PROPOSED SCHOOL SPORTS CENTRE
ST LEONARDS SCHOOL
ST ANDREWS

PHASE I GEO-ENVIRONMENTAL
DESK STUDY REPORT

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EXECUTIVE SUMMARY

Introduction
St Leonards School (the Client) proposes to renovate the existing sports facilities within the south eastern extents of the school grounds to comprise a new sports facility incorporating the existing swimming pool. The site of the proposed development is located on a National Grid Reference of NO51552 16481. Geovia Ltd has been commissioned by to complete a phase I geo-environmental and geotechnical desk study for the subject site, in order to support and inform on the proposed development.

Desk Study Information
The subject site is situated within the south eastern extents of the St Leonards School Campus, St Andrews and is partially covered by an existing sports centre (swimming and squash), tarmacadam and peripheral soft landscaping.

Historical review documents the site to have remained largely undeveloped, set within the context of the St Leonards campus, from the first edition OS map to around the early 1970s. At this time a swimming pool was constructed followed by an extension during the 1980s. No significant change is noted from this period to the present.

The published geological maps do not indicate the presence of made ground deposits to lie within the site. However, due to the development of a swimming pool, cuttings associated with its construction are likely to have been deposited within the close surrounding area. Thin and localised made ground, may be present in the form of reworked natural soils may also be present associated with the existing building. Made ground has previously been identified during the construction of the adjacent junior school to depths of between 0.80mbgl and 2.00mbgl comprising a mixture of reworked topsoil and sands with extraneous brick fragments, traces of ash, tarmac, concrete, pottery and animal bones of varying

Natural superficial deposits within the subject site and close surrounding area are reported to comprise late and post glacial raised marine deposits. These soils were encountered beneath the adjacent junior school site as generally medium dense slightly silty slightly gravelly fine to medium sands with pockets of clay and silty sandy gravels with cobbles of sandstone. Localised areas of glacial till may also be present. Anecdotal evidence from previous construction works within the school grounds indicates the potential for running sands to be present within this area. Published geological maps indicate the underlying bedrock to comprise calciferous sandstone measures of the Sandy Craig Formation.

Mining risks are not considered to exist as the site lies outside former mining areas and coal bearing strata does not underlie the site. In addition, he site is not located within an area identified as requiring a Coal Authority Report for proposed new developments. Historical quarrying of the site has not been documented.

The Flood Risk Management Map, available on the SEPA website, records the site to lie adjacent to, but outwith the potential flood zone associated with surface, river and coastal influence. It should be noted that this does not constitute a formal flood risk assessment.

Environmental risk assessment/conceptual site model (CSM)
The potential for made ground materials to exist within the study area has been identified, arising from historic construction on the site. Given that these soils are likely to be present in the form of reworked natural deposits, the overall environmental risk rating is considered to be low. No other potentially contaminating former land uses have been identified on the site. Some notable historical industrial land uses were identified within the surrounds including a former gas works. However it is presently considered unlikely that these features represent a contamination risk to the study area.

Geotechnical issues
Made ground soils have been identified to between 0.80mbgl and 2.00mbgl as part of previous site investigation for the junior school. Due to the requirements of Historic Scotland's Ancient Monument Consents, the proposed foundation options were narrowed to include either pad and strip footings over trench fill or bottom driven steel cased mini-piles. No information has been viewed of the actual foundation type adopted. A maximum safe net bearing capacity for the sand and gravel deposits of up to 170kN/m^2 was recommended within the primary school investigation.

Based on the information obtained from the site inspection and review of the published historical maps, made ground soils may be exist beneath the site associated with the cut from the construction of the existing swimming pool and tarmac covered areas.

The potential for running sands beneath the study area cannot be discounted based on evidence that these soils were encountered during the construction of St Katherine's House. The presence of running sands may be problematic for certain foundation types and this should also be clarified by way of intrusive investigation.

It is anticipated that the Historic Scotland constraints placed upon the development of the primary school are likely to extend to the proposed sports centre. The historical boundary walls adjacent to the south and east are unlikely to tolerate significant vibrations during the construction process and this should be a major consideration during foundation selection.

Early edition maps record a historical draw well and well approximately 5m and 10m to the west of the proposed sports centre western boundary respectively. It is understood that a manhole currently covers the historical draw well location. The position of the other well, reported approximately 5m to the west of the subject site, was not identified during the site walkover. The position and status of the well should be clarified prior to development commencing on site and workers should remain vigilant to the possibility of its presence during the site strip.

Recommendations

Based on the findings of this desk study, a phase II geotechnical investigation is recommended in order to provide assessment of the shallow soils and groundwater whilst providing geotechnical information to aid in detailed foundation design for the proposed new sports centre. Outline recommendations are considered to include a series of boreholes beneath the proposed building footprint, trial pits to establish the depth and condition of the existing building foundations and post site works gas and groundwater monitoring.

Discussions with Historic Scotland may also be prudent during foundation assessment and when selecting appropriate foundation solutions.

This executive summary forms part of the Geovia Ltd report for St Leonards School, St Andrews (Ref.: 1603-10). Under no circumstances is it to be used as an independent document.

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1.0 INTRODUCTION

1.1 General

St Leonards School (the Client) proposes to renovate the existing sports facilities within the south eastern extents of the school grounds to comprise a new sports facility incorporating the existing swimming pool. The site of the proposed development is located on a National Grid Reference of NO51552 16481. Geovia Ltd has been commissioned by to complete a phase I geo-environmental and geotechnical desk study for the subject site, in order to support and inform on the proposed development.

1.2 Project details

The site is proposed to undergo an extension to improve the existing pool facility including a new sports hall, changing and storage. The proposed development is understood to be set over two storeys and include a fitness suite. A site location plan is presented as Figure 1, with a site layout plan and proposed development layout plan presented as Figures 2 and 3 respectively.

1.3 Purpose and aims of the phase I desk study

This desk study has been developed in order to make a preliminary assessment of the geo-environmental and geotechnical characteristics of the site. The desk study research is used to develop both a preliminary conceptual site model (CSM) for the site and preliminary environmental risk assessment using the Source - Pathway - Receptor model. The assessment findings enable the scope of an appropriate ground investigation to be developed, where required. The desk study has considered the following:

- The current and former uses of the site and its surrounds;
- The environmental setting of the site as determined by the geology, hydrogeology, hydrology and mineral stability;
- Collation of environmental data for the site and its surrounds;
- Collation of existing site investigation within the school grounds which may be pertinent to the proposed development;
- Consultation with the relevant environmental regulators and environmental databases including British Geological Survey (BGS), Fife Council and the Scottish Environment Protection Agency (SEPA);
- A hazard and constraints assessment, development of a preliminary CSM and a risk assessment (potential pollutant linkage assessment) for the site, highlighting the potential sources of contamination, pathways and sensitive receptors; and
- The report draws conclusions from the available desk study information in respect to the environmental/ contamination status of the site and recommendations are made for further work including targeted ground investigation, if appropriate.
- Identification of potential geotechnical and construction related constraints based on available information.

1.4 Report limitations

Limitations of this study are included in Appendix A.

1.5 Previous reporting

A site investigation report associated with the development of the St Leonards Junior School has been viewed (report reference. St Leonards Primary School Geotechnical and Geo-environmental Interpretive Report, Arup, November 2010, including a factual ground investigation report produced by BAM Ritchies, October 2010). Where pertinent, the report findings have been incorporated into this desk study.

2.0 SITE INFORMATION

2.1 General

Details of the site are summarised in Table 1 below.

Table 1 – Site details

Site Address:	St Leonards School, St Andrews, Fife, KY16 9QJ
National Grid Reference (NGR):	NO51540 16480
Size:	Approximately 0.23 hectares
Site description:	The broadly rectangular shaped site is situated within the eastern extents of the St Leonards School Campus, St Andrews. The study area comprises a sports centre, tarmac covered expanse and peripheral soft landscaping. The centre is understood to include a swimming pool, squash courts and associated facilities at present. The study area is positioned approximately 30m to the west of the East Sands within the eastern extents of St Andrews and adjacent to the north of an all-weather playing field. The area is generally flat and is reported to lie approximately 4m AOD.
Description of the surrounding area:	The St Leonards School complex comprises a large campus incorporating both modern and historical buildings, a large proportion of which are linked to the historic cathedral. The school is positioned within the eastern extents of St Andrews dominated by the university, schools, residential developments and commercial shops. The harbour is located approximately 10m east of the site on the opposite side of the wall forming the eastern campus boundary.

2.2 Site walkover

A site inspection was completed on 21st April 2016. A series of photographs from the site visit is presented as Appendix B.

2.3 Site history

The history of the site has been researched from historical survey plans specific to the site. Historical map extracts are presented in Appendix C and are summarised in Table 2 below. All distances from the site are approximate.

Table 2 – Site history

Map Date (Scale)	Site Features	Surrounding Features
1855 (1:1,056 and 1:10,560)	The site is shown to be predominantly undeveloped comprising probable gardens within the south eastern extents of the grounds of the St Leonards Abbey Mill (Flour). A few unidentified small scale buildings are present at the eastern extents of the subject site.	The subject site is set within the south eastern extents of the St Leonards College and probably associated Abbey Mill grounds. The site appears to be adjacent to or partially walled along its northern and eastern boundaries. The Abbey Mill (flour) is present approximately 30m west of the site with a mill dam located approximately 45m to the west. A draw well and well are recorded approximately 10m and 5m to the west of the subject site respectively. The Shore Mill (corn and flour) is noted approximately 20m north east of the subject site with a gas works including 2 gas holders recorded approximately 70m and 110m north of the study area. A timber yard is positioned approximately 110m south of the site. A Cathedral, associated gardens, priory and burial grounds are located extending northwards from approximately 140m

Map Date (Scale)	Site Features	Surrounding Features
1855 (1:1,056 and 1:10,560) continued.		north west of the subject site. The remains of the St Leonards College are present extending northwards and westwards from an approximate distance of 200m to the west. The harbour is present approximately 60m to the north east and the Kinness Burn approximately 10m east of the site flowing northwards.
1895 (1:500 and 1:2,500) – 1896 (1:10,560)	The subject site remains largely unchanged.	A structure (possibly a greenhouse) is located adjacent to and over the northern site boundary. The previously identified Abbey Mill is now designated as an oilcake mill likely to have processed linseed or similar. A new cemetery is located in previously undeveloped land approximately 20m north of the site. The previously identified gasometers are removed, possibly being moved to locations approximately 100m south / south east of the site. Several additional developments are recorded within the St Leonards School/ College grounds extending from an approximate distance of 70m extending towards the north west. In addition, a recreation ground is now present approximately 40m to the south west.
1914 (1:2,500)	No significant change noted.	An additional gasometer is identified approximately 100m to the south of the site. The previously identified Abbey Mill has been redeveloped to comprise St Kathrine's House. The previously identified mill dam and pond is no longer recorded.
1921 (1:10,560)	No significant change noted.	No significant change noted.
1938 (1:10,560)	No significant change noted.	No significant change noted.
1958 (1:10,000)	No significant change noted.	An extension to the St Katherine's House is noted.
1967 (1:2,500)	The site remains undeveloped comprising part of a playing field.	A small Harbour Office is noted on the eastern side of the wall, approximately 20m east. A public convenience is located to the immediate north of the Harbour Office, approximately 20m east of the north eastern corner of the site. Tennis courts are present approximately 20m south of the southern edge of the study area.

Map Date (Scale)	Site Features	Surrounding Features
1973 (1:10,000) and 1974 (1:2,500)	A building, anticipated to comprise the existing swimming pool, covers the northern extents of the site. The southern half remains within the playing fields with a road/ pathway present from east to west through its centre.	A few additional school buildings are noted within a 250m radius including a single storey building and walkway within the southern area adjacent to the west of the site. Outwith a 250m radius, no significant change is noted.
1988 (1:1,250)	An extension to the existing swimming pool has been developed within the south western corner of the site.	No significant change noted.
1993 (1:1,250)	No significant change noted.	No significant change noted.
2000 (1:10,000)	No significant change noted.	No significant change noted.
2015 (1:10,000)	No significant change noted.	The previously identified gas holders, located approximately 100m south of the site, are no longer identified.

The site is recorded to have remained largely undeveloped, set within the context of the St Leonards campus, from the first edition OS map to around the early 1970s. A swimming pool and changing facilities were developed at this time with an extension, anticipated to comprise squash courts developed during the 1980s. External maintenance and renovation aside, no significant changes to the sports centre layout are evident to the present day.

The close surrounding area of St Leonards is noted to include a school, the remains of the former St Leonards College, a former Priory, Bishopshall, hospice, Cathedral remains and cemetery noted prior to 1900.

Early edition maps record a draw well approximately 10m west of the subject site and an additional well approximately 5m west of the subject site The positon of the draw well appeared to have been marked by a manhole cover at the time of site walkover, however the well positioned to the immediate west of the existing sports centre was not identified.

The town of St Andrews is recorded to have been fairly well developed by around 1850 comprising a mixture of residential, commercial, industrial and harbour related developments. The Abbey Mill (flour and oilcake), Shore Mill (corn and flour) and gasometers are notably present, within potential influencing distance, to the north of the site pre 1900 and to the south of the site post 1900 with little additional industrial developments of this type recorded post 1914.

3.0 ENVIRONMENTAL SETTING

3.1 General

The environmental setting for the site has been determined by information obtained from the BGS, SEPA and a site specific Envirocheck report (reference no. 83793123_1_1). Relevant search information received to date is presented in Appendix C.

3.2 Geology

The geology of the site has been reviewed from the following published data:

- BGS Sheet 49, Arbroath drift edition map, 1981 (1:50,000) and solid edition map, 1980 (1:50,000);
- Open-Geoscience – solid and drift geology, obtained from the BGS website.
- A site specific Envirocheck geology report (ref. 83793123_1_1).

Made ground
The published geological maps do not indicate the presence of made ground deposits to lie within the site. However, due to the development of a swimming pool, cuttings associated with its construction may have been deposited within the close surrounding area. Thin and localised made ground, considered likely to be present in the form of reworked natural soils may also be present associated with the existing building.

Site investigation carried out by BAM Ritchies for the Junior School to the west of the study site encountered made ground soils to between 0.80mbgl and 2.00mbgl comprising a mixture of topsoil with brick fragments and reworked brown fine to coarse sands with brick and cobbles of sandstone. Extraneous materials including brick, traces of ash, tarmac, concrete, pottery and animal bones were identified within the made ground soils of varying proportions.

Superficial geology
Natural superficial deposits within the subject site and close surrounding area are reported to comprise late and post glacial raised marine deposits (littoral sand and gravel including intertidal and sub-tidal silts and clays). A zone of bedrock, at or near to the surface is located approximately 150m – 175m to the north.

The natural superficial soils encountered during the Junior School investigation beneath the made ground soils comprise orange-brown slightly silty slightly gravelly fine to medium sands with pockets of clay and silty sandy gravels with cobbles of sandstone. The sand and gravels are reported to fall within the medium dense range within the Arup report. In addition, glacial till was encountered at the south eastern extent of the Junior School at a depth of 2.20mbgl to the base of the borehole at 4.80mbgl. The factual report describes this material as stiff becoming very stiff brown gravelly clay with cobbles and very sandy pockets.

Groundwater monitoring results from the post site works monitoring period identified groundwater levels to vary between dry and 1.95mbgl. Anecdotal evidence from the construction of St Katherine's House indicates the potential for areas of running sand to be present.

Solid geology
Published geological maps indicate the underlying bedrock to comprise calciferous sandstone measures of the Sandy Craig Formation also including sedimentary rock cycles and marine bands.

3.3 Hydrogeology

The Hydrogeological Map at 1:625,000 scale available on the BGS website indicates the bedrock strata underlying the area to comprise sandstone of the Sandy Craig Formation. These rocks are described as a minor to moderately productivity aquifer. Flows are through fractured or potentially fractured rocks which do not have a high primary permeability or other formations of variable permeability.

Superficial raised beach deposits underlying the site are considered likely to have an intermediate to high permeability. The East Fife bedrock and localised sand and gravel aquifers underlying the subject site are reported within the SEPA RBMP to exhibit an overall status of 'Poor' with 'Medium'

confidence (2008). The quality of the groundwater has been classified as 'Good' with 'High' confidence and the quantity of groundwater has been classified as 'Poor' with 'Medium' confidence.

3.4 Hydrology

Water courses
The Kinness Burn is located approximately 10m to the east flowing in a north. The watercourse is classified as having an overall status of 'Poor' with 'Medium' confidence (2008) with an overall ecological status of 'Poor' and overall chemical status of 'Pass'.

The Carnoustie to Fife Ness section of coastal waters associated with St Andrews Bay joins with the Kinness Burn approximately 50m to the north east of the site. This water body is classified as having and overall status of 'Good' with 'High' confidence (2008) with and overall ecological status of 'Good' and overall chemical status of 'Pass'.

Flooding
The Flood Risk Management Map, available on the SEPA website, records the site to lie adjacent to, but outwith the potential flood zone associated with surface, river and coastal influence. It should be noted that this does not constitute a formal flood risk assessment.

3.5 Mineral abstraction

Quarrying
The historical maps do not record any evidence of quarrying on the site or in the immediate surrounding area.

Mining
A low risk of shallow mining related subsidence is considered for the site. The site is not located within an area identified as requiring a Coal Authority Report for proposed new developments.

3.6 Regulatory authority information

Table 3 (overleaf) summarises the relevant and key findings detailed within the Envirocheck report. A copy of the report is presented in Appendix D.

Table 3 – Summary of regulatory authority information

Land Use/ Data type	Distance from site (m)			Details
	On site	0 – 250	251 – 500	
Landfill and other Waste Sites (Historic)				
Operational and non-operational waste treatment, transfer and disposal sites.	0	0	1	463m W – University of St Andrews, incineration, site produced wastes only. Authorised wastes include animal bedding, carcasses and flesh, excrement, medical, surgery, veterinary wastes, paper and sawdust.
Current Land uses				
Discharge Consents	0	0	3	263m SW – Glebe Park, Wpc/E/20353, Storm Overflow; 381m NE – St Andrews Stw, Wpc/E/10265, Primary sewage settlement; 393m NE – University of St Andrews, Wpc/E/20724, Trade effluent.
Registered radioactive substances	0	0	9	292m SE, 297mSE, 399m SE, 403m SE, 479m W, 480m W, 485m W (2) – All University of St Andrews.
Environmentally sensitive receptors				
The Craig Hartle region of the coastline located approximately 600m SE of the study site is reported as a site of special scientific interest (SSSI).				
Health Protection Agency				
Radon potential	Information obtained from the Health Protection Agency presented by UK Radon indicates that less than 1% of houses within the 1km grid square area exhibit radon concentrations above the Action Level (200Bq/m^3). As a result, no specific radon protection measures are considered necessary against ingress and accumulation.			

4.0 CONCEPTUAL SITE MODEL (CSM)

4.1 Introduction

As part of this assessment, and in line with current guidance (e.g. BS10175:2001 Investigation of Potentially Contaminated Sites), the desk study information is used to develop a preliminary Conceptual Site Model (CSM) for the site. The CSM is a written or pictorial representation or working description of an environmental system on the site and the surrounding area, and its purpose serves to draw together the potential sources of contamination (hazards) that may be present on or surrounding the site. The CSM also identifies the sensitive receptors that may harmed by a given source and identifies the pertinent pathways that may be present between the two.

The nature of sources, pathways and receptors are site specific and will vary depending on such things as site history, ground and ground water conditions, and current and proposed end uses of a particular site.

The conceptual model comprises the following:

Potential contamination sources – contamination sources (anthropogenic) that may have originated from potentially contaminative processes/operations as highlighted by the current and historical land uses at the site, and the information gathered during consultation with the environmental regulators. Naturally occurring sources may also be present and could be due to the natural ground conditions below the site (e.g. soils of high organic content).

Receptors – Sensitive receptors, (e.g. future users of the site, environmental receptors such as the water environment etc.) which may be harmed by a source of contamination or hazard. Off site and on site sensitive receptors will vary and depend on the end use of the site and its environs. The future sensitivity of the site, and hence number of receptors available, may also depend upon the sensitivity of the intended use (e.g. an industrial end use will be less sensitive in respect to human health than a land use comprising residential dwellings with private gardens).

Potential pathways – Pathways comprise media through which contamination can be transported. Pathways available to link a source to a receptor may depend on the underlying geology, groundwater regime and future site uses. The number of pathways available will also depend on the sensitivity of the end use of a particular site.

4.2 Potential sources of contamination

Historical review helps the understanding of the historical processes/operations that have occurred on the site and in its surrounds, and helps to identify whether potential sources of contamination may be present. Potential contaminants have been selected from the site's current and former uses and by review of the now withdrawn R&D Report CLR8 (for information only) and the Department of Environment (DoE) Industry profiles, where appropriate.

The observations from the site inspection and review of the site history has identified limited potential for on-site sources of contamination, anticipated to be associated with the development of the existing buildings. Made ground soils are considered likely to be present predominantly in the form of reworked natural soils. Extraneous building materials such as brick and concrete may also be present. Part of the proposed development area is tarmac covered and is therefore likely to be underlain by a hardcore capping layer/ sub-base.

It is noted that chemical analysis of soils carried out within the site investigation for the St Leonards Primary School identified no elevated soil concentrations with respect to human health within the made ground or natural soils tested.

Whilst several historical potential sources such as gasometers have been identified within the surrounding area, the operational ages, distance from site and direction of groundwater flow is such that they are not considered to exhibit a significant potential for migration onto site.

4.3 Potential pathways

Based on the proposed residential and commercial end use, including limited soft landscaping and associated infrastructure, the following potential pathways are considered relevant:-

- **Dermal contact** - Direct skin contact with soils, dust or groundwater. This pathway will be largely restricted to proposed areas of proposed soft landscaping;
- **Ingestion** – Ingestion of soil, dust and groundwater. As with dermal contact, this pathway will be most prevalent in proposed soft landscaped areas;

- **Inhalation** – Inhalation of soil, dust or vapours within the built and outdoor environment;
- **Plant root uptake** – Restricted to proposed areas of soft landscaping;
- **Leaching** – Contaminant mobility in aqueous phase through soil via leaching;
- **Direct contact** – Attack and corrosion of buried services and concrete; and
- **Ground gas migration** – Build-up of hazardous gas resulting in asphyxiation, explosion or fire.

4.4 Potential receptors

Potential receptors pertinent to the proposed future residential redevelopment include the following:

- **Future site users, staff, pupils and visitors** - The most sensitive end user in this scenario is likely to be a female aged 5+ years, with behaviour patterns leading to high exposure;
- **Vegetation** - In areas of soft landscaping, anticipated to be limited due to majority coverage by building footprint;
- **Water environment** – Underlying groundwater aquifer, either perched within the superficial deposits or within the bedrock, Kinness Burn and the Carnoustie to Fife Ness section of St Andrews Bay;
- **Buildings and structures** - In-ground structures and buried services.

Table 4 below summarises the potential sources of contamination that may be associated with the study area, and whether a potential pollutant linkage has been identified.

Table 4 – Potential contaminants of concern

Source	Rationale	Potential contaminants	Potential pollutant linkage identified
On-site sources			
Localised made ground associated with historical development of the existing site buildings.	Deposits of made ground may be anticipated given the site's existing development. Considered likely to be present mainly in the form of reworked natural soils. Extraneous materials such as brick cannot be discounted with a limited potential for ground gas identified.	Ground gases such as methane, carbon dioxide and depleted oxygen concentrations.	Unlikely.
Off-site sources			
The Abbey Mill (Flour and latterly oilcake), present to around 1914, approximately 30m W.	Potential migration onto site	Soil contaminants considered unlikely given mill produce. Ground gases such as methane, carbon dioxide and depleted oxygen concentrations.	Unlikely.
The Shore Mill (Corn and Flour) from 20m NE, no longer listed as a mill post 1900.	Potential migration onto site		Unlikely.
Historical Gasometers (70m and 110m N to 1895, 100m south)	Potential migration onto site	May include metals, sulphur, cyanide, asbestos, pH, phenol, BTEX or VOCs, PAH.	Unlikely.
Historical Timber Yard/ Sawmill, 110m S, disused by 1900.	Potential migration onto site	May include metals, asbestos, sulphur, Ph, phenol, hydrocarbons, PAH.	Unlikely.

4.5 Potential geotechnical constraints noted for the previous primary school development

Whilst made ground soils were identified to between 0.80mbgl and 2.00mbgl as part of previous site investigation for the junior school, these soils are likely to have been associated with the former Abbey Mill and latter construction of St Katherine's House.

Groundwater levels of between 1.95mbgl and 2.15mbgl were recorded within the primary school site investigation. In addition, soil infiltration rates from tests carried out within 2 of the trial pits identified soil conditions to vary between low and moderate permeability. The Arup report recommends that

conventional sump and pump groundwater be allowed for where groundwater is encountered at foundation formation depth.

Potential foundation options for the proposed primary school were identified as conventional pad/ strip footings placed onto trench fill at depths of up to 2.00mbgl into the natural sand and gravel deposits. Additional options initially considered include a raft foundation, vibro-improvement and mini-piling. Due to the requirements of Historic Scotland's Ancient Monument Consents, the proposed foundation options were narrowed to include either pad and strip footings over trench fill or bottom driven steel cased mini-piles. No information has been viewed of the actual foundation type adopted.

A maximum safe net bearing capacity for the sand and gravel deposits of up to 170kN/m^2 was recommended within the primary school investigation.

4.6 Potential geotechnical constraints:- proposed sports centre

Made ground and running sand
Based on the information obtained from the site inspection and review of the published historical maps, made ground soils may be exist beneath the site associated with the cut from the construction of the existing swimming pool and tarmac covered areas.

As no significant historical development has been identified within the study area prior to the construction of the swimming pool and later extension, the likelihood of made ground soils being present to similar depths to those encountered beneath the former Abbey site (St Leonards Primary School), is considered to be low.

Typically, made ground deposits do not represent a suitable founding stratum and as such, it is likely that structural loadings resulting from the proposed sports centre redevelopment will require to be transferred to the underlying natural soils at a depth to be confirmed by intrusive investigation.

The potential for running sands beneath the study area cannot be discounted based on evidence that these soils were encountered during the construction of St Katherine's House. The presence of running sands may be problematic for certain foundation types and this should also be clarified by way of intrusive investigation.

Groundwater
Given the close proximity of the propose sports centre to the primary school, groundwater levels beneath the proposed sports centre may be similar.

Historic Scotland
It is anticipated that the Historic Scotland constraints placed upon the development of the primary school are likely to extend to the proposed sports centre. The historical boundary walls adjacent to the south and east are unlikely to tolerate significant vibrations during the construction process and this should be a major consideration during foundation selection.

Historic wells
The presence of historic wells have been identified approximately 10m and 5m to the west of the proposed sports centre western boundary. It is understood that a manhole currently covers the historical draw well location. The position of the well, identified approximately 5m to the west of the subject site, was not identified during the site walkover. The position and status of the well should be clarified prior to development commencing on site.

4.7 Potential mining related constraints

Based on the research carried out, the risk of mining related ground instability is not considered to represent a potential development constraint.

5.0 ENVIRONMENTAL RISK ASSESSMENT

5.1 General

Planning Advice Note (PAN) 33, (revised 2000), Development of Contaminated Land, was issued by the Scottish Executive Development Department with the objectives of providing advice on development when contamination is known or suspected to be present. PAN 33 records that a number of definitions of contaminated land exist.

Contaminated land is defined in the Environmental Protection Act (1990) Part IIA, as:

'Any land which appears to the local authority in whose area it is situated to be in such a condition, by reasons of substances in, on or under the land, that significant harm is being caused or there is a significant possibility of such harm being caused', or 'Pollution of the water environment is being, or is likely to be caused.'

PAN 33 further states

'It is important to recognise that Part IIA definition reflects the intended role of the contaminated land regime, i.e. to enable the identification and remediation of land from which contamination currently represents an unacceptable risk to human health or the wider environment. Part IIA contaminated land does not necessarily include all land where contaminants are present. With regard to a planning regime, a site containing contaminants may not be likely to cause significant harm in its current use, but if a different use were proposed, then the potential for significant harm may be enhanced. Moreover, the mere presence (or suspected presence) of contaminants may prove an impediment to the successful development of a site.'

In considering the reuse of land, the Scottish Executive considers the "*suitable for use*" approach as the most appropriate way of dealing with potentially contaminated land. This focuses on the risks that may be posed by contamination on the basis of the proposed future use of a particular site and serves to avoid future unacceptable risks to human health and the surrounding environment.

Planning Advice Note 33 further states,

"*The possibility of contamination on a site proposed for development should trigger a response which takes into account the potential risk. Planning authorities, therefore, need to consider 'contaminated land' in its broadest sense. Contaminated sites, for planning purposes, may be regarded as any site where the presence or suspected presence of contaminants is an obstacle to development, regardless as to whether development is proposed.*"

5.2 Risk assessment

The consideration of potential harm is based upon the principles of risk assessment where "risk" is defined as the combination of the probability, or frequency of occurrence of a defined hazard (for example, exposure to a property of a substance with potential to cause harm) and the magnitude (including the seriousness) of the consequences.

A conceptual site model for the site has been established in the previous section by using the source - pathway - receptor model. An assessment of risk is also developed using this model and is assessed in terms of plausible pollutant linkages. A plausible pollution linkage is the existence of all three elements in a particular linkage, i.e. a source, a receptor, and a pathway enabling the source to 'migrate' to the receptor. For a potentially significant or unacceptable risk to be present it is considered that a pollutant linkage must be present. Without one or more of these elements the pollutant linkage is not considered complete and therefore the presence of contaminants does not necessarily mean that unacceptable risks may exist.

During the risk assessment, consideration is given to the potential for significant pollutant linkages to exist at the site and assigns a level of risk to each linkage. This risk rating establishes what further work may be required in order to clarify whether a certain linkage is potentially significant or not. Further work will usually include intrusive investigation works including chemical assessment of soils and/or groundwater.

Table 5 lists the possible source-pathway-receptor linkages and assesses the likelihood of the linkages existing. Whilst assessing the likelihood of linkages occurring, mitigating circumstances are

taken into consideration including distances, direction of groundwater flow, age of former site uses and subsequent development works where appropriate.

In considering the environmental risk the following levels of risk are assigned.

- **Low risk** - It is considered unlikely that plausible significant pollutant linkages are present on site. Therefore significant environmental issues are deemed low risk. Further work is usually not required.
- **Medium risk** - It is considered possible that plausible significant pollutant linkages are present on site that may represent an environmental issue. Further work would be usually required to clarify the risk.
- **High risk** - It is likely that plausible significant pollutant linkages are present on the site that would represent an environmental liability. Further work would be required to assess the environmental issues.

A preliminary environmental risk assessment is presented in Table 5 overleaf.

Table 5 – Preliminary environmental risk assessment

Potential sources	Contaminants of concern (CoCs)	Pathway	Receptor	Potential pollutant linkage identified	Assessment of risk
On-site Sources					
Potential made ground soils associated with the development of the existing swimming pool and extension.	Unknown but considered unlikely to be present provided soils considered likely to comprise reworked natural. Ground gas associated with made ground soils such as methane, carbon dioxide and depleted oxygen.	Ingestion and dermal contact	Human health – Future site end users, staff, pupils, maintenance workers and visitors.	✗	**LOW** – Potential significant sources of contamination are considered unlikely within the made ground soils given the site history and existing developments. In addition, pathways are considered to be significantly restricted by the presence of a proposed building footprint which will dominate the site. As such, the risk of harm to human health through ingestion, dermal contact and inhalation pathways is considered to be at a low level.
		Volatilisation and inhalation of contaminants		✗	
		Inhalation of dust borne particulates		✗	
		Root Uptake	Plants and vegetation within oft landscaped areas	✗	**LOW** – Potential significant sources of contamination are considered unlikely within the made ground soils given the site history and existing developments. In addition, proposed soft landscaped areas are limited and the risk to the success of plant life is considered to be low.
		Leaching of contaminants and migration in aqueous phase	Water Environment: Groundwater aquifer and surface water bodies	✗	**LOW** – Potential significant sources of contamination are considered unlikely within the made ground soils given the site history and existing developments. In addition, the majority of the site will comprise building footprint and hardstanding which will act to limit surface water ingress beneath the proposed sports centre.
		Generation and migration of ground gas.	Human health – Future site end users and general public	✗	**LOW** – Based on the documented site history, the potential for significant made ground soils is considered to be low. On this basis, the risk of significant ground gas generation is also considered to be low.
		Direct contact	Services/ Utilities	✗	**LOW/ LOW to MEDIUM** – Based on the site history, existing development and presence of existing services, the risk to new foundations and buried services is considered to be low. Given that the structure is to be located within close proximity to a coastal water body a marginally elevated potential for chloride attack is identified.

Potential sources	Contaminants of concern (CoCs)	Pathway	Receptor	Potential pollutant linkage identified	Assessment of risk
Off-site sources					
The Abbey Mill (Flour and latterly oilcake), present to around 1914, approximately 30m W.	Soil contaminants considered unlikely given produce. Ground gases, methane, carbon dioxide and depleted oxygen.	Migration onto site	Future site end users, staff, maintenance workers and visitors.	✗	**LOW** – Pollutant linkages associated with this potential historical source are considered unlikely to impact the study site given the reported mill produce and date of operation. In addition, chemical testing carried out as part of the adjacent junior school site investigation identified no elevated soil contaminants within the near surface soils within this area.
The Shore Mill (Corn and Flour) from 20m NE, no longer listed as a mill post 1900.	Soil contaminants considered unlikely given produce. Ground gases, methane, carbon dioxide and depleted oxygen.	Migration onto site	Future site end users, staff, maintenance workers and visitors.	✗	**LOW** – Pollutant linkages associated with this potential historical source are considered unlikely to impact the study site given the reported mill produce, date of operation and anticipated direction of groundwater flow.
Historical Gasometers (70m and 110m N to 1895, moved 100m south post 1895).	May include metals, sulphur, cyanide, asbestos, pH, phenol, BTEX or VOCs, PAH.	Migration onto site	Future site end users, staff, maintenance workers and visitors.	✗	**LOW** – Pollutant linkages associated with this potential historical source are considered unlikely to impact the study site given the reported date of operation and anticipated direction of groundwater flow in relation to the study site.
Historical Timber Yard/ Sawmill, 110m S, disused by 1900.	May include metals, asbestos, sulphur, Ph, phenol, hydrocarbons, PAH.	Migration onto site	Future site end users, staff, maintenance workers and visitors.	✗	**LOW** – Pollutant linkages associated with this potential historical source are considered unlikely to impact the study site given the reported date of operation and anticipated direction of groundwater flow in relation to the study site.
OVERALL RISK					**LOW**

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 General

St Leonards School (the Client) proposes to renovate the existing sports facilities within the south eastern extents of the school grounds to comprise a new sports facility incorporating the existing swimming pool. The site of the proposed development is located on a National Grid Reference of NO51552 16481. Geovia Ltd has been commissioned by to complete a phase I geo-environmental and geotechnical desk study for the subject site, in order to support the proposed development.

6.2 Desk study information

The site is situated within the eastern extents of the St Leonards School Campus, St Andrews, comprising a sports centre, tarmac covered expanse and peripheral soft landscaping.

The site is recorded to have remained largely undeveloped, set within the context of the St Leonards campus, from the first edition OS map to around the early 1970s, at which time a swimming pool was developed, with an extension subsequently developed during the 1980s. No significant change is noted from this period to the present.

Early edition historical maps record St Andrews to be fairly well developed by around 1850 comprising a mixture of residential, commercial, industrial and harbour related developments. The Abbey Mill (flour and oilcake), Shore Mill (corn and flour) and gasometers are notably present, within potential influencing distance, to the north of the site pre 1900 and to the south of the site post 1900 with little additional industrial developments of this type recorded post 1914.

The published geological maps do not indicate the presence of made ground deposits to lie within the site. However, due to the development of a swimming pool, cuttings associated with its construction may have been deposited within the close surrounding area. Thin and localised made ground, considered likely to be present in the form of reworked natural soils may also be present associated with the existing building.

Site investigation carried out by BAM Ritchies for the Junior School to the west of the study site encountered made ground soils to between 0.80mbgl and 2.00mbgl comprising a mixture of reworked topsoil and sands with extraneous brick fragments, traces of ash, tarmac, concrete, pottery and animal bones to varying degrees.

Natural superficial deposits within the subject site and close surrounding area are reported to comprise late and post glacial raised marine deposits.

The natural superficial soils encountered during the Junior School investigation were reported as orange-brown slightly silty slightly gravelly fine to medium sands with pockets of clay and silty sandy gravels with cobbles of sandstone. The sand and gravels are reported to fall within the medium dense range within the Arup report. In addition, glacial till was encountered at the south eastern extent of the Junior School at a depth of 2.20mbgl to the base of the borehole at 4.80mbgl. The factual report describes this material as stiff becoming very stiff brown gravelly clay with cobbles and very sandy pockets.

Published geological maps indicate the underlying bedrock to comprise calciferous sandstone measures of the Sandy Craig Formation.

Groundwater monitoring results from the post site works monitoring period identified groundwater levels to vary between dry and 1.95mbgl. Anecdotal evidence from the construction of St Katherine's House indicates the potential for running sand to be present within this area.

A low risk of shallow mining related subsidence is considered for the site. The site is not located within an area identified as requiring a Coal Authority Report for proposed new developments. Historical quarrying of the site has not been documented.

The Flood Risk Management Map, available on the SEPA website, records the site to lie adjacent to, but outwith the potential flood zone associated with surface, river and coastal influence. It should be noted that this does not constitute a formal flood risk assessment.

6.3 Environmental issues

Based on the available desk study information and the observed condition of the site, a preliminary conceptual site model and environmental risk assessment have been developed. Significant potential sources of contamination have not been identified at or within influencing distance associated with historical development of the study area. In addition, the proposed building footprint will dominate the site with limited proposed soft landscaping significantly limiting potential exposure to human health and plant life. Consequently the overall environmental risk is considered to be **low**.

6.4 Geotechnical issues:- Primary school site investigation

Whilst made ground soils were identified to between 0.80mbgl and 2.00mbgl as part of previous site investigation for the junior school, these soils are likely to have been associated with the former Abbey Mill and latter construction of St Katherine's House.

Groundwater levels of between 1.95mbgl and 2.15mbgl were recorded within the primary school site investigation. In addition, soil infiltration rates from tests carried out within 2 of the trial pits identified soil conditions to vary between low and moderate permeability. The Arup report recommends that conventional sump and pump groundwater be allowed for where groundwater is encountered at foundation formation depth.

Foundation options considered for the proposed primary school were identified as conventional pad/ strip footings placed onto trench fill at depths of up to 2.00mbgl into the natural sand and gravel deposits. Additional options initially considered include a raft foundation, vibro-improvement and mini-piling.

Due to the requirements of Historic Scotland's Ancient Monument Consents, the proposed foundation options were narrowed to include either pad and strip footings over trench fill or bottom driven steel cased mini-piles. However the actual foundation type adopted is not currently known. A maximum safe net bearing capacity for the sand and gravel deposits of up to 170kN/m^2 was recommended within the primary school investigation.

6.5 Potential geotechnical constraints:- Proposed sports centre

Made ground and running sand
Based on the information obtained from the site inspection and review of the published historical maps, made ground soils may be exist beneath the site associated with the cut from the construction of the existing swimming pool and tarmac covered areas.

As no significant historical development has been identified within the study site prior to the construction of the swimming pool and later extension, the likelihood of significant made ground soils being present to similar depths encountered beneath the former Abbey site (St Leonards Primary School), is not anticipated although this would need to be proved/ confirmed by specific ground investigation .

Typically, non-engineered made ground deposits do not represent a suitable founding stratum and as such, it is likely that structural loadings resulting from the proposed sports centre redevelopment will require to be transferred to the underlying natural soils at a depth to be confirmed by intrusive investigation.

The potential for running sands beneath the study area cannot be discounted based on evidence that these soils were encountered during the construction of St Katherine's House. The presence of running sands may be problematic for certain foundation types and this should also be clarified by way of intrusive investigation.

Groundwater
Given the close proximity of the propose sports centre to the primary school, groundwater levels beneath the proposed sports centre may be similar.

Historic Scotland
It is anticipated that the Historic Scotland constraints placed upon the development of the primary school are likely to extend to the proposed sports centre. The historical boundary walls adjacent to the south and east are unlikely to tolerate significant vibrations during the construction process and this should be a major consideration during foundation selection.

Historic wells
Early edition maps record a historic well and a draw well approximately 5m and 10m to the west of the proposed sports centre western boundary respectively. It is understood that a manhole currently covers the historical draw well location. The position of the other well, identified approximately 5m to the west of the subject site, was not identified during the site walkover. The position and status of the well should be clarified prior to development commencing on site. Construction phase personnel should be vigilant during the site strip to the possible presence of a well within the western extents of the site.

6.6 Mining Constraints

Based on the available information, the risk of mining related ground instability is considered to be low. The site is considered to lie outside former mining areas or coal fields.

6.7 Recommendations

Based on the findings of this investigation, a geotechnical phase II investigation is recommended in order to provide sufficient information for a detailed assessment of the underlying soils and groundwater to aid in detailed foundation design.

The following table 6 summarises the investigation requirements which would take into consideration both geotechnical and environmental considerations. The density of exploratory holes and sample analyses should be carried out in accordance with BS10175 – Investigation of Potentially Contaminated Sites – Code of Practice (2011 + A1 (2013)).

Table 6 – Summary of proposed intrusive investigation

Method	Rationale
Machine excavated trial pits/ hand excavated trial pits	To investigate the geotechnical characteristics of the near surface soils and to allow for sampling of the near surface soils. Hand pits to confirm the foundation configuration of the existing swimming pool building.
Cable percussive boreholes	To allow investigation and description of the near surface soils. Samples would also be recovered for subsequent geotechnical testing. Within the boreholes, in-situ testing to be completed to allow derivation of engineering parameters to aid foundation and engineering design.
Combined ground gas and groundwater monitoring installations	Allow assessment of any groundwater at the site. Post site works groundwater monitoring to confirm water table depth. In addition, post site works gas monitoring to clarify the gas regime beneath the site with respect to made ground soils within influencing distance or beneath the site.
Geotechnical testing	In-situ testing within the boreholes and a limited number of soil classification tests to provide geotechnical design parameters for the foundation and engineering requirements of the development.
Chemical testing	Limited chemical testing of near surface soils primarily to determine appropriate concrete classification. This may also include