8 Geology, Contaminated Land and Groundwater

This chapter identifies existing geology, contaminated land and groundwater conditions and assesses the potential impacts for the Northern Leg of the proposed scheme. Where possible, measures for avoiding or mitigating these impacts are identified.

Based on a desk based assessment, preliminary ground investigations and consultations, site specific descriptions of drift and solid geology were provided. No sites of geological importance were identified. Data were also collected on sites of potential contaminated land and on groundwater flow and groundwater resources, including wells and springs.

No potential significant impacts were identified for solid geology or drift deposits, but the potential for moderate to substantial impacts were identified on groundwater flow and quality. However, a series of mitigation measures, including groundwater flow and quality monitoring will enable the future development of additional, site-specific mitigation if required. Private water supplies will be replaced if any major impairment is noted during construction.

Contaminated material will be treated or removed to avoid risks to construction workers and impacts upon groundwater. The assessment identified the requirement for further contaminated land investigation in the area surrounding West Hatton landfill. Potential impacts on groundwater quality arising from disturbance to contaminated land will be assessed in further detail prior to construction. The proposed scheme would result in a Slight adverse overall impact significance for geology and groundwater and a Slight beneficial impact significance for contaminated land.

8.1 Introduction

8.1.1 This chapter assesses the effects of the Northern Leg of the proposed scheme on geology, including contaminated land and local groundwater resources. The assessment includes solid (bedrock) and drift geological deposits, such as peat and sands and gravels. Assessment of the value of local soils is limited to their agricultural capability and this issue is discussed in Chapter 7 (Land Use).

8.1.2 Both geology and soils play an important part in determining the environmental characteristics of a region. The underlying geology has a major influence on landform, and rocks provide the parent material from which soils are created. The nature of the rock helps to determine not just the nature and chemistry of the soil, but also the rate at which it forms. This in turn strongly affects the vegetation that will grow naturally and the type of agriculture or horticulture that can be sustained.

8.1.3 There are a variety of ways in which road developments can impact on geological resources. Road schemes may sterilise or remove soils associated with prime agricultural land, or sterilise underlying mineral resources. Excavating or masking exposures of rocks or drift geological deposits of scientific interest can represent a serious impact if the features of interest are not reproduced elsewhere in the area. Similarly, removal or modification of geomorphological features can affect their scientific value or the local landscape resource. Impacts can also affect the existing or potential future commercial exploitation of resources and ground conditions may impose constraints on a proposed road scheme, for example, where land has become unstable due to mining or has been contaminated by previous land uses.

8.1.4 Road schemes can have potential impacts on underlying groundwater aquifers both during construction and operation. For example, construction works which involve excavation can lead to dewatering of shallow aquifers. There is also a risk of spillage or leakage of fuel or oil from storage tanks or construction plant. Without suitable mitigation measures, these pollutants can enter the aquifers. Once a new road is opened, runoff from the surface may contain elevated concentrations of pollutants such as oils, suspended solids, metals (e.g. copper and zinc) and, in winter, salt and engine coolants (e.g. ethylene glycol). Consequently, without adequate design measures, highway drainage discharges can cause pollution to aquifers.

8.1.5 This chapter presents baseline conditions, potential impacts and any associated mitigation measures in relation to the solid strata, the covering drift deposits and the associated

groundwaters. Residual impacts are then predicted taking into account the proposed mitigation. The assessment also focuses on current and historic mineral extraction and contaminated land, and considers impacts occurring both during construction and operation.

8.2 Approach and Methods

Baseline Conditions

8.2.1 The study area for the assessment extends to approximately 250m either side of the proposed route. The assessment was undertaken by means of consultation, a desk study and site investigations.

8.2.2 Consultations were undertaken with a number of statutory and non-statutory bodies holding records pertinent to the assessment. These include the following:

- Aberdeenshire and Aberdeen City Councils, for records of Regionally Important Geological Sites (RIGS) and information on contaminated sites and private water supplies;
- British Geological Survey (BGS), for information on local geology, drift and borehole information; and
- Scottish Environment Protection Agency (SEPA), for contaminated sites, waste disposal sites and industrial processes.

8.2.3 The desk-based studies followed the recommended scope of DMRB, Volume 11, Section, Part 11 Chapter 5, Geology and Soils (The Highways Agency, 1993 as amended). Information provided by consultees and publicly available information was supplemented by information from preliminary ground investigations undertaken in 2004. These investigations concentrated on assessing the geotechnical characteristics of the drift geology. The materials encountered were described in detail to facilitate the identification of potentially contaminated ground for the purposes of this assessment.

8.2.4 A programme of additional consultation with landowners commenced in March 2007, following publication of the December 2006 ES. This consultation focused on the confirmation of desk study identified private water supplies located partly or fully within the study area (i.e. 250m either side of the proposed scheme).

Impact Assessment

8.2.5 As described in Chapter 5 (Overview of Assessment Process), impact significance was determined with respect to the sensitivity/importance of the baseline conditions and the magnitude of potential impact. This is described in detail below.

Sensitivity/Importance

8.2.6 The importance or sensitivity of the geological and groundwater interest of the study area was determined using the criteria set out in Tables 8.1 and 8.2.

Table 8.1 – Sensitivity Criteria for Geology

Sensitivity	Description	Examples of Receptors
High	Areas containing geological or geomorphological features considered to be of national interest.	Sites of Special Scientific Interest (SSSIs).
Medium	Areas containing features of designated regional importance considered worthy of protection for their educational, research, historic or aesthetic importance.	Regionally Important Geological Sites (RIGS).
Low	Features not currently protected and considered not to require specific protection.	n/a

Table 8.2 – Sensitivity Criteria for Groundwater

Sensitivity	Description
High	Local groundwater aquifer(s) constitutes a valuable resource because of its high quality and yield, or extensive exploitation for public, private domestic, agricultural and/or industrial supply. Designated sites of nature conservation dependent on groundwater.
Medium	Local aquifer(s) of limited value because quality does not allow potable or other quality sensitive uses. Exploitation of local groundwater is not extensive. Local areas of nature conservation known to be sensitive to groundwater impacts.
Low	Poor groundwater quality and/or very low permeabilities make exploitation of the aquifer(s) unfeasible. Changes to groundwater not expected to have an impact on local ecology.

8.2.7 Specific criteria are not defined for the assessment of mineral extraction or contaminated land as these aspects primarily represent engineering considerations for the scheme construction and their extent, nature and required mitigation will be assessed by specific site investigations undertaken by the Contractor prior to detailed design of the development. However, the occurrence and proposed management of these aspects has been considered, assessed qualitatively, and presented as part of this assessment.

Impact Magnitude

8.2.8 The magnitude of impact on geological and groundwater interests was determined in accordance with the criteria shown in Table 8.3 and 8.4.

Table 8.3 – Magnitude Criteria for Geology

Magnitude	Description
High	Where there would be partial (greater than 50%) or total loss of a site, or where there would be complete severance of a site such as to significantly affect the value of the site.
Medium	Where there would be loss of part (between approximately 15% to 50%) of a site, major severance, major effects to the setting, or disturbance such that the value of the site would be affected, but not to a major extent.
Low	Where there would be a minimal effect on a site (up to 15%) or a medium effect on its setting, or where there would be a minor severance or disturbance such that the value of the site would not be affected.
Negligible	Very slight change from baseline condition. Change hardly discernible, approximating to 'no change' conditions.

Table 8.4 – Magnitude Criteria for Groundwater

Magnitude	Description
High	Major permanent or long-term change to groundwater quality or available yield. Existing resource use is irreparably impacted upon. Changes to quality or water table level would have an impact upon local ecology.
Medium	Changes to the local groundwater regime are predicted to have an impact slightly on resource use but not rule out any existing supplies. Minor impacts on local ecology may result.
Low	Changes to groundwater quality, levels or yields do not represent a risk to existing resource use or ecology.
Negligible	Very slight change from groundwater baseline conditions approximating to a 'no change' situation.

Impact Significance

8.2.9 The significance of impacts was then determined by reference to both the sensitivity of the site and the magnitude of impact, according to the matrix shown in Table 8.5.

Table 8.5 – Significance of Impacts on Geology and Groundwater

Magnitude	Sensitivity			
	High	**Medium**	**Low**	**Negligible**
High	Substantial	Moderate/Substantial	Moderate	Slight
Medium	Moderate/Substantial	Moderate	Slight/Moderate	Negligible/Slight
Low	Moderate	Slight/Moderate	Negligible/Slight	Negligible
Negligible	Slight	Negligible/Slight	Negligible	Negligible

Limitations to Assessment

8.2.10 The listing of wells and springs is based on information received from consultation with Aberdeenshire Council and Aberdeen City Council, from information gathered during hydrological surveys, from current Ordnance Survey (OS) map data, and landowner consultation. Wells and springs not notified to the Councils, not identified during surveys or landowner discussions, or not recorded by OS are therefore not assessed within the ES.

8.2.11 Available private water supplies information is presented within this chapter. However, it should be noted that detailed consultation and mitigation development is anticipated to continue as part of the pre-construction activities for the proposed scheme, and as such the exact location of some springs and wells is still not known.

8.2.12 Contour maps were produced for groundwater contours, rockhead elevation and drift thickness. These contours are solely based on ground investigation data available to date, which are mainly concentrated along the route of the proposed scheme and not on the wider area.

8.3 Baseline Conditions

Designations

8.3.1 No geological Sites of Special Scientific Interest (SSSIs), Regionally Important Geological Sites (RIGS) or other designated sites of geological value have been identified in the area, and no other features of special importance to geology have been identified.

Geology

8.3.2 The solid geological succession and drift deposits are described below, and provide context to the mineral extraction, contaminated land and groundwater assessments. The local solid geology is shown on Figure 8.4, with key drift deposits highlighted on Figures 8.1a-g.

8.3.3 As there are no geological designations, and the local geological strata are extensively represented elsewhere throughout the area, geology is considered to be of low sensitivity. No additional assessment is considered necessary with respect to solid geology or drift deposits.

<u>Solid Geological Succession</u>

8.3.4 BGS geological maps indicate that along most of the scheme route, the bedrock is mainly metasediments comprising psammites, semipelites and subsidiary pelites with very scarce calc-silicate ribs. The route also crosses an area shown as a foliated muscovite-biotite granite body to the north and east of the Aberdeen airport.

8.3.5 The BGS information has been complemented by more detailed information gained from site investigations. These took place from March to June 2004 (Phase 1) and April to October 2004

(Phase 2). Phase 1 gives an overview of the surrounding geology while Phase 2 provides details along the proposed scheme.

8.3.6 The Northern Leg is characterised by a variety of igneous and metamorphic rocks, including the following occurrences:

- psammites identified between the Kirkhill Overbridge (ch320200) and Pitmedden Home Farm (ch321300);
- granite and granodiorite mostly found from the start of the Northern Leg as far as Goval Junction (ch324850);
- granitic gneiss occurs between the Goval Junction (ch324850) and the B977 Overbridge (ch325900);
- psammites are then present from Ch325900 to the Newtonhill Overbridge (ch328500);
- pelitic rocks dominate the eastern part of the Northern Leg, starting from the Newtonhill Overbridge (ch328500); and
- isolated areas of other igneous rocks are present after the B977 Overbridge (ch325900).

Rockhead Elevation

8.3.7 Based on the geotechnical site investigation, rockhead elevation contours have been produced (Figures 8.3a-g), indicating a variable rock head surface.

8.3.8 The Northern Leg starts with a relatively high rockhead elevation of 150m Above Ordnance Datum (AOD) and drops to 80mAOD by Craibstone (ch317000). This is followed by a maximum of 160mAOD to the south of Bogenjoss (ch319700).

8.3.9 Rockhead then drops to a minimum of 10mAOD around the River Don (ch322800-323300) before stabilising at between 70mAOD and 90mAOD until ch328900 (Backhill of Cranbog) where rockhead becomes deeper again. Rockhead reaches 20mAOD at the A90 North Junction (ch330000-331000).

Drift (Superficial) Deposits

8.3.10 Published geological maps indicate that the Northern Leg mostly runs above glacial till including significant meltwater deposits, which is consistent with the results of the site investigations. Made ground and peat deposits are present locally. Composition and thickness of drift deposits are very variable along the route, and described further below.

Drift Composition

8.3.11 The site investigations uncovered the presence of made ground, peat, river alluvium, and both cohesive (clay-rich) and granular (sand and gravel) glacial deposits, as described in Table 8.6 below.

Table 8.6 – Drift Composition

Drift Material	Description
Glacial Deposits	Cohesive glacial (boulder clay) deposits - characterised by soft to very stiff, sandy, slightly gravelly clay with occasional cobbles.
	Granular glacial (meltwater) deposits - described as clayey and/or gravelly fine to coarse sand, with subangular to subrounded fine to coarse gravel.
River Alluvium	Loose to very dense deposits ranging from silty sands to coarse gravels.
Peat	Plastic, slightly sandy and fibrous.
Made Ground	Defined as a clayey sand and gravel, with some cobble and boulder sized fragments. Made ground is further discussed under contaminated land.

8.3.12 Granular and cohesive glacial deposits are often interbedded and where this occurs it is referred to in the ES collectively as glacial deposits, being mixtures of sandy gravels, gravelly clay, cobbles and boulders. Glacial deposits are the most abundant drift material in the area, underlying the majority of the route of the Northern Leg. These are considered to be of low sensitivity

8.3.13 The BGS drift deposit map indicates that granular (meltwater) deposits forming part of a glacial valley cross the route at several locations, which was confirmed by the site investigations (sandy deposits from Craibstone ch317000 to A96 Junction ch317700). Cohesive deposits beyond the River Don (ch323150) become much sandier again (granular deposits) after Newtownhill Overbridge (ch327400).

8.3.14 Alluvium deposits are present around the River Don and Goval Burn (ch322400-324900), and are considered to be of low sensitivity.

8.3.15 Isolated areas of peat were encountered at the A96 Junction (ch317000) and near Pitmedden (ch321000). The presence of peat deposits around the Corby Loch, although indicated by the BGS map, has not been confirmed by the site investigations. Due to the limited size of these peat areas, they are considered to be of low sensitivity.

8.3.16 Made ground was encountered along the route and results are discussed further in paragraph 8.3.24.

Drift Thickness

8.3.17 Drift thicknesses have been plotted using the site investigation results and are presented on Figures 8.3a-g.

8.3.18 The Northern Leg begins with relatively thin drift deposits (2.5m) at the North Kingswells Junction (ch315000). Drift thickness then fluctuates between 5m and 25m up to ch319100 with a maximum near Gough Burn (ch316400) and a minimum at A96 Junction (ch317400).

8.3.19 The drift deposits remain less than 5m thick to ch320500, when the thickness varies again between 5m and 37.5m as far as ch324500. Specifically, thin drift deposits of approximately 5m thick are found to the south of Pitmedden (ch320800) and near the Goval Burn (ch323900-324100), while thicker drift deposits are found by the River Don (ch322900).

8.3.20 The drift thickness along the remainder of the Northern Leg route varies from 5m to 15m thick, with the thickest areas to the north of Corby Loch (ch327700) and around the A90(T) North Junction (ch330100-330700).

Mineral Extractions

8.3.21 No mine working or shaft locations were identified along the route alignment during the desk study or site investigations, and this was not raised as an issue through consultation. An absence of underground mining is consistent with the geological strata in the area.

8.3.22 Sand and gravel pits were however identified. These features are of interest in relation to potential landfilling and associated contamination, and are identified in the following section.

Contaminated Land

8.3.23 Information relevant to contaminated land is based on a desk study review of historical maps and consultations, and a review of potential contaminated areas identified during the assessment of route options within the preferred route corridor undertaken in 2004. Subsequent site investigations not only confirmed some of the potential contaminated sites, but also indicated further zones of made ground. Representative samples were taken and analysed for pH and sulphate, with detailed contamination analyses undertaken on selected samples.

8.3.24 Made ground was encountered to the north of Corby Loch (ch327600 and ch327700) and along the A90(T). Isolated made ground areas are also noted in the vicinity of Gough Burn (ch316400), the A96 junction (ch317100), Newton (ch318500) and Corsehill (ch325550).

8.3.25 Known areas of contaminated land are indicated on Figures 8.5a-g. Table 8.7 below summarises the potentially contaminated sites indicated by the desk study and/or site investigations.

Table 8.7 – Potentially Contaminated Sites

Potential contaminated land & location	Chainage	Desk Study Evidence	Site Investigation Evidence	Observations / Lab Analysis
Made Ground - South Kingswells Junction	E of ch314900	None	Yes: ash.	Acid pH
Made ground - North Kingswells Junction	E of ch315250	None	Yes : inert material	Acid pH
Made Ground - Kepplestone	ch315700	None	Yes: ash.	Acid pH (of 4.7)
Made Ground - Gough Burn	Western edge of ch316400	None	Yes: inert material.	-
Made Ground - A96 Junction	ch317200	None	Yes: concrete, metal, plastic and ceramic.	Evidence of zinc
Parkhead Wood Quarry - Chapel Croft	W of ch317250	Quarry identified on 1963 OS map. No current evidence.	Not investigated	-
Craibstone backfilled pond (formerly part of the Mill of Craibstone)	N of A96, E of ch317400	Pond indicated on first edition and 1901 maps. This feature is no longer evident.	Not investigated	-
Works north of Chapel of Stoneywood	W of ch317400	Works indicated on current OS map.	Not investigated	Acid pH
Made Ground - Newton	ch318400	None	Not investigated	-
Quarry - Bogenjoss	E of ch320650	Quarry is labelled as 'old' on the 1900 OS map. 1925 & 1995 maps show an unlabelled quarry pit. No evidence on the current OS map. It is unknown whether it has been backfilled.	Not investigated	-
Lady's Jointure	N of ch322400	An area called "Lady's Jointure" is identified on the first edition Ordnance Survey map (1856) and 1900 edition.	Yes: wood, ceramic, pipe	A high level of sulphate, lead, copper, arsenic and cyanide.
Dyce Gravel Pit (north of railway)	N of ch322400	The 1981-89 maps show a large sand & gravel pit. The remains are now indicated by small ponds. According to the 2003 Mouchel report a waste licence was later granted for inert waste, split tyres and bentonite, but waste from the Mugiemoss paper mill may also have been deposited. The pit is probably part of the Mill of Dyce Quarry. Not listed by SEPA.		
Mill of Dyce Quarry	N of ch322400	The Mouchel 2003 Report indicated this large sand and gravel pit was noted on the 1989-95 OS maps. No current evidence. This site received a waste disposal licence in 1980 for inert materials only, until 1985 when the waste was accepted and the site became a landfill. In 1991, a licence was issued for disposal of commercial and industrial waste.		
Made Ground near Pitmedden Road	N of ch322400	None		

Potential contaminated land & location	Chainage	Desk Study Evidence	Site Investigation Evidence	Observations / Lab Analysis
Remains of Aberdeen to Inverurie Canal	N of ch322500	Indicated of historical OS maps 1925 to 1981.	Not investigated	-
Quarry - Nether Kirkton	S of ch323200	Active quarry noted on the 1963 map. It is located between the River Don and the former canal. The map indicates a pond in the southern part of the quarry. No evidence on the current OS map. The 2003 Mouchel report indicates this sand and gravel pit was infilled around 1960 with waste from new road works. The site is not listed by SEPA.	Not investigated	-
Made Ground - River Don Crossing	ch323250	None	Yes: orange colouration	Acid pH
Quarry 3 - Place of Goval	N of ch323200	Noted as an old quarry in 1900, and there is no evidence on the current OS. It is unknown whether this quarry has been backfilled.	Not investigated	-
Goval Pit - Place of Goval	N of ch323250	Noted as a small pit on the 1900 map only. No evidence on the current map. It is unknown whether this pit has been backfilled.	Not investigated	-
Sand Pit 8 - Parkhill	S of ch323900	Sand Pit 8 was listed by Aberdeenshire Council. Active quarry in 1900 only, located to the NW of Parkhill. No evidence on the current OS. Unknown whether pit has been backfilled.	Not investigated	-
Sand Pit 7 - Little Goval	S of ch324250	Sand Pit 7 was listed as such by Aberdeenshire Council. Active quarry in 1900 only, located to the S of Goval Burn. No evidence on the current OS. It is unknown whether this pit has been backfilled.	Yes: slag, ash, brick, ceramic & clinker	High levels of lead, sulphate, mercury, zinc selenium, copper & nickel
Saw Mill - Corsehill	S of ch325200	Former saw mill which is no longer evident.	Not investigated	-
Pits - Corsehill	S of ch325450	2 small active quarries on the first edition Ordnance Survey map (1856). Still indicated in 1900 but in 1964 these quarries appear as a pond (disused quarry). The current OS map only indicates the northern quarry. It is unknown whether these quarries have been backfilled.	Not investigated	-
Made Ground - Corsehill	ch325550	None	Yes: brick, concrete, wood, metal, plastic	-
Quarry - Leuchlands	ch327700	This site has been mentioned in previous assessments by Mouchel (2003). However, no record was found on the historical or current OS maps.	Yes: inert material	-
Quarry - Joss	ch327800	This site was mentioned by Mouchel (2003). However, no record was found on the historical or current Ordnance Survey maps.	Yes: blaes	-
Quarry - Newtownhill	N of ch328300	Quarry noted on the 1962 map and expands in 1964 to the north. No evidence on the current OS map.	Yes: paper, cardboard, wooden slats & plastic	Evidence of lead, sulphate, copper & zinc
Made Ground - Newtownhill Overbridge	ch328550	None	Yes: inert material	Acid pH
West Hatton Sand Pit & Hatton Gravel Pit	W of northern A90	Hatton gravel pit was indicated on historical maps from 1900 until 1968 while Wester Hatton sand pit is shown from 1962 to 1990. No evidence of those pits on the current OS map.	Not investigated	-

Potential contaminated land & location	Chainage	Desk Study Evidence	Site Investigation Evidence	Observations / Lab Analysis
Fife Hill Gravel Pits & Fife Hill Sand Pit	E of ch3310800	Fife Hill gravel pits were indicated on the first map edition and in 1900, while the Fife Hill sand pit was shown on 1962-69 maps only. There is no current evidence of those pits.	Not investigated	-
Wester Hatton Landfill	Adjacent to W of northern A90	None	Not investigated	-
Backfilled Racecourse Wester Hatton	E of the northern A90	Although the racecourse is indicated on the current OS map, site visits indicated that the racecourse has been backfilled and no longer exists.	Not investigated	-
Made Ground, A90(N) Junction	SE of ch330700	None	Yes: inert material	-
Made Ground - A90 North Junction	SE of ch330700	None	Yes: organic & 'fishy' odour. Wood, plastic, slag, ceramic, concrete, ash & coal	Evidence of boron, acid pH, sulphate, zinc, copper, nickel, mercury & selenium.
Sand and Gravel Pit - Blackdog	E of southern A90(T)	Pit indicated in 1968 as an active pit. This site was indicated as a disused pit in 1992 and on current OS map.	Not investigated	-

8.3.26 The main area with evidence of contamination in the Northern Leg is the Wester Hatton Landfill, which is currently active.

8.3.27 Areas of potential contamination are also located at Corsehill, Leuchlands, Joss and Newtownhill. Corsehill and Joss are expected to be the most contaminated, with evidence from the site investigations being typical of domestic waste landfill (brick, blaes, ash, concrete and plastic). No laboratory analyses have been carried out at Corsehill, Leuchlands or Joss to confirm this.

8.3.28 The made ground located at the A96 junction contains elevated zinc, metal and plastic.

8.3.29 Made ground was also identified along the scheme at Kepplestone, near the Gough Burn and at the North Kingswells Junction (ash present with acid pH). Only simple analyses have been undertaken and therefore the full potential of contamination in these areas cannot be confirmed.

8.3.30 Beyond the landtake required directly for the proposed scheme, but within the study area, several suspected contaminated sites are present; at Homefarm Quarry, Fairley Home Farm, near Pitmedden Road, near the A90(T) Junction, at Sand Pit 7 southwest of Goval Junction and at Newtownhill Quarry (Table 8.7). The proposed scheme is not anticipated to affect, or be affected by, these areas.

Groundwater

8.3.31 The crystalline igneous and metamorphic rocks present beneath the Northern Leg do not have the capacity to store or transmit large volumes of water, although some limited potential may exist in cracks and joints opened by weathering close to rockhead.

8.3.32 The alluvial deposits around the major watercourses crossed by the proposed scheme and significant deposits of glacial sand and gravel deposits may represent shallow aquifers capable of producing small scale private supplies. Groundwater in local drift deposits may also support important ecological resources, such as areas of peat.

Groundwater Resources

8.3.33 Historical maps show that numerous wells were present along the route of the Northern Leg, but many of these are no longer indicated on OS maps. However, there is still evidence of wells in the vicinity of Chapel of Stoneywood, Little Goval, East Woodlands, Nether Kirkton, Middleton Farm, Corsehill and Newtonhill, the current uses of which are anticipated to be for domestic water supply and/or agricultural use (see figures 8.2a to 8.2g).

8.3.34 In addition, several private springs used for domestic use and/or cattle supply were identified during landowner consultation undertaken in April/May 2007 in the area of Newton Farm, Standingstones, West Overton and possibly Rowett Research Institute and North Kingswells Junction. Two natural springs are evident from maps to the south of Howemoss.

8.3.35 Groundwater flow is generally considered to be of low sensitivity in this area. However, where wells or springs used as water supply are in close proximity (within 250m), sensitivity is considered to be moderate to high, as shown in Table 8.9 of Section 8.4 (Potential Impacts).

8.3.36 Groundwater in many areas of the Northern Leg is considered to be of medium to high sensitivity due to the presence of wells/springs. Sensitivities are listed in Table 8.9 of Section 8.4 (Potential Impacts).

8.3.37 Private water supply questionnaires completed in April/May 2007 as part of the ongoing landowner consultation and incorporated within this assessment are provided in Appendix A8.1.

Groundwater Pattern

8.3.38 Approximately 55 boreholes have been installed in bedrock for groundwater monitoring during the Phase 1 and 2 site investigations. Groundwater levels recorded in these boreholes have allowed average groundwater level contour plans to be produced (Figures 8.2a-g).

8.3.39 Groundwater flow is mostly influenced by the topography, flowing from high areas to low. In the Northern Leg, groundwater generally flows from 150m AOD at Bogenjoss (ch319700- ch320100), northwards towards the River Don (35mAOD), and southwards towards Green Burn (90mAOD). At the end of the Northern Leg, groundwater is noted to flow from the north west of Corby Loch (90m AOD between ch325800-328700), towards the east (30mAOD) and southwest towards the River Don.

Groundwater Supporting Sensitive Habitats

8.3.40 The proposed scheme will pass to the north of Bishops, Lily and Corby Lochs (between approximately ch327000 and ch328100). Newtonhill Overbridge cut (ch327550 and ch329950) would be approximately 300m to the northeast of Corby Loch.

8.3.41 BGS map Scotland Sheet 77 (drift edition) indicates that Lily and Corby Lochs are surrounded by a peat unit underlain by glacial meltwater deposits. Bishops Loch is located approximately 650m to the southwest of Lily loch, and although also underlain by the same glacial meltwater deposits is beyond the indicated extent of the peat unit. As described in Table 8.6, ground investigation has confirmed the predominant granular nature of the meltwater deposits. Peat deposits are described as plastic, slightly sandy and fibrous although this description applies to the peat deposits encountered elsewhere along the proposed route and is not necessarily representative of local conditions of this specific area.

8.3.42 The Corby, Lily and Bishops Lochs composite is designated as a Site of Special Scientific Interest (SSSI). Further details are provided in Chapter 10 (Ecology and Nature Conservation). Appendix A9.1 (Surface Water Hydrology) indicates that Corby and Lily Lochs have a catchment area of 1.2 km^2 and 3.6 km^2 respectively. Water level measurements suggest that Lily Loch (76.46 mAOD) provides water to Corby Loch (76.16 mAOD).

8.3.43 Corby Loch is fed by Red Moss Burn and drained by the Burn of Mundurno which runs to the south east towards the coast.

8.3.44 The Lily Loch area was subject to a hydrological walkover on 30 April 2007. The most relevant outcomes are as follows:

(i) there is no surface watercourse connecting Lily and Corby Lochs;

(ii) the land in between Lily and Corby Lochs is damp underfoot (boggy);

(iii) the soil section surveyed consists of decomposed organic matter for at least 0.3m below the surface;

(iv) Lily Loch has an inflow channel which is believed to be fed by a pond located to the west of Lochgreens Cottage. Apart from this inflow channel no other channels were observed to flow into the lake; and

(v) shallow groundwater is likely to contribute to the balance of the two lochs (Lily and Corby Lochs), however it is unclear at this stage whether deep groundwater (bedrock groundwater also contributes to the water balance of both lochs.

8.3.45 Bishops Loch catchment of this lake will be not severed by the proposed scheme. Following landowner consultation undertaken in April/May 2007 the area to the west of Bishops Loch is identified as a high well/spring density area with good groundwater resources.

8.3.46 The above considerations suggest that:

(i) Bishops, Lily and Corby lochs may be in hydraulic continuity through the underlying geological materials;

(ii) Lily and Corby lochs are recharged by direct rainfall, surface water and are also likely to be fed by groundwater; and

(iii) shallow groundwater at Lily-Corby Lochs is of high sensitivity. However, the relative contribution of surface water and groundwater (shallow and deep) to the overall balance of the lakes is unknown.

8.4 Potential Impacts

Geology

Solid Geological Succession

8.4.1 Table 8.8 below details the main excavations required for the Northern Leg of AWPR. This indicates that several excavations are likely to affect the solid geology (the largest of which are the Standingstone Wood and West Overton cuttings).

Table 8.8 – Excavated Areas

Road cutting	Chainage	Maximum Excavation Depth (mbgl)	Average Drift Thickness (mbgl)	Excavation to Depth of Solid Geology
Kepplestone and Craibstone Overbridge	ch315450 – 316200	8	6-7.5	Yes
Gough Burn	ch316450 – 316550	2	15-13	No
A96 area	ch317200 –3 17225	0.7	10	No
Chapel of Stoneywood	ch317550 – 317700	0.5	10	No
Standingstone Wood	ch319550 – 320400	9	2-5	Yes
West Overton cut	ch321500 – 322200	18	2-4	Yes
After River Don	ch323300 – 323360	2	22.5	No
Goval Farm Cottages	ch323650 – 324100	8	12-7.5	Excavation is expected to reach the transition zone between solid bedrock and drift deposits
Corsehill	ch325400 – 325950	8	7.5-2.5	Yes
Lochgreens overbridge	ch326550 – 327000	3	3	Excavation is expected to reach the transition zone between solid bedrock and drift deposits
Newtonhill overbridge	ch327750 – 329750	16	2-17.5	Potentially
Harehill cut	ch330100 – 330800	2	9-19	No

8.4.2 The solid geology is considered to be of low sensitivity. The impact magnitude given the extent of the same strata types across the area is negligible, and the overall significance of impacts on solid geology is therefore assessed as Negligible.

Impact of Blasting

8.4.3 It is anticipated that rock blasting will be required where cuttings extend into bedrock. Although no areas of geological interest have been identified, blasting may impact on the hydrogeological characteristics of the rock mass.

8.4.4 There are three major mechanisms whereby rock blasting can impact on rock structure:

- generation of new fractures in previously intact rock;
- dilation of existing joints and discontinuities by the action of high pressure explosive gases; and

- promotion of slip along unfavourably oriented joints and fracture surfaces.

8.4.5 All three mechanisms are vibration controlled. The generation of new fractures in previously intact rock and the dilation of existing joints and discontinuities occur close to the blast zone (termed 'near-field' effects), and promotions of slippage along unfavourably oriented joints can occur several hundreds of metres from the blast (termed 'far-field' effects).

8.4.6 The potential impacts from blasting in terms of disruption are addressed in Chapter 18 (Disruption due to Construction).

8.4.7 Blasting effects on rock mass as described above may result in consequential impacts on hydrogeology by creating or changing groundwater pathways. Potential impacts could therefore accrue if the contractor opts for the use of explosives in the excavation of the cuttings where there are sensitive receptors and potentially significantly contaminated sites in relatively close proximity. There is one location of potential risk in the Northern Leg; at Newtonhill cut where the existing water table (groundwater) would be expected to be above the final base of the cuttings without mitigation (i.e. proposed road drainage as mitigation, which will locally lower the water table to prevent flooding), several private water supplies are present, and Newtonhill and Joss Landfills are located adjacent to the Newtonhill Bridge as shown on Figures 8.2f and 8.5f. Consequently, this area is considered of medium to high sensitivity and the blasting magnitude of impact is considered as medium. The overall significance of impact is Moderate. In all other areas, the significance of impact of blasting on the rock mass is expected to be Slight to Negligible.

8.4.8 Utilities/services such as gas and water mains, power cables, and pylons may be subject to vibration impacts from blasting. Allowable vibration limits set by service providers/utility companies will be relatively low, typically 10-15mm/sec.

8.4.9 Further detail and identification of further studies required in the next phase of the development are described in Appendix A8.2 (Blasting Assessment).

Drift (Superficial) Deposits

8.4.10 Table 8.8 above indicates that excavations are likely to affect drift deposits, in some cases extensively. The sensitivity of drift deposits (dependant on the nature of the drift), and the magnitude of potential impact (dependant on the depth of cutting and the drift deposit thickness) vary from one cutting to another and are considered further below.

8.4.11 Glacial deposits underlie the majority of the route, and are of low sensitivity. The impact magnitude of excavating through glacial deposits is estimated to be negligible to low. The overall significance of impact is therefore assessed to be Negligible to Negligible/Slight.

8.4.12 River alluvium deposits are indicated along the River Don and the Goval Burn and are of low sensitivity. The magnitude of impact is estimated to be negligible to low, and the overall significance of impact is therefore assessed to be Negligible to Negligible/Slight.

8.4.13 Areas of localised peat deposits may be encountered along this section but are of low sensitivity. The magnitude of impact may range from negligible to low depending on the degree of loss or dewatering and on the ecological sensitivity of the site. Therefore, the impact significance of excavating through localised peat deposits is considered to be Negligible to Negligible/Slight.

8.4.14 Made ground deposits are discussed under Contaminated Land below.

Mineral Extraction

8.4.15 The only mineral extraction areas identified were sand and gravel pits and any impacts associated with these features relate to infilling or landfilling with potentially contaminating material and are discussed in the following section. No impacts are therefore predicted specifically relating to mineral extraction.

Contaminated Land

8.4.16 Areas of contaminated land are not environmentally sensitive receptors. However, there is potential for contaminated land to impact on human health and other environmental receptors, particularly during the construction phase, and this is dependant on the type of contamination present.

8.4.17 The road scheme is not expected to have any interaction with the areas of contaminated land located away from the road, and this assessment therefore focuses on areas of potential contamination encountered on or immediately adjacent to the AWPR route. Gross contamination (significant levels of contamination likely to cause harm to the environment and human health) has not been identified along the proposed road scheme. The development is also considered unlikely to exacerbate any migration of contamination to the wider environment.

8.4.18 The main occurrences of contaminated land identified by site investigations along the Northern Leg are as follows:

- made ground present at Kepplestone (ch315700) characterised as ash with an acid pH;
- made ground at the A96 Junction (ch317200), where the material encountered included concrete, metal, plastic and ceramics and some elevated levels of zinc;
- acidic ash identified at a small backfilled area at North Kingswell Junction (ch315000); and
- inert material identified at an area of backfill at Gough Burn (ch316400).

8.4.19 Although the Kepplestone occurrence coincides with an area that will be excavated (Table 8.8), available information suggests that this and the other occurrences of contamination identified do not present a considerable hazard to human health or the wider environment.

8.4.20 The most significant occurrence of contamination in the remaining part of the Northern Leg is the made ground identified by site investigations along the southern A90(T) southeast of ch330700, where some material had an organic and 'fishy' odour and contained wood, plastic, ceramics, concrete, slag, ash and coal. Chemical analyses provided evidence of boron, acid pH, sulphate, copper, mercury, selenium, nickel and zinc. If no remedial measures were taken, exposure to these materials, and to gases that may be produced by degrading organic matter, could be hazardous to the health of site workers.

8.4.21 Other occurrences of made ground with potentially degradable material were identified at Corsehill (ch325550) and Joss Quarry (ch327800), however no chemical analyses have been undertaken. Occurrences of material described as inert, albeit sometimes with acidic pH, were confirmed at the River Don Crossing (ch323200), Leuchlands Quarry (ch327550) and Newtownhill Overbridge (ch328525).

8.4.22 Finally, the presence of Wester Hatton Landfill adjacent to the northern A90(T) represents a significant potential hazard. Although aerial photographs suggest that the nearest infilled material is located approximately 100m from the existing A90(T), the exact extent of infilled material is unknown. Without remediation measures, site workers could be exposed to this material and gases during the construction phase.

Groundwater

8.4.23 The impacts on groundwater are considered in relation to the presence of private groundwater supplies and/or ecological receptors supported by groundwater, and their proximity to the proposed road scheme.

Groundwater Quality

8.4.24 In the event of an accidental road spillage, contamination may either migrate through the unsaturated zone or discharge directly into groundwater in cuttings, and impair groundwater quality. The magnitude of impacts on groundwater quality is determined as moderate where embankments or grade sections are proposed, and as high in areas of proposed road cutting. As a result, potential impacts of Moderate to Substantial significance have been identified in several locations. Active wells and springs used for water supply located in the immediate vicinity of the proposed scheme (North Kingswell junction, Standingstones, West Overton, Chapel of Stoneywood, East Woodlands, Newton Farm, Corsehill and Newtonhill) are at risk of contamination if appropriate mitigation measures are not applied.

8.4.25 At approximately ch320950 (Pidmedden Home Farm) a tank supplying water to several properties is located in an area where new embankments are proposed as part of the proposed scheme, and is therefore likely to be directly affected. The source of the water is unknown but it might be not very distant from the tank, as it would suggest the presence of a well in the adjacent property in close proximity to the tank (Figure 8.2d). This area is considered of high sensitivity and the potential impact is assessed as of medium magnitude. The potential impact is therefore of Moderate/Substantial significance.

8.4.26 Shallow groundwater (mainly present in areas covered by sand and gravel or peat deposits) is at risk from the same contaminated run-off and spillages as surface waters, as assessed in Chapter 9 (Water Environment). However, the potential impact is reduced because groundwater does receive direct discharge from the road and would only be impacted upon if the road drainage design was did not collect all run-off and overspill onto adjacent land occurred. Any potential groundwater quality impacts are therefore predicted to be temporary and of low magnitude. Given the low sensitivity of this environment the overall impact has been assessed as of Negligible to Slight significance.

8.4.27 Table 8.9 provides a list of wells and springs, including those identified during results of the private water supply consultation obtained during April and May 2007, and a summary of the potential impacts on the groundwater quality in the absence of mitigation measures.

Table 8.9 – Potential Impacts on Wells / Springs

Well/ Spring No.	Well / Spring Location	Well / Spring Distance from AWPR (m)	Well / Spring Sensitivity	Borehole / Spring Elevation (mAOD)	Existing Elevation (mAOD)/ direction of land gradient fall from AWPR	Proposed Elevation of Road / Cutting – Embankment	Significance of impact	Comments from landowners consultation
N1	Homemoss Farm	610m west	Negligible	120	104.5m / southeast	104 / Cutting	Slight	No further data available at this stage. Consultation ongoing.
N2	A96 Junction	Adjacent to the road	Negligible (not in use)	107	104 / east	109 / Cutting	Moderate/ Substantial	Consultation indicated that the property was on mains and no private supply was confirmed.
N3	Newton Farm & Chapel Works	75m east	High	125	123 / east	126 / Embankment	Moderate/ Substantial	The spring is used for cattle and growing potatoes, and supplies only this property. The water is sometimes scarce and therefore mains water is also installed in the house.
N4	Leuchlands Croft	140m	High	92	98 / north	84.5 / Cutting	Substantial	No further data available at this stage. Consultation ongoing.
N5	Home Farm Parkhill	360m south	Low	58	52 / west	56 / Embankment	Slight / Moderate	Goval Farm and No.1 Goval Cottage are on a mains water supply. Home Farm Parkhill is supplied by a well (170-270m from the farm building) and this water is also used for livestock. Well provides reliable supply.
N6	Aryburn Farm – Todhill Wood Springs	360m-1600m south	Negligible / Low	Unknown	Unknown	Unknown	Slight (worse case scenario)	This property (Aryburn Farm) and other houses are supplied by an undefined number of springs (Todhill Wood springs) and 4-5 wells. The springs appear to be connected to a lake. The well is used for drinking purposes and for the cattle, and provide reliable supply although it fluctuates between seasons. The springs yield approximately 90,000 l/day. Water quality analysis is undertaken on a regular basis.
N7	Parkhill Sawmill	370m south	Low	39	45 / south	44 / Cutting	Moderate	Currently the property is supplied by mains water. However there is a pipe at the entrance (gate) of the property that is fed by one spring. The owner is planning to going back to the spring for water supply as not satisfied with the quality of the mains water supply. Spring provides reliable supply.
N8	Standingstones	Two springs: 130m east and 120 west	High	130	141 / southeast	145 / Embankment	Moderate/ Substantial	Properties discussed include Upper Kirkton, Standingstones and Bogenjoss. Standingstones is supplied by springs that are on the west of the proposed route. In addition, there is also one spring used for cattle. Bogenjoss is on mains supply and is thererefore not listed as a private water supply in this table. The cattle also uses an open channel which is thought to be fed by a group of springs, and a trough is supplied by one spring on the boundary of the property, which would be intercepted by the proposed scheme. Well provides reliable supply for all the above supplies.
N9	Pitmedden Home Farm	Within proposed scheme	High	100	108 / northwest	119m / Embankment	Moderate/ Substantial	There is a large tank which reliably supplies the farm, the main house and 5 cottages, numerous troughs and a swimming pool in one of the houses. Drinking water has been tested several times.

Well/ Spring No.	Well / Spring Location	Well / Spring Distance from AWPR (m)	Well / Spring Sensitivity	Borehole / Spring Elevation (mAOD)	Existing Elevation (mAOD)/ direction of land gradient fall from AWPR	Proposed Elevation of Road / Cutting – Embankment	Significance of impact	Comments from landowners consultation
		landtake						This would be directly affected by the proposed scheme.
N10	Lyndmoore Cottage	80m north	Negligible	60	62 / northeast	69m / Embankment	Negligible/ Slight	The well is thought to be abandoned (see questionnaire for land reference No. 64).
N11	Newton Farm	100m southeast	High	150	154 / east	159 / Embankment	Moderate/ Substantial	The farm building is on mains water supply. Cattle drinks water coming from a spring located on Brimmond Hill (west of the farm, close to the AWPR). There is also a reservoir near to the route (between the AWPR and Brimmond Hill) which belongs to Scottish Water. Well provides reliable supply. There is a gravity system which distributes the water to the Farm by means of ditches. Spring yields approximately 900 l/day.
N12	Rowett Research Institute	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	A complex network of wells is located to the east and west of the AWPR. Consultation indicates that these are beyond proposed scheme landtake and therefore are not directly threatened. Given the complexity of the supply network consultation is ongoing.
N13	Hillhead Farm	1020m north	Negligible	100	83 / west	80m / Cutting	Slight	One well 4-5 m deep (water level 2-3 m deep). Water has been analysed in the past. Well provides reliable supply and the water level is fairly constant. The water is used both for domestic use and cattle.
N14	Newton of Sheilhill	100m south	High	90	90.5 / northeast	82m / Cutting	Substantial	Water is supplied by one well - 24m deep (water level 4-6m), depending on season. Well provides reliable supply but level fluctuates. The water was analysed 2-3 years ago and results can be viewed.
N15	Birchville	40m south	High	95	92.5 / southwest	86m / Cutting	Substantial	Property is on mains but water from a well is used for washing cars and irrigating the garden. Well provides reliable supply. This supply has been tested in the past but the results could not be found.
N16	RoseLea	70m south	Negligible (not in use)	96	94 / southwest	89m / Cutting	Slight	The property is on mains. There is an abandoned well which could be used if needed in the future. There is approximately 1m of water at the bottom and the water has been tested in the past.
N17	Stanedykes	90m south	High	96	93 / southwest	87m / Cutting	Substantial	A well is used for irrigation of gardens and it appears that all adjoining properties have a well. The water level is approximately 4.5m above the bottom of well during winter.
N18	Kepplestone Farm	450m northwest	Low	163	154 / southeast	157m / Embankment	Slight/ Moderate	In the north, there is evidence of one spring and the water for is used for cattle and sheep.
N19	Craibstone Junction	900m east	Negligible	70	106 / northeast	106m / Embankment	Negligible / Slight	Caribstone Estate is fed by mains. The well has been abandoned.

Well/ Spring No.	Well / Spring Location	Well / Spring Distance from AWPR (m)	Well / Spring Sensitivity	Borehole / Spring Elevation (mAOD)	Existing Elevation (mAOD)/ direction of land gradient fall from AWPR	Proposed Elevation of Road / Cutting – Embankment	Significance of impact	Comments from landowners consultation
N20	Middleton Farm	200m north	Negligible (not in use)	50	41 / northwest	39m / Cutting	Slight	The property is on mains supply. All properties in the area appear to be mains supply as well. .
N21 (two wells)	Corsehill Cottage	160-260m south	Low	80	63 / west	71m / Embankment	Slight / Moderate	There are two adjacent wells: one for domestic use (3-4 houses including Corsehill and surroundings) and one feeding 3 troughs for cattle. Wells provide reliable supply.
N22	Upper Kirkton	Within proposed scheme landtake	High	94	94 / southeast	82m / Cutting	Substantial	See description of N8 above.

Groundwater Flow

8.4.28 Several road cuttings are likely to affect groundwater flow (Kepplestone, Standingstone, West Overton, Goval Farm, Corsehill, Newtonhill and Harehill). In the areas of cutting the potential impact on local groundwater level is considered to be of medium magnitude, as the scale of reduction may cause localised dewatering. Impact significance therefore ranges from Negligible/Slight to Substantial.

8.4.29 Table 8.10 identifies areas where groundwater flow may be affected by cutting required for the proposed scheme.

Table 8.10 – Potential Impact of Cuttings on Groundwater Flow

Road Cutting	Groundwater Parameters			Receptor(s) Sensitivity	Groundwater affected by Cutting / Magnitude of Impact	Significance of Impact
	Max Cutting Depth (mbgl)	Local Monitoring	Estimated Level mAOD/mbgl			
Kepplestone & Craibstone ch315450-316200	8	No	155-140 / 5 - 2	High: potential high well\spring density area (N12) in proximity of cutting	Affected / Medium (groundwater level likely to be intercepted by excavation)	Moderate/ Substantial
Gough Burn ch316450-316550	2	No	115 -120 / 2 - 3	Low	Not affected / Low (estimated groundwater level below base of excavation)	Negligible/ Slight
A96 area ch317200-317225	0.7	No	95 / 7	Low	Not affected / Low (estimated groundwater level below base of excavation/low)	Negligible/ Slight
Chapel of Stoneywood ch317550-317700	0.5	Yes	95 -100 / 3	High: potential high well density area in proximity of Chapel Croft	Not affected / Low (estimated groundwater level below base of excavation)	Moderate
Standingstone Wood ch319550-320400	9	Yes	130 – 155 / 1-8	High: springs N8 in proximity of the cutting	Affected / Medium (most of the excavation intercepts groundwater)	Moderate/ Substantial
West Overton ch321500-322200	18	Yes	65 -95 / 11	High: spring N22 crossed by AWPR. Potential abandoned well (N10) N of Nether Kirkton, distant from West Overton cut. Exact occurrence of spring N9 unknown.	Affected / Medium (groundwater likely to be intercepted in centre of excavation)	Moderate/ Substantial
After River Don ch323300-323360	2	No	35 / 3-8	Low	Not affected / Low (estimated groundwater level below base of excavation)	Negligible/ Slight
Goval Farm Cottages ch323650-324100	8	Yes	40 – 45 / 1-4	Medium: spring N7 distant from the cutting.	Affected / Medium (groundwater likely to be intercepted in centre of excavation)	Moderate
Corsehill ch325400-325950	8	Yes	80 -95 / 4-8	High: high well density (N15, N16 and N17) very close to Corsehill cut.	Affected / Medium (groundwater likely to be intercepted in centre of excavation)	Moderate/ Substantial

Road Cutting	Groundwater Parameters			Receptor(s) Sensitivity	Groundwater affected by Cutting / Magnitude of Impact	Significance of Impact
	Max Cutting Depth (mbgl)	Local Monitoring	Estimated Level mAOD/mbgl			
Lochgreens Overbridge ch326550-327000	3	No	93 / 4	Low	Not affected / Low (estimated groundwater level below base of excavation)	Negligible/ Slight
Newtonhill Overbridge ch327750-329750	16	Yes	50 – 90 / 8	High: high well density area (N4, N14) in close proximity.	Affected / Medium (estimated groundwater level likely to be intercepted)	Moderate/ Substantial
Harehill ch330100-330800	2	Yes	40 – 25 / 2	Low: one well no longer used (N20) distant from the cutting.	Affected / Medium (groundwater may be slightly intercepted)	Slight/ Moderate

Groundwater Supporting Sensitive Habitats

8.4.30 Corby Loch is located approximately 300m from the nearest cutting required as part of the proposed scheme (Newtonhill Overbridge cutting). All drift deposits will be removed and Table 8.10 indicates that bedrock groundwater is likely to be intercepted and therefore groundwater levels are likely to be lowered down at Newtonhill cut, however the extent of the area impacted by the lowering down of water levels is unclear at this stage. Based on the data available to date, the magnitude of impact of the Newtonhill Overbridge cutting on the groundwater contribution to the lochs is assessed as low and the resulting significance of impact is Moderate.

Groundwater Flow and Potential Contaminated Land

8.4.31 There are areas along the Northern Leg study area where the groundwater zone of influence of road cutting (i.e. disturbance of groundwater flow caused by dewatering) may reach areas of potential contaminated land (i.e. landfills or backfilled quarries). This could result in contamination flowing towards groundwater receptors (private water supplies), but also towards human receptors (construction workers operating during the construction phase). Where this occurs, there is potential for humans to come into direct contact with contamination transported by groundwater and arising from contaminated land.

8.4.32 At present, groundwater in the vicinity of the proposed Newtownhill cutting is interpreted to flow locally to the north. The proposed cutting is likely to reverse this flow and to locally disturb groundwater around private wells (high sensitivity). Joss landfill and Newtownhill landfill are located 70m and 150m respectively to the north of Newtownhill Overbridge cut. These landfills are currently located down gradient of the private water supplies and therefore do not impact on the groundwater quality of those wells. However, Newtownhill cutting has the potential to draw contaminated groundwater towards private groundwater supplies, resulting in a high magnitude of impact, of Substantial significance.

8.4.33 There is an uncertainty in the exact occurrence of spring N7 (Parkhill Sawmill), which could be located between the identified contaminated land site Sand Pit 7 – Little Goval (refer to Table 8.7) and the Goval Farm Cottage cut. The Goval Farm Cottage cut is indicated in Table 8.10 to intercept groundwater and potential contamination issuing from Sand Pit 7 may therefore be mobilised towards the proposed cutting. Due to this uncertainty, the potential impact is therefore assessed as of Substantial significance.

8.5 Mitigation

8.5.1 The mitigation measures described below have been identified to minimise or eliminate the potential impacts of the proposed scheme.

Solid Geology

8.5.2 The assessment indicates that there would be potential for Negligible impacts with respect to the local solid geology and therefore no mitigation measures are required.

8.5.3 However, as noted in Section 8.4 (Potential Impacts), rock blasting has the potential to impact on the hydrogeology by creating or changing groundwater pathways, and on utilities/services due to vibration. In Newtownhill cut, identified potentially at risk in paragraph 8.4.7, mitigation measures during construction, should blasting be undertaken, will include the used of technical methodologies such as use of low-explosive loading densities, following to current British Standards and regulations. These technical considerations are provided in Appendix A8.2 (Blasting Assessment).

Drift Deposits

8.5.4 As only negligible to Negligible/Slight impact significance has been determined for drift deposits, no mitigation measures are required.

Contaminated Land

8.5.5 Any hazardous contaminated made ground/backfill would be treated or removed to avoid risks to site workers and also because the material would generally be geotechnically unsuitable for construction. Areas where further investigation will be needed as part of the mitigation strategy is identified below.

8.5.6 The route would cross a number of areas of known or suspected contaminated ground, as indicated by the site investigations discussed in the previous sections. Although no areas of gross contamination have been identified that may present significant human health or environmental risks, additional investigation would be required in the areas of known contamination prior to construction, to further define the contamination and allow the design of any required remedial measures.

8.5.7 Further enquiries and pre-construction investigations will be undertaken as necessary to ensure that the required earthworks do not extend into the landfilled area at Wester Hatton Landfill. Dependant on the proximity and nature of local drift deposits, monitoring of confined earthworks for asphyxiating or explosive conditions resulting from landfill gases may be required.

8.5.8 Although not envisaged, the earthworks required for construction of the scheme may encounter other potentially contaminated ground, not currently identified. Should any contaminated land be encountered, its treatment and/or removal would be required as part of the Employer's Requirements for Construction.

8.5.9 For all contaminated areas, the Contractor would be required to prepare Method Statements which would be submitted to the appropriate regulatory authorities and the Employer's Representative would monitor compliance. Potentially contaminated materials would be tested and removed if necessary in a controlled manner in accordance with the Environmental Protection (Duty of Care) Regulations (The Stationery Office, 1991).

8.5.10 The Employer's Requirements would include measures to prevent any contaminated run-off or contaminated groundwater produced by the works, entering and polluting the local drainage system as further detailed in Table 8.10. Any contaminated waters produced would be removed for off-site disposal at an appropriate facility in accordance with waste management regulations, or treated on-

site and discharged in compliance with a Consent to Discharge issued by SEPA. Further details on measures to avoid contamination of watercourses during construction are provided in Chapter 18 (Disruption due to Construction).

Table 8.10 – Mitigation Measures for Contaminated Land

Type of Measure	Description
Prevent	The adoption of procedures to deal with any hazardous ground and gas being encountered and the removal of potentially contaminated materials to prevent the release of contaminated materials into the environment. Removal and disposal off-site of any contaminated waters to prevent contaminated run-off or groundwater produced by the Works, entering and polluting the drainage system.
Reduce	Adoption of soil handling procedures during construction to contain contaminated soil and reduce potentially adverse impacts on soil quality and the potential for spread of contamination to impact workers, the public and adjacent land or controlled water.
Offset	Only remove contaminated soil from the development where there is a demonstrable need via environmental risk assessment for risk management, Otherwise where suitable, made ground or moderately contaminated soil may be contained within the construction.
Enhance	None

Groundwater

8.5.11 As uncertainties remain on the exact location of private groundwater supplies (wells and springs), a walkover survey will take place over June-July 2007 in order to confirm the locations of all supplies at risk (based on Table 8.9); this will include gathering an understanding of the nature of the springs and additional information on total depth and groundwater level in wells.

8.5.12 During the proposed walkover surveys, groundwater (both from springs and wells) will be sampled and analysed to allow preliminary groundwater quality background conditions to be defined. This background quality information will be used to compare against groundwater sampled and analysed at a later stage during the construction process.

Groundwater Quality

8.5.13 To prevent contamination of private wells/springs used for water supply and to prevent changes in groundwater quality of the wetland area around Corby-Lily lochs caused by accidental spillages, the following sections of the AWPR road drainage system will be lined:

- North Kingswell junction (ch315000-315400);
- Chapel of Stoneywood (ch317350-317650);
- Standingstones Wood (ch319400- 319700);
- Newton Farm (ch318000-318400);
- East Woodlands (ch320800-321000);
- West Overton cut (ch321700-322700);
- Goval Farm (ch323700-324200);
- Corsehill (ch325100-325900);
- LochGreens (ch327000- 327200) at proximity of Corby and Lily lochs; and
- Newtonhill (ch328100-328400).

8.5.14 Mitigation measures to prevent or minimise the potential for contamination of local groundwaters elsewhere during construction or operation are the same as those required for surface water protection and are detailed in Chapter 9 (Water Environment) and Chapter 18 (Disruption due to Construction).

Groundwater Flow

8.5.15 Mitigation for local impacts on groundwater levels associated with 7 proposed road cuttings (refer to Table 8.10) include provision of an appropriate road drainage system, and no further design mitigation is possible, as intercepting groundwater that would otherwise flood the road necessitates the reduction of the immediate groundwater level to the level of the road.

8.5.16 Localised change of groundwater levels in the vicinity of the road cuttings may affect nearby groundwater supplies. An extensive groundwater monitoring network will therefore be installed in areas identified in Table 8.10 and groundwater testing undertaken prior to construction (both qualitative and quantitative) to identify and specific mitigation required to address potential impacts on private groundwater supplies.

8.5.17 Based on the pre-construction groundwater monitoring and assessment, further mitigation measures may be implemented, and it may be necessary to undertake monitoring of selected groundwater supply sources during construction and into the start of the operational phase to assess whether there has been any discernible effect on the supply. If yields of water supplies are shown to be reduced, mitigation measures would be likely to include an alternative or replacement supply.

Groundwater Supporting Sensitive Habitats

8.5.18 Hydrological mitigation measures for Corby Loch and Lily Loch are provided in Chapter 9 (Water Environment). The proposed mitigation includes measures to maintain hydrological connectivity, and to supplement this, a network of monitoring piezometers (groundwater level and quality) will be installed prior to construction. The piezometers will be monitored before, during and after the construction of the proposed road scheme to define a baseline hydrogeological condition for the area and to better understand the connectivity between shallow groundwater and surface water.

Groundwater Flow and Potential Contaminated Land

8.5.19 Changes in groundwater flow conditions and potential migration of contaminants towards cuttings may potentially impact on private water supplies around Newtownhill and Goval farm cuttings and on construction workers at all cuttings listed in paragraphs 8.4.34 and 8.4.35.

8.5.20 The measures proposed in paragraph 8.5.16 are also applicable here (monitoring network). The groundwater flow and quality monitoring data will provide the background information to determine the zone of influence of each cutting. If potentially contaminated land is within the zone of influence, a ground investigation will then be required to determine the exact nature of any contamination. If required, a risk assessment will be carried out and further measures will be proposed, as appropriate.

8.5.21 If groundwater becomes contaminated and is then intercepted by the road drainage, treatment will be required before the drainage can be discharged.

8.6 Residual Impacts

Solid Geology

Solid Geological Succession

8.6.1 The residual impact on local solid geology is anticipated to be Negligible.

Blasting

8.6.2 Mitigation measures have been proposed in paragraph 8.5.3 to reduce blasting impacts on the mass rock to a minimum. Based on these, the residual impact at Newtownhill cut is assessed as of Slight Significance.

Drift (Superficial) Deposits

8.6.3 There are only Negligible to Negligible/Slight anticipated residual impacts on local drift deposits.

Contaminated Land

8.6.4 The mitigation measures for the management of known or encountered occurrences of contaminated ground during construction will ensure that any human or environmental risks are appropriately addressed. The residual impacts may therefore be considered as Slight (beneficial) where any existing contaminated ground is treated or removed.

Mineral Extraction

8.6.5 No mineral extraction impacts are predicted.

Groundwater

Groundwater Quality

8.6.6 All drainage features in areas of high well density and where groundwater supports sites of ecological interest will require to be lined and in consequence residual impacts are considered of Slight significance.

8.6.7 Potential impacts on shallow groundwater quality in sand and gravel aquifers are mitigated by the same management procedures as proposed for protection of surface waters. It is predicted that these measures will result in Negligible significance residual impacts.

Groundwater Flow

8.6.8 Groundwater levels will be lowered in the vicinity of road cuttings which extend below the water table. The only potential impact of significance associated with this effect is the impact on private groundwater supplies yields in the cutting areas. It is anticipated that the characterisation of the local groundwater conditions and supply details, followed by provision of alternative or replacement supplies, if necessary, will appropriately mitigate impacts on private groundwater supplies. This will therefore result in Negligible significance residual impacts.

Groundwater Supporting Sensitive Habitats

8.6.9 As part of the proposed mitigation (paragraph 8.5.18), further investigation by piezometer installation and groundwater level monitoring will be carried out. This information will need to be assessed to understand in detail the connectivity between groundwater and the system Corby-Lily Loch. Therefore at present, there is an uncertainty on the level of residual impact, and as a precautionary approach residual impact is therefore considered at this stage to be of Slight to Moderate significance.

Groundwater Flow and Potential Contaminated Land

8.6.10 Once monitoring, ground investigations, risk assessments and any other measures considered necessary have been undertaken, it is anticipated that residual impacts on both humans and private water supplies will be of Negligible significance.

8.7 References

BGS - British Geological Survey. Drift and Solid maps – Aberdeen – Sheet 77.

Historical maps of the area (First edition until current Ordnance Survey) at 1:10,000 and 1:2,500 scale.

Mouchel (2003). Western Peripheral Route (western leg) – Stage 2 Addendum Environmental Assessment.

Norwest Holst Reports 2004.

The Stationery Office (1991). Environmental Protection (Duty of Care) Regulations. Statutory Instrument 1991 No. 2839.