1
5	Full	Stage 2
6	Full	Stage 2

*The Radon Potential Class number should not be included in answers.

** in 2008 HPA recommended that building regulations be amended to ensure that all new buildings, extensions etc. include basic radon protective measures. At the time of writing, relevant UK authorities were considering this advice.

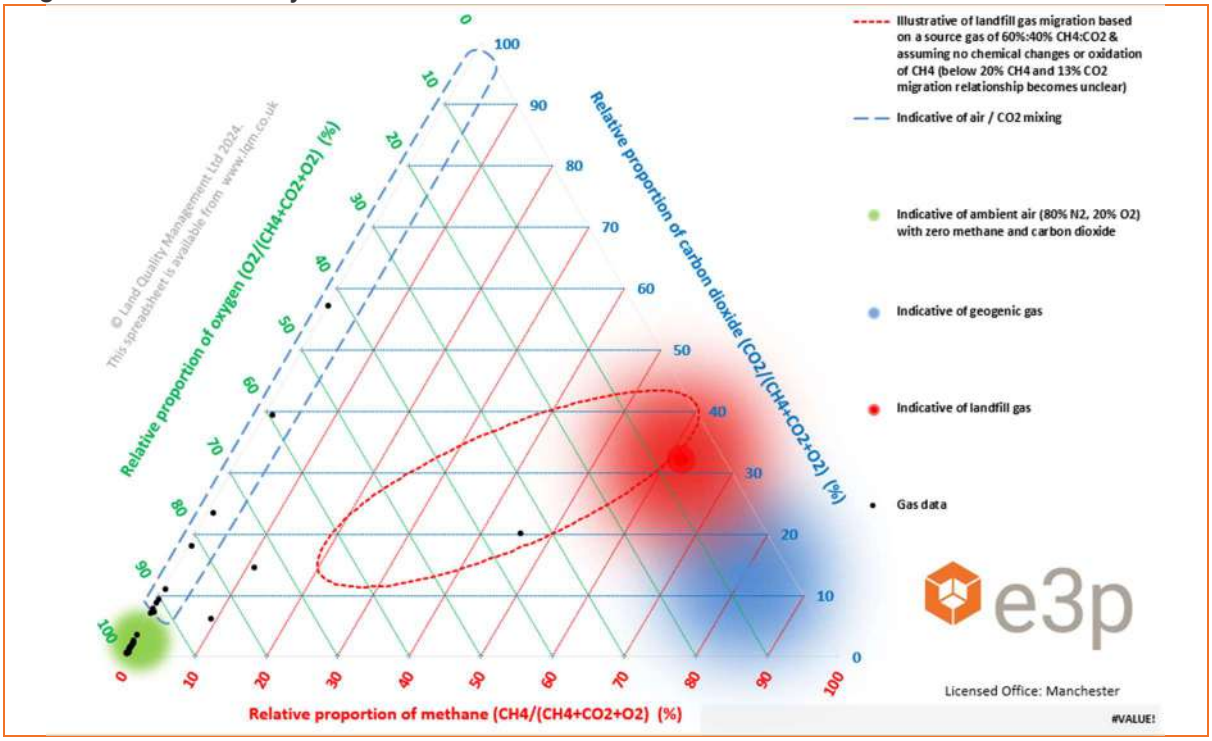
Source: User Guide for the HPA-BGS Joint Radon Potential Dataset for Great Britain (Ref: IR/11/044, dated 2011)

10.4.12. TERNARY PLOT FOR GROUND GAS

A ternary gas plot is a triangular plot of three variables which equal 100%. They allow the composition of gas to be identified and can help to identify the potential source of gas. As carbon dioxide is present in natural soils (such as Glacial Till), this can lead to uncertainty about whether it is necessary to increase the gas regime. On this basis, a ternary plot has been used as an assessment tool for the gas monitoring data to identify if there is a true risk.

Figure 12 shows the ternary gas plot for the gas monitoring data.

Figure 12 Ternary Gas Plot



The ternary gas plot indicates the majority of the ground gas monitoring results have standard oxygen and generally low carbon dioxide concentrations with limited occasions of carbon dioxide concentrations above 5%, and no elevated methane, which is indicative of natural sources (green area on the ternary plot).

On three occasions within WS103, WS105 and WS107, elevated methane and carbon dioxide and partially depleted oxygen were recorded, which could indicate organic material, Made Ground or organic contamination undergoing anaerobic degradation.

On one occasion in WS109, elevated methane concentrations with no elevated carbon dioxide and depleted oxygen were recorded, which is indicative of the 'cross-gas' effect from potential volatile contamination in the ground. Further investigation into these elevated concentrations is recommended.

10.4.13. CONCLUSION

The determined Characteristic Situation for each standpipe for each visit is presented in Table 36. This indicates that based on the peak flow rates the majority of the monitoring visits classify as Characteristic Situation (CS)1 – Very Low Gas Risk. However, WS103 and WS105 are noted to be classified within CS2, and WS107 and WS109 classified within CS3.

Table 36 Gas Risk Profile and Location

WELL	DEPTH TO WATER (m bgl)	MAX FLOW (l/hr)	MAX CH_4 (%V/V)	MAX CH_4 Q_{hg} (l/hr)	MAX CO_2 (%V/V)	MAX CO_2 Q_{hg} (l/hr)	CHARACTERISTIC SITUATION
WS101	1.02	0.2	0.100	0.001	0.300	0.001	CS1
WS102	0.62	0.4	0.100	0.001	0.300	0.001	CS1
WS103	1.09	0.2	2.700	0.005	3.400	0.007	CS2
WS104	0.93	0.1	0.100	0.001	0.200	0.001	CS1
WS105	2.64	0.1	1.900	0.002	1.200	0.001	CS2
WS106	2.11	0.1	0.100	0.001	1.400	0.001	CS1
WS107	2.72	0.1	0.100	0.001	17.000	0.017	CS3
WS108	0.79	0.1	0.100	0.001	0.100	0.001	CS1
WS109	3.78	0.1	6.000	0.006	2.700	0.003	CS3
WS110	0.97	0.1	0.100	0.001	1.600	0.002	CS1
CP101	3.14	0.1	0.100	0.001	0.200	0.001	CS1
CP102	4.02	0.1	0.100	0.001	0.100	0.001	CS1

Based on the above, the site is variable with the majority of site situated within Characteristic Situation 1 (CS1), however there are two noted areas falling within Characteristic Situation 2 (CS2), and an additional two areas falling within Characteristic Situation 3 (CS3). Therefore, as a precautionary measure, it is recommended that the whole site should be categorised within CS2, which will require basic gas protection measures, with any proposed plots within the area of CS3 classification potentially requiring further precautions.

Further environmental monitoring wells are required within the footprint of the main factory structure in addition to further ground gas monitoring regimes under lower pressure conditions and further falling and rising pressure events due to elevated readings and known VOC impacted soils and groundwater.

Furthermore, with regards to the elevated volatile contaminants identified within soils and groundwater across the southern boundary of the site, vapour resistant membranes may be required to be installed during the build phase for any proposed buildings situated within the immediate vicinity of the impacted soils.

It is recommended that the full ground gas assessment and recommended protection measures (if applicable) are agreed with the local authority prior to their adoption on-site. Furthermore, all protection measures adopted should be validated by a suitably qualified engineer.

A Radon Class 1 has been applied to the site, therefore no protective measures are required in the construction of residential dwellings.

10.5. POTABLE WATER SUPPLY

This section provides a summary of the preliminary ground investigation data with reference to the selection of potable water supply pipework. The assessment is made with reference to the UK Water Industry Research (UKWIR) publication "Guidance on the selection of Water Supply Pipes to be used in Brownfield Sites".

Table 37 Pipeline Selection PE Threshold Concentrations

CONTAMINANT GROUP	PE-THRESHOLD (MG/KG)	CONCENTRATIONS AT CURRENT PIPELINE DEPTH (MG/KG)
Total VOC	0.5	>1.0
Total BTEX And MTBE	0.1	<0.001
Total SVOCs (Excluding PAH and those substances marked with an *)	2	<1.0
EC5-EC10 Aliphatic and Aromatic Hydrocarbons	2	<1.0
EC10-EC16- Aliphatic and Aromatic Hydrocarbons	10	<1.0
EC16-EC40 Aliphatic and Aromatic Hydrocarbons	500	<1.0
Phenols (From SVOC Analysis)*	2	<0.10
Cresols and Chlorinated Phenols (From SVOC Analysis)	2	NA
Ethers*	0.5	<0.50
Nitrobenzene*	0.5	<0.50
Ketones*	0.5	NA
Aldehydes*	0.5	NA
Amines	Fail	<0.50
Other Consideration		
Are there any exceedances of the PE threshold outside of the pipeline depth?	Yes – known VOC impact was recorded outside of the pipeline depth within multiple exploratory locations towards the southern boundary of the main factory structure.	
Is free product present in soil and groundwater?	Yes – VOC impact was recorded within groundwater within multiple exploratory locations towards the northwest and southern boundary of the main factory structure.	
Could hydrocarbon impact at greater depth than current pipeline depth be mobilised by rising groundwater levels?	Yes – groundwater monitoring visits indicate the groundwater in the south of the site is mobilising compounds.	
Will soils impacted with above determinands likely be utilised elsewhere on-site?	No	
Will soils be imported to site as part of any future earth works	Currently unknown, however it is unlikely soils will be required to be imported to site.	

Notes - Pipe line depth normally between 0.75 m–1.35 m

Based on the assessment of current site conditions it is likely that barrier pipe will be required at the proposed development.

10.6. DEVELOPED CONCEPTUAL SITE MODEL

Following the completion of the preliminary intrusive ground investigation, chemical analysis and risk assessment, the developed conceptual site model shown in Table 38 has been prepared for the site. Diagrammatic human health and controlled waters developed conceptual site models are presented as Drawings 17-500-010 and 17-500-027 in APPENDIX IV.

Table 38 Developed Conceptual Model

CONTAMINANT RISK			LIKELIHOOD	SEVERITY	MITIGATION DISCUSSION	RESIDUAL RISK
SOURCES	MIGRATION PATHWAYS	RECEPTORS				
SOIL						
HUMAN HEALTH						
Made Ground Metals (Arsenic, Lead, Nickel) – encountered along the northern boundary of the site.	Accidental ingestion and/or dermal contact with contaminated soil and/or leachate. **PL1/PL2**	Human Health – construction workers Human Health – end users	Likely	Medium	The CSM has identified contaminants of concern as above assessment criteria. Site personnel have a greater chance of coming into contact with contaminated soils. Particularly during excavation and soil recovery works. **Recommendation:** Further investigation is required across the site to assess site wide contamination levels. Construction works to be completed with appropriate PPE and welfare facilities.	Low

CONTAMINANT RISK			LIKELIHOOD	SEVERITY	MITIGATION DISCUSSION	RESIDUAL RISK
SOURCES	**MIGRATION PATHWAYS**	**RECEPTORS**				
Oven Manufacturing Factory (Main Factory Structure) VOCs (Trichloroethene (TCE), cis 1,2-Dichloroethene, Trans 1,2-Dichloroethene, Vinyl Chloride) - encountered along the southern boundary of the site.	Inhalation of vapours. **PL4** Migration through permeable strata and preferential pathways.	Human Health – end users Human Health – Off-site receptors	Likely	High	Intrusive ground investigation has identified the presence of enamel slurry waste storage tanks which may be a significant source of TPHs/VOCs. Soil analysis has confirmed the presence of VOCs in three locations across the southern boundary of the site. No sources of TPHs have been identified. **Recommendation:** Further intrusive ground investigation is required to determine the spatial extent of contamination within the soils and understand whether leaching has occurred into the underlying natural strata. Visual and olfactory evidence of contamination has been identified in a number of locations; therefore, a watching brief should be completed during remediation works to monitor the locations where visual or olfactory hydrocarbon impact has been identified during all phases of investigation completed to date.	High

CONTAMINANT RISK			LIKELIHOOD	SEVERITY	MITIGATION DISCUSSION	RESIDUAL RISK
SOURCES	**MIGRATION PATHWAYS**	**RECEPTORS**				
Made Ground & Main Factory Structure Asbestos (Asbestos containing materials (ACM) and loose fibres)	Inhalation (of fibres). Construction works disturbing bound material and releasing fibres. **PL3**	Human Health - Site personnel, end land users, and users of adjacent sites	Likely	Medium	Risk of inhalation of fibres during Ground Investigation and construction works. Disturbance of ACMs and dust derivatives from construction would increase risk to adjacent sites. **Recommendation:** Cover system to garden and landscaped areas will prevent exposure to future site users. Construction works completed with PPE and provision of welfare.	Moderate/High
Made Ground Sulphate from potential ash within the Made Ground.	Sulphate attack on concrete. **PL6**	Building concrete	Unlikely	Low	Chemical soil analysis categorises the soils as within DS1, AC1s. Further investigation and sampling is required to confirm concrete classification in areas not investigated. **Recommendation:** Classification based upon chemical soil analysis falls within DS1-AC1s, all concrete design should be in accordance with appropriate classification. Construction works to be completed with appropriate PPE and welfare facilities.	Low

CONTAMINANT RISK			LIKELIHOOD	SEVERITY	MITIGATION DISCUSSION	RESIDUAL RISK
SOURCES	**MIGRATION PATHWAYS**	**RECEPTORS**				
Made Ground Organic contaminants such as hydrocarbons, solvents	Ingestion of tainted water supply. **PL7**	Human Health – End Users Water pipeline	Likely	High	Significant VOC contamination has been identified at and below pipeline depth (0.75–1.35 m). **Recommendation:** Barrier pipe is likely to be required following a pipeline risk assessment.	High
Made Ground Phytotoxic contaminants	Direct contact (plant uptake). **PL8**	Flora	Likely	Medium	Likely probability as contamination considered possible, which may be taken up by flora in soft landscaping/gardens. **Recommendation:** Hotspot removal / treatment of impacted material.	Moderate
CONTROLLED WATERS						
Made Ground VOCs (Trichloroethene (TCE), cis 1,2-Dichloroethene, 1,1-Dichloroethene, Trans 1,2-Dichloroethene, Vinyl Chloride)	Leaching of contaminants from Made Ground through infiltration and percolation of rainwater. **PL5**	Controlled waters, underlying Principal Aquifer	Likely	High	The current development and associated hardstanding will assist in reducing the leachate produced from contaminated soils, and therefore reduce the impact to groundwater. On-site sources including historical industrial processes are still likely to be predominant mechanisms of contamination to controlled waters. **Recommendation:** Further testing is required to determine the spatial extent of contamination within the groundwater and understand the	High

CONTAMINANT RISK			LIKELIHOOD	SEVERITY	MITIGATION DISCUSSION	RESIDUAL RISK
SOURCES	**MIGRATION PATHWAYS**	**RECEPTORS**				
					full nature and extent of the VOC plume.	
		Infrastructure and services	Likely	High	The development of proposed estate roads (hardstanding and drainage) will reduce the leachate produced from contaminated soils. Infrastructure and services shall be designed to resist chemical attack and ingress.	High
Groundwater VOCs (Trichloroethene (TCE), cis 1,2-Dichloroethene, Trans 1,2-Dichloroethene, Vinyl Chloride).	Contact with contaminated groundwater. **PL2**	Human Health – site personnel	Likely	High	Groundwater is known to be below construction level and as such, is expected to not rise above ground level or the final level of the road. **Recommendation:** Construction works to be completed with appropriate PPE and welfare facilities.	High
	Contaminants leached from the Made Ground and from off-site sources may be mobilised to greater distances through advective flow. **PL5**	Human Health – end users	Likely	High	Impacted groundwater could transport contaminants vertically. **Recommendation:** Further investigation is required to understand the groundwater regime. Groundwater will need to be considered for surrounding developments.	High

CONTAMINANT RISK			LIKELIHOOD	SEVERITY	MITIGATION DISCUSSION	RESIDUAL RISK
SOURCES	**MIGRATION PATHWAYS**	**RECEPTORS**				
GROUND GAS						
Ground gases Methane and Carbon Dioxide **Volatile Vapours** VOCs (Trichloroethene (TCE), cis 1,2-Dichloroethene, Trans 1,2-Dichloroethene, Vinyl Chloride)	Inhalation of ground gas. **PL4** Accumulation of ground gas in confined spaces (asphyxiation or explosion)	Human Health – site personnel	Likely	Medium	The site is classified within CS1–CS3, precautionary CS2 measures recommended across the site with localised areas of CS3. No elevated readings of volatile vapours were encountered during monitoring visits. **Recommendation:** Further investigation and monitoring required in order to determine full ground gas regime.	Moderate
		Human Health – end users	Likely	High		High
		Infrastructure and services	Likely	High		High
Radon	Inhalation of ground gas. **PL4** Accumulation of ground gas in confined spaces (carcinogenic)	Human Health – site personnel	Unlikely	Low	The site is situated within a Radon Class 1 and therefore no radon protection measures are required.	Very low
		Human Health – end users	Unlikely	Low		Very low

Main Exposure Pathways:
PL1 = soil ingestion, PL2 = dermal contact and ingestion, PL3 = dust inhalation; PL4 = vapour/gas inhalation; PL5 = vertical / lateral migration; PL6 = corrosion of concrete; PL7=tainting of water supply; PL8 = uptake by plants.

LEVEL OF RISK	
Very Low	
Low	
Low/Moderate	
Moderate	
Moderate/High	
High	

11. GEOTECHNICAL ASSESSMENT

11.1. SOIL CONSISTENCY

Undrained shear strength values were measured using both field hand shear vane tests and laboratory undrained triaxial tests. Results of the tests are presented in Table 39, respectively, which indicate the clay soils to be very stiff. Strength test data is generally consistent with the field descriptions of the aforementioned soils.

Results of the standard penetration tests, including undrained shear strengths derived from SPTs are included in Table 40.

Table 39 Summary of Undrained Shear Strength in Triaxial Compression – Laboratory Test

LOCATION	SAMPLE DEPTH (m)	LAB DESCRIPTION	UNDRAINED SHEAR STRENGTH (kN/m^2)	CONSISTENCY
WS103	3.50–4.00	Brown silty slightly sandy slightly gravelly CLAY.	211	Very Stiff
WS105	2.50–3.00	Brown silty slightly sandy slightly gravelly CLAY.	244	Very Stiff
WS109	1.50–2.00	Brown silty slightly sandy slightly gravelly CLAY.	208	Very Stiff

Table 40 Standard/Cone Penetration Test Results

BOREHOLES	DEPTH (m bgl)	MATERIAL FIELD DESCRIPTION	CPT/SPT "N" VALUE	CORRECTED "N" VALUE $(N_1)_{60}$	TERZAGHI & PECK RELATIVE DENSITY (SANDS)	EUROCODE SOIL STRENGTH	CONSISTENCY (BS 5930)	TERZAGHI & PECK APPROXIMATE UNDRAINED SHEAR STRENGTH (kN/m^2)	ALLOWABLE BEARING CAPACITY (kN/m^2)*
WS101	1	MADE GROUND	6	6.05	Loose	N/A	N/A	N/A	60.49
WS101	2	Very clayey fine to medium SAND	7	6.39	Loose	N/A	N/A	N/A	63.95
WS101	3	Light brown mottled red slightly gravelly very sandy CLAY	8	6.96	N/A	Low strength	Firm	34.79	71.52
WS101	4	Slightly gravelly very sandy CLAY	21	17.74	N/A	High strength	Very Stiff	88.71	182.39
WS101	5	Brown very sandy CLAY	20	16.59	N/A	High strength	Very Stiff	82.96	170.57
WS102	1	Black slightly gravelly CLAY	5	5.04	N/A	Low strength	Firm	25.20	51.82
WS102	2	Light orange mottled brown slightly sandy gravelly CLAY	8	7.31	N/A	Low strength	Firm	36.54	75.13
WS102	3	Light orange mottled brown slightly sandy gravelly CLAY	13	11.31	N/A	Medium strength	Stiff	56.53	116.22
WS102	4	Light orange mottled brown slightly sandy gravelly CLAY	33	27.88	N/A	High strength	Very Stiff	139.40	286.61

BOREHOLES	DEPTH (m bgl)	MATERIAL FIELD DESCRIPTION	CPT/SPT "N" VALUE	CORRECTED "N" VALUE $(N_1)_{60}$	TERZAGHI & PECK RELATIVE DENSITY (SANDS)	EUROCODE SOIL STRENGTH	CONSISTENCY (BS 5930)	TERZAGHI & PECK APPROXIMATE UNDRAINED SHEAR STRENGTH (kN/m^2)	ALLOWABLE BEARING CAPACITY (kN/m^2)*
WS102	4.8	Light orange mottled brown slightly sandy gravelly CLAY	50	41.61	N/A	Very high strength	Very Stiff	208.03	427.72
WS103	1	MADE GROUND	5	5.04	Loose	N/A	N/A	N/A	50.41
WS103	2	Light grey and orange very clayey very silty fine to medium SAND	7	6.39	Loose	N/A	N/A	N/A	63.95
WS103	3	Dark reddish brown slightly gravelly sandy CLAY	19	16.52	N/A	High strength	Very Stiff	82.62	169.86
WS103	4	Dark reddish brown slightly gravelly sandy CLAY	28	23.66	N/A	High strength	Very Stiff	118.28	243.18
WS103	5	Dark reddish brown slightly gravelly sandy CLAY	43	35.67	N/A	Very high strength	Very Stiff	178.37	366.73
WS104	1	MADE GROUND	8	8.07	Loose	N/A	N/A	N/A	80.65
WS104	2	Dark reddish brown very sandy CLAY	10	9.14	N/A	Medium strength	Stiff	45.68	93.91
WS104	3	Dark reddish brown very sandy CLAY	38	33.05	N/A	Very high strength	Very Stiff	165.23	339.72

BOREHOLES	DEPTH (m bgl)	MATERIAL FIELD DESCRIPTION	CPT/SPT "N" VALUE	CORRECTED "N" VALUE $(N_1)_{60}$	TERZAGHI & PECK RELATIVE DENSITY (SANDS)	EUROCODE SOIL STRENGTH	CONSISTENCY (BS 5930)	TERZAGHI & PECK APPROXIMATE UNDRAINED SHEAR STRENGTH (kN/m^2)	ALLOWABLE BEARING CAPACITY (kN/m^2)*
WS104	4	Dark reddish brown very sandy CLAY	50	42.24	N/A	Very high strength	Very Stiff	211.21	434.25
WS105	1	Brown mottled grey silty sandy CLAY	8	8.07	N/A	Medium strength	Stiff	40.33	82.91
WS105	2	Brown mottled grey silty sandy CLAY	37	33.80	N/A	Very high strength	Very Stiff	169.00	347.47
WS105	3	Brown mottled grey silty sandy CLAY	50	43.48	N/A	Very high strength	Very Stiff	217.41	447.00
WS106	1	MADE GROUND	6	6.05	Loose	N/A	N/A	N/A	60.49
WS106	2	Orange slightly clayey fine to medium SAND	33	30.15	Dense	N/A	N/A	N/A	301.47
WS106	3	Orange slightly clayey fine to medium SAND	32	27.83	Medium Dense	N/A	N/A	N/A	278.29
WS106	4	Orange slightly clayey fine to medium SAND	50	42.24	Dense	N/A	N/A	N/A	422.43
WS107	1	Orange mottled grey slightly sandy slightly gravelly CLAY	6	6.05	N/A	Low strength	Firm	30.24	62.18
WS107	2	Orange mottled grey slightly sandy slightly	12	10.96	N/A	Medium strength	Stiff	54.81	112.69

BOREHOLES	DEPTH (m bgl)	MATERIAL FIELD DESCRIPTION	CPT/SPT "N" VALUE	CORRECTED "N" VALUE $(N_1)_{60}$	TERZAGHI & PECK RELATIVE DENSITY (SANDS)	EUROCODE SOIL STRENGTH	CONSISTENCY (BS 5930)	TERZAGHI & PECK APPROXIMATE UNDRAINED SHEAR STRENGTH (kN/m^2)	ALLOWABLE BEARING CAPACITY (kN/m^2)*
		gravelly CLAY							
WS107	3	Orange mottled grey slightly sandy slightly gravelly CLAY	29	25.22	N/A	High strength	Very Stiff	126.10	259.26
WS107	3.9	Orange mottled grey slightly sandy slightly gravelly CLAY	50	42.34	N/A	Very high strength	Very Stiff	211.70	435.26
WS108	1	MADE GROUND	23	23.19	Medium Dense	N/A	N/A	N/A	231.87
WS108	1.6	MADE GROUND	50	47.08	N/A	Very high strength	Very Stiff	235.40	483.98
WS109	1	Brown sandy gravelly CLAY	15	15.12	N/A	High strength	Very Stiff	75.61	155.46
WS109	2	Reddish orange clayey fine to medium SAND	35	31.97	Dense	N/A	N/A	N/A	319.74
WS109	3	Reddish orange clayey fine to medium SAND	30	26.09	Medium Dense	N/A	N/A	N/A	260.90
WS109	4	Very gravelly medium to coarse SAND	50	42.24	Dense	N/A	N/A	N/A	422.43
WS110	1	MADE GROUND	7	7.06	Loose	N/A	N/A	N/A	70.57
WS110	2	Orangish brown mottled grey slightly sandy CLAY	8	7.31	N/A	Low strength	Firm	36.54	75.13

BOREHOLES	DEPTH (m bgl)	MATERIAL FIELD DESCRIPTION	CPT/SPT "N" VALUE	CORRECTED "N" VALUE $(N_1)_{60}$	TERZAGHI & PECK RELATIVE DENSITY (SANDS)	EUROCODE SOIL STRENGTH	CONSISTENCY (BS 5930)	TERZAGHI & PECK APPROXIMATE UNDRAINED SHEAR STRENGTH (kN/m^2)	ALLOWABLE BEARING CAPACITY (kN/m^2)*
WS110	3	Brown slightly gravelly CLAY	50	43.48	N/A	Very high strength	Very Stiff	217.41	447.00
CP101	1.2	MADE GROUND	4	3.92	Very Loose	N/A	N/A	N/A	39.25
CP101	2	MADE GROUND	6	5.48	Loose	N/A	N/A	N/A	54.81
CP101	4	Firm orangish brown mottled grey gravelly CLAY	14	11.83	N/A	Medium strength	Stiff	59.14	121.59
CP101	6	Orangish brown mottled grey sandy gravelly CLAY	32	26.24	N/A	High strength	Very Stiff	131.18	269.71
CP101	7.5	Orangish brown mottled grey sandy gravelly CLAY	21	17.04	N/A	High strength	Very Stiff	85.19	175.14
CP101	8.7	Dark orangish red very gravelly medium to coarse SAND. (Highly Weathered SANDSTONE)	50	40.38	Dense	N/A	N/A	N/A	403.75
CP101	9	Dark orangish red very gravelly medium to coarse SAND (Highly Weathered	50	40.34	Dense	N/A	N/A	N/A	403.42

BOREHOLES	DEPTH (m bgl)	MATERIAL FIELD DESCRIPTION	CPT/SPT "N" VALUE	CORRECTED "N" VALUE $(N_1)_{60}$	TERZAGHI & PECK RELATIVE DENSITY (SANDS)	EUROCODE SOIL STRENGTH	CONSISTENCY (BS 5930)	TERZAGHI & PECK APPROXIMATE UNDRAINED SHEAR STRENGTH (kN/m^2)	ALLOWABLE BEARING CAPACITY (kN/m^2)*
		SANDSTONE).							
CP102	1.2	MADE GROUND	4	3.92	Very Loose	N/A	N/A	N/A	39.25
CP102	2	MADE GROUND	7	6.39	Loose	N/A	N/A	N/A	63.95
CP102	3	Dark orangish red very clayey fine to medium SAND and GRAVEL	50	43.48	Dense	N/A	N/A	N/A	434.83
CP102	5	Orangish brown mottled grey gravelly CLAY	40	33.18	N/A	Very high strength	Very Stiff	165.92	341.14
CP102	7.5	Orangish brown mottled grey gravelly CLAY	46	37.32	N/A	Very high strength	Very Stiff	186.60	383.64
CP102	9	Dark orangish red very gravelly medium to coarse SAND. (Highly Weathered SANDSTONE)	50	40.34	Dense	N/A	N/A	N/A	403.42
CP102	9.3	Dark orangish red very gravelly medium to coarse SAND (Highly Weathered SANDSTONE)	50	40.31	Dense	N/A	N/A	N/A	403.14

NOTES
* The Allowable Bearing Capacity (ABC) should be considered indicative.
The interpretation of in situ mass undrained shear strength (cu) data from SPT Blow Count (N) results and the influence of the Plasticity Index (PI) was reported in Standard Penetration Test in Insensitive Clays and Soft Rocks. Stroud (1974). The standard penetration test and the engineering properties of glacial materials subsequently. Stroud and Butler (1975) and (1989).
Allowable bearing capacity on sands. Soil Mechanics in Engineering Practice Terzaghi, K. & Peck, R.B. 1996.

11.2. CONSOLIDATION

Two undisturbed samples of Glacial Till were submitted for oedometer analysis. The results are provided in Table 41.

Table 41 Oedometer Consolidation Results

LOCATION	DEPTH (M)	SAMPLE TYPE	MOISTURE CONTENT (%)	OEDOMETER CONSOLIDATION		
				PRESSURE RANGE (kPa)	Mv (m^2/MN)	Cv (m^2/year)
CP101	5.00–5.45	U100	11.1	0–115	0.20	7.99
				115–230	0.14	3.15
				230–460	0.08	6.60
				460–920	0.04	3.65
				920–115	0.02	–
CP102	6.00–6.45	U100	14.8	0–135	1.01	18.81
				135–270	0.27	7.34
				270–540	0.09	4.16
				540–1080	0.04	2.61
				1080–135	0.00	–

When considered at over-burden pressure with an additional load of 110 kPa, the coefficient of volume compressibility (Mv) ranged from 0.00 m^2/MN up to 1.01 m^2/MN. The material is considered to be low to high compressibility.

The rate at which settlement is likely to occur is determined by the coefficient of consolidation (Cv). As shown in Table 41, the coefficient ranges from 2.61 m^2/yr to 18.81 m^2/yr. The rate at which settlement will occur is increased by the presence of sand within the Glacial Till and it is likely that settlement will occur over a period of months to years.

11.3. PARTICLE SIZE DISTRIBUTION

Particle Size Distribution Tests have been undertaken on selected samples of granular material via wet sieve to obtain information on the soil fractions. The results are included in Table 42. The full results can be found in APPENDIX IX.

Table 42 Summary of Particle Size Distribution Test Results

LOCATION	DEPTH (M)	SOIL FRACTION (%)			
		COBBLES	GRAVEL	SAND	SILT/CLAY
CP101	3.00 (Natural)	0	22	49	29

11.4. SOIL INFILTRATION

Based upon the initial investigation and surrounding geology it is considered the significant volumes of low permeable CLAY deposits on the site, extensive depths of Made Ground and VOC contamination likely preclude the use of soakaway drainage for the proposed development.

However, the application of soakaway drainage will ultimately be dependent on the specific requirements of the development. All soakaways should be designed in accordance with BRE Special Digest 365 – *Soakaway Design*.

11.5. SOIL PLASTICITY

The liquid and plastic limits of samples of natural in-situ clay are determined using the cone penetrometer method and the rolling thread test. These tests enable determination of an average plasticity index (PI) for each "type" of clay, although judgement is applied where variable results are reported.

PI can be related to shrinkability (low, medium or high) and then to minimum founding depth.

E3P typically only consider a soil to be shrinkable if the proportion finer than 63 µm is > 35%.

PI results are compared against guidance given in the NHBC standards, Chapter 4.2 (revised January 2014), which advocates the use of modified plasticity index (I'p), defined as:

$$I'p = Ip \times (\% < 425\ \mu m/100)$$

In other words, if PI is 30%, but the soil contains 80% < 425 µm, then I'p = 30 × 80/100 = 24%.

It should be noted that in accordance with the requirements of BS 1377, the % passing the 425 µm sieve is routinely reported by testing labs.

E3P apply engineering judgement where PI results are spread over a range of classifications. Consideration is given to the average values for each particular soil type (differentiate between residual soil and alluvium), the number of results in each class and the actual values.

The Atterberg limits determinations, summarised in
Table 43, show the clay to be of predominantly low plasticity with discrete areas of moderate plasticity clay.

Table 43 Summary of Plasticity Index Test results

LOCATION	DEPTH (M)	NATURAL MOISTURE CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	PASSING 425 MM SIEVE (%)	MODIFIED PLASTICITY INDEX	NHBC VOLUME CHANGE POTENTIAL
WS101	3.00–3.45	15.7	15	27	12	97	11.64	Low
WS102	2.00–2.45	20.2	15	29	14	95	13.30	Low
WS103	3.50–4.00	12	10	28	18	96	17.68	Low
WS104	2.00–2.45	11.2	10	27	17	97	16.49	Low
WS105	2.50–3.00	10.1	10	28	18	98	17.64	Low
WS107	2.00–2.45	14.8	11	29	18	95	17.10	Low
WS109	1.50–2.00	11.8	12	28	16	92	14.72	Low

The results of the Atterberg limits testing confirmed that the soils would be deemed to be "Low Volume Change Potential" in accordance with the classification system utilised by the LABC/NHBC industry guidance.

11.6. PH AND SULPHATE

Chemical analyses for pH and soluble sulphate content contained in APPENDIX VIII (summarised in Table 44), shows that the soils at the site generally meet Class DS-1, Aggressive Chemical Environment for Concrete Classification (ACEC) AC-1s in accordance with BRE *Special Digest 1* (2005).

Table 44 Summary of pH and Sulphate Data

LOCATION	DEPTH (M)	SO_4 IN 2:1 WATER/SOIL (G/L)	PH VALUE	CLASSIFICATION
WS101	1.3	0.022	8.1	DS1, AC-1s
WS102	0.9	0.028	7.1	DS1, AC-1s
WS102	1.4	<0.010	7.2	DS1, AC-1s
WS103	0.8	0.028	7.8	DS1, AC-1s
WS103	1.6	<0.010	7.3	DS1, AC-1s
WS104	1.5	<0.010	7.9	DS1, AC-1s
WS105	0.4	0.050	8.7	DS1, AC-1s
WS106	2.2	0.017	9.2	DS1, AC-1s
WS108	0.6	0.016	8.2	DS1, AC-1s
WS107	0.4	0.043	9.0	DS1, AC-1s
WS108	1.3	0.012	8.7	DS1, AC-1s
WS109	0.6	0.24	8.7	DS1, AC-1s
WS110	0.7	0.016	8.6	DS1, AC-1s

11.6.1. HIGHWAYS AND CONCRETE

MCHW Series 600 provides a criteria of 1500 mg/l for water-soluble sulphate within 500 mm of any concrete structure. A second criteria of 300 mg/l is given with respect to soils within 500 mm of steel structures.

11.7. GROUNDWATER

Table 45 Summary of Groundwater Strikes

LOCATION	DEPTH RANGE (M BGL)	DESCRIPTION OF STRIKE	STRATA	EVIDENCE OF CONTAMINATION
Preliminary Ground Investigation Water Strike Information				
WS104	1.00	Seepage	MADE GROUND	None identified
CP101	3.50	Seepage	CLAY	None identified
CP101	7.00	Seepage	CLAY	None identified
Groundwater Monitoring Summary from Installations				
LOCATION	**DEPTH RANGE (M BGL)**	**PERIOD OF MONITORING**	**WEATHER CONDITIONS DURING MONITORING**	**COMMENTS**
WS101	1.02–1.33	April–May	Overcast	–
WS102	0.62–3.52			No LNAPL/DNAPL Identified
WS103	1.09–1.52			No LNAPL/DNAPL Identified
WS104	0.93–2.45			–
WS105	2.64–2.78			
WS106	2.11–2.13			

LOCATION	DEPTH RANGE (M BGL)	PERIOD OF MONITORING	WEATHER CONDITIONS DURING MONITORING	COMMENTS
WS107	2.72–2.81	April–May	Overcast	No LNAPL/DNAPL Identified.
WS108	0.79–0.98			–
WS109	3.78–3.95			
WS110	0.97–0.99			
CP101	2.38–5.47			No LNAPL/DNAPL Identified.
CP102	4.02–4.60			No LNAPL/DNAPL Identified.

The presence of groundwater appears common to bedrock levels both within the overlying superficial deposits and the bedrock.

Groundwater levels indicate a shallow groundwater level, which is significantly lower towards the south of the site.

11.7.1. INFLUENCING FUNCTIONAL WATERBODIES

Long term monitoring of groundwater has not been conducted as a part of this investigation and interpreted levels are approximate and may be dependent on seasonal variation. It should be noted that seasonal variation is likely to result in potentially significant changes in groundwater levels beneath the site.

The water table can have significant effects on the foundation of a building, including:

- **Soil settlement**: Changes in the water table can cause soil to expand or contract, which can result in foundation settlement or movement. This can lead to cracks in the foundation, walls, or floors of a building.
- **Soil erosion**: High water tables can cause soil erosion, which can lead to the loss of soil support beneath the foundation. This can result in foundation settling or movement, which can be dangerous for the stability of the structure.
- **Hydrostatic pressure**: When the water table rises, the water exerts hydrostatic pressure on the foundation. This can cause foundation walls to crack or bow, which can compromise the structural integrity of the building.
- **Moisture infiltration**: High water tables can result in moisture infiltration into the foundation and surrounding soil. This can lead to Mold growth, decay, and deterioration of building materials.
- **Drainage problems**: Poor drainage around a building can cause water to pool around the foundation, increasing the likelihood of soil erosion and hydrostatic pressure. This can lead to foundation settling or movement and can also cause flooding in the basement or crawl space.

It is important to consider the effects of the water table on the foundation when designing and constructing a building. Proper drainage and foundation waterproofing can help to mitigate the effects of the water table on the foundation and improve the longevity and stability of the structure.

11.8. SITE PREPARATION

Our assessment has been based on the fact that the site will be cleared and any vegetation below areas of proposed development stripped in accordance with Series 200 of the *Manual of Contract Documents for Highway Works (MCHW).* This should include the following:

- Roots present below the footprint of proposed structures and infrastructure should be grubbed out and the resulting void infilled with suitable compacted engineered fill.
- Demolition of all existing buildings and removal of all concrete hardstanding.
- Redundant services should be sealed off and grubbed out and replaced with suitable compacted engineered fill.
- Buried structures and old foundations have been encountered on-site. These should be excavated from below the proposed development footprint with the resulting void backfilled.

11.9. FOUNDATION CONDITIONS AND ASSESSMENT OF POTENTIAL BEARING CAPACITIES

In due consideration of the identified ground conditions, in-situ and laboratory geotechnical testing, E3P has undertaken an assessment of the safe allowable bearing capacity (ABC) within the underlying natural stratum to assist in the detailed design of foundations and infrastructure and determine the target founding stratum. The results of this assessment are summarised in

Table 46.

Table 46 Summary of ABC

GRANULAR SOILS			
Description	**Depth (Range m bgl)**	**Relative Density**	**Allowable Bearing Capacity (kN/m^2)**
Clayey fine to medium SAND (WS101, WS103)	2.00–2.45	Loose	63.95
Clayey fine to medium SAND (WS106, WS109)	3.00–5.00	Medium Dense	231.87–278.29
Clayey fine to medium SAND (WS106, WS109)	2.00–4.45	Dense	301.47–422.43
SAND and GRAVEL (CP102)	3.00–3.50	Dense	434.83
Weathered SANDSTONE (CP101, CP102)	8.70–9.30	Dense	403

COHESIVE SOILS			
Description	**Depth (range m bgl)**	**Undrained Shear Strength (Cu) (kN/m^2)**	**Allowable Bearing Capacity (kN/m^2)**
Firm Gravelly CLAY (WS101, WS102, WS107, WS110)	1.00-3.45	25.20–36.54	51.82–75.13
Stiff Gravelly CLAY (WS102, WS104, WS105, WS107, CP101)	1.00-4.45	40.33–59.14	82.91–121.59
Very Stiff, Gravelly CLAY (10 Locations)	1.00–9.00	75.61–244.00	155.46–447.00

The above ABC data demonstrates that suitable materials for founding have been identified at 1.00 m bgl within the natural firm to very stiff CLAY in WS102, WS105, WS107 and WS109, with all other locations containing Made Ground exceeding 1.40 m bgl.

Within three other locations, a suitable ABC was identified at 2.00 m bgl, in the firm to very stiff gravelly CLAY in WS104 and WS110, and in the dense clayey fine to medium SAND in WS106.

Towards the south of the site, the remaining four exploratory hole locations (WS101, WS103, CP101 and CP102), reached a material considered a suitable ABC at 3.00 m bgl, in either the firm to very stiff gravelly CLAY or the dense SAND & GRAVEL, with CP101 recorded at 4.00 m bgl due to extensive MADE GROUND.

Loose SAND was identified in two locations (WS101 and WS103) and 2.00 m bgl, overlying the firm to very stiff gravelly CLAY.

No instances of very soft or soft CLAY were identified during this phase of preliminary intrusive ground investigation.

11.10. FOUNDATIONS OPTIONS APPRAISAL

Based on the assessment of the relative undrained shear strength, relative in-situ densities and corresponding safe allowable bearing capacity, the following recommendations have been developed for the site of the potential foundation solutions that may be adopted for the future residential development. The suitable target founding stratum has been identified as the underlying firm to very stiff glacial clays and localised areas of medium dense to dense sands.

Following this assessment, the following foundation recommendations have been determined:

- Shallow strip foundations bearing upon the firm to very stiff CLAY at 1.45 m bgl;
- Reinforced trench fill to support reinforced strip foundations should be considered where the target bearing stratum is greater than 1.50 m below the proposed level and in areas of softer variable ground and/or potential tree influence;
- Driven pile foundations within areas of extensive MADE GROUND (>2.50 m bgl) or anomalies.

Within the site, there are areas of variable ground conditions that will preclude the use of a shallow spread foundation. This includes the footprint of the main factory structure and outbuildings, where extensive Made Ground deposits are anticipated. Therefore, consideration should be given to the use of Ground Improvement by Vibro Stone Column (VSC) to ensure the treatment achieves a suitable ABC to support a doubly reinforced strip foundation or construction of piled foundations.

To determine if VSC is viable at the subject site, E3P has completed a Ground Improvement Design Risk Matrix that is summarised in Table 47.

Table 47 Ground Improvement Design Risk Matrix

RISK ITEM	COMMENT	PASS/FAIL
Soft clays with an undrained shear strength less than 30 kN/m^2	All clays identified contain a CU >30 kN/m^2 however further investigation is required to confirm no soft deposits are present on-site.	PASS – on completion of further investigation
Ground with peat layers close to foundation level or the base of the stone column, or where intermediate layers of peat are thicker than 200 mm, either as a single layer or the sum of the thicknesses of individual layers throughout the length of the stone column	No peat or highly organic deposits have been identified during this phase of investigation. However, three historical infilled ponds have been identified which may contain peat layers within the immediate vicinity.	PASS – on completion of further investigation
Voided filled ground, e.g. old water tanks, pottery, glass bottles, concrete rubble or brick fill of unsuitable grading	Made Ground beneath the site will likely require removal and processing to render the site suitable for VSC. The existing buildings substructure will also require excavation and processing into a graded aggregate suitable for vibro treatment.	PASS – on completion of enabling works
Loose or non-engineered fill not previously subject to rising or fluctuating water levels saturation	None identified.	PASS – on completion of further investigation
Filled ground still settling or expected to settle under its own weight or due to the effects of surcharging/upfilling where there is a high organic content or where decay is continuing	None identified – the site was historically filled in excess of 100 years ago with a mixture of clayey SAND and sandy CLAY and engineered fill. It is considered that the material has consolidated under self-weight settlement.	PASS
Fill, containing degradable material where organic material forms more than 15% of fill by volume	None identified.	PASS
Clays with a plasticity index greater than 40%	None identified.	PASS
Highly sensitive soils liable to collapse or remoulding	None identified.	PASS
Cohesive soils with trees in influencing distance	Plots where tree influence has been modelled and will either be subject to a piled or mass trench-fill solution.	PASS
Overall Risk Rating and Suitability for Vibratory Ground Improvement		**PASS**

It is advisable to consult with geotechnical engineers and foundation specialists who can assess the specific ground conditions and design an appropriate Vibro Stone Column system to meet the project's requirements. They will consider factors such as soil composition, depth, and spacing of the stone columns to ensure effective ground improvement and proper load distribution for the strip foundation.

The exception to this would be in the location of the footprint of the area where Made Ground was identified to be deep and within the footprint of the main factory structure where no intrusive ground investigation was completed. Dependent on development levels, plots in this area may require a driven pile foundation.

Foundation depths should take account of the presence of existing and proposed trees, with foundations deepened locally to mitigate the potential for volumetric instability attributed to fluctuations in moisture content, in accordance with the requirements of NHBC standards.

It is recommended that at working drawing stage a foundation schedule is prepared for the development, taking account of the physical change of natural clay soils and the current/proposed locations of trees.

At this time, it is not possible to accurately define the foundation types due to the absence of a full ground investigation and final development levels; however, based on our extensive experience of similar sites, we would anticipate that the final foundation solution would be a combination of the following:

- Shallow strip foundations bearing on the firm to very stiff gravelly CLAY at 1.45 m bgl;
- Reinforced trench fill to support reinforced strip foundations should be considered where the target bearing stratum is greater than 1.50 m below the proposed level and in areas of softer variable ground and/or potential tree influence.
- Driven pile foundations within areas of extensive MADE GROUND (> 2.50 m bgl) or anomalies; and
- Ground improvement by Vibro Stone Columns to ensure the treatment achieves a suitable design ABC to support a doubly reinforced strip foundations or piled foundations within the footprint of the main factory site and outbuildings.

11.11. GROUND FLOOR SLABS

Current building control regulations require that where infilled ground is present to depths in excess of 600 mm, or where the substratum is variable in terms of the structure and settlement potential, or where clay soils are present within the influence of existing or proposed trees, a suspended floor slab is required.

In this instance, it is considered that for the majority of substructures, the underlying stratum would have in excess of 600 mm of infill and, as such, a suspended floor slab will be required.

Where a cast in-situ suspended slab is utilised with no subfloor void, appropriate compressible material (heave precautions) will be required in the construction of the substructure.

In clay soils, if the foundation depth is greater than 1.50 m, allowance should be made in the design for heave. This must incorporate either a clear void of a specified minimum depth under the suspended floor, or a proprietary compressible material/void former below the underside of the floor construction.

Ground bearing slabs should not be used in ground conditions where heave can occur or where the foundation depth is greater than 1.50 m. Under these circumstances a suspended floor construction should be used.

11.12. HEAVE PRECAUTIONS

The site has been proven to be underlain by clay soils which are susceptible to volumetric instability due to fluctuations in moisture content, particularly within influencing distance of trees as per the NHBC/LABC conjectures zones of influence.

The clay has been determined as being of low volume change potential. Table 48 shows where heave precautions are required for a trench fill, pier and beam and pile and beam foundation types which are in the zone of influence of trees which are to remain or be removed.

Table 48 Position of Heave Precautions

SITUATION	TRENCH FILL	PIER AND BEAM	PILE AND BEAM
External trench fill and pier foundations. Unless NHBC is satisfied that the soil is not desiccated compressible material should be provided to the:	Inside faces of external wall foundations deeper than 1.50 m, based on the appropriate tree height.	All faces of pier foundations deeper than 1.50 m, based on the appropriate tree height.	N/A
External ground beams. Unless NHBC is satisfied that the soil is not desiccated, compressible material or void formers should be provided to the:	N/A	Inside faces	Inside faces
Internal trench fill foundations and ground beams. Compressible material required:	No	No	No
External and internal ground beams. Compressible material, void former or void should be provided to the underside of:	N/A	All	All
Heave precautions required for proposed trees where the soil is not desiccated:	No	No	No

Note: Information taken from NHBC Standards 2024, Chapter 4.2, Table 8 – Position of heave precautions

A summary of heave precautions is presented in Table 49.

Table 49 Summary of Heave Precautions

VOLUME CHANGE POTENTIAL	VOID DIMENSION AGAINST SIDE OF FOUNDATION AND GROUND BEAM	VOID DIMENSION UNDER GROUND BEAMS, AND SUSPENDED IN-SITU CONCRETE GROUND FLOOR	VOID DIMENSION UNDER SUSPENDED PRECAST CONCRETE AND TIMBER FLOORS(1)
High	35 mm	150 mm	300 mm
Medium	25 mm	100 mm	250 mm
Low	0 mm	50 mm	200 mm

In addition to the requirements of the 'Drainage' section, drainage near trees should incorporate additional provisions. Where there is a volume change potential within the ground, the provisions include:

- Increased falls to cater for any ground movement.
- Deeper and wider backfill of granular material.
- A drainage system that is capable of movement should heave and shrinkage occur.
- Drainage pipes should not be encased in concrete.
- Additional clearance is required where drains pass through the structure of a building to allow for additional movement.

11.13. HIGHWAYS CONSTRUCTION

Unsuitable materials are potentially present within areas of the infilled ponds.

A programme of remediation and enabling works will be required to remediate the proposed road subgrade in accordance with the requirements of the Manual of Contract Documents for Highway Works Volume 1 Specification For Highway Works (Series 600-Earthworks) for a method compaction.

11.14. DRAINAGE

Where loose or soft materials have been identified at drainage invert levels, there will need to be consideration for the use of reinforced pipe bedding.

Shrinkage and heave of clay soils can affect pipelines. To protect against the effects of heave, drainage should be designed:

- To take account of potential ground movement as shown in
- Table 50 , including where pipes and services pass through substructure walls or foundations.
- With gradients which may need to be steeper.
- To use alternative means of catering for the movement when sufficient falls cannot be provided, for example, by deepening the excavation and laying pipework on a granular bedding of suitable thickness to reduce the extent of potential movement.

Table 50 Potential Ground Movement for Drainage

VOLUME CHANGE POTENTIAL	HIGH	MEDIUM	LOW
Potential ground movement	150 mm	100 mm	50 mm

11.15. EXCAVATIONS

Site observations indicated that excavations may be limited in the near surface within the footprint of the main factory structure utilising normal plant due to former foundations and former floor slabs. It is anticipated that any obstructions will be grubbed out during the reduced-level dig for the substructure works.

However, due to the depth and variability of the Made Ground and likelihood of trench collapse, it is considered that all excavations are supported or battered back in accordance with guidance contained in CIRIA R97.

If local pumping of groundwater is required during the advancement of excavations for the proposed foundations then consideration should be given to the potential for dewatering gravels in the surrounding areas that may cause structural damage to building substructures in close proximity to the site.

Table 51 Civil Engineering Excavation Risk Matrix

RISK ITEM	PRESENT	COMMENT
Running Sands	No	No running sand has been identified.
Minor Water Ingress	No	Minor water ingress will require localised dewatering/sump pumping during the construction of site drainage infrastructure. Ingress of water into foundation excavation will potentially flood foundation excavations, limiting the viability of spread foundations to be constructed.
Shallow Bedrock	Yes	Bedrock has been identified towards the northern part of site at depths less than 5.00 m bgl, decreasing to 7.00 m bgl towards the southwest, and further deepening to 9.00 m towards the southeast of the site. However, bedrock is considered likely to be deep enough not to significantly impede excavation for drainage infrastructure using traditional excavation plant and equipment.

11.16. CONSTRUCTION ACTIVITY AND INSPECTION

The following activities and inspections should be incorporated into the site works:

- Due to the variability of the soils at the site, it is recommended that sufficient allowance is made for the inspection of formations and sub formations to foundations and pavement construction.
- Excavations where access is required should be subject to a risk assessment from a competent person and, where appropriate, mitigation measures such as benching back the sides or use of support systems in accordance with CIRIA R97 should be utilised.
- It is considered that dewatering may be required, especially following periods of heavy rainfall. Removal of surface water and water within trenches should be possible with conventional sump pumping. Discharge of any water should be agreed with the relevant regulatory body and be undertaken under a trade effluent discharge, where required.
- Where access to confined spaces is required, appropriate mitigation measures should be addressed within the construction stage health and safety plan. Particular account should be taken of the gas results.
- The presence of potential contamination and mitigation measures should be addressed as part of the construction stage health and safety plan and should include measures to design out the risks, reduce their impact and, finally, to include the use of personnel protective equipment (PPE).

11.17. DEVELOPED GEOTECHNICAL RISK REGISTER

Table 52 Developed Geotechnical Risk Register

POTENTIAL ABNORMAL CONSTRAINT	LOCATION ON-SITE	ESTIMATED AREA OF SITE AT RISK (%)	ASSESSMENT AND MITIGATION
Remediation of contaminated soils	On-site	TBC	Extensive sources of VOCs have been identified within MADE GROUND and natural soil chemical analysis and within groundwater, with the primary source likely to be within the vicinity of WS102 (enamel slurry waste storage area). Due to the extensive impact identified, a hotspot removal and/or treatment is required within WS102 to remove the source to mitigate further spread across the site. At this stage, further investigation is required to determine the spatial extent of contamination within the soils and understand whether leaching has occurred into the underlying natural strata, particularly in WS101 and WS103, where exceedances were only recorded within the MADE GROUND deposits. Minor instances of heavy metalloid contamination was identified within MADE GROUND deposits in the northern part of the site, which may require removal prior to the construction.
Bedrock	On-site	TBC	Bedrock has been identified towards the northern part of site at depths less than 5.00 m bgl, decreasing to 7.00 m bgl towards the southwest, and further deepening to 9.00 m towards the southeast of the site. However, bedrock is considered likely to be deep enough not to significantly impede excavations and earthworks prior to the development.
Obstructions	All	100	Site has been subject to significant historical development with all above ground structures still present. Further extensive potential subsurface obstructions from relict foundations, railway/tramway sidings and slabs potentially remain.
Artificially levelled and filled platforms	N/A	100	The site appears to have been levelled and artificially backfilled.
Trench collapse	All	100	Made Ground present beneath the site is likely to be loosely compacted and possibly prone to collapse.
Volume change potential clay	On-site	80	The site is likely to be underlain by predominantly cohesive soils. The assessment of volume change potential denoted all tested soils are of low volume change potential. Further assessment following further investigation into previously inaccessible areas is required to complete a full assessment.

POTENTIAL ABNORMAL CONSTRAINT	LOCATION ON-SITE	ESTIMATED AREA OF SITE AT RISK (%)	ASSESSMENT AND MITIGATION
Running sands	N/A	N/A	Data searches indicate very low risk.
Ground dissolution	N/A	N/A	Data searches indicate no hazard.
Concrete design	TBC	-	Based upon the chemical soil analysis, the concrete classification is within DS1, AC-1s. All concrete should be designed in accordance with this classification. Further sampling is required within areas not investigated to confirm concrete classification in these areas.
Low-permeability ground	On-site	70	Soakaways unlikely to be effective within the site due to the presence of extensive low permeability cohesive deposits are present. Additionally, towards the south where areas of potentially contaminated soil and groundwater are present precluding the use of soakaway drainage.
Abnormal foundation solutions	TBC	TBC	Within the footprint of the current main factory structure, extensive MADE GROUND is anticipated which may require abnormal foundations. Furthermore, three historically infilled ponds were recorded towards the centre south, southeast and northeast boundaries of the site which may contain soft clay or silty deposits to unknown depths which may require abnormal foundation solutions.
Areas not investigated	On-site	75	A large portion of the site was inaccessible during the preliminary intrusive ground investigation due to the oven manufacturing factory still being active. This included the main factory structure occupying the centre of the site, areas of car parking towards the southwestern sector, and within proximity to electricity sub stations towards the south. Further investigation into the footprint of the main factory structure and all other areas not investigated is required to obtain additional soil and groundwater samples, across the southern boundary to determine potential VOC plume extent and within the footprint of the main factory structure to determine the potential presence of PFAS/PFOA, Explosive Compounds and Propellants.
Historically infilled ponds	On-site	15	Three small historical infilled ponds were recorded towards the centre south, southeast and northeast boundaries of the site, which were infilled approximately 52 years ago (southeast) and over 100 years ago (centre south and northeast). The historical infilled ponds present potential geotechnical risk associated with soft clay, silts and potentially peat deposits within the footprint. A small outbuilding structure was present where the infilled pond to the southeast was, and therefore could not be investigated; further investigation following demolition is recommended.

POTENTIAL ABNORMAL CONSTRAINT	LOCATION ON-SITE	ESTIMATED AREA OF SITE AT RISK (%)	ASSESSMENT AND MITIGATION
Consolidation & Settlement	On-site	100	The presence of variable historical Made Ground represent an unacceptable risk associated with the consolidation of materials that could induce unacceptable settlement to structures and infrastructure. A detailed settlement analysis will be required as part of a Geotechnical Design Report.
Enabling Earthworks	On-site	100	All proposed earthworks will need to be designed by a suitably qualified geotechnical engineer in accordance with NHBC Chapter 4.6. The earthworks design will incorporate a Geotechnical Specification for Earthworks that will define protocols to ensure no unacceptable future risk.

11.18. FURTHER WORKS

Based on the findings of the preliminary intrusive ground investigation, the following additional works are recommended to be completed in due course:

- Further intrusive ground investigation, including delineation of VOC impacted soils and groundwater and determination of any potential PFAS/PFOA, Explosive Compounds and Propellant contamination;
- Further intrusive ground investigation of inaccessible areas (main factory structure and outbuildings);
- Human Health DQRA of VOC impacted soils (subject to findings of further phases of intrusive ground investigation);
- Controlled Waters DQRA of VOC DNAPL plume;
- Plot-specific foundation schedule (upon receipt of the final development levels);
- Geotechnical Design Report (GDR), including settlement analysis;
- Geotechnical Earthworks Specification (infrastructure);
- Remediation and enabling works strategy; and
- Specification for Mitigation of Hazardous Ground Gasses & Verification Plan.

END OF REPORT