

## **Appendix 13.2 Land Contamination Desk Study**

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### Introduction

- 13.2.1 This is a Technical Appendix (TA) to Chapter 13: Hydrology, Hydrogeology and Ground Conditions of the Environmental Statement (ES) for the proposed West Benhar Wind Farm and should be read with reference to this chapter.
- 13.2.2 RPS was commissioned by Partnership for Renewables (PfR) in August 2012 to complete a land contamination desk study for the proposed wind farm.
- 13.2.3 The following land contamination assessment has been undertaken in order to support the ES and the planning application for the proposed wind farm. It has therefore been completed in the context of Planning Advice Note (PAN) 33: Development of Contaminated Land (Scottish Executive, 2000) and the Environmental Protection Act 1990.
- 13.2.4 It should be noted that PfR will be leasing the developable area of the site only and not the entire area of the planning application boundary. As such, PfR will not be therefore be responsible for addressing any areas of potential contamination not underlying the final development footprint.

### West Benhar Wind Farm

- 13.2.5 The West Benhar Wind Farm is proposed to comprise a total of 8 wind turbines of 132 m to blade tip and associated infrastructure including:
- upgraded forestry tracks;
  - new internal access tracks;
  - construction compound;
  - lay down areas; and
  - control building and compound.
- 13.2.6 A detailed description of the proposed wind farm is presented in ES Chapter 4.

### Project Objectives

- 13.2.7 The principal objective of this Desk Study is to determine potential land contamination risks upon statutory receptors. This may ultimately guide development considerations, such as remedial activities, to ensure the site's suitability for its intended future use.
- 13.2.8 The specific objectives of this report are to:
- investigate the site history, and its surrounds, and establish its environmental setting to inform site conceptualisation;
  - develop a preliminary Conceptual Site Model (CSM) in the context of the proposed future site use in order to identify and appraise potential source-pathway-receptor linkages; and
  - provide outline recommendations, as required, for Phase II intrusive works to further assess potential source-pathway-receptor linkages. The findings of such works may then in turn guide appraisal of possible remedial requirements.

### Scope of Works

- 13.2.9 In order to deliver the objectives outlined above, the following broad scope of works was performed as part of this Desk Study:
- a desk based review of published information/data from various sources detailed below; and
  - recording and reporting, critically the formation of the CSM and the qualitative appraisal of potential source-pathway-receptor linkages.
- 13.2.10 In accordance with best practice guidance (see below), desk based research was completed using various sources, including (but not limited to) the following:
- geological maps;
  - historical maps;
  - aerial photographs;
  - information available from regulatory authorities including the Scottish Environmental Protection Agency (SEPA) and The Coal Authority (CA);
  - Royal Commission on the Ancient and Historic Monuments of Scotland (RCAHMS); and
  - British Geological Survey (BGS) Borehole Records.
- 13.2.11 A site walkover was completed as part of a peat probing survey (TA 13.4) undertaken in September 2012. This did not expressly target historical industrial areas, however notes of potentially contaminative features encountered were recorded to inform this Desk Study.

### Legislation

- 13.2.12 Relevant legislation, guidance and best practice documentation pertinent to this assessment, includes (but is not limited to) the following:
- Scottish Executive, May 2006: *Environmental Protection Act 1990: Part IIA Contaminated Land Statutory Guidance (Edition 2)*;
  - Scottish Executive, 2000: *PAN 33: Development of Contaminated Land*;
  - British Standards Institute, 2011: *BS10175: Investigation of Potentially Contaminated Sites – Code of Practice*;
  - Environment Agency, 2004: *CLR11: Model Procedures for the Management of Land Contamination*;
  - Department of the Environment Industry Profiles, various dates;
  - Construction Industry Research and Information Association (CIRIA) 2007: *CIRIA C665: Assessing Risks Posed by Hazardous Gases to Buildings*; and
  - CIRIA 2001: *CIRIA C552: Contaminated Land Risk Assessment – A Guide to Good Practice*.

### Further Information

- 13.2.13 Further information regarding the site setting and of relevance to this Desk Study is presented in the following TAs:

- 13.1: Geotechnical Desk Study & Risk Assessment; and
- 13.3: Mineral Stability Desk Study & Risk Assessment.

13.2.14 The Land Contamination Desk Study presented below should be read with reference to the above ES TA chapters for further detailed information on geotechnical and mineral (mining) stability issues present at the site of the proposed wind farm.

## **Desk Study Information**

### **Site Location**

- 13.2.15 The site is located between Benhar Road, Shotts and East Benhar near Fauldhouse. A site location plan is presented as ES Figure 1.1.
- 13.2.16 The site is located approximately 170 m (at its closest point) to the north of the Edinburgh to Glasgow mainline railway. Adjacent land uses to the south of the site include Shotts Golf Club at the south-west and felled forest areas to the south. Further peat bog is located to the south-east.
- 13.2.17 To the north and north-west of the site is an area of unconfirmed industrial use, and to the north-east and east is further forestry land.
- 13.2.18 Beyond the site to the west is located the Hassockrigg and North Shotts Mosses Special Area of Conservation (SAC) and the Hassockrigg and North Shotts Mosses Site of Special Scientific Interest (SSSI).

### **Site Description**

- 13.2.19 The site is generally forested. It includes an internal forestry track network that comprises a blaes, clinker and shale track trending centrally through the western section in a north-eastward direction from Benhar Road towards the north-eastern site boundary. The track turns southward close to the site boundary before curving around into the eastern section of the site. There is an additional branch of the forestry track located within the eastern section of the site that extends southward from the main track and leaves the site through the western boundary of the site.
- 13.2.20 The current land use of the site is dominated by the Benhar Forestry Commission plantation. The plantation comprises plots of *pinus* trees at various stages of the forestry rotation (i.e. clear felled, mature & replanted).
- 13.2.21 In addition to the forestry plantation the site also contains two bings. The bings are generally vegetated with a mixture of deciduous trees, bushes and grasses. One of these bings encroaches the southern site boundary in the south western area of the site, and the second encroaches the eastern boundary, centrally to the east of the site, and appears to have been quarried for track building aggregate.
- 13.2.22 There is no evidence of any structures or utilities currently on site, however, it is of note that overhead cables (electricity) pass above the main site entrance at the western extent of the site.
- 13.2.23 The topography of the site generally gently falls towards the south and southwest. In the western area of the site, the ground north of the forestry track is generally level. To the south of the track the topography gently falls in a southward direction before levelling close to the site boundary. In the eastern area, the topography is generally level to the north of the

track. To the south of the track the topography is moderately steep and falls towards the southwest.

13.2.24 A site layout plan is presented as ES Figure 1.2.

### **Geology**

13.2.25 A complete review of site geology is presented in TA 13.1 Geotechnical Desk Study. A summary of pertinent geological conditions is presented herein.

#### ***Superficial Geology***

13.2.26 The superficial lithology of the site is summarised in the BGS DiGMap-50k presented as ES Figure 13.3.

13.2.27 ES Figure 13.3 indicates that the site is expected to be largely underlain by peat that is shown to extend beyond the north, northeast, west and south-east of the site. In addition, glacial till is shown to underlie parts of the south-west of the eastern area and the south and north-west of the western area. The glacial till at the site is described as a silty sandy stiff clay with stones in the BGS Geology for Land Use Planning Map 1.

13.2.28 Although peat is shown to dominate the site, the peat is likely to be underlain by the glacial till deposits. In areas where soil cuttings have been made for forestry drainage the lithographic sequence of superficial deposits is confirmed as peat overlying glacial till comprising sand, gravel and cobbles of various geologies.

13.2.29 The superficial geology map also identifies the bings as areas of artificial ground above the original ground surface located in the far east, west and central area of the site. Additional smaller pockets of artificial ground are also shown in the BGS mapping within the centre of the eastern area of the site and at the northern boundary of the western area. In the south-west of the western area, a small pocket of undifferentiated superficial deposits are shown to extend on to the site.

#### ***Bedrock Geology***

13.2.30 The geology of the site is shown to be divided along a geological fault that trends generally north-west south-east through the narrowest part of the site. To the north of the fault the underlying bedrock geology is expected to be the Middle Coal Measures (MCMS) which comprises a cyclical sequence (repetitive beds or strata) of sandstone, siltstone, mudstone, ironstones, coal and seatrocks. To the south of the fault the site is shown to be underlain by the Lower Coal Measures (LCMS) comprising cyclical sequences of sandstone, siltstone, mudstone, ironstones, coal and seatrocks. The bedrocks are part of the Coal Measures of the Scotland Group.

13.2.31 A summary of the bedrock geology of the site is presented in ES Figure 13.4.

#### **Borehole Records**

13.2.32 A search of the BGS GeoIndex reveals that there are more than 50 borehole records within or close to the site boundary. However, many of these are confidential records that are not available for review or are only concerned with peat depth. A total of 18 borehole logs located in or within 250m of the site boundary were considered to be of value and have been reviewed. A borehole records plan is presented as TA Figure 13.3.4. The borehole records are summarised in TA 13.3 Appendix 1.

- 13.2.33 The borehole logs available for the site indicate that the site is underlain by coal measures comprising cyclical sequences of sandstone, shale, mudstone, ironstone and coal seams. The beds of each strata are of varying thicknesses ranging from <0.025 m to >10 m. In a number of boreholes the sandstones are described as fakey (bedded), hard or extra hard indicating that the underlying sandstones may have sufficient strength for foundation bearing. In addition, some of shale beds are also described as hard fakes indicated that the shale is laminated and potentially of sufficient strength for foundation bearing.
- 13.2.34 The hard beds of sandstone and shale are often the thickest, ranging between 0.3 m to 1.80 m in thickness. These beds are also often underlain by thinner beds of softer or soft sandstone. It is therefore likely that there are exploitable beds of sandstone suitable for foundation bearing beneath the site.
- 13.2.35 The borehole logs also indicate the presence of coal seams of various thickness within both the middle and lower coal measures located beneath the north and south of the site respectively. The borehole logs indicate that there is the potential for some of the seams to have been worked at shallow depths (<50 m bgl) underlying the site, particularly within the north and north-east of the eastern section and south of the western section. Furthermore, one borehole log (NS96SW69) indicates that there may have been a collapse of old workings at 45 m bgl adjacent to the north of the eastern section of the site. The borehole logs describes the strata at the base of the boreholes as 'Waste' comprising old props and metal.
- 13.2.36 The logs also indicate the potential for the whole site to have been undermined by coal workings at depths greater than 50 m bgl. This includes possible workings of the Upper Drumgray, Armadale Main & Ball, Airdrie Virtuewell and the Mill Coal seam.
- 13.2.37 In addition to coal seams the borehole logs have identified a number of ironstone seams within the LCMS that are generally <0.2 m thick and are unlikely to have been exploited. A named ironstone seam has been identified underlying the south of the eastern section of the site that is likely to be of exploitable thickness, although it is identified at a depth >150 m bgl.

#### ***Mineral Stability***

- 13.2.38 Given the extent of coal mining that has taken place historically both within and surrounding the proposed site area, a Mineral Stability Desk Study and Risk Assessment has been completed in support of this ES and is presented as TA 13.3.
- 13.2.39 TA 13.3 concludes that a number of mine shafts may require remedial works to mitigate against stability issues.
- 13.2.40 Coal mining land uses are described in greater detail in the following Site History section.

#### ***Hydrogeology***

- 13.2.41 The SEPA River Basins Management Plan (RBMP) Interactive Map and Aquifer maps were reviewed to provide information on the underlying hydrogeology of the site.
- 13.2.42 Table 1 below summarises hydrogeological information available for the site.

**Table 1 Summary of Hydrogeological Information**

<b>Bedrock Aquifer</b>	<b>Name</b>	Stirling and Falkirk bedrock aquifer; and Clydesdale bedrock aquifer.
	<b>Type</b>	IF M - Intergranular fracture flow with a moderate productivity.
	<b>Productivity</b>	Moderate productivity potentially 1 to 10 l/s.
	<b>Flow Direction</b>	Groundwater within the bedrock aquifer is likely to flow along the dip of the bedrock following regional flow patterns. However, flow may be interrupted, diverted and potentially artesian where it encounters a geological fault. In addition, the presence of underground voids resulting from mining are likely to create artificial preferential pathways for groundwater flow.
	<b>Depth to Groundwater (m)</b>	Unconfirmed.
<b>Superficial Aquifer</b>	<b>Name</b>	Stirling and Falkirk localised sand and gravel aquifer; and Clydesdale localised sand and gravel aquifer.
	<b>Type</b>	I L – Intergranular fracture flow with a low productivity.
	<b>Productivity</b>	Low productivity potentially 0.1 to 1 l/s
	<b>Flow Direction</b>	The direction of the superficial aquifer flow is likely to be down topographic gradient and towards surface water receptors. In addition to groundwater within the superficial deposits, groundwater will also be present within the shallow peat mass. The direction of flow within the peat is likely to be influenced by both the topography and any artificial or natural drainage channels.
	<b>Depth to Groundwater (m)</b>	Unconfirmed.
<b>Groundwater Vulnerability</b>	<p>The following groundwater vulnerability classification are shown within the site boundary:</p> <p>2 - Vulnerable to some pollutants, but only when continuously discharged or leached;</p> <p>3 – Vulnerable to some pollutants with many significantly attenuated;</p> <p>4b - Vulnerable to those pollutants not readily adsorbed or transformed;</p> <p>4c – Vulnerable to those pollutants not readily adsorbed or transformed. and</p> <p>4d - Vulnerable to those pollutants not readily adsorbed or transformed.</p>	
<b>Drinking Water Protected Area</b>	<p>Groundwater - Yes <input checked="" type="checkbox"/> No</p> <p>Surface Water - Yes <input type="checkbox"/> No <input checked="" type="checkbox"/></p> <p>Comments: Both aquifers identified beneath the site have a protected status.</p>	

13.2.43 SEPA Water Body Information Sheets are included in Appendix 1.

### **Hydrology**

13.2.44 Table 2 below summarises the hydrology information available on the SEPA RBMP Interactive Map.

**Table 2 Summary of Hydrological Information**

Name	Distance (m)	Direction	SEPA Classifications 2008 (2011)	
South Calder Water	300	SW	Overall	Poor (Good)
			Chemical	Pass
			Ecological	Poor
River Almond	300	N	Overall	Poor (Moderate)
			Chemical	Pass
			Ecological	Poor
<b>Note:</b> The classifications given in brackets are the results of SEPA's annual classification in 2011.				

**Private Water Supplies**

- 13.2.45 Information on the location and nature of private water supplies was requested from North Lanarkshire Council and West Lothian Council's Environmental Health department. Data from West Lothian Council showed that there were no supplies within close proximity to the site boundary. North Lanarkshire confirmed that there was one supply close to the site recorded as shown in Table 2 and Figure 13.5.
- 13.2.46 Note that the information on Type B supplies in Table 2 may be less accurate as this is largely based on historic information provided to the council. This is the only available register of private water supplies.

**Table 3 Private Water Supplies within 3 km of Site Boundary (see ES Figure 13.5 for locations)**

Name	Properties Served	Source	Source Location	PWS type
Starryshaw Farm	Starryshaw Farm	Spring	289807, 660812	B

**Public Water Supplies**

- 13.2.47 Scottish Water provided detailed drawings showing the location of their water supply and sewerage infrastructure near the site.
- 13.2.48 There is a distribution main immediately adjacent to the site boundary, at the proposed site entrance. There is no sewerage infrastructure within or in the vicinity of the site, as shown in ES Figure 13.5.

**Abstractions and Discharges**

- 13.2.49 Nearby abstractions and discharges, as licensed under the Controlled Activities Regulations (CAR), were supplied by SEPA and are shown in Table 4, and are presented in ES Figure 13.5.

**Table 4 Licensed Discharges within 3 km of the Site**

Ref	CAR licence number	Name	Licensed Activity
1	CAR-L-1001325	Tam's Loop Quarry	Sewage (Private)
2	CAR-R-1086156	Charles Street	Sewage (Private)
3	CAR-R-1092151	West Benhar Road	Sewage (Private)
4	CAR-R-1092455	Hirst Road	Sewage (Private)
5	CAR-R-1017459	Greenrigg Farm	Sewage (Private)

Ref	CAR licence number	Name	Licensed Activity
6	CAR-L-1026509	Scottish Water	CSO
7	CAR-L-1026205	Scottish Water	CSO

13.2.50 As shown in Table 4 there are 7 licensed discharges within 3 km of the site boundary and there are no licensed abstractions. The discharges include private sewage outfalls (typically from septic tanks) and discharges from multiple Combined Sewer Overflows (CSO).

## Site History

### Historical Map/Aerial Photography Review

13.2.51 A review of historical maps held at the National Library of Scotland (NLS) Map Library was conducted in order to provide information on the historical land uses of the site. The table below summarises the historical maps available for review at the NLS Map Library.

**Table 5 Historical Map Reference List**

Publisher	Map/Sheet Reference	Survey/ Revision Date	Map Scale
Ordnance Survey Scotland	Linlithgowshire	1854 - 1855	1:10560
	Lanarkshire	1859	1:10560
	Lanarkshire Sheet XIII and Linlithgowshire Sheet XI.7.8.11.12	1898	-
	Lanarkshire Sheet IX.16 and Linlithgowshire Sheet XI.3.4.7.8	1898	1:2500
	Lanarkshire Sheet XIII.3	1898	1:2500
	Lanarkshire Sheet IX.15	1898	1:2500
	Lanarkshire Sheet IX.16	1912	1:2500
	Lanarkshire Sheet XIII.3	1912	1:2500
	Lanarkshire Sheet IX.15	1912	1:2500
	Lanarkshire Sheet XIII and Linlithgowshire Sheet XI.7.8.11.12	1912	-
	Lanarkshire Sheet IX.16	1915	1:2500
	Lanarkshire Sheet XIII.4 and Linlithgowshire Sheet XIII.4	1915	-
	Lanarkshire Sheet XIII.3	1939	1:2500
	Lanarkshire Sheet XIII.4 and Linlithgowshire Sheet XIII.4	1939	-
Ordnance Survey	Sheet NS9162	1956	1:2500
	Sheet NS86SE	1957	1:10560
	Sheet NS96SW	1957	1:10560
	Sheet NS8762	1957	1:2500
	Sheet NS8862	1957	1:2500
	Sheet NS8962	1957	1:2500
	Sheet NS9062	1957	1:2500
	Sheet NS8761	1957	1:2500

Publisher	Map/Sheet Reference	Survey/ Revision Date	Map Scale
	Sheet NS8861	1957	1:2500
	Sheet NS8961	1957	1:2500
	Sheet NS9061	1957	1:2500
	Sheet NS9161	1957	1:2500
	Sheet NS9060	1957	1:2500
	Sheet NS86SE	1967	1:10560
	Sheet NS96SW	1967	1:10560
	Sheet NS86SE	1973	1:10000
	Sheet NS96SW	1980	1:10000
	Sheet NS86SE	1982	1:10000
	Sheet NS86SE	1992	1:10000
Ordnance Survey LandLine Digital Map	Seamless digital map with full coverage.	1998 - 2005	1:2500
Ordnance Survey MasterMap Digital Map	Seamless digital map with full coverage.	2006 - 2012	1:2500

13.2.52 A summary of the historical development of the site and its immediate surrounding area is provided in the Table 6 and Table 7 respectively.

**Table 6 Summary of Historical On-Site Land Uses**

Land Use	Map Dates	Comments
Open moorland	-	The majority of the site constitutes open moorland until the development of plantation forestry in approximately 1975.
Railways	1898 - 1980	Evidence of colliery railway infrastructure (i.e. railway tracks, sidings, etc) is present on historic sheets from 1854/1855 to the present edition. It is of note that a dismantled railway is also shown on this edition, indicating development at the site prior to this date. It is of note that the railways have now been dismantled and a number are now utilised as tracks, including the main forestry track in the south east corner of the site.
Collieries	1898 – 1939/1940	Evidence of collieries is shown on the historic plans in the south-east of the site from 1854/1855 to 1967. This includes a bing and old airshaft (1898) with adjacent dismantled railway which becomes the Starryshaw Colliery Pits 1 & 2 (circa 1910). It is assumed that the colliery includes bings, marshalling yards and works buildings with associated infrastructure (including railways). A further bing is noted to encroach the southern boundary of the site in the western area of the site, this is associated with the former Rimmon Colliery. A total of 8 shafts are identified within the site boundary, with 3 further recorded shafts immediately adjacent to the site boundary in the north-east corner of the site.
Plantation Forestry	1975 - Present	Aerial photographs indicate the development of the current plantation forestry from circa 1975.

13.2.53 The locations and extents of historical site features are presented in TA Figure 13.2.1.

**Table 7 Summary of Historical Surrounding Land Uses**

Land Use	Map Dates	Comments
Collieries	1854/1855 – 1967	The site is located in a heavily industrialised area and the immediate surroundings have a long history of colliery activity. A number of named and un-named collieries are located within 500 m of the site boundary. Named collieries include Fallahill Colliery, Leadlock Colliery, Braehead Colliery, Rimmon Colliery, Benhar Colliery and Brownhill Colliery. Various works activities are known to have taken place at these colliery sites and the historic maps show evidence of such features including bings, tanks and reservoirs. Substantial infrastructure in the form of railway tracks links these collieries to the mains line.
Railways	1854 - present	The site is surrounded by numerous historic mineral railways associated with the areas mining heritage. All of the nearby mineral railways have been dismantled and a number now form compacted aggregate access tracks.
Reservoirs	1859 - present	A number of reservoirs and settling ponds thought to be associated with historic mining activities are located within 500 m of the site boundary as shown on TA Figure 13.2.1.
Refuse Pits	1967 - present	It is of note that a number of areas within the abundant surrounding former collieries are identified as refuse tips/pits from circa 1967. The nature of refuse material is not confirmed but could comprise anything from colliery waste to domestic refuse.
Possible Brickworks	1939	A 'Brickworks Cottage' is shown on the 1939 edition, suggesting the potential for a brickworks to have been located to the south-east of the site. This was only identified on this edition and no evidence of the brick works itself is apparent.
Shafts	1854 – present	A number of shafts associated with historic colliery activities are identified surrounding the site, with the closest adjacent to the site boundary in the north east corner of the site.

13.2.54 The locations and extents of nearby historical features are presented as TA Figure 13.2.1.

### Summary of Mapped Site History

13.2.55 The review of available maps and aerial photography indicates that previous industrial history at the site is limited to colliery activities and their associated infrastructure. Colliery activities are identified to have taken place in the east of the site at Starryshaw Colliery (Pits 1 & 2). The colliery on site and adjacent collieries outwith the site boundary were linked by a mineral railway network which has been dismantled and now forms part of the main forestry track in the south-east corner of the site. Limited extents of the mineral railway are also noted in the north-east corner of the site. Additionally, a number of former airshafts are present around the site, indicating that the site overlies former workings. The current condition of these airshafts is unconfirmed, however, based on anecdotal evidence from the Forestry Commission Scotland (FCS) and on-site observations, the locations of known shafts have been fenced off.

13.2.56 There are two bings located within the site boundary, one encroaching the south western boundary of the site associated with the former Rimmon Colliery and one in the east of the site associated with the former Starryshaw Colliery. The bings are generally vegetated with a mixture deciduous trees, bushes and grasses. It is of note that the Rimmon Colliery bing is steep sided.

13.2.57 The locations and extents of historical site features and nearby historical features are presented as TA Figure 13.2.1.

## **Wider Historical Sources**

- 13.2.58 The review of historical maps and aerial photography identifies a long industrial heritage predominantly related to coal mining and mining infrastructure. A number of shafts, reservoirs and settling ponds have also been recorded within close proximity to the site boundary. The more recent maps (circa 1965) indicate the decline of the extent of coal mining within the region, and it is of note that previously worked areas, surface mines and reservoirs have been back-filled, in some cases identified in maps as refuse pits. It is suspected that these pits may contain a wide range of possible materials from colliery waste to domestic refuse (with little or no records kept or available regarding their filling).

## **Conceptual Site Model**

### **Introduction**

- 13.2.59 Based on the information summarised above, a preliminary conceptual site model (CSM) has been developed to identify potential pollutant linkages present at the site. This CSM will assist in determining the need to undertake any further intrusive investigation works at the site (subject to the final detailed design of the proposed wind farm).
- 13.2.60 The CSM is based on the 'source-pathway-receptor pollutant linkage' concept. For a potential risk to arise, each stage of the pollutant linkage must be present. The CSM focuses on site specific potential contamination (soil, groundwater and gas phases) and potential pathways in the context of the sites proposed use.
- 13.2.61 It is of note that this CSM has been designed to reflect perceived land contamination risks identified within and adjacent to the site. Given the limited nature and extent of the previous industrial history relative to the size of the site, the design of the proposed wind farm may avoid areas of potentially contaminated land, thus rendering pollutant linkages incomplete. In this case, potential risks to statutory receptors associated with the proposed wind farm would be minimised. Similarly, should the design of the proposed wind farm incorporate hardstanding underlying site structures, then some human health pollutant linkages will also be rendered incomplete for the working life of the constructed wind farm (site staff during construction and decommissioning phases will remain at risk). The realisation of potential pollutant linkages therefore depends upon the finalised development design. This is assumed as presented herein. Should this alter at any future point the assessment made herein should be revisited to identify any possible changes to the conclusions drawn and their implications.
- 13.2.62 Based on the above, two separate initial CSMs, as presented below, have been developed to address the risks during the operational and construction/decommission phases of the proposed wind farm.

### **Sources**

- 13.2.63 The locations of potential sources of contamination are presented on TA Figure 13.2.1.
- 13.2.64 The review of historical mapping indicates that the south-east of the site was subject to development through mining from circa 1898 (and possibly even before that) to circa 1940. Infrastructure including mineral railways associated with former mining activities are also recorded within this south eastern area, as well as limited areas within the north of the site. What remains of these uses or the condition of the land in these areas remains unconfirmed.

- 13.2.65 The status of former air shafts and whether these have been infilled also remains unconfirmed. As such, these features also remain of unknown condition.
- 13.2.66 Two bings remain present within the site boundary, one encroaching the south-western boundary of the site and one in the east of the site.
- 13.2.67 Most recently, the site has been developed as plantation forestry, and the sites peat lands have been artificially drained.
- 13.2.68 The industrial nature of the former land uses within the site boundary indicates potential for contamination sources to be present, albeit of likely limited extent. This potential exists within the south-eastern and northern areas of the site as well as in the area surrounding the former Rimmon Colliery Bing to the west of the site. It remains unconfirmed whether any infilling of ground or ground reinstatement has taken place within the site boundary. It is of note that those potential sources located within the north of the site are limited to the locations of former mineral railways and infilled shafts. Potential sources include:
- S1 – Made ground (fill) or impacted ground associated with historic collieries and their associated infrastructure (namely railways, shafts and bings).
- 13.2.69 Contaminants associated with made or impacted ground may include but are not limited to the following:
- inorganic contaminants (metals, asbestos, etc);
  - volatile organic contaminants;
  - non-volatile organic contaminants; and
  - soil gases (methane, carbon dioxide, etc).
- 13.2.70 It is of note that there are not considered to be any potential off-site contamination sources requiring consideration.
- 13.2.71 Only those sources identified above are considered in the conceptual site model regarding the potential for the generation of soil gases. Naturally occurring sources of potential methane generation, e.g. peat, are excluded from consideration within the CSM.

### ***Contemporary Sources***

- 13.2.72 In addition to potential sources associated with historic industrial land uses on site, potential contaminated land risks also exist associated with the construction phase of the proposed wind farm. This is primarily associated with the bulk storage of fuels in the construction compound (S2).

### **Construction Phase CSM**

#### ***Receptors***

- 13.2.73 Based on the information gathered during the desk study, and in the context of the development of the site as a wind farm, the following receptors are considered to be at potential risk from potential on-site contamination sources:
- Human health – construction workers associated with the development of the proposed wind farm (R1);
  - Water Environment – underlying bedrock aquifer (R2 and nearby surface water bodies (R3).

It is of note that there are not considered to be any potential off-site human health receptors, e.g. residential properties, requiring consideration. There are also not considered to be any plausible property receptors (e.g. construction compound or temporary site offices) to include given that the locations of these proposed facilities are coincidental or near the identified source areas.

13.2.74 The underlying bedrock aquifer is identified as a potential receptor (groundwater body) to pollutants generated on site. Groundwater in the superficial deposits is unlikely to constitute a groundwater body (as defined by SEPA guidance) and so is instead assumed as a pathway (see below) to surface water receptors.

#### **Pathways**

13.2.75 Pathways are the means by which a receptor is likely to come in to contact with a source. Whilst many contaminants in soils are generally immobile (unless mobilised by wind or some other physical force), soil leachate, pore water, gas or vapour that may be generated could migrate to underlying groundwater and/or off-site through made ground to adjoining land/surface and water receptors.

13.2.76 The potential pathways that could link the sources and receptors previously discussed are considered to be:

- P1 – dermal contact with soil and dust;
- P2 – ingestion of soil or dust;
- P3 – inhalation of dust;
- P4 – migration of soil gases to excavations and subsequent asphyxiation or explosion;
- P5 – vertical migration of leachate or spills through the unsaturated zone to underlying groundwater in bedrock (and subsequent lateral migration off site); and
- P6 – shallow lateral migration or runoff of leachate or spills to nearby water courses.

13.2.77 Given the temporary nature of any likely construction compound, this assessment excludes indoor inhalation pathways, although these are unlikely to be at risk in any case due to their location away from potential gas generating source areas (as highlighted above).

#### **Operational Phase CSM**

##### **Receptors**

13.2.78 Based on the information gathered during the desk study, and in the context of the proposed future site use as a wind farm, the following receptors are considered to be at potential risk from potential on-site contamination sources:

- Human health – wind farm operatives during the operational life span of the wind farm (R1);
- Water Environment –underlying bedrock aquifer (R2 and nearby surface water bodies (R3).

It is of note that there are not considered to be any potential off-site human health receptors, e.g. residential properties, requiring consideration. There are also not considered to be any plausible property receptors (e.g. turbines or control building) to

include given that none of the proposed locations of these facilities are coincidental or near the identified sources areas on site.

- 13.2.79 The underlying bedrock aquifer is identified as a potential receptor (groundwater body) to pollutants generated on site. Groundwater in the superficial deposits is unlikely to constitute a groundwater body (as defined by SEPA guidance) and so is instead assumed as a pathway (see below) to surface water receptors.

***Pathways***

- 13.2.80 The potential pathways that could link the sources and receptors previously discussed are considered to be:
- P1 – vertical migration of leachate through the unsaturated zone to underlying groundwater in bedrock (and subsequent lateral migration off site); and
  - P2 – shallow lateral migration or runoff to nearby water courses.
- 13.2.81 Similar to the pathways during the construction phase, given the location of any permanent structures away from potential source areas, there are not considered to be plausible pathways associated with direct contact to building materials, potable water supplies or migration of soil gases. Furthermore, although the alignment of the proposed access track does coincide with areas of historic activity, e.g. mineral railways, it is assumed the engineered construction of the track (compacted aggregate) will preclude potential exposure of the underlying ground (potentially affected by historic site activity) to humans, i.e. wind farm operators. This assumes that new aggregate cover will be imported to upgrade all existing track surfaces and will have a minimum thickness to mitigate exposure to any historic track materials.

**Initial CSMs**

- 13.2.82 On the basis of the sources, pathways and receptors identified above, CSMs have been derived. These are represented graphically in TA Figures 13.2.2 and 13.2.3 and summary tables of the potential source-pathway-receptor linkages are presented below. The CSM tables also present an estimation of the environmental risk based on the guidance provided in CIRIA C552.

**Table 8 Initial CSM (Construction, including decommissioning Phase)**

Source/Contaminant		Human Health				Water Environment		Property
		Direct Exposure	Indoor/Outdoor Inhalation	Gas Migration to Excavations (explosion or asphyxiation)	Permeation of Water Supplies	Shallow Lateral Migration or Runoff to Surface Water	Vertical Migration to Deep Groundwater and Migration off Site Through	Direct Contact with Building Materials
<b>On Site</b>	Inorganic Contaminants (e.g. Metals/Asbestos)	<input checked="" type="checkbox"/> (low)	-	-	<input type="checkbox"/>	<input checked="" type="checkbox"/> (low)	<input checked="" type="checkbox"/> (low)	<input type="checkbox"/>
	Volatile Organic Contaminants	<input checked="" type="checkbox"/> (low)	<input type="checkbox"/>	-	<input type="checkbox"/>	<input checked="" type="checkbox"/> (low)	<input checked="" type="checkbox"/> (low)	<input type="checkbox"/>
	Non-Volatile Organic Contaminants	<input checked="" type="checkbox"/> (low)	-	-	<input type="checkbox"/>	<input checked="" type="checkbox"/> (low)	<input checked="" type="checkbox"/> (low)	<input type="checkbox"/>
	Soil Gases	-	-	<input checked="" type="checkbox"/> (low)	-	-	-	-
<b>Off Site</b>	Inorganic Contaminants (e.g. Metals/Asbestos)	-	-	-	-	-	<input type="checkbox"/>	-
	Volatile Organic Contaminants	-	<input type="checkbox"/>	-	-	-	<input type="checkbox"/>	-
	Non-Volatile Organic Contaminants	-	-	-	-	-	<input type="checkbox"/>	-
	Soil Gases	-	-	<input type="checkbox"/>	-	-	-	-
<p><b>Notes:</b>            Direct Exposure includes dermal, inhalation (dust) and ingestion human health pathways.  <input checked="" type="checkbox"/> Potentially complete source pathway receptor linkage.  <input type="checkbox"/> Theoretical source pathway receptor linkage but not considered potentially complete or plausible by virtue of site specific circumstances.            - Source pathway receptor linkage not theoretically possible.            (low) Risk level as defined by CIRIA C552 guidance.</p>								

**Table 9 Initial Conceptual Site Model (operational Phase)**

Source/Contaminant		Human Health				Water Environment		Property
		Direct Exposure	Indoor/Outdoor Inhalation	Gas Migration (explosion or asphyxiation)	Permeation of Water Supplies	Shallow Lateral Migration or Runoff to Surface	Vertical Migration to Deep Groundwater and Migration off Site Through Saturated Zone	Direct Contact with Building Materials
On Site	Inorganic Contaminants (e.g. Metals/Asbestos)	<input type="checkbox"/>	-	-	<input type="checkbox"/>	<input checked="" type="checkbox"/> (low)	<input checked="" type="checkbox"/> (low)	<input type="checkbox"/>
	Volatile Organic Contaminants	<input type="checkbox"/>	<input type="checkbox"/>	-	<input type="checkbox"/>	<input checked="" type="checkbox"/> (low)	<input checked="" type="checkbox"/> (low)	<input type="checkbox"/>
	Non-Volatile Organic Contaminants	<input type="checkbox"/>	-	-	<input type="checkbox"/>	<input checked="" type="checkbox"/> (low)	<input checked="" type="checkbox"/> (low)	<input type="checkbox"/>
	Soil Gases	-	-	<input type="checkbox"/>	-	-	-	-
Off Site	Inorganic Contaminants (e.g. Metals/Asbestos)	-	-	-	-	-	<input type="checkbox"/>	-
	Volatile Organic Contaminants	-	<input type="checkbox"/>	-	-	-	<input type="checkbox"/>	-
	Non-Volatile Organic Contaminants	-	-	-	-	-	<input type="checkbox"/>	-
	Soil Gases	-	-	<input type="checkbox"/>	-	-	-	-
<p><b>Notes:</b>            Direct Exposure includes dermal, inhalation (dust) and ingestion human health pathways.  <input checked="" type="checkbox"/> Potentially complete source pathway receptor linkage.  <input type="checkbox"/> Theoretical source pathway receptor linkage but not considered potentially complete or plausible by virtue of site specific circumstances.            - Source pathway receptor linkage not theoretically possible.            (low) Risk level as defined by CIRIA C552 guidance.</p>								

## Conclusions and Recommendations

### Site History

- 13.2.83 Historically, the site of the proposed wind farm has been exposed to colliery activities and those associated with colliery infrastructure (e.g. mineral railways and bings). These activities are evident on maps from the first published editions (circa 1854/1855 to present).
- 13.2.84 Although these historic activities give rise to potential land contamination risks, the areas associated with these historic activities are limited in their extent.
- 13.2.85 The remainder of the site has historically comprised open moorland. Historic aerial photography indicates that this moorland has been under the influence of artificial drainage from at least 1948.
- 13.2.86 Following the decline of the colliery activities within the site boundary, the land was developed for plantation forestry. This is evident from circa 1975 to the present day.

13.2.87 It is also observed that sections of former mineral railway within the site boundary have been redeveloped as forestry access tracks.

### **Initial CSM**

13.2.88 There are a range of potential pollutant linkages typically associated with the former land uses within the site which have the potential to impact upon human health and the Water Environment in the context of the proposed wind farm, both in its operation, construction or decommissioning. However, these linkages are expected to be relatively few and dependent upon the known areas of historic industrial activity on site and where these are coincident with the footprint of the proposed wind farm, particularly where human health risk are of concern.

13.2.89 In order to represent risks to statutory receptors, the initial CSMs have been developed to inform the design of the proposed wind farm such that possible risks can be duly accounted for and any mitigation measures adopted to ensure the future development is suitable for its intended use.

### **Construction Phase CSM**

13.2.90 The construction phase CSM includes the following potential source-pathway-receptor linkages:

- Linkage 1 – Direct contact with made ground by construction workers;
- Linkage 2 - Migration of soil gases to excavations from underlying made ground and subsequent asphyxiation or explosion;
- Linkage 3 - Shallow lateral migration or runoff of impacted leachate or spills to nearby water courses; and
- Linkage 4 - Vertical migration of leachate or spills through the unsaturated zone to underlying groundwater in bedrock (and subsequent lateral migration off site).

13.2.91 The construction phase CSM makes the following assumptions:

- the layout of the proposed wind farm does not alter from that assumed herein.

It is of note that TA 13.3 concludes that a number of mine shafts may require remedial works to mitigate against stability issues. Environmental sampling and testing should be carried out during any intrusive investigation of these shafts to confirm any potential contamination risk.

### **Operational Phase CSM**

13.2.92 The operational phase CSM includes the following potential source-pathway-receptor linkages:

- Linkage 1 - Shallow lateral migration or runoff of impacted leachate to nearby water courses; and
- Linkage 2 - Vertical migration of leachate through the unsaturated zone to underlying groundwater in bedrock (and subsequent lateral migration off site).

13.2.93 The operational phase CSM makes the following assumptions:

- human health direct exposure linkages (dermal contact, ingestion and dust inhalation) are not considered to be complete due to the absence of plausible

pathways (complete coverage by hardstanding or compacted aggregate) of the future development; and

- the layout of the proposed wind farm does not alter from that assumed herein.

### **Recommendations**

13.2.94 In order to address the potential linkages identified in the CSM it is recommended that the following measures be undertaken:

- Construction Phase CSM

Linkage 1 - undertake appropriate health and safety measures as part of the required Construction Phase Health and Safety Plan and other health and safety measures completed during construction works.

Linkage 2 - as linkage 1.

Linkage 3 - complete exploratory site investigations to confirm the nature of any fill material in the areas of historic mineral railways or bings. All bulk storage of liquids should meet the minimum required standards to guard against accidental product releases. These measures should be detailed in the Construction Phase Environmental Management Plan.

Linkage 4 - as linkage 3.

- Operational Phase CSM

Linkage 1 - complete exploratory site investigations to confirm the nature of any fill material in the areas of historic mineral railways or bings.

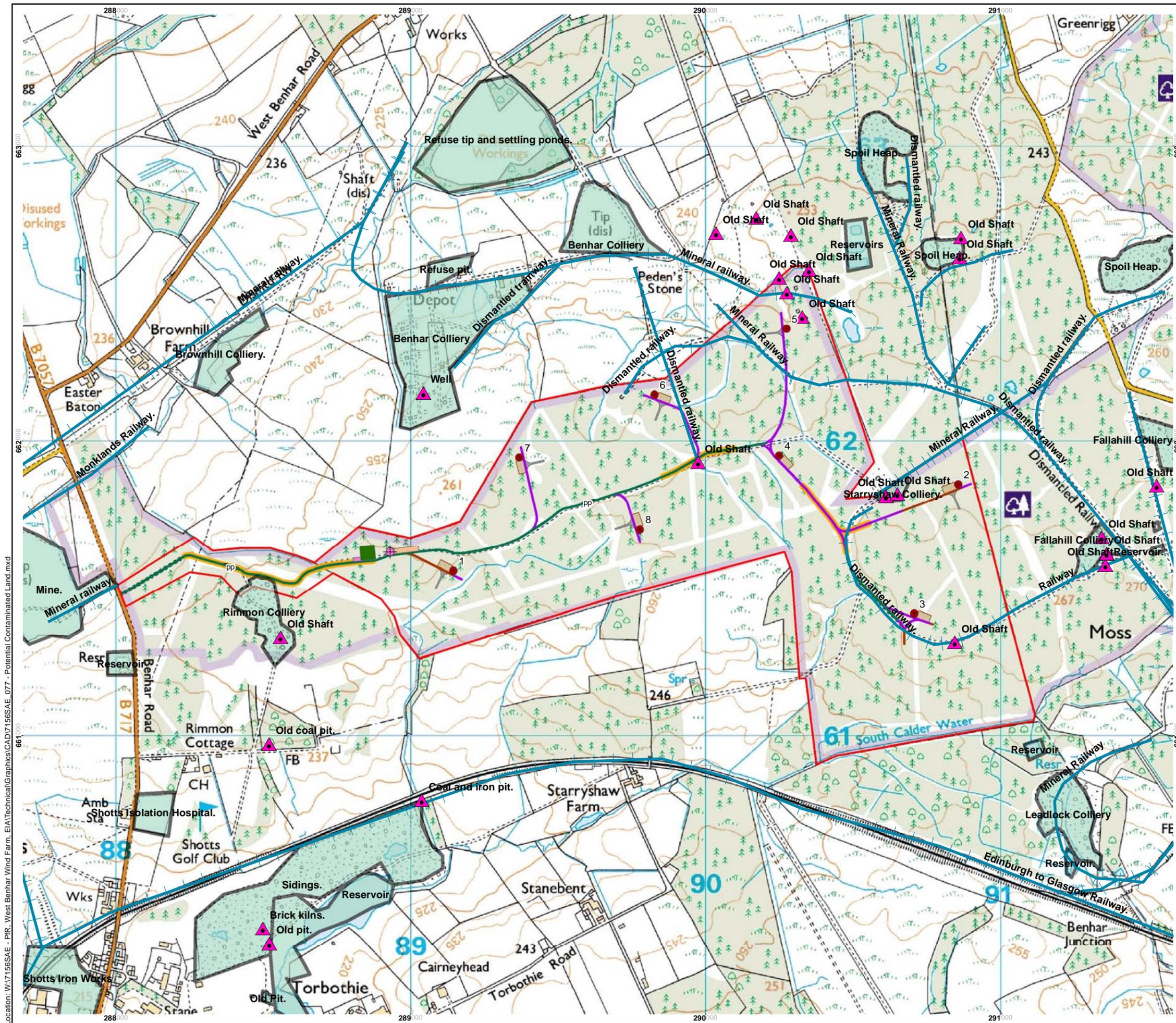
Linkage 2 - as linkage 1.

13.2.95 On the basis of the results of intrusive investigations any mitigation action can be considered should potential linkages to the water environment be apparent associated with these historic source areas on site.

13.2.96 Should fill materials be handled as part of earthworks completed on site, intrusive investigations and sampling will also inform any constraints on the reuse or disposal of this material, e.g. should it be considered hazardous waste or be inappropriate to reuse on site.

13.2.97 Given the low level of risk identified with the potential water environment linkages in the CSMs, reflecting the low sensitivity of the development and the less severe nature of the sources, it is envisaged that a limited level of investigation would be necessary. This may comprise a limited number of boreholes or excavations to prove the nature of fill material and any complimentary sampling and analytical testing of the fill that may be required to characterise leaching potential.

13.2.98 It is not recommended that any remedial action is taken regarding the shafts located on site given the low likelihood of environmental risks associated with these and the high health and safety risks that would be involved should these be attempted to be investigated.






A CARBON TRUST ENTERPRISE

**Legend**

- Application site boundary
- Proposed turbine locations
- Existing access track (to be upgraded)
- Proposed access track
- Proposed floating access track
- Proposed strengthened track section
- Proposed control building and compound
- Proposed temporary construction compound
- Proposed crane hardstanding
- Proposed turning area
- Proposed passing place
- Permanent met mast laydown area
- ⊕ Permanent met mast location (288932, 661623)

**Potential Sources of Contaminated Land:**

- Historical Line
- Historical Polygon
- ▲ Historical Points



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Project name: West Benhar Wind Farm

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Title : Potential Contaminated Land

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Date: 16/05/2013 Created by : AS

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Scale @ A3 1:12,500  
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 Kilometres

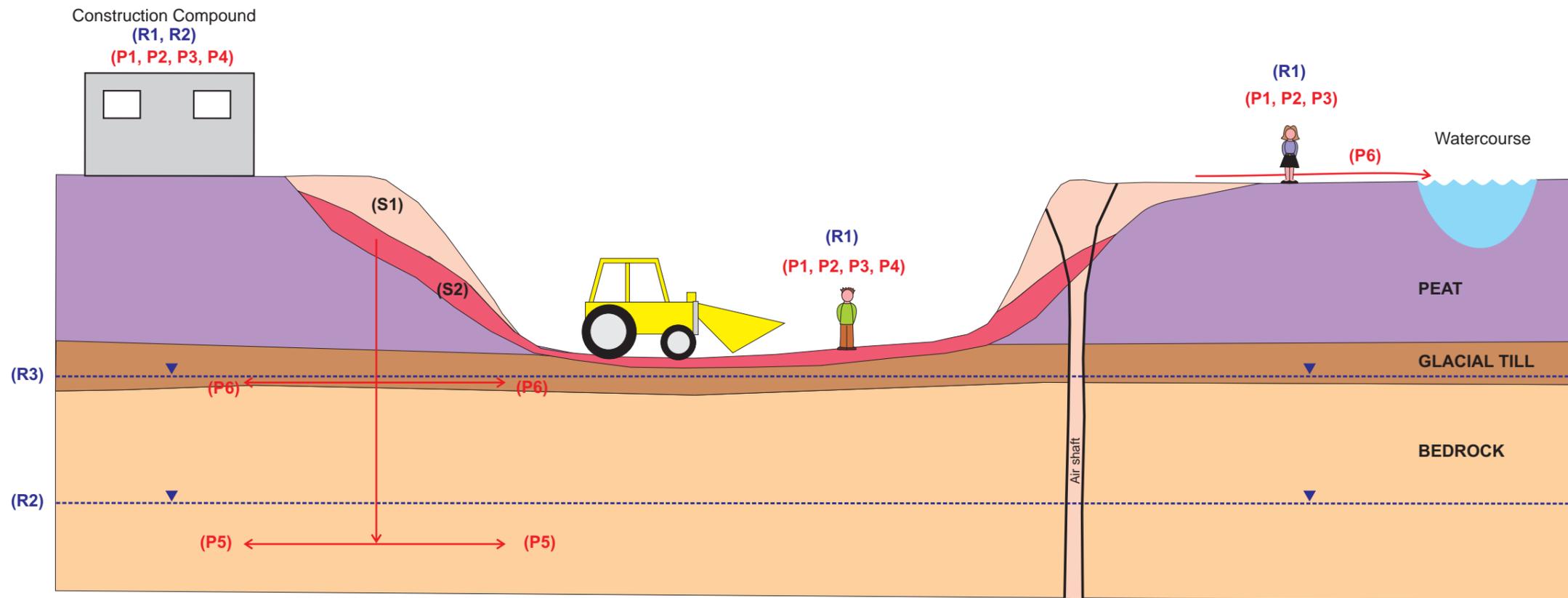
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REV: - A3 Figure : 13.2.1

Location: W:\7156SAE - PIR - West Benhar Wind Farm - EIA\Technical\Graphics\CAD\7156SAE\_077 - Potential Contaminated Land.mxd

Legend

- (S1) Source
- (R1) Receptor
- (P1) Pathway
- Water level



**Source**

- (S1) - Made ground or impacted material associated with historic collieries and their associated infrastructure;
- (S2) - Leachate or porewater contained within made ground.

**Receptors**

- (R1) - Human health;
- (R2) - Bedrock aquifer;
- (R3) - Superficial aquifer.

**Pathways**

- (P1) - Dermal contact with soil or dust;
- (P2) - Ingestion of soil or dust;
- (P3) - Inhalation of dust;
- (P4) - Migration of soil gases to excavations and subsequent asphyxiation or explosion;
- (P5) - Vertical migration of leachate or spills through the unsaturated zone to underlying groundwater in bedrock (and subsequent lateral migration off site);
- (P6) - Shallow lateral migration or runoff of leachate or spills to nearby watercourses.

Location: W:7156SAE - PIR - West Benhar Wind Farm. EIA\Technical\Graphics\CAD\7156SAE\_031 - Construction & Operational Phase Initial CSM.cdr

Project name: West Benhar Wind Farm

Title: Conceptual Site Model - Construction (including decommissioning) Phase

Date: 16/05/2013

Created by: KAG

Scale - not applicable

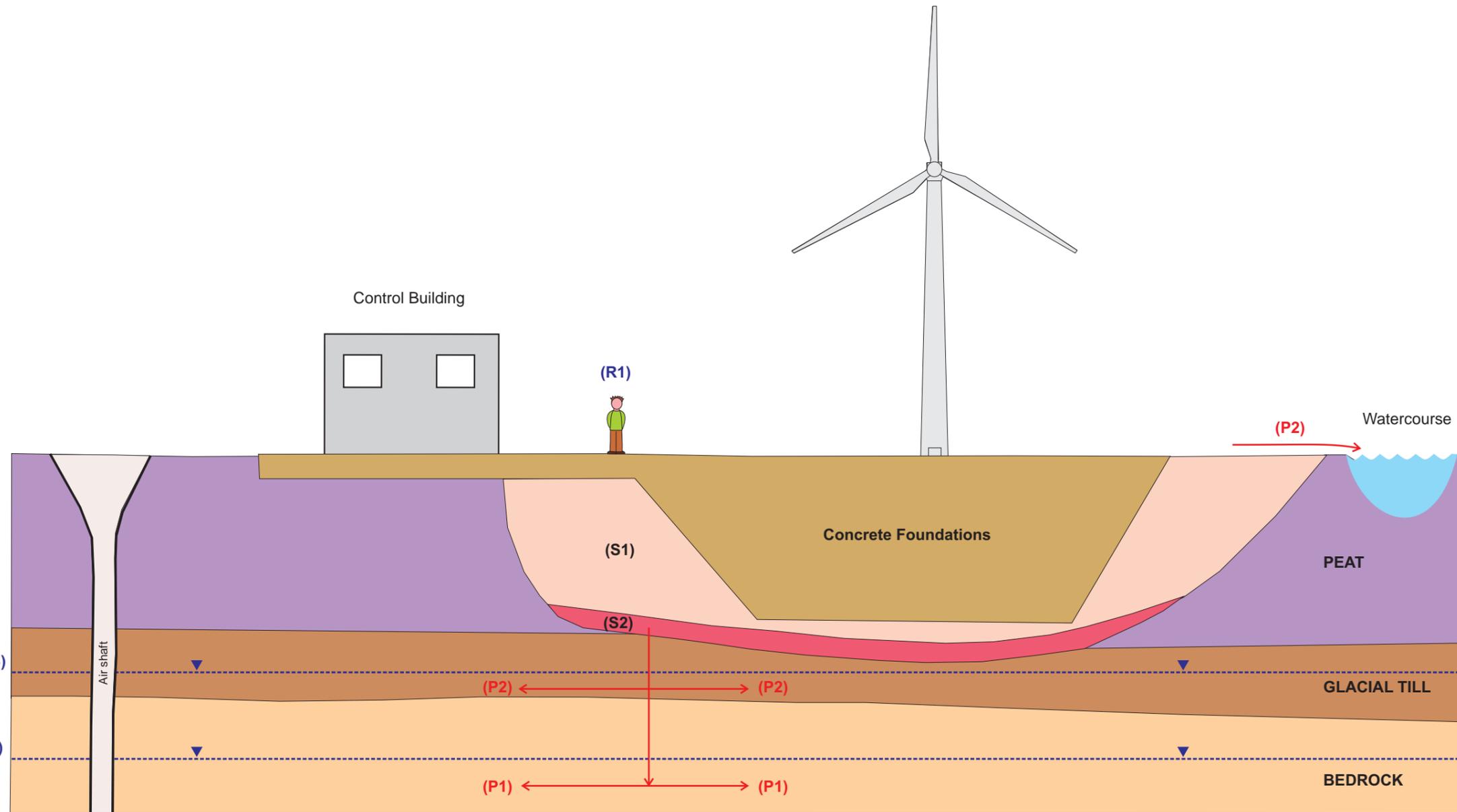
REV: -

A3

Figure: 13.2.2

Legend

- (S1) Source
- (R1) Receptor
- (P1) Pathway
- Water level



**Source**

- (S1) - Made ground or impacted material associated with historic collieries and their associated infrastructure;
- (S2) - Leachate or porewater contained within made ground.

**Receptors**

- (R1) - Human health;
- (R2) - Bedrock aquifer;
- (R3) - Superficial aquifer.

**Pathways**

- (P1) - Vertical migration of leachate through the unsaturated zone to underlying groundwater in bedrock (and subsequent lateral migration off site);
- (P2) - Shallow lateral migration or runoff to nearby watercourses.

Project name: West Benhar Wind Farm

Title: Conceptual Site Model - Operational Phase

Date: 16/05/2013

Created by: KAG

Scale - not applicable

REV: -

A3

Figure: 13.2.3