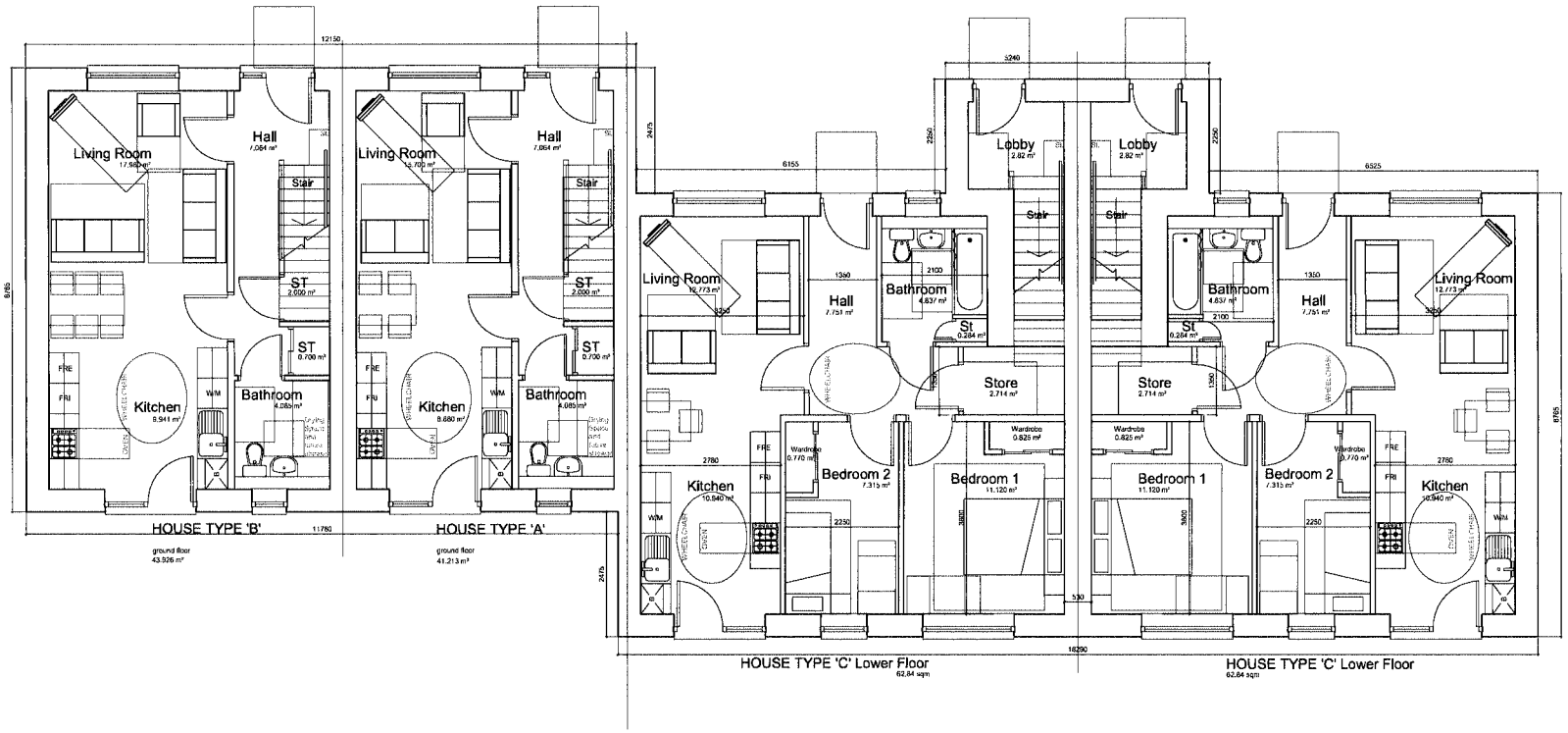

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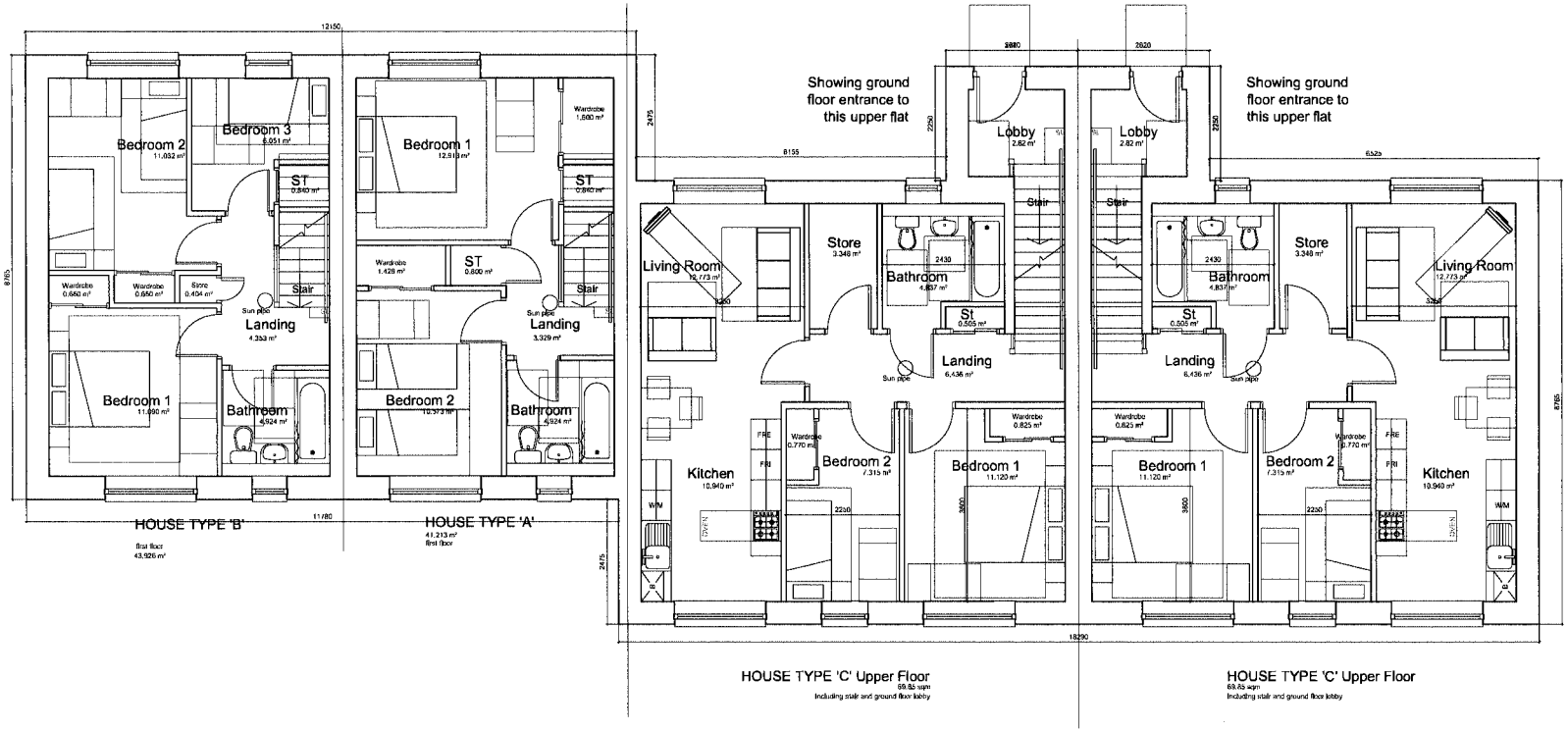
Contractor to check all sizes on site.
Contractor to confirm detailed finishes specification with client.

REV	NOTES	BY	DATE

THE MORRISON PARTNERSHIP
CHARTERED ARCHITECTS AND CDM CO-ORDINATORS
242 QUEENSFERRY ROAD, EDINBURGH, EH4 2BP
TELEPHONE 0131 343 3114 FAX 0131 332 7836 EMAIL: edin@themorrisonpartnership.co.uk

Client: Hanover Housing Association Ltd
Project: Housing Development at West Quarter, Falkirk.
Drawing: Block 3 : Ground Floor Plan.
Date: 30th April 2014 | Drawn By: CP | Scale: 1:100
Job No: 09-107 | Drawing No: 10



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Contractor to confirm detailed finishes specification with client.

REV	NOTES	BY	DATE

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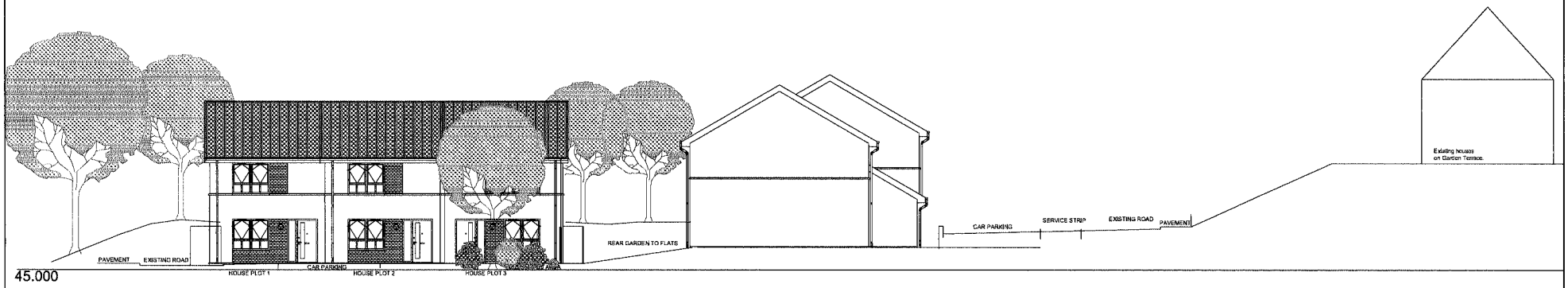
242 QUEENSFERRY ROAD, EDINBURGH, EH4 2BP
TELEPHONE 0131 343 3114 FAX 0131 332 7836 EMAIL: edin@themorrisonpartnership.co.uk

Client: Hanover Housing Association Ltd
Project: Housing Development at West Quarter, Falkirk.
Drawing: Block 3 : First Floor Plan.
Date: 30th April 2014 | Drawn By: CP | Scale: 1:100
Job No: 09-107 | Drawing No: 11



SITE SECTION AA

SITE SECTION BB

279

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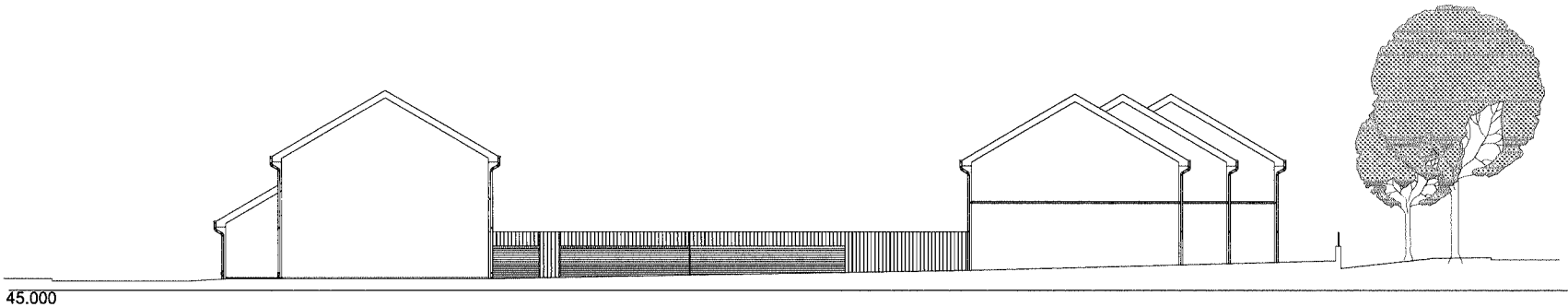
Contractor to check all sizes on site.
Contractor to confirm detailed finishes specification with client.

REV	NOTES	BY	DATE

THE MORRISON PARTNERSHIP
CHARTERED ARCHITECTS AND CDM CO-ORDINATORS
242 QUEENSFERRY ROAD, EDINBURGH, EH4 2BP
TELEPHONE 0131 343 3114 FAX 0131 332 7836 EMAIL: edin@themorrisonpartnership.co.uk

Client: Hanover Housing Association Ltd
Project: Housing Development at West Quarter, Falkirk.
Drawing: Site Sections AA and BB.
Date: 30th April 2014 | Drawn By: CP | Scale: 1:200
Job No: 09-107 | Drawing No: 14



SITE SECTION CC

281

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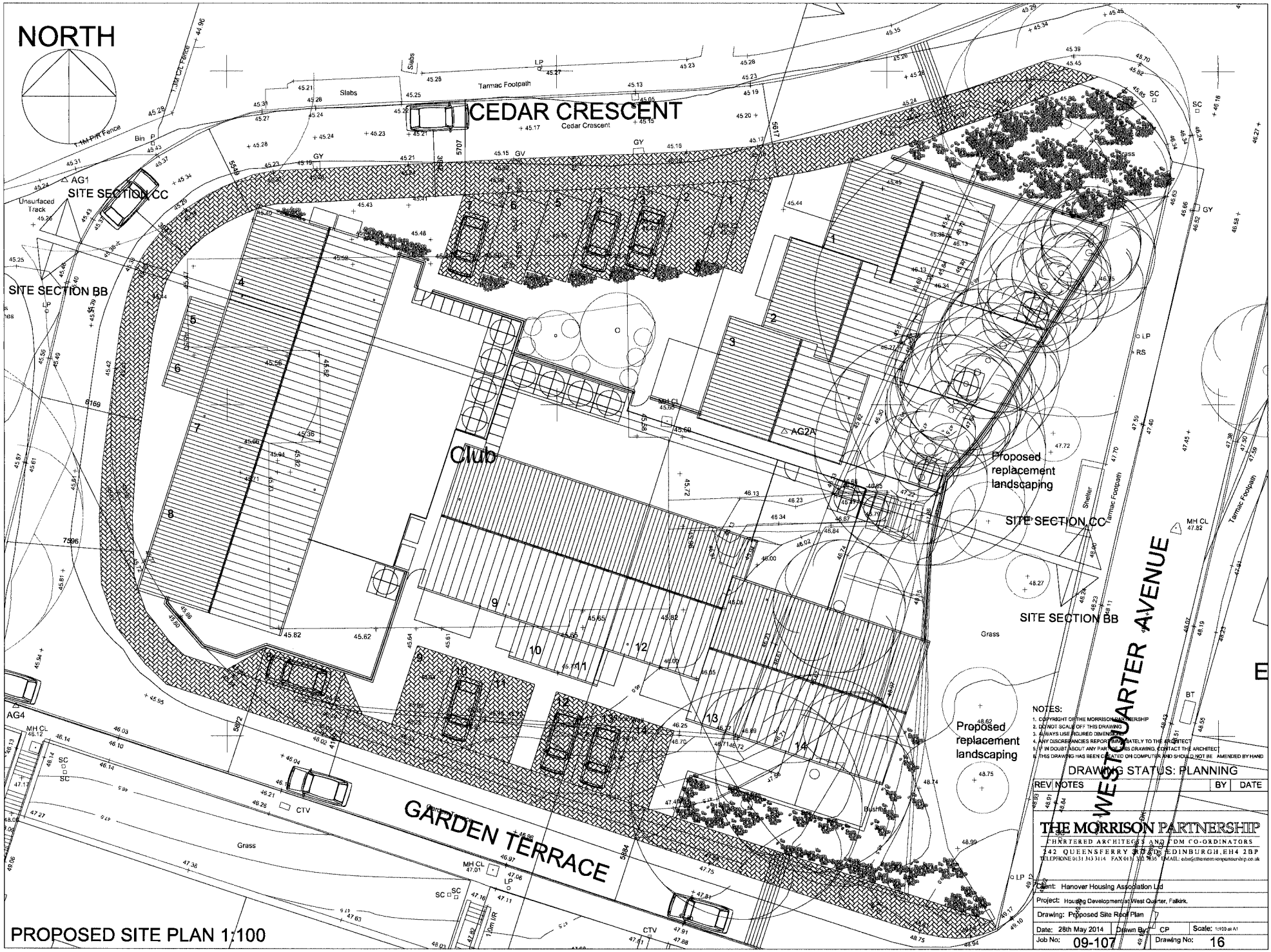
Contractor to check all sizes on site.
Contractor to confirm detailed finishes specification with client.

REV	NOTES	BY	DATE

THE MORRISON PARTNERSHIP
CHARTERED ARCHITECTS AND CDM CO-ORDINATORS
242 QUEENSFERRY ROAD, EDINBURGH, EH4 2BP
TELEPHONE 0131 343 3114 FAX 0131 332 7836 EMAIL: edin@themorrisonpartnership.co.uk

Client: Hanover Housing Association Ltd
Project: Housing Development at West Quarter, Falkirk.
Drawing: Site Section CC.
Date: 30th April 2014 | Drawn By: CP | Scale: 1:200
Job No: 09-107 | Drawing No: 15



PROPOSED SITE PLAN 1:100

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DRAWING STATUS: PLANNING

REV	NOTES	BY	DATE

THE MORRISON PARTNERSHIP
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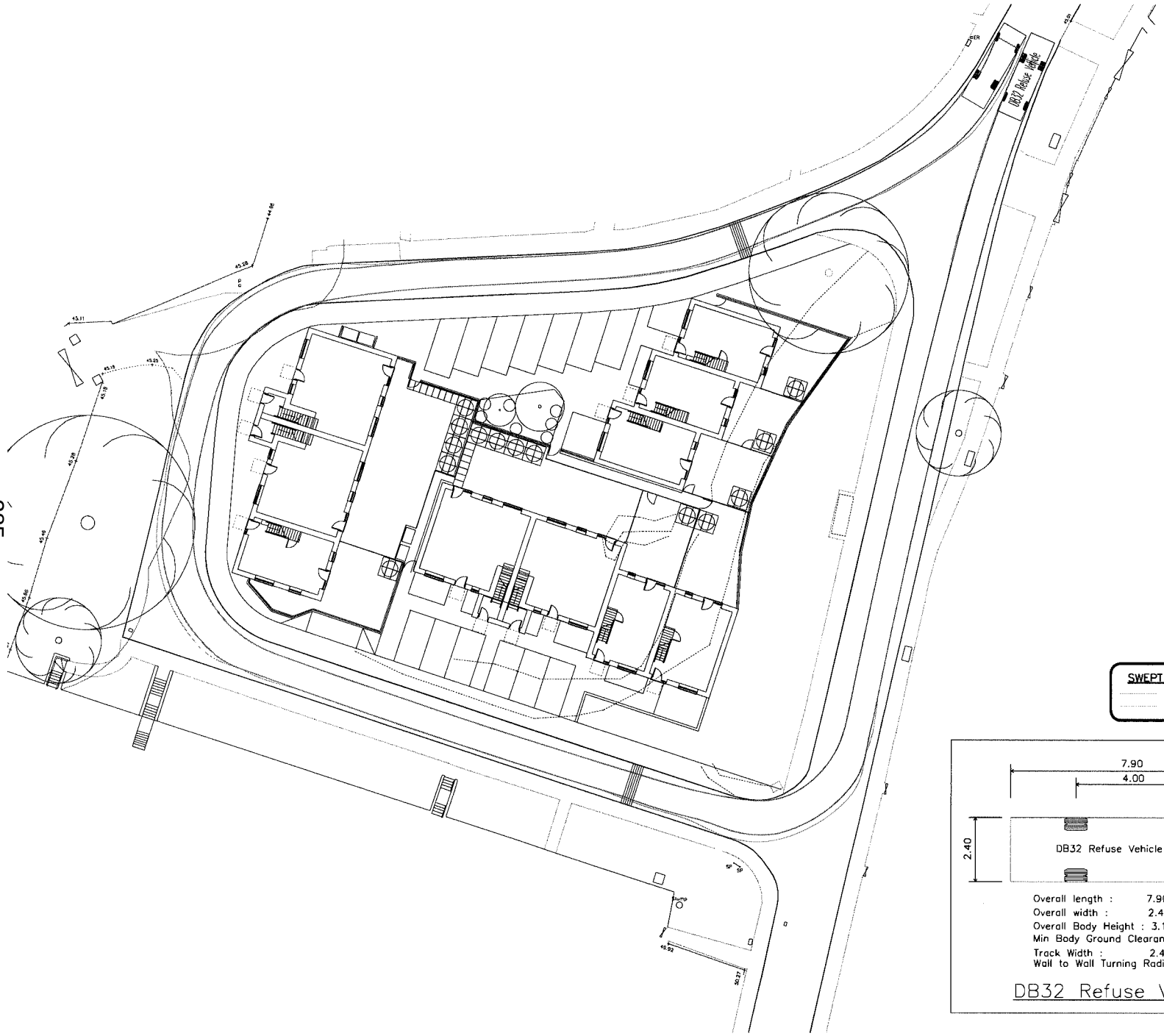
142 QUEENSFERRY ROAD EDINBURGH EH4 2BP
TELEPHONE 0131 343 3114 FAX 0131 332 7836 EMAIL: edin@themorrisonpartnership.co.uk

Client: Hanover Housing Association Ltd
Project: Housing Development at West Quarter, Falkirk.
Drawing: Proposed Site Roof Plan
Date: 28th May 2014 | Drawn By: CP | Scale: 1:100 at A1
Job No: 09-107 | Drawing No: 16



SWEPT PATH LEGEND

EXTENT OF VEHICLE WHEELS

EXTENT OF VEHICLE OVERHANG

Overall length : 7.900m
Overall width : 2.400m
Overall Body Height : 3.183m
Min Body Ground Clearance : 0.388m
Track Width : 2.400m
Wall to Wall Turning Radius : 9.625m

DB32 Refuse Vehicle

NOTES

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4. All work to conform to the relevant British Standards.
5. This Drawing must be read in conjunction with Scott Bennett Associates, Hazard & Risk Assessment document. The Contractor should ensure the H & R document is available on site for use by all site personnel.

REV	DESCRIPTION	BY	CHKD	DATE

DOCQUET
We hereby certify this is a true and fair copy of the plan/drawing referred to in the application for Building Warrant.

Dated Signed

client

Hanover Housing Association

project

Westquarter Avenue, Falkirk

title

Swept Path Analysis for DB32 Refuse Vehicle

Scott Bennett Associates
consulting civil and structural engineers
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T: 01383 837337. F: 01383 837338. E: EnquiriesDbsassociates.com

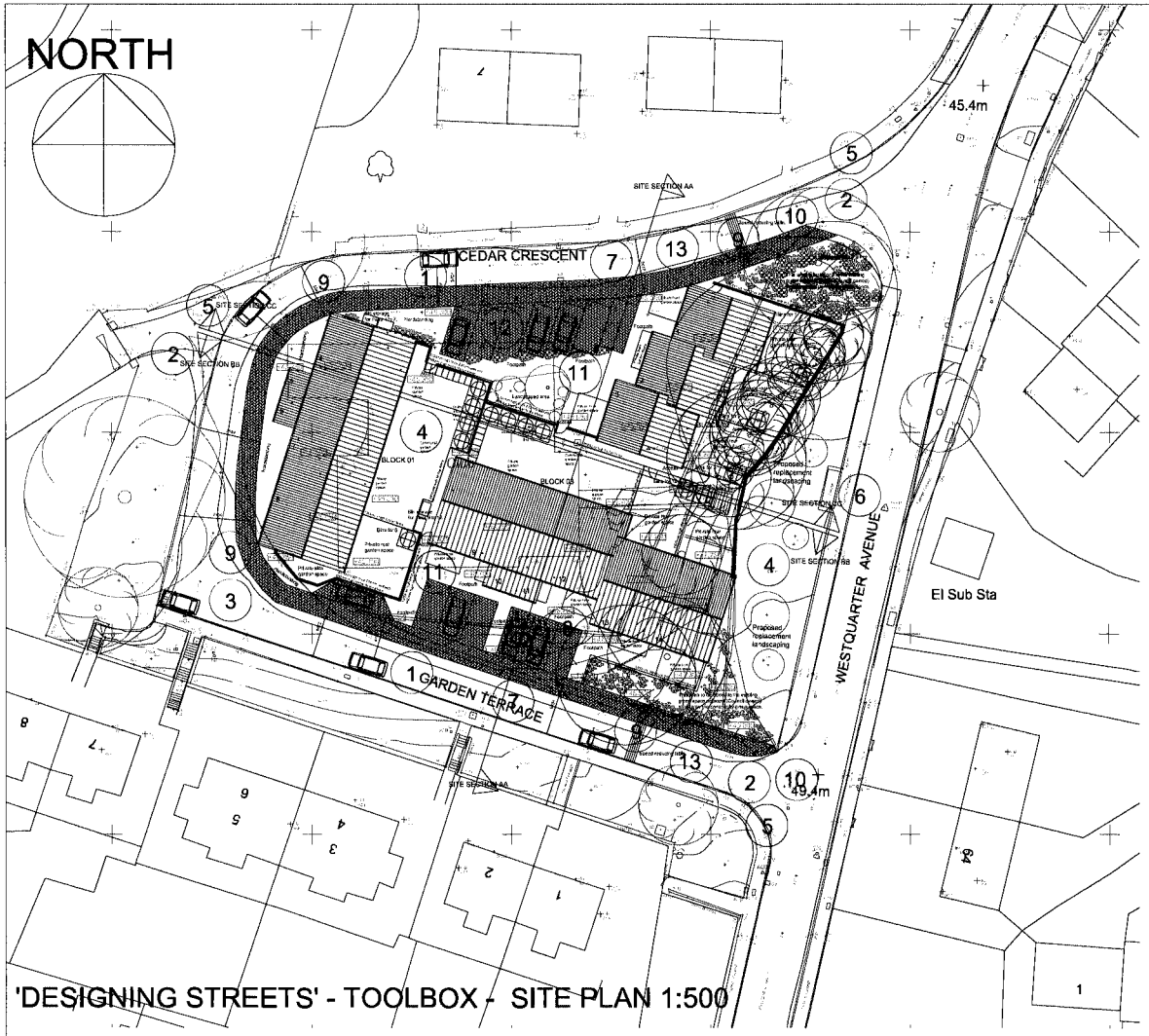
Issue status

Planning

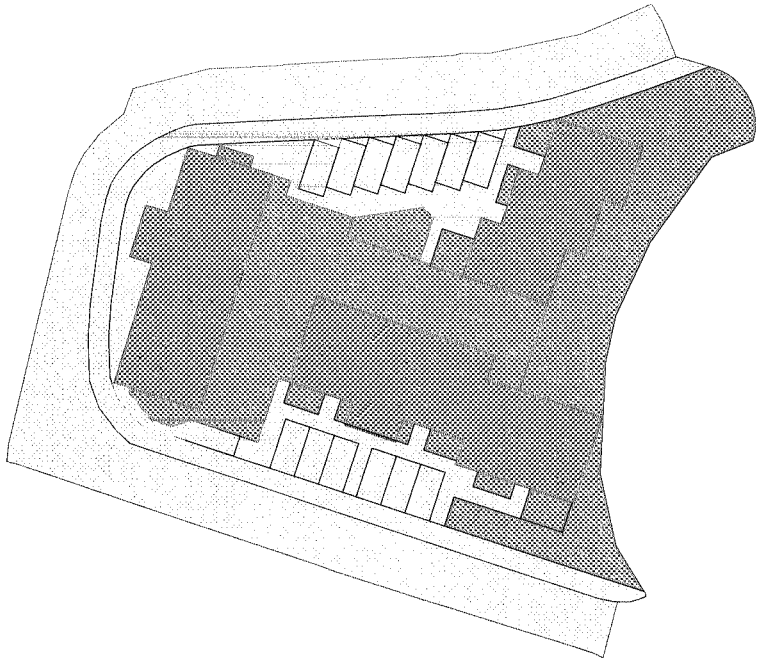
drawn	checked	date
SMcF	SP	22.07.14
scales 1:250		sheet size A2

Drawing Number J2429-010

Revision -



'DESIGNING STREETS' - TOOLBOX - SITE PLAN 1:500



MOVEMENT

GREEN SPACE

BUILDINGS

'DESIGNING STREETS' - TOOLBOX ASSESSMENT

BAVARIAN 'B' PLAN 1:500

DESIGNING STREETS - TOOLBOX ASSESSMENT.

1st July 2014

West Quarter, Falkirk.

The development site is bounded on the north, south and west sides by an existing roadway. This roadway varies in width from 3900mm average along the southern part of the site, 3600mm average along the northern part of the site and narrows to approximately 3500mm along the western part of the site.

The proposal illustrates a 2m wide service strip inside our client's site ownership. This service strip will also act as a road widening arrangement resulting in an overall road width of minimum 5600mm and in many places, exceeding 5900mm. All the car parking bays on our client's site will be out with this widened road way.

The principal driving force behind the roadway proposal of this scheme is the Scottish Government's ' *Designing Places*' (2009) and '*Designing Streets*' (2010) documents. To these has been added the " *Designing Streets* - Toolbox" on 16th May 2014.

Our assessment of the Bavarian 'B' Plan lists the following issues:

1. **Pedestrians and cyclists.** The layout allows for a wide street with shared surface offering pedestrian priority, use by a diverse age group, and access for cyclists by keeping the motor vehicle use to a minimum. The street is therefore an inclusive place for all road users in a hierarchy that places people first.
2. **Connections to wider networks.** There are three key contact points around the site which allow enhanced connections to the wider street and pathway network. The north east and south east corners of the site connect to the existing Westquarter Avenue which has a bus route (with bus stop adjacent to the site) and road connections out of the Westquarter area. Immediately to the west of the site is a pathway connection to a walkway network at Westquarter Burn. In this regard, because of the existing street pattern around the site, the site itself must be deemed fully integrated with surrounding networks, providing flexibility and accommodating change in the built and social environments. The site also offers permeability to the adjacent street network with multiple access points that connect with and complement the existing street patterns and urban grain.
3. **Connections within a place.** The site itself is contained within an historic laid out 'Garden City' model village. As such, it provides historic connections with other facilities in the immediate area and provides good connectivity for all modes of movement and for all groups of street users, respecting diversity and inclusion.
4. **Block structure.** Obviously, the existing crescent provides a structure to the local street network. The proposal seeks to reinforce that structure by enhancing the existing roadway itself and creating a street that will offer better ease of use and adaptability to the existing and new residents. On a small scale, the site offers a block structure solution which creates an enclosed rear private garden areas at the core of the site, housing in the next layer of block structure and finally a varied profile movement area on the outer edge of the site and enhancing the existing roadway. SUDS is able to be fully incorporated in the proposed layout. The street pattern also offers variety and a distinct sense of place to the site. The width between buildings and their relative heights have also been taken into consideration to provide variety and interest in achieving a sense of place and establishing views and vistas that allow visual interest into, through and beyond the site. The large grassed landscaped area (owned by the Council) to the east of the site has been enlarged by integration with the north east and south east corners of the site. This achieves a reinforcing of a landscape block structure for the site.
5. **Walkable neighbourhoods.** Access to and from the site is not altered from the existing layout, thus affording direct access and egress to the houses and encouraging walking to the existing local facilities. These include shops, schools, e bus stop and other social facilities in the vicinity.
6. **Public transport.** A bus route and bus stop on Westquarter Avenue are immediately adjacent to the site, providing excellent connections with public transport.
7. **Context and character.** The street design around the site has been created with a distinct character of a 'crescent', reinforcing and enhancing the existing urban grain. Variety is introduced by employing fragmented and separated blocks of flats and houses, varying their internal floor levels, using set back and stepped facades and framing views and vistas into and through the site development. The site is also punctuated with soft landscaping, varied parking bay arrangements and a mixture of garden boundary enclosure treatments to create interesting streetscapes and landmarks using colour coded rendering on the buildings.
8. **Orientation.** The orientation of the buildings has been a major factor in developing the site layout. Obviously, the existing street pattern of the crescent has been retained and enhanced to make best use of the southerly aspect and maximise on solar gain to Block 03 on the site. Blocks 01 and 02 have an east-west orientation due to the restriction in overlooking separation between buildings. Nonetheless, such an east-west orientation allows deeper penetration of sunlight into and through the site, affording good sunlight and benefit to garden areas in blocks 02 and 03. The site itself sits down in a hollow protected by a existing and longstanding tree belt to the western edge, housing and higher ground to the immediate south and another tree belt to the east on the Council owned ground. Where possible, house and flat windows have a southerly orientation.
9. **Appropriate traffic speed.** The existing crescent roadway has two access/egress points to Westquarter Avenue. It is proposed that a traffic calming speed table be located adjacent to these junctions. Further round the crescent, house block 01 'kisses the kerb' and provides a speed controlling mechanism by reduced forward visibility for the crescent corners at these points. The design therefore endeavours to embed a physical environment that will influence driver behaviour to reduce vehicle speed for the local context and deliver safe streets for all. In addition, the use of road definition markings, a reduced carriageway width, the continuation of on-street parking and the distinctive surface finishes to the roadway will encourage reduced traffic speed.
10. **Junction types and arrangements.** There are only two existing road junctions. It is not intended to alter these arrangements, except to introduce traffic calming to allow the needs of pedestrians to be prioritised. The crescent access road around the site is a loop road and does not require any turning head or space.
11. **Streets for people.** The development has a number of pathway and pedestrian access areas as well as a soft landscaped area to the north of the site which allows good social connectivity and interaction. Greenspaces are enhanced around the site to the east, with an existing parkland area to the immediate west of the site. The roadway itself is varied and maintains the physical restrictions to reduce traffic speed and permit/encourage pedestrians to use the shared surface space. Additionally, the road levels and flat/house access is designed to allow full wheelchair access.
12. **Integrating parking.** 100% parking for the new flats/houses is provided with the spaces closely position to the entrance door. The parking areas are fragmented to lessen the visual intrusion of large groupings of cars and there is a variety of parking arrangement ranging from parallel to 90° and 45° angled. Cycle storage and parking is to be provided in each secure rear garden space for the flats and houses. On street parking already existing around the crescent roadway and this will continue unaffected by the proposal, except that with the road widening, full access to cars and emergency/service vehicles will now be possible as well. The existing on street parking is also at times footway parking and the proposal will remove the need for car owners to continue this practice because the effective road width is being substantially increased to allow free flow of cars and other vehicles around the crescent loop road.
13. **Emergency/service vehicles.** The proposed road layout and arrangement will permit access for emergency and service vehicles. The minimum carriageway width of 3.7m is incorporated in the roadway design, allowing for parked cars on the roadway itself. Other larger vehicles like refuse collection lorries are also able to access through the crescent roadway. All of this larger vehicle accommodation is provided without compromising the sense of place being created in this development and does not result in over-dominance of the roadway or vehicles over pedestrians.

Taking these issues forward into the next step in the Designing Streets Toolbox Assessment, we have matched them against the six qualities of successful places as follows:

a) **Distinctive.** We believe that the street/road design being proposed responds to the local context and delivers a distinctive place that enhances the 'Garden City' model within Westquarter. This is principally achieved by the block structure (item 4 above) and the context and character assessment (item 7 above).
b) **Safe & Pleasant.** This quality is achieved by the prioritising of pedestrians and cyclists (item 1 above) and the control of traffic speed through the development (item 9 above). We believe that the street will therefore be a safe and attractive place to live.
c) **Easy to move around.** Largely because the development site is within an existing movement network, many of the features of connectivity are well established. The proposal has only reinforced and enhanced those connections to achieve a road system that is both easy to move around and well connected to adjacent networks. These outcomes have been established by items 2, 6 and 10 above which show that the proposal achieves the aims of this quality of successful places.
d) **Welcoming.** The detailed street arrangement and varied profile of buildings, pathways, parking and green spaces encourages positive interaction for all users of the roadway. Items 5 and 11 above endorse this 'Welcoming' character of the developments roadway and area proposed.
e) **Adaptable.** The street arrangement achieves 'adaptable' quality by virtue of the combination of items 2, 12 and 13 above. These characteristics permit future adaptation as global resources and local facilities change in addition to the resident profile and capability.
f) **Resource efficient.** Environmental issues have been central to much of the design development and item 8 above has expanded on how this has been achieved. The road design also takes account of SUDS, groups the utilities in a fully accessible service strip around the site, integrates soft and hard landscape areas to enhance biodiversity and uses different materials on the shared surface area to make it distinctive, easily maintained, durable and visually attractive within context. Subsequently, we believe that the quality of 'Resource efficient' is achieved by this road layout.

Finally, we have checked the above assessments against Designing Streets Policy as follows:

- The proposal uses street design guidance as set out in 'Designing Streets' and as such is a material consideration in determining this Planning Consent.
- Planning Permission and Roads Construction Consent can be processed in parallel.
- The proposed street design meets the six qualities of successful places.
- The proposed roadway considers place before movement.
- We consider that the road design is based on balanced decision making and has adopted a multidisciplinary collaborative approach.

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DRAWING STATUS: PLANNING

REV	NOTES	BY	DATE

THE MORRISON PARTNERSHIP
CHARTERED ARCHITECTS AND CDM CO-ORDINATORS
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TELEPHONE 0131 343 3114 FAX 0131 332 7836 EMAIL: edin@themorrisonpartnership.co.uk

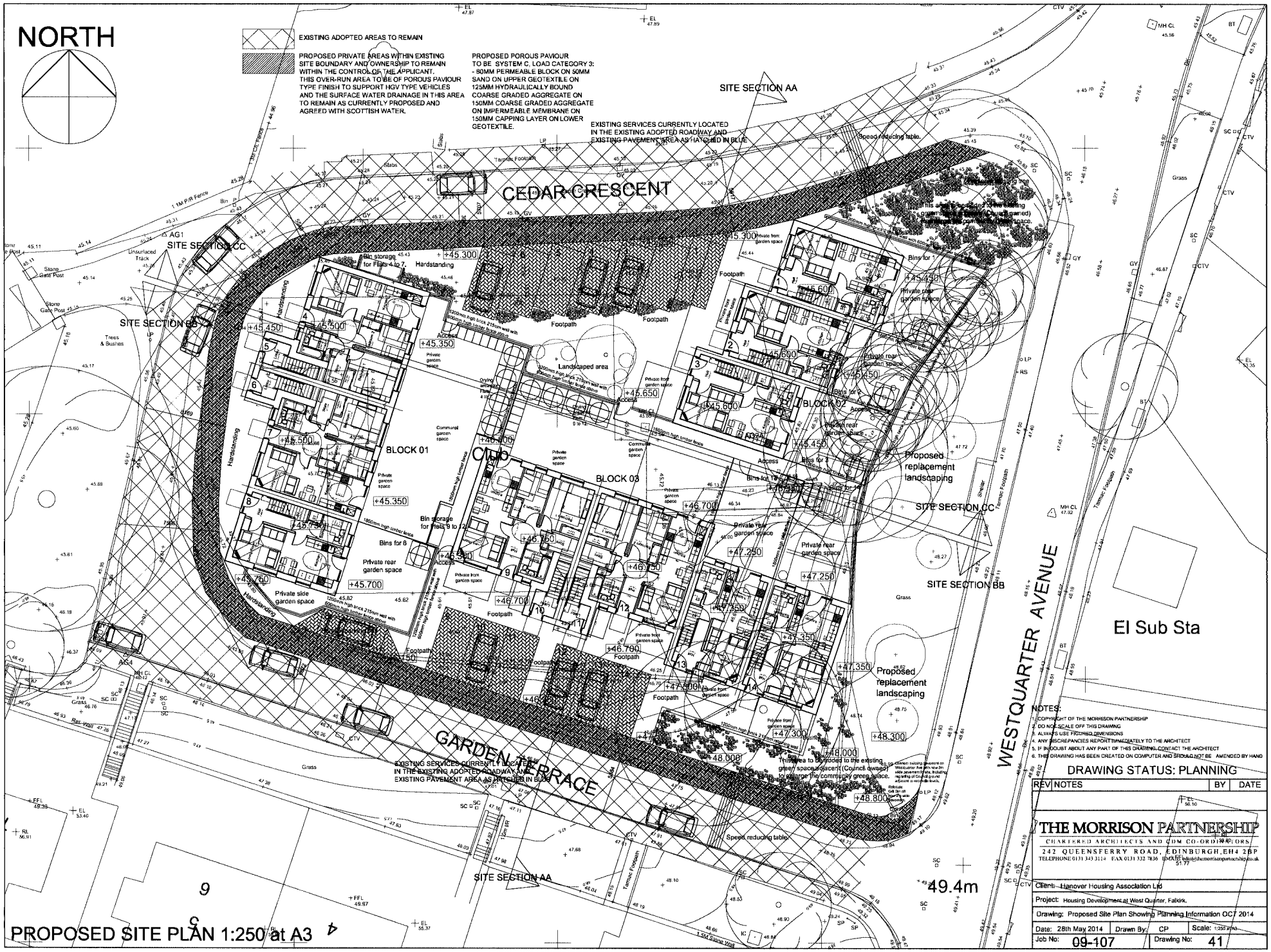
Client: Hanover Housing Association Ltd

Project: Housing Development at West Quarter, Falkirk.

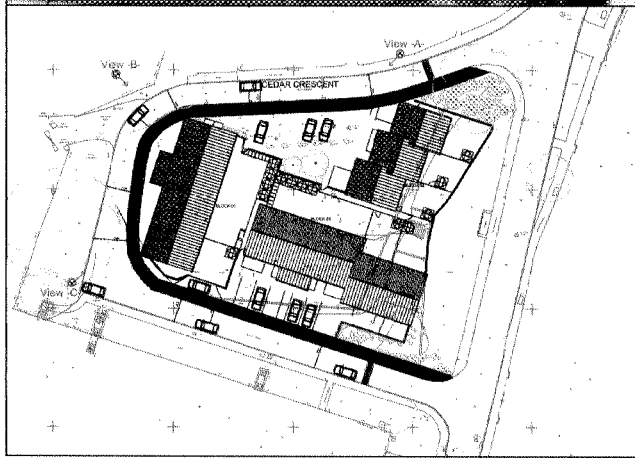
Drawing: Designing Streets Toolbox Plan

Date: 28th May 2014 | Drawn By: CP | Scale: 1:500

Job No: 09-107 | Drawing No: 17



PROPOSED SITE PLAN 1:250 at A3



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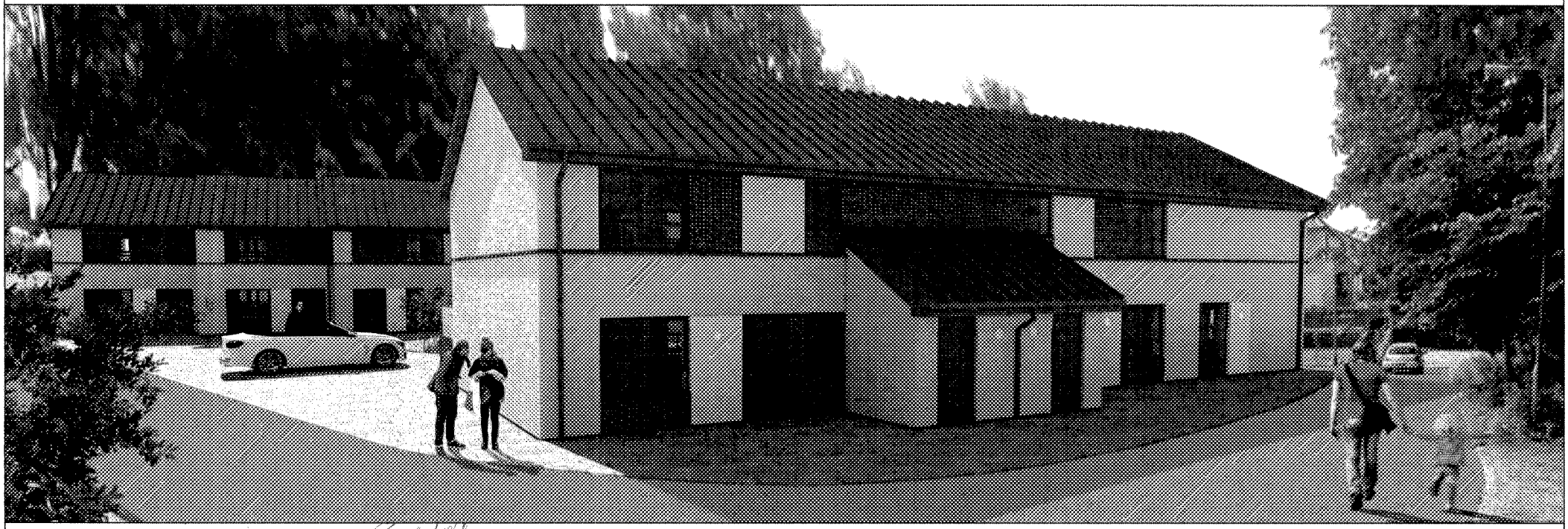
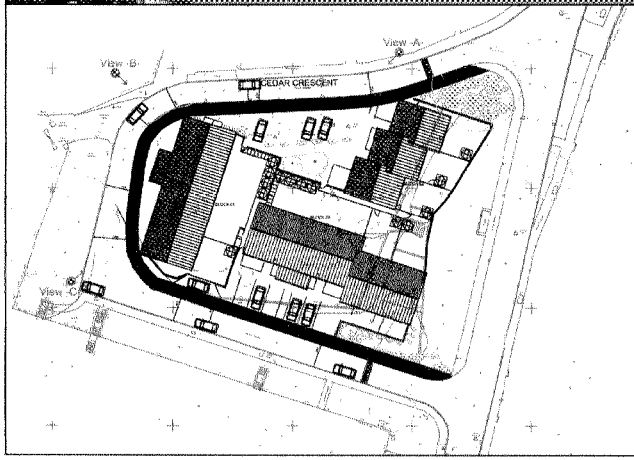
TELEPHONE 0131 343 3174 FAX 0131 332 2836 EMAIL admin@themorrisonpartnership.co.uk

Client:	Hanover Housing Association Ltd
Project:	Housing Development at West Quarter, Falkirk
Drawing:	Rendered Perspective - View A
Date:	16th June 2014
Drawn By:	CP
Scale:	N.T.S
Job No:	09-107
Drawing No.	21





REV	NOTES	BY	DATE

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TELEPHONE 0131 343 3414 FAX 0131 332 7836 EMAIL admin@morrisonpartnership.co.uk

Client:	Hanover Housing Association Ltd
Project:	Housing Development at West Quarter, Falkirk
Drawing:	Rendered Perspective - View B
Date:	16th June 2014
Drawn By:	CP
Scale:	N.T.S
Job No:	09-107
Drawing No:	22

Scott Bennett Associates

consulting civil and structural engineers

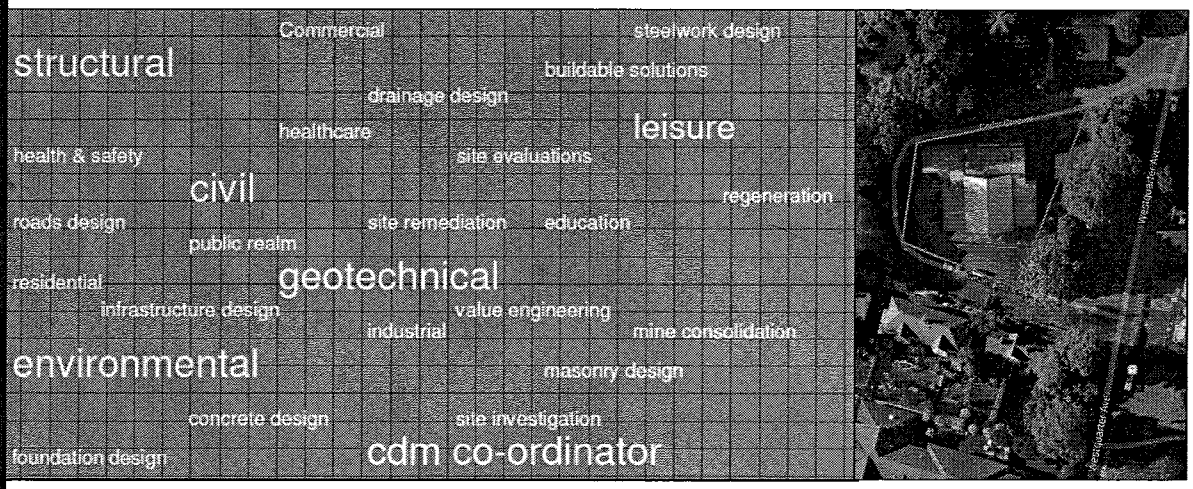
SITE INVESTIGATION REPORT

AT

WESTQUARTER AVENUE, FALKIRK

FOR

HANOVER (SCOTLAND) HOUSING ASSOCIATION



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T: 01383 627537 F: 01383 627538
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Project ID: J2429D
Dated: May 2014

HANOVER (SCOTLAND) HOUSING ASSOCIATION

WESTQUARTER AVENUE, FALKIRK

SITE INVESTIGATION REPORT

Report Reference: J2429D			
Issue No		Prepared By	Approved By
V1	May 2014		
		Andrew Miller	Craig Stevenson
		Associate - Geo	Director

Scott Bennett Associates (Group 1) Ltd
No. 19 South Castle Drive, Carnegie Campus, Dunfermline KY11 8PD
Telephone: 01383 627537 Facsimile:01383 627538 Email:enquiries@sbascotland.com

EXECUTIVE SUMMARY

Site Details	Site Name	Westquarter Avenue, Falkirk			
	National Grid Reference	291260, 678800			
	Site Area	0.02Ha (approximately)			
	Local Authority	Falkirk Council			
	Current Usage	Recreational Welfare 'Club' Facility			
	Former Usage	'Westquarter House' & Undeveloped open space			
Brief	Investigation of existing ground and geo-environmental conditions, including chemical contamination, ground gas emissions and assessment of any mining instability constraints.				
Nature of Development	The development will comprise the construction of low rise residential housing with private gardens and soft landscaping areas. Associated access and parking areas will also be included in the development.				
Physical Investigation Works	2No. cable percussion boreholes to a maximum depth of 3.6mbgl. 4No. trial pits to a maximum depth of 2.9mbgl. 4No. rotary percussion boreholes to a maximum depth of 20.0mbgl. Gas/Groundwater monitoring				
Laboratory Analysis	Geotechnical testing: (PSDs) Chemical analysis (soil and leachate)				
Summary of Site History	The site was shown to comprise undeveloped land prior to the construction of Westquarter House, which appeared to have been demolished prior to 1938. The site remained undeveloped until around 1980, when a structure of unspecified use was noted to have been constructed within the site. Our walkover survey subsequently established the structure to comprise a clubhouse and associated grounds.				
Summary of Encountered conditions	**Material**		**Depth encountered (mbgl)**	**Proven Thickness (m)**	**Typical Description**
	Made Ground	Topsoil (Localised)	Ground Level	0.1 – 0.2	Topsoil (no – description).
		Tarmac	Ground Level	0.05 - 0.1	Tarmac (no – description).
		Granular (Burnt Shale)	GL – 0.1	0.1 – 0.2	Reddish brown slightly clayey fine to coarse sand and gravel of burnt shale.
		Granular	0.2 – 0.4	0.15 – 0.8	Brown sandy gravelly clay with ash, brick, cobbles, burntshale and concrete.
	Natural	Granular (Sand & Gravel)	0.6 – 2.6	0.8 – 1.9	Loose to medium dense very silty slightly gravelly fine to coarse SAND.
		Granular (Silt – localised)	2.0 – 2.2	0.6	Firm consistency brown sandy gravelly SILT.
	Bedrock	Rockhead	0.8 – 4.0	N/A	Light brown SANDSTONE.
Foundations	It is understood the development will comprise the construction of low rise residential housing; based on previous experiences with similar structures, the associated line loadings are considered unlikely to exceed 50kN/m. Based on the visual descriptions and in situ testing, the allowable bearing capacity of the loose to medium dense SAND would be expected to be at least 100kN/m^2. The underlying bedrock is expected to provide a presumed bearing value of at least 1000kN/m^2, even when weathered to a very weak rock. Settlements would be expected to be no more than 25mm and would be expected to be immediate upon construction within the granular materials. Suitably competent natural materials appeared to be present at shallow depth (i.e. within approximately 1m depth) over the vast majority of the site from existing ground level. A Design Sulphate class of DS1 and an Aggressive Chemical Environment for Concrete (ACEC) designation of AC-1s has been established for the site. Concrete conforming to this specification should be utilised for all concrete structures likely to be in contact with the ground.				

Chemical Contamination	Based on the analytical data, no significant contamination was identified. No significant leachability or risk to controlled waters was identified. This appeared consistent with the historical assessment. Any imported soils or materials will however require appropriate chemical certification.
Gas Emissions Data	Based on the results obtained and in recognition of the nature of the materials encountered at the site, a gaseous risk is not considered to be presented by the existing ground conditions. No specific ground gas protection measures are considered to be necessary for the development. Radon protection measures are not considered to be necessary.
Potable Water Supplies	UKWIR Compliance testing has indicated that PVC, PE-Al-PE, wrapped steel and wrapped ductile iron pipe water supply pipes are suitable for the ground conditions encountered at the site. Formal approval will however be required from Scottish Water.
Mining Instability	Mining instability constraints are considered to affect the site. Shallow abandoned mineworkings have been established to affect the entire site area, arising from extraction at the level of the Armadale Main Coal.
Further Work	Mine stabilisation procedures facilitated by drilling and pressure grouting are required prior to development. The conditions beneath the existing structure should be assessed following site clearance to confirm they are not at variance with the remainder of the study area. Waste Acceptance Criteria (WAC) testing will require to be carried out on any materials designated for off-site disposal.

Note: The above should be read as a brief summary of the interpretative report, the aim of which is to highlight the principal outputs of the investigation and areas of concern, and is for guidance purposes only. Any quantification given is an estimation based on the density and resultant interpolation between sampling points, and may be subject to variation. In addition, unless expressly stated otherwise, all depths and thicknesses are quoted from existing ground levels and no adjustment has been made in relation to any proposed pre-development site re-profiling.

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APPENDICES

1.0 INTRODUCTION

1.1 General

Scott Bennett Associates (Group 1) Ltd were appointed by Hanover (Scotland) Housing Association (the Client), to provide a geo-environmental report relative to a proposed residential development at Westquarter Avenue, Falkirk (Figure 1).

The aim of this study was to assess the ground conditions within the subject area and to evaluate the impact the identified conditions could potentially have on the development. The objectives included were:

- Establishing the geological conditions in the vicinity of the site and the surrounding area.
- Utilising available historical and Public Information to derive an appropriate Conceptual Site Model.
- The identification of potential constraints related to soil, gas and groundwater contamination and appropriate remediation solutions as appropriate.
- Provision of recommendations on the load bearing characteristics of the encountered strata and possible foundation options.
- The assessment of any potential mineral instability constraints affecting the subject area.

This report details the findings of the investigations, identifies potential geotechnical and environmental constraints, potentially significant pollutant linkages and provides recommendations in relation to the proposed development in terms of compliance with Part IIA of the Environmental Protection Act 1990 and the appropriate Planning Advice Note (PAN33).

While every effort has been made to determine the conditions across the area of investigation, it should be noted that ground conditions can vary between sample locations and consequently, conditions may exist within certain areas, which may be at variance to those disclosed by this report.

This report and the conclusions contained herein have been written in the context of the purpose stated above and should not be utilised in any differing context without prior reference to us, to ensure continued pertinence of the recommendations advised.

In addition, changes in accepted practices, legislation, regulation or guidance may necessitate review and possible revision of the report in part, or in whole, following its submission. Where no changes to the above occur and the recommendations of the report are not implemented within a period of 12 months from the report date, it should be referred to us for review and, if necessary, amendment.

2.0 SITE DETAILS

2.1 Site Location, Usage and Access

The site is situated on the eastern approach to the town of Falkirk. Access to the site could be taken from Garden Terrace off Westquarter Avenue.

Site Name:	Westquarter Avenue, Falkirk
National Grid Reference:	291270, 678800
Site Area:	0.02Ha (approximately)
Local Authority:	Falkirk Council

2.2 Site Description

At the time of our investigation, the subject area was occupied by a disused re-creational 'clubhouse' facility with an associated area of peripheral car parking/hardstanding. The structure appeared to be in a moderate to poor condition and state of repair.

An area of soft landscaping was present within the south of the site, comprising unmaintained grass and opportunistic scrub vegetation with localised areas of blaes (burnt shale) noted at the site surface.

Topographically the site was generally flat, with a slight increase in elevation towards the south east. A small retaining wall was present along the eastern site boundary.

Minor quantities of general household refuse and broken glass were present at the site surface.

A selected photographic record of the site condition is presented within Appendix A.

2.3 Properties in Proximity

Residential properties were noted to the north and south, with Westquarter Avenue present to the east, leading on to an area of landscaped ground. Areas of woodland were present to the west.

2.4 Tanks and Drums

No tanks or drums were noted within the site.

2.5 Contamination

No evidence of potentially contaminative sources was apparent within the site. Localised deposits of fly-tipped domestic refuse were present on site.

2.6 Public Utilities

Public utility infrastructure was noted within and surrounding the site, in the adjacent public road and footpaths.

2.7 Ground Conditions

The site was principally covered with hardstanding, which prevented detailed assessment of the ground conditions. Made ground was however considered likely to be present across the site. No evidence of any buried structures was present at the site surface in the area around the existing building.

2.8 Invasive Species

The site walkover survey did not identify the presence of invasive plant species (e.g. Japanese Knotweed) at the site, although a detailed study was not included within our brief. We would be pleased to engage the services of a landscape architect or specialist in this regard, should a more detailed study ultimately be required

3.0 APPRAISAL OF EXISTING INFORMATION

3.1 Information Sources

The following sources of information have been utilised in the compilation of this report:

- Site Photographs & Site Walkover Information (Appendix A).
- SEPA Flood Map (Appendix B).
- Coal Authority Information (Appendix B).
- BGS Archive Borehole Information (Appendix B)
- Envirocheck Report and Historical Map Extracts (Appendix C).

3.2 Site History

An examination of the history of the site was made utilising the historical survey data compiled through the Landmark information Group Limited. The objective of these studies was to determine the former uses of the site and that of the surrounding area (typically within 250m), and to obtain any information which may identify potential constraints to its development, particularly the presence of any industrial processes in the vicinity of the study area. The limitations of such a study principally relate to the frequency of re-survey, particularly in rural areas. The relevant map extracts are presented in Appendix C. In conducting our assessments, while large scale maps have been reviewed and are included within the appendices, we have utilised the data and increased definition provided by the small scale maps where possible. The key findings of our historical researches are presented below.

Historical maps dating from 1862 to 2010 were consulted to ascertain the site history. The site was largely open, undeveloped land prior to the construction of Westquarter House, which was present on the initial survey of 1862 and appeared to have been demolished prior to 1938. The site remained undeveloped until around 1980, when a structure of unspecified use was noted to have been constructed within the site. Our walkover survey subsequently established the structure to comprise the existing 'clubhouse' and associated grounds. No further significant changes were noted up until the present day.

The surrounding area was noted to be largely open, undeveloped with woodland of varying density in 1862. The Westquarter Burn was shown to be present approximately 40m to the north west, with a railway noted around 200m to the south. By 1897, gravel pits were indicated to the south east and west at distances of approximately 120m and 160m respectively. These features were shown to be disused by 1918. Extensive development of a primarily residential nature was shown to the north, east and south of the site by 1944, with development shown to progress to the west by 1957. By the map edition of 1980, an electrical sub-station was indicated to have been constructed around 20m east of the site. There did not however appear to have been any further significant land use changes in the area.

3.3 Public Register & Regulatory Consultation

The following section includes a summary of information obtained from the Envirocheck report obtained from the Landmark Information Group (see Appendix C), the Local Authority and other sources. The distances to the environmental features have generally been established from the centre of the site. The relevant data is collated within Table 1 below.

Table 1: Public Register Information

Environmental Information	Contaminated Land Register.	No record of site being on register.
	Pollution Incidents	No notification of pollution incidents.
	Statutory Enforcement or Prohibition Notices	None noted within 250m.
	IPPCs or IPCs	None noted within 250m.
	COMAH* or NIHHS**	None noted within 250m.
	Flood Risk	The site was not considered to be at risk of flooding
	Air Pollution Controls	None noted within 250m.
	Radioactive Substance Licenses	None noted within 250m.
	Discharge Consents	No discharge consents were noted within 250m.
Waste	Registered Landfill Sites	None noted within 250m.
	Waste Transfer Sites	None noted within 250m.
	Waste Treatment or Disposal Sites	None noted within 250m.
Geological Hazards	Collapsible, landslide, running sand and shrinking or swelling clay ground stability hazards were recorded as very low risk. Ground dissolution stabilities were recorded as no hazard, while compressible ground hazards were documented to be of moderate site risk.	
Mining	The Envirocheck Report identified the site to lie within an area which was likely to be affected by historical coal mining, although the mining instability risk was deemed to be inconclusive. 6No infilled former gravel / quarries were recorded within 250m of the site.	
Fuel Stations	No fuel station entries were identified within 250m of the site.	
Contemporary Trade Directory Entries	The Envirocheck report identified 2No. contemporary trade directory entries within 250m of the site. Further details are presented in Appendix C.	
Sensitive Land Uses	No sensitive land uses are present within 250m of the site.	
Local Authority Petroleum Officer	The Local Authority petroleum officer was contacted regarding the potential presence of any underground or above ground fuel storage tanks at the site. No records were held by the Council.	
Local Authority Environmental Health	The Local Authority Environmental Health department was consulted as an integral element of the statutory consultation process. Falkirk Council Environmental Services have not disclosed the presence of any known environmental constraints or concerns within the site.	
Radon Control	The HPA/BGS Indicative Atlas of Radon in Scotland (2011) indicates that the site is in a lower radon probability area where less than 1% of homes are at or above the action level, indicating that no radon protective measures are necessary in the construction of new dwellings or extensions.	

* COMAH – Control of Major Accident Hazard Sites

** NIHHS – Notification of Installations Handling Hazardous Substances

3.4 Documented Geological Conditions

The Geological Survey information relating to the area suggested that the site was underlain by sand and gravel deposits which were indicated to be up to 5m thick in the area. Deposits of glacial till were documented to the immediate south, while undifferentiated soils (alluvium), associated with the Westquarter Burn, were present to the west. No indication of the presence of significant accumulations of made ground was encountered, although the possibility of such materials could not be discounted. (Figures 2 & 3)

The underlying solid strata were indicated to comprise sedimentary rocks of the Carboniferous Lower Coal Measures. These typically include cyclical sequences of sandstones, siltstones and mudstones with some seams of coal.

The Armadale Main Coal (~0.0m – 0.9m thick) was indicated to outcrop approximately 100m to the north of the site, striking in an approximate west to east orientation and was indicated to dip in a South South-Easterly direction, at an unspecified inclination. The Armadale Ball Coal (0.43m – 1.17m thick) was indicated at conjectured outcrop through the south eastern corner of the site, striking in a similar orientation. Both mineral seams were therefore considered to be present at comparatively shallow depths beneath rockhead in the area. (Figure 4).

Archive borehole information from the BGS was also examined, and a number of boreholes were found which were relevant to the site area. These have been principally considered in relation to potential mining instability and consequently are referenced appropriately. (Appendix B)

3.5 Hydrology and Hydrogeological Conditions

While definitive information concerning the precise groundwater conditions was not possible from the available documentary information, we can provide the following general comments based on our researches.

Table 2: Hydrology

Surface infiltration	The rate of surface water infiltration or of possible lateral shallow groundwater migration will be determined by the nature of the shallow soils and their permeability. Given the extensive hard surfacing over the site, surface infiltration would generally be expected to be low.
Surface water run-off	Surface water run-off from the site was anticipated to be moderate to high. These conditions were, however, considered likely to change following development, as a considerable proportion of rainfall will be directed towards surface water drainage infrastructure.
Surface Watercourses	No watercourses were identified to exist within the site boundaries, although the Westquarter Burn was indicated to be present approximately 100m to the west.
Flooding	Based on the SEPA flood map and Envirocheck flood map information, the site and its close proximity was not indicated to be potentially at risk from flooding.

Table 3: Hydrogeology

Groundwater migration through superficial materials	Based on the documented geological conditions the underlying soils are considered to be unlikely to be receptive to significant groundwater flow, particularly vertical migration. Deeper groundwater bodies may be present at or below the bedrock level.
Groundwater Vulnerability	The Hydrogeological Map of Scotland (1988) classed the Dinantian and Namurian Strata to be a locally important aquifer, in which flow is dominantly within fissures and discontinuities. Significant flows may however be encountered where the strata have been disturbed by mining activities.
Groundwater Abstractions	There are no records of any groundwater abstraction wells within influencing distance of the site. We would, however, highlight that groundwater abstraction has only comparatively recently become a licensed activity in Scotland and unrecorded 'wells' could exist in the area.
Groundwater Flow Direction	No specific information in relation to groundwater flow was established, although groundwater movement was expected to be to the west, towards the Westquarter Burn.

3.6 Mining Conditions

The Coal Authority report for the site did not identify the existence of any mine abandonment plans or records relating to the study area, although they did note that they believed coal was likely to be present at, or close to the site surface, which may have been worked at some time in the past.

Correspondence received from the Coal Authority Mine Abandonment Records Office suggested the closest documented workings were present at the level of the Armadale Main Coal, some 165m to the south of the site.

The Environmental Series Geological Map (Shallow Mining) relating to the area did, however, indicate an area of documented shallow mineral workings in the extreme north eastern corner of the site, extending further to the north east, beyond the site boundary (Figure 5). The Coal Authority Online Interactive Map confirmed the site to lie within a development 'high risk' area and a zone within which historical abandoned mineral workings were considered likely to exist.

Based on the documented geological conditions, it was considered that the site was at increased potential risk from mining instability constraints, particularly given that unrecorded mineral workings were documented to be present in the immediate area. These mineral workings were confirmed from examination of archival borehole information obtained from the British Geological Survey (appended).

The Environmental Series Geological Map (Shafts & Adits) indicated the presence of an abandoned mine entry approximately 40m to the north of the site, with an abandoned mine adit situated approximately 70m to the north. On the basis of the documented geological conditions, it appeared that these mine entries possibly accessed workings at the level of the Armadale Main Coal. (Figure 6)

3.7 Quarrying

There was no documentary or physical evidence to suggest that quarrying operations had formerly occurred at the site. However, several gravel pits are noted in the wider area on the geology maps and the possibility of quarrying on site cannot be definitively discounted. Vigilance should therefore be maintained during any future site works for any suspect features.

4.0 PRELIMINARY CONCEPTUAL SITE MODEL

4.1 General

The risk-based approach to the assessment of sites is founded on the "contaminant—pathway—receptor" relationship, using the following definitions:

Contaminant: ("source") - the hazardous substance/agent. In many cases this will be a potentially hazardous chemical present on or within the ground at concentrations that are considered potentially hazardous.

Receptor: ("target") - the entity (e.g. human, animal, water, vegetation, buildings, services) that is vulnerable to the adverse effects of the hazardous substance or agent.

Pathway: the means by which a hazardous substance or agent comes into contact with, or otherwise affects a receptor.

For a risk to exist there must be a contaminant capable of causing harm, a receptor sensitive to that contaminant, and a pathway linking them. If there is no link between the contaminant and receptor then there will be no unacceptable risk to that receptor posed by the contaminant.

The contaminant—pathway—receptor relationship is often known as a "pollutant linkage". On an individual site there may be more than one such pollutant linkage, and each of these requires individual assessment. An effective risk assessment and Conceptual Site Model (CSM) aims to identify all the pollutant linkages.

In broad terms, risk assessments consider the following types of receptor:

- Humans (current and future site users or construction workers).
- Environment, i.e. water (ground and surface waters), flora and fauna.
- Structure and fabric of buildings and the associated infrastructure.

The conceptual site model is derived from the data collected from the desk-top researches and walkover survey. The model draws together and summarises the key information. The conceptual site model presents a picture of the current and potential future contamination at the site in the context of the site's environmental setting, taking into account the local hydrology, hydrogeology, geology and historical land use. It includes an assessment of the following:

- The known or potential sources of contamination at a site.
- The potential pathways whereby chemicals could be introduced into the ground e.g. via leakages from underground tanks, deposition of dust etc.
- The potential for those chemicals to migrate away from the source areas e.g. transport through the unsaturated (soils) and saturated (groundwater) zones.
- Identifies the different types of human populations (e.g., residents, workers, recreational visitors) who might come into contact with contaminated media.
- Lists the potential exposure pathways (e.g., ingestion of contaminated water, inhalation of chemicals in air, contact with contaminated soil etc.) that may occur for each population or receptor.

The model forms a central tool in both the assessment of the need for a site investigation and the design of any investigation. It should be recognised, however, in many cases, the development of a site introduces additional receptors, which may not be present in the pre-development stage.

4.2 Source Characterisation

The potential sources of contamination identified by this desk study are listed in Table 4 below.

Table 4: Contaminants of Concern

THE SITE	Industrial Activity/Site Use	Potential Contaminative Processes	Associated Potential Contaminants
Current	• 'Clubhouse'	• None expected	• None expected
Historical	• Westquarter House	• None expected	• None expected
IMMEDIATE SURROUNDING AREA	**Industrial Activity/Site Use**	**Potential Contaminative Processes**	**Associated Potential Contaminants**
Current	• Residential	• None expected	• None expected
Historical	• Infilled Quarries • Railway	• Deposition of made ground of unspecified origins • Possible spillage of fuel/wastes and residue.	• Cadmium • Chromium • Copper • Lead • Nickel • Asbestos • PAH • Sulphate • Gas Emissions

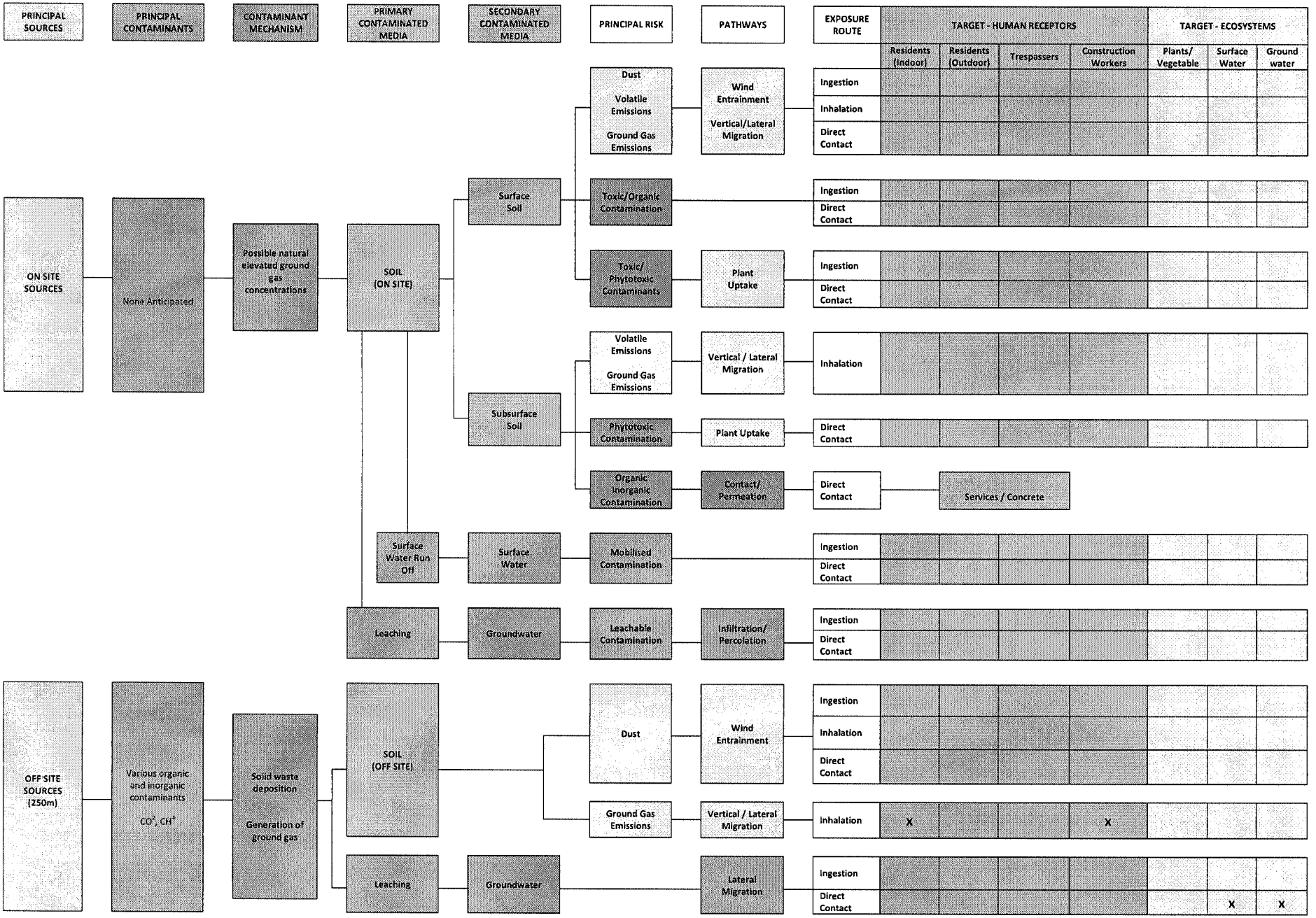
The potential contaminants listed above are intended as a guide to the possible contaminant species which may be encountered in such sites, and other contaminants could potentially be present. Only offsite sources within 250m of the site boundaries have been considered, as sources at greater distances would generally be considered unlikely to impact upon the subject area. Based on the ground conditions in the surrounding area, the pathways for historical processes affecting the site conditions would generally be restricted to groundwater or gas migration and the appropriate testing parameters would be adjusted accordingly based on the site condition.

4.3 Preliminary Quantitative Risk Assessment

On the basis of the above, a preliminary qualitative risk assessment has been detailed in Table 5 below.

The potential source-pathway-receptor relationships identified at the site, based on the preliminary qualitative risk assessment, are summarised in Figure 7 - Preliminary Conceptual Site Model (CSM).

Table 5: Preliminary Qualitative Risk Assessment



4.4 Development Constraints Related to Documented Ground Conditions

Contamination	No current potentially contaminative processes were identified at the site during our walkover. The potential for significant contamination constraints arising directly from the historical site use or processes in the immediate surrounding area was considered to be low, however confirmatory soil sampling and analysis was considered prudent.
Gas Emissions	The most likely source of contamination, identified from the historical appraisal was considered to be associated with the potential existence of any natural organic soils or quarry infill in the surrounding area, possibly presenting a source of elevated ground gas concentrations. Significant ground gas constraints were considered unlikely based on the historical assessment and former site use, however, it was considered prudent to investigate for the possible presence of elevated concentrations.
Engineering	Although the presence of significant made ground on site was considered unlikely, the nature of the underlying ground conditions required to be assessed in relation to the impact on possible foundation solutions for the proposed development.
Mining	Based on the documentary information, mining instability constraints were considered to possibly affect the site.

4.5 Site Investigations

Based on the documented historical uses of the site and those in the surrounding area, it was considered that appropriate site investigations would require to be implemented at the site. An appropriate scope of works was therefore devised to accommodate the requirements of the initial brief. These works were undertaken by a reputable contractor and were implemented in accordance with BS10175:2011- Investigation of Potentially Contaminated Sites and BS5930:1999 - Code of Practice for Site Investigations.

The objectives of the investigations, based on the information derived from the CSM were as follows:

- Provide information in relation to the nature of the superficial soils, thickness of made ground and spatial distribution of materials relative to the former site use.
- Investigate the possible presence of contamination constraints based on the historical use.
- Assess the potential presence of elevated ground gas conditions.
- Assess the hydrogeological conditions beneath the subject area.
- Assess the geotechnical properties of the soils in relation to possible foundation solutions
- Investigate the underlying mineral condition.

The positioning of the sampling points was devised to provide maximum coverage over the site area, taking cognisance of any services and access restrictions and to comply with the requirements of B.S 10175. The sampling rationale adopted from 0.0m-1.0m was determined in accordance with R&D Technical Report P5-066/TR Secondary Model Procedure for the Development of Appropriate Soil Sampling Strategies for Land Contamination and was specifically designed to assess potential surface contamination constraints (Table 6).

Table 6: Rationale for Sampling at Different Depths

Depth Range	Rationale
0 – 0.5m*	To assess: • Human/animal intake arising from ingestion and dermal contact. • Potential for wind entrainment leading to inhalation (of contaminated soils and dusts) or deposition onto neighbouring land. • Surface water run-off (e.g. due to flash flooding). • Uptake by shallow rooting plants (e.g. crops, ornamental and wild species). • Surface leaching to groundwater.
> 0.5m in made or natural ground	To assess: • Intake via ingestion/inhalation/dermal contact arising from 'abnormal' (or unpredicted) excavation. • Uptake by deep rooting shrubs and trees. • Intake by, or arising from, the activities of burrowing animals. • Intake arising from construction/maintenance of buildings and services, for example: o Foundations (usually within 2m of final formation level). o Water supply pipes, telecommunications, gas & power (0.5 – 1m of final formation level). o Sewers (from 0.5m > 1m of final formation level). • To locate perched water or groundwater. • To confirm depth of made ground. • To locate possible lateral pathways for gas or vapour migration in made ground. • To establish extent of any leaching of soluble constituents from superficial soils. • To detect 'deep' contaminants (e.g. gas generated materials, leachable materials, dense solvents located on top of an impermeable stratum). • To obtain information on 'background' soil properties. • To locate 'natural' lateral migration pathways.

* Note that in some applications (particularly where an established use is in place, or where surface soil or deposits are susceptible to windblow, run-off or uptake by fauna and shallow rooting flora) it may be necessary to characterise the top 0 – 0.20m depth range

Accordingly, the scope of works as detailed within Table 7 was implemented at the site. Detailed sampling protocols are included within Appendix D.

The location of all of the trial excavations, boreholes and sampling points is presented on the Site Investigation Location Plan (Figure 8).

4.6 Health & Safety

No specific health & safety constraints were identified in relation to the implementation of the relevant site investigations.

Table 7: Scope & Methods of Investigation

Investigation Method	Justification/Description		Number	Depth Range	Sample Strategy / Density	Comments
Cable Percussion Boreholes (Aitken Laboratories Ltd – March 2014)	To determine the nature, composition and distribution of the superficial materials and to obtain representative samples for chemical analysis. Sampling frequency was generally every half metre or at each change of strata. To provide an assessment of the geotechnical properties of the underlying materials and to obtain appropriate samples.		2	3.6m – 1.2m	Non targeted general site assessment.	• Samples obtained for general geo-environmental analysis. • Borehole logs presented within Appendix E.
Rotary Percussion Boreholes (Soil Engineering Geoservices Ltd – March 2014)	To determine ground composition along with depth to rockhead. Boreholes were advanced to investigate the presence of potential mine workings beneath the site.		4	20.0m	No samples were required.	• Borehole logs presented within Appendix E
Trial Pits (Aitken Laboratories Ltd – March 2014)	To determine the nature, composition and distribution of the superficial materials and to obtain representative samples for chemical analysis. Sampling frequency was generally every half metre or at each change of strata. To provide an assessment of the geotechnical properties of the underlying materials and to obtain appropriate samples.		4	0.8m – 2.9m	Non targeted general site assessment.	• Samples obtained for geochemical analysis. • Trial pit logs presented within Appendix E.
Gas Standpipe Installation (Aitken Laboratories Ltd – March 2014)	50mm combined gas/groundwater monitoring standpipe installed to assess potential presence of elevated ground gas concentrations and determine flow rates		1	3.6m	Non targeted general site assessment.	• Gas Measurements obtained from LMS GX600 monitoring system. • Gas measurements included within Appendix I.
Groundwater Standpipe Installation (Aitken Laboratories Ltd – March 2014)	50mm combined gas/groundwater standpipe to assess groundwater conditions and permit sampling for geo-environmental analysis. The monitoring wells were constructed from 50mm diameter threaded HDPE slotted well screen and plain casing. Washed filter gravel was utilised to fill the annulus between the screened section and borehole wall. Bentonite or lean mix concrete was placed above the filter gravel. The bores were completed with threaded standpipe caps and security covers.		1	3.6m	Non targeted general site assessment of underlying groundwater conditions.	• Groundwater observations included within Appendix I • Excavation logs presented within Appendix E.
In Situ Geotechnical Analysis (Aitken Laboratories Ltd – March 2014)	To assess the 'in-situ' geotechnical properties of the soils	SPT	2	2.0m – 3.0m	Non targeted assessment of materials to determine geotechnical parameters and appropriate sampling~ 1.0m intervals.	• Sampling undertaken by Aitken Laboratories in accordance with BS 5930. • Test results presented within Appendix F.
Geotechnical Laboratory Analysis (Aitken Laboratories Ltd – March 2014)	To assess the geotechnical properties of the soils	Particle Size Distribution	2	1.0m – 2.0m	Targeted assessment of various geotechnical parameters to assist in evaluating possible foundation solutions.	• Sampling and testing undertaken at the UKAS accredited laboratories of Aitken Laboratories. • Test Results presented within Appendix F.

5.0 ENCOUNTERED CONDITIONS

5.1 Superficial Soils

Details of the ground conditions encountered at each of the exploratory borehole locations were presented on the respective excavation/borehole logs. The relevant data was presented within Appendix E of this report. The recent investigations have identified the following materials during the investigation.

Table 8: Summary of Findings

Material		Depth Encountered (m)	Proven Thickness (m)	Typical Description
Made Ground	Topsoil (Localised)	Ground Level	0.1 – 0.2	Topsoil (no – description).
	Tarmac	Ground Level	0.05 - 0.1	Tarmac (no – description).
	Granular (Burnt Shale)	GL – 0.1	0.1 – 0.2	Reddish brown slightly clayey fine to coarse sand and gravel of burnt shale.
	Granular	0.2 – 0.4	0.15 – 0.8	Brown sandy gravelly clay with ash, brick, cobbles, burntshale and concrete.
Natural	Granular (Sand & Gravel)	0.6 – 2.6	0.8 – 1.9	Loose to medium dense very silty slightly gravelly fine to coarse SAND.
	Granular (Silt – localised)	2.0 – 2.2	0.6	Firm consistency brown sandy gravelly SILT.
Bedrock	Rockhead	0.8 – 4.0	N/A	Light brown SANDSTONE.

5.2 Solid Geology

All of the trial pits and boreholes were noted to terminate on obstructions which were considered representative of the underlying bedrock. Rockhead was established to be present at depths of between 0.8m and 4.0m below existing round levels.

5.3 Groundwater

Groundwater was not noted within any of the boreholes or trial pits during drilling or excavation. The results of follow up groundwater monitoring (post- intrusive investigation) are summarised in Table 9 below:

Table 9: Groundwater Observations

BH No.	Range of Monitored Groundwater Depths (m.b.g.l.)	Maximum Variation (m)
CP01	DRY	N/A

On the basis of the initial investigations and subsequent observations over the monitoring period, it does not appear that a shallow groundwater system exists within the shallow soils beneath the site.

5.4 Scope of Chemical Analysis

Based on the historical assessment, former site use, Preliminary Conceptual Site Model and information obtained from the regulatory consultation, the scope of analysis detailed in Table 10 was recommended, in accordance with the general guidance presented within Science Reports SR2 and SR3 – 'Human health toxicological assessment of contaminants in soil' and 'Updated technical background to the CLEA model'. While specific contamination constraints were not envisaged, the analytical suite was considered sufficiently robust to assess the

potential presence of the majority of common potential contaminants.

Table 10: Proposed Chemical Testing Suites

Key Contaminants of Concern (COC's) – Soil Analysis					
Metals	**Semi Metals & Non Metals**	**Inorganic Chemicals**	**'Standard' Organic Parameters**	**Specialist Organic Parameters**	**Others**
• Cadmium • Chromium • Copper • Lead • Mercury • Nickel • Zinc	• Arsenic • Boron • Selenium	• Total Cyanide • Sulphate • Sulphide	• Phenol • PAH (16 USEPA)	• TPH CWG	• pH • Organic Matter
Key Contaminants of Concern (COC's) – Leachability Analysis					
Metals	**Semi Metals & Non Metals**	**Inorganic Chemicals**	**'Standard' Organic Parameters**	**Specialist Organic Parameters**	**Others**
• Cadmium • Chromium • Copper • Lead • Mercury • Nickel • Zinc	• Arsenic • Boron • Selenium	• Total Cyanide • Sulphate • Sulphide	• Phenol	• TPH CWG • PAH	• pH • Hardness

A total of 4No. representative soil samples were obtained during the course of the works and submitted for chemical analysis. The results of the analysis are presented within Appendix G.

The chemical analysis was undertaken at the specialist testing facilities of DETS. The laboratory utilises UKAS accredited test methods.

In addition to the above, 4No. soil samples were submitted for leachability testing to assess the potential risk to surface and groundwater from leaching of the site soils. The scope of testing was broadly similar to that undertaken on the soil samples.

UKWIR compliance testing and the associated geochemical testing parameters was also undertaken on all four samples. This is subject to further discussion in the relevant section of this report.

6.0 GEOTECHNICAL CONSIDERATIONS

6.1 Geotechnical Testing

As an integral part of the site investigations, a number of in-situ geotechnical tests were implemented as the boreholes were advanced. Where possible these were instructed to include undisturbed (U100) samples and also Standard Penetration Tests (SPTs), dependant on the nature of the materials encountered. The 'blow' counts required to obtain the sample or to conduct the test were recorded by the drilling foreman at regular intervals as the boreholes were progressed, and were noted on the appropriate borehole log.

Representative samples from the boreholes were subsequently selected and scheduled for appropriate geotechnical testing to assess the nature and properties of the materials encountered at the site. It should, however, be noted that the properties of the materials may be subject to localised variations and consequently the information provided below should be considered to be indicative of the general nature of the soils encountered at the site.

For the purposes of the assessment and for summarising the geotechnical properties, we have described the materials into the following sub-grouping:

- Made Ground
- Natural Granular

6.2 Made Ground

Based on the information from the site investigation, the made ground soils were generally established to be generally of restricted thickness across the area, with an average noted as approximately 0.7m .The made ground was however expected to be variable in both consistency and density.

The made ground materials were not considered suitable for accepting foundation loadings in an unimproved condition. The conjectured thickness and distribution of made ground is presented on Figure 9.

6.3 Natural Soils

Natural Granular

The underlying natural deposits were comprised of granular materials consistent with the documentary information. These were typically described as loose to medium dense very silty slightly gravelly fine to coarse SAND, with localised deposits of firm brown sandy gravelly SILT.

Limited SPT values were obtained within these materials, reflective of the shallow bedrock depths. The data yielded corrected 'N' value results of between 8.4 and 19.5, suggestive of essentially loose to medium dense soils.

'Obstructions' and conditions considered consistent with bedrock were encountered at depths of between 0.8m and 4.0m below existing ground level. The conjectured depth to rockhead encountered across the site is presented on Figure 10.

6.4 Foundation Design Criteria

In consideration of the geotechnical properties of the soils established above, and of the observations made during the investigations, we would provide the following general comments in relation to possible foundation options.

It is understood the development will comprise the construction of low rise residential housing with the associated line loadings considered unlikely to exceed 50kN/m.

Based on the descriptions and in situ testing, the made ground materials would not be considered suitable for accepting foundation loadings in their current condition. These materials are however generally thin across the site and likely to be penetrated at the majority of locations at 'conventional' (0.6m) foundation depths.

The underlying natural materials & bedrock are considered to present an appropriate foundation bearing material. The allowable bearing capacity of the loose to medium dense SAND would be expected to be at least 100kN/m^2 while the underlying bedrock is expected to provide a presumed bearing value of at least 1000kN/m^2, even when weathered to a very weak rock. Suitably competent natural materials consistent with the foregoing appeared to be present at shallow depth (<1.0m) over the vast majority of the site (Figure 11). Settlement on the granular materials would be expected to be immediate upon construction and to be limited to 25mm.

The conditions beneath the existing structure should be assessed following site clearance to confirm they are not at variance with the remainder of the study area.

6.5 Adoptable Road and Car Park Construction

No CBR testing was implemented as part of the investigations. It is recommended that CBR tests are carried out at the appropriate road / car park formation level following site clearance completion.

As a general comment for road or car parking construction, should any particularly 'soft' spots be encountered in the formation, these should be removed and replaced with well compacted hardcore. In addition, consideration may be made of the possible use of a geogrid or geotextile to reduce any required capping thickness, particularly in the areas of development car parking or non-adopted areas.

6.6 Foundation Concrete

The results of the pH and sulphate analysis were compared with the appropriate guidance contained within Concrete in Aggressive Ground, BRE Special Digest 1.

The site has been assessed as 'brownfield' and we have assumed a shallow groundwater system to not be present, based on the findings of the site investigation and subsequent monitoring.

A Design Sulphate class of DS1 and an Aggressive Chemical Environment for Concrete (ACEC) designation of AC-1s has been established for the site. Concrete conforming to this specification should be utilised for all concrete structures likely to be in contact with the ground.

6.7 Site Drainage

It is noted that the site soils are predominantly granular in nature and as such, would generally be expected to have a moderate to high permeability. Given the comparatively limited thicknesses of overburden encountered at the site it may be difficult to engineer SUDS infiltration, or soakaway design for the development.

6.8 Other Considerations

Deterioration of Formation

The foundation formation is likely to be susceptible to the effects of moisture ingress, particularly if left exposed. All foundation formations therefore require to be inspected by suitably qualified personnel to ensure the conditions remain consistent with those assumed in the design.

In the event that there is a significant delay between foundation excavation and construction, we would recommend that the formation be protected by a blinding layer of concrete to ensure that further deterioration of the formation materials does not occur.

In addition, where excavations are extended through increased thicknesses of granular materials, due consideration should be made in relation to health & safety and also the general stability of the materials under excavation.

Where any soft spots are encountered within the formation these should be excavated to competent materials and backfilled to the formation level with well compacted hardcore.

Groundwater Control

We have not conducted any detailed assessments of the possible impact on deep excavations from groundwater ingress, although based on the conditions encountered during the investigation, temporary groundwater control measures may not be required, given the absence of any noted groundwater during the investigation.

7.0 CHEMICAL CONTAMINATION

7.1 Statutory Position

The contaminated land regime in Part IIA of the Environmental Protection Act 1990 (Part IIA) was introduced specifically to address the historical legacy of land contamination. One of the key features of Part IIA is a statutory definition of "contaminated land" – which is:

"any land which appears to the local authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land, that:

a) Significant harm is being caused or there is a significant possibility of such harm being caused; or

b) Pollution of the Water Environment is being, or is likely to be caused."

A revised Statutory Guidance Edition 2 (Paper SE/2006/44) to the Act was published by the Scottish Executive in May 2006, which, in addition to the above, raised the issue of what is determined to be 'significant'.

Neither the above definition, nor the accompanying statutory guidance provides any absolute, measurable criteria. Therefore, determining whether any land is "contaminated land" is likely to involve local authorities making a judgemental decision in each individual case.

The legislation does, however, seek to ensure the identification and remediation of sites that pose "unacceptable risks" to human health or the wider environment, in the context of their current or proposed use.

The approach to "unacceptable risk" is based on the principles of risk assessment, including the concept of a contaminant, a pathway and a receptor, which if combined, form a pollutant linkage. This relationship has previously been described within the site Preliminary Conceptual Model (Section 4.0).

The legislation was designed and intended to encourage the application of voluntary remediation of land scheduled for redevelopment, rather than regulatory enforcement action, and to integrate with the established role of Planning and Building Control departments in the approvals process. Both remediation and the associated validation now form a critical part of the regulatory procedure.

Current Planning Policy clearly states, that the standard of remediation to be achieved through the grant of planning permission for new development, is the removal of unacceptable risk and making the site 'suitable' for its new use.

The "suitable for use" approach then consists of three elements:

- Ensuring that land is suitable for its current use.
- Ensuring that land is made suitable for any new use.
- Limiting requirements for remediation, to only the work necessary to prevent unacceptable risks to human health or the environment in relation to the current or future use of the land, for which planning permission is being sought.

As a minimum, after carrying out the development and commencement of its use, the land should not be capable of being determined as 'contaminated land' under the definitions stated above.

7.2 Technical Guidance - Soil Guideline Values

To provide an initial assessment of the potential significance of contaminant concentrations detected in soil samples collected from the site, a generic risk assessment is presented below using soil assessment criteria that are derived to be protective of human health.

The soil assessment criteria are intended to provide a conservative means of initial assessment. Where contaminant concentrations are less than the appropriate assessment criteria, it is considered unlikely that the contaminant concentrations will pose a potentially unacceptable risk to human health or the water environment. Where a contaminant concentration exceeds the assessment criteria, it does not automatically follow that an unacceptable risk exists, but that further assessment may be necessary to quantify the risk taking into account site-specific information.

A residential development incorporating domestic garden areas is understood to be proposed for the site. The soil test results obtained have therefore been assessed with respect to the 'residential with gardens' end-use scenario which is the most conservative scenario possible and allows for the on-site planting and cultivation of vegetables for human consumption. Should the proposed land use change, then the basis of the risk assessment presented in this report will require to be reviewed and amended to reflect changes to the CSM, as appropriate.

To assess the potential risks for this end use, assessment criteria for soil have been utilised that are protective of human health and relevant Soil Guideline Values (SGVs) have been used where available. Where SGVs are not available, other generic assessment criteria (GAC) have been adopted, utilising the same pathway and receptor data as used in deriving SGVs. The adopted SGVs are those produced by the Environment Agency in 2009 (with the exception of lead; the 2002 SGV for lead from 2002 has been adopted).

For contaminants where no SGV exists, Generic Assessment Criteria (GAC) produced by LQM-CIEH (second edition, published in July 2009) was adopted, which are broadly equivalent in their derivation to the soil guideline values published by the Environment Agency. Both incorporate the most up-to-date Environment Agency CLEA methodology to calculate the assessment criteria. The SGVs and GACs are intended to provide a means of assessing chronic risks to human health, and are dependent on exposure in the context of the specified land use, in accordance with the 'suitable for use' approach. They do not alter the assessment of risk to other environmental receptors (groundwater, surface water, flora, fauna, etc) or to acute risks to health. The SGVs and GACs represent intervention values which indicate that soil concentrations above these values could pose an unacceptable risk to the health of site users, and that further risk assessment/investigation, or remedial action, is required.

7.3 Phytotoxicity

It is recognised that the CLEA derived SGVs do not provide any protection against the potential effects of phytotoxicity. In this respect, the assessment of phytotoxicity of the existing site soils with respect to future landscaping potential has been made by reference to maximum concentrations of potentially toxic elements provided in the Scottish Executive publication 'Prevention of Environmental Pollution from Agricultural Activity, A Code of Good Practice' (2005).

7.4 Risk Assessment – Soil Analysis

Soil Analysis Summary

Assessment of the analytical data indicated that none of the inorganic or organic parameters were recorded to be present at concentrations in excess of the assessment criteria.

This would appear to be generally consistent with the nature of the soils encountered and of the documented historical use of the site.

7.5 Water Environment

The risk assessment for the water environment includes both relevant surface waters and groundwater. For the screening of the groundwater results the most conservative standard derived from UK Drinking Water Standards (DWS) or Environmental Quality Standards (EQS) for the protection of groundwater and surface waters have been adopted.

Soil Leachability Analysis Summary

Leachability analysis was targeted to the possible made ground near-surface materials, as it was these soils which were considered to potentially represent an increased risk. The leachability testing recorded contaminant concentrations below the assessment criteria.

Groundwater Analysis Summary

Given the results of the soil leachability analyses, no significant risk to the water environment was envisaged. No groundwater sampling and analysis was possible as the monitoring well was found to essentially dry on each of the monitoring visits.

7.6 Conclusions

No risk to the proposed development has been identified from the chemical analysis.

No risk to the water environment (groundwater or surface waters) has been identified.

As a consequence of the foregoing, no specific environmental considerations require to be made in relation to the development.

8.0 GAS EMISSIONS

8.1 General

The investigation indicated made ground materials to be present at the site. However based on the nature and general observations concerning the material thickness, the associated risk was considered to be generally low. An assessment of near surface ground gas conditions was however undertaken from monitoring of a semi-permanent standpipe installation placed in one of the soil boreholes. The relevant gas measurements were obtained on six occasions. The instrumentation utilised was a Gas Data LMS Detection Unit which was capable of assessing methane, carbon dioxide and oxygen concentrations, differential pressure, flow rate and atmospheric pressure.

8.2 Gas Assessment Criteria

The assessment of risk due to ground gases has been variously discussed in publications for CIRIA (Report 149 – Protecting Development from Methane) and BRE (Construction of New Buildings on Gas Contaminated Land), amongst others, which have indicated a number of "Characteristic Situations" depending on the concentrations and flow rates of gas. Further industry guidance was provided within CIRIA C659 (November 2006) and in January 2008 [CIRIA C665 – Assessing Risks Posed by Hazardous Ground Gases to Buildings]. Our interpretation and assessment of the site conditions have therefore been based the CIRIA C665 guidance.

8.3 Standpipe Monitoring

The following summary data was obtained from the boreholes during the period of monitoring. The location of the gas monitoring wells is shown on Figure 12. The gas monitoring results are included in Appendix I.

Table 11: Gas Data Summary

BH No.	Methane Range (%v/v)	Carbon Dioxide Range (%v/v)	Oxygen Range (%v/v)	Borehole Flow Range (l/hr)	Atmospheric pressure Range (mB)
CP01	<0.1	<0.1 – 1.7	18.0 – 20.6	<0.1	990 - 1018

8.4 Gas Screening Value (GSV)

The formula for assessing the characteristic gas screening value is as follows:

Limiting borehole gas volume flow rate = Gas concentration (decimal) x Measured borehole flow rate.

In determining the site specific conditions:

Maximum observed concentration: CH_4 = <0.1% (use instrument LOD of 0.1)
Maximum observed concentration: CO_2 = 1.7%
Maximum observed borehole flow: (l/hr) = <0.1% (use instrument LOD of 0.1)

Therefore: **Site Gas Screening Value = 0.0017** (very low risk)

On the basis of the site observations we have therefore categorised the site as Characteristic Situation 1 based on CIRIA C665. Accordingly, a negligible ground gas risk has been identified at the site.

8.5 Conclusions

Based on the results obtained and risk assessment carried out, and in recognition of the nature of the materials encountered at the site, no special ground gas protection measures are considered to be necessary.

8.6 Radon

The HPA/BGS Indicative Atlas of Radon in Scotland (2011) indicates that the site is in a lower radon probability area where less than 1% of homes are at or above the action level. No radon protective measures are therefore considered necessary in the construction of new dwellings or extensions.

9.0 POTABLE WATER SUPPLIES

9.1 General

The WRAS guidelines (WRAS Information & Guidance Note, October 2002, No 9-04-03 Issue 1: The Selection of Materials for Water Supply Pipes to be Laid in Contaminated Land) have now been withdrawn, and as of autumn 2011 Scottish Water now require the selection of pipe materials for water supply pipes to be carried out in line with the UKWIR Guidance for the Selection of Water Supply Pipes to be Used in Brownfield Sites, dated 2010.

Scottish Water provided developers with additional guidance on the new UKWIR assessment regime, in October 2011. The UKWIR documentation suggests chemical analysis does not require to be carried out where barrier pipe (HPPE) is proposed, as this pipe specification is deemed to be protective of all contaminants which may be present in the ground. Scottish water **do not** however accept that HPPE barrier pipe be considered a default pipe material, without the submission of a desk study or full site investigation report.

The Scottish Water Guidance (as revised V1.3 – April 2013) advises that, where it is established that the land has previously been developed (i.e. 'brownfield'), there is a mandatory requirement for the site investigations to be implemented in accordance with the UKWIR guidance.

Barrier pipe (PE-Aluminium-PE) is deemed to be protective of all contaminants which may be present in the ground. Ductile iron water mains are deemed to be protective of all contaminants which may be present in the ground although analysis to confirm that the ground is not corrosive is required.

It should be noted that polyethylene (PE) or polyvinylchloride (PVC) water supply pipes are only likely to be suitable for uncontaminated sites where the no exceedences of the UKWIR analysis suite are likely to occur.

With respect to water supply main pipe material, chemical analysis to the new UKWIR test suite has been implemented to confirm the pipe material specification requirements. This assessment confirms PVC, PE-Al-PE, wrapped steel and wrapped ductile iron pipe materials are suitable for the site.

Formal approval by Scottish Water would be required for any water pipe material specification recommendation.

10.0 MINING AND MINERAL EXTRACTION

10.1 General

Research of the relevant Geological maps, British Geological Survey, and Coal Authority Data suggest that the site lies within an area that has been affected by historical mining. Correspondence received from the Coal Authority has indicated that they retain records of coal mining in the vicinity of the site. In our review of the site conditions, we have interpreted the general geological and mining configuration based on the evidence of the documentary information and recent physical site investigations, augmented by historical site investigation data for the area.

10.2 Review of Existing Information

British Geological Survey

The geological map indicated the underlying solid strata to belong to the Lower Coal Measures of Carboniferous age. The strata were indicated to dip to the south south-east at an unspecified inclination. Superficial thicknesses were suggested to be up to 5m thick across the site.

The geological map indicated the Armadale Main Cole (~0.0m – 0.9m thick) to outcrop approximately 100m to the north of the site, striking in an approximate west to east orientation. The Armadale Ball Coal (0.43m – 1.17m thick) was indicated to have a conjectured outcrop through the south eastern corner of the site, striking in a similar orientation. The generalised succession of these coal seams beneath the study area is presented below.

Table 12: Conjectured Geological Sequence

Seam Name.	Approximate Intact seam thickness in the vicinity (m)	Approximate Intermediate Strata Thickness(m)
Armadale Ball Coal	0.0 – 0.9 (1-3 leaves)	
Strata		10
Armadale Main Coal	0.43 – 1.17 (2-3 leaves)	

Summary of Existing Site Investigations

The mineral boreholes encountered strata comprising of an alternating sequence of sandstones and coal seams, with conditions consistent with the localised presence of mineral workings also noted. The sequences encountered were considered to be consistent with strata of the Lower Coal Measures. The borehole data has been utilised, where appropriate, to augment the recent studies.

Summary of Documented Mining Conditions — Coal Authority Data

The Coal authority indicated that they were unaware of any mineplans relating to shallow mining in the area. As it did not become a statutory requirement to compile mining records and lodge the appropriate abandonment plans until 1872, a considerable amount of mining had already taken place in the Scottish Coalfields prior to this date and consequently unrecorded mining was considered possible in the area.

10.3 Mining Investigations

The rotary boreholes sunk during the course of the recent investigations were designed to assess the depth to the underlying mineral seams and to determine, the presence or otherwise, of mineworkings at critical depths beneath the site. The boreholes generally recorded a sequence of sandstones and coal measures, which were considered to be consistent with strata

of the Lower Coal Measures. Rockhead was encountered within the rotary boreholes at depths of between 2.5m and 4.0m below existing ground levels, deepening to the east.

In general terms, the mineral seams encountered appeared consistent with the geological base plan information, seam thicknesses and the general stratigraphy suggested for the area.

Solid coals interpreted to represent the Armadale Main Coal were recorded at depths of between 8.0m-14.0m. The geological information confirmed the Armadale Main Coal to be present in 2 leaves. The coals were noted to vary in thickness from 0.5m to 1 .0m within the bores.

In addition, one of the bores (R04) recorded 'soft' and 'broken' at depths of between 8.5m and 12.5m co-incident with a loss of drilling flush. These conditions appeared to be representative of mineworkings at the level of the Armadale Main Coal.

10.4 Surface Instability

In our assessments we seek to achieve a rock / overburden cover thickness of 8 to 10 times the seam extraction height. This is consistent with a number of recent studies in the field of mining stability assessment. In some circumstances, a smaller amount of cover is required, depending on the specific geological and mining conditions. Where considerable and consistent thicknesses of competent glacial till exist, we have assumed a contribution to the stability assessment equivalent to one half of the recorded overburden thickness.

In this case we have sought to achieve an equivalent rock cover of 12.5m, based on an average seam thickness of 1 .0 and 0.5m for the upper and lower leaves of the Armadale Main Coal respectively and the relative contribution of the individual seams.

Based on a review of the information contained within the borehole records and documented depths of the mineral seams beneath the area, it would appear that the entire site lies in a potentially unstable configuration.

In the event that development were to proceed, all structures and any adoptable roads within the potentially unstable zone, including the associated development 'stand-off', would require to be the subject of consolidation by drilling and pressure grout injection.

When assessing the possible abnormal costs associated with the proposed treatment works, it should recognised that some of the boreholes encountered solid strata, suggesting that the workings were not conducted beneath the entire site, and areas of intact mineral would be expected to be present. The extent of the worked areas would therefore be probed out, as an integral element of the treatment operations.

In addition, the drilling and pressure grouting operations would be ultimately designed relative to a definitive development layout, incorporating only those elements which require treatment. Areas of public open space, landscaping and similar, could be excluded from treatment to maximise cost savings.

While unrecorded mineral extraction may have taken place in other deeper lying strata, these mineral workings were considered to lie at sufficient depths to preclude mining instability constraints.

10.5 Quarrying

There is no documentary or physical evidence to suggest that quarrying operations have formerly occurred at the site. However, we would recommend that vigilance be maintained

during site works for any features or evidence, which may suggest the presence of an unrecorded backfilled quarry, although based on the findings of the investigation and historical assessments such features were considered unlikely.

10.6 Mine Entries

The Coal Authority Report did not identify the existence of a mine entry within, or within 20m of the site boundary.

As in all areas of mineral extraction, however, the potential presence of unrecorded mine entries within the study area cannot conclusively be discounted and we would therefore recommend that vigilance be maintained during the site clearance works, in order to identify any feature which could potentially represent unrecorded mineshafts.

11.0 REVISED CONCEPTUAL SITE MODEL

11.1 General

No risk to the proposed development from the identified geo-environmental conditions was identified.

No risk to the water environment (groundwater or surface waters) has been identified.

Based on our assessment of the ground gas monitoring results obtained, special ground gas protection measures are not considered to be necessary.

With respect to water supply main pipe material, PVC, PE-AI-PE, wrapped steel and wrapped ductile iron pipes are considered likely to be suited to the ground conditions.

Mining instability constraints are considered to affect the site and will require consolidation prior to development.

In consideration of the above, the CSM was appropriately revised (Figure 13).

11.2 Assessment of Potential Remediation Options

No remedial measures are considered to be required in relation to the identified environmental condition.

Appropriate certification should be sought prior to the import of any materials to the site. This should include any construction materials

A program of consolidation will be required in order to treat and stabilise the mineworkings beneath the site.

As our evaluations are formulated upon risk based assessments, we would recommend that discussions proceed at this time with both the relevant Local Authority Department to ensure appropriate approvals are obtained prior to detailed design.

12.0 SUMMARY & CONCLUSIONS

12.1 General

This report and the conclusions contained herein have been written in the context of a residential development incorporating domestic garden areas and should not be utilised in any differing context without prior reference to us.

It should be recognised that data interpolation is required whenever engineering or related disciplines are utilised to interpret subsurface conditions and conditions can be subject to considerable variation between survey/sampling points.

12.2 Foundation Options

The made ground materials would not be considered suitable for accepting foundation loadings.

The underlying suitably competent natural granular soils and bedrock are therefore considered to present an appropriate foundation bearing material. , the allowable bearing capacity of the loose to medium dense SAND would be expected to be at least 100kN/m^2. The underlying bedrock is expected to provide a presumed bearing value of at least 1000kN/m^2

Suitably competent natural materials consistent with the foregoing, appeared to be present at shallow depth (<1.0m) over the vast majority of the site. Where the depth to a suitably competent stratum lies at slightly deeper levels, foundations should be deepened and formed by trench filling techniques.

12.3 Chemical Contamination

No specific proprietary measures are considered necessary in relation to the identified geo-environmental conditions.

No risk to the water environment (groundwater or surface waters) has been identified.

12.4 Gas Emissions

Based on current guidance and a risk assessment, ground gas protection measures are not required within the proposed development. No radon protective measures are necessary in the construction of new dwellings or extensions.

12.5 Potable Water Supplies

PVC, PE-AI-PE, wrapped steel and wrapped ductile iron pipe materials are considered likely to be suitable for the site water supply pipework. Formal approval by Scottish Water would however be necessary for any water pipe material specification recommendation.

12.6 Mining

Mineral instability is considered to affect the site. Based on the observed depths of the mineral seams encountered within the boreholes, the entire site is considered to lie in a potentially unstable configuration.

12.7 Other Considerations

A Design Sulphate class of DS1 and an Aggressive Chemical Environment for Concrete (ACEC) designation of AC-1s has been established for the site. Concrete conforming to this specification should be utilised for all concrete structures likely to be in contact with the ground.

12.8 Further Work

Waste Acceptance Criteria (WAC) testing will require to be carried out on any materials designated for off-site disposal.

Consolidation of mine workings will require to be carried out prior to development. The treatment area should be designed relative to the development layout.

The conditions beneath the existing structure should be assessed following site clearance to confirm they are not at variance with the remainder of the study area.

CBR testing will ultimately be required at the appropriate road formation level.

13.0 VALIDATION REQUIREMENTS

13.1 General

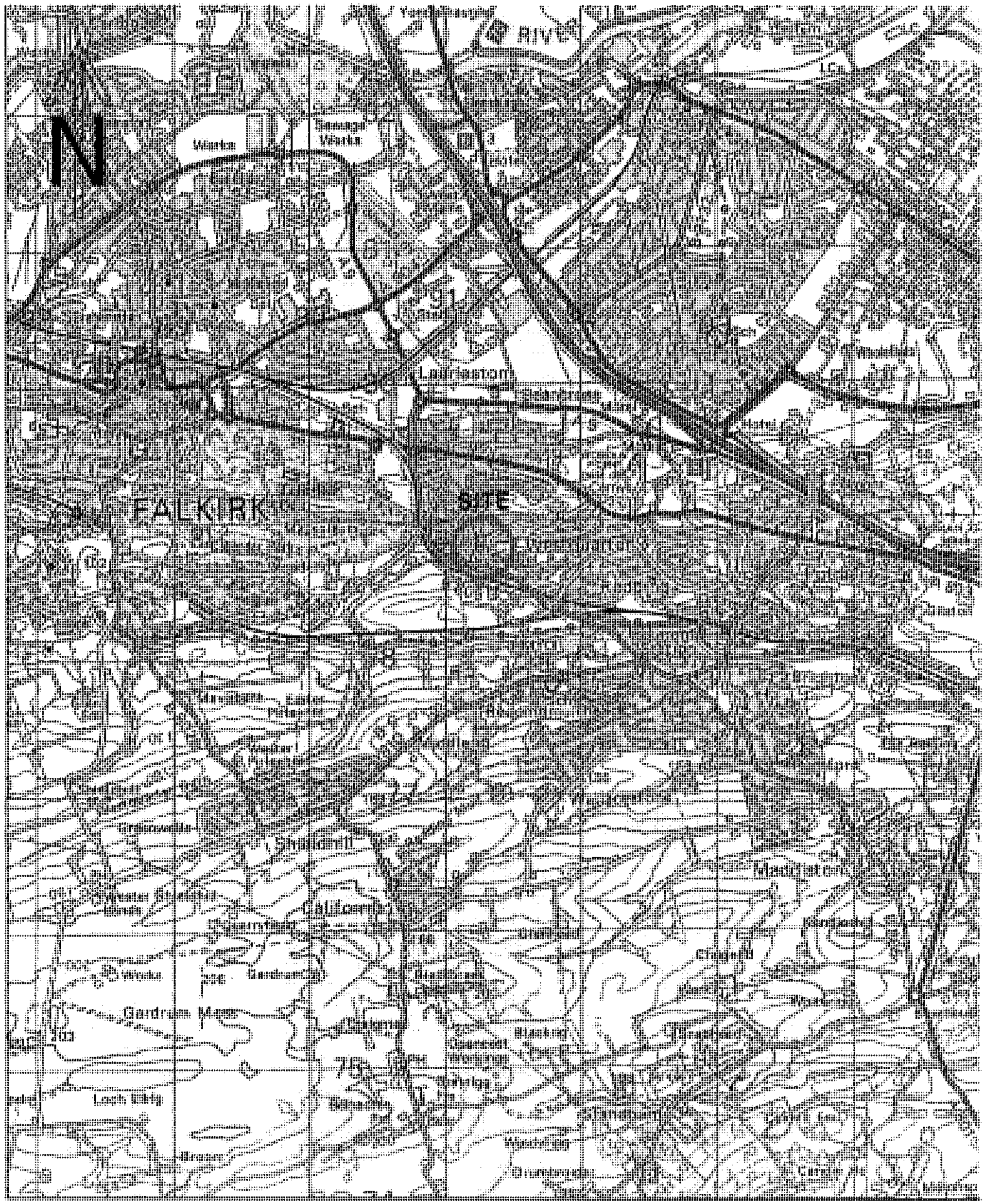
Local Authority regulators and the NHBC require the submission of appropriate validation monitoring and certification, particularly in relation to issues of contaminated land. This requires to be in accordance with the site 'Remediation Statement' following approval by the Local Authority. While the relevant approvals remain to be obtained, based on our understanding of the site conditions, it is possible that validation may ultimately be required in relation to the following

A) Validation of grouting works following consolidation of mine workings
B) Validation of imported materials

We would recommend that where possible all arising materials are adequately managed within the site. Any waste materials disposed to landfill will require to be subjected to Waste Acceptance Criteria (WAC) testing in order that the soil can be appropriately categorised. WAC analysis is carried out to ensure that selected leachable contaminants and organic parameters are below the levels set out in The Criteria for the Acceptance of Waste at Landfills (Scotland) Direction (2005). It is unlikely that the materials will be accepted at landfill unless the results of the WAC testing are available. The analysis takes approximately 3 weeks to complete and this should be accounted for within the development programme. Soil material stockpiled for removal off-site should also be subjected to standard chemical analysis.

It is recommended that any imported soils for placement in domestic gardens, landscaping etc. should be accompanied by relevant chemical analysis, confirming its suitability for use. In the absence of this data, independent analysis would be required to confirm the geochemical nature of the soils prior to placement.

Figures



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client
Hanover (Scotland) Housing Association

project
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title
Site Location Plan

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