Environmental Statement

Volume 2i: Scheme-wide Assessment

Chapter 12: Geology, soils and land contamination

CONTENTS

12. GEOLOGY, SOILS AND LAND CONTAMINATION 12-3

Summary of principal findings 12-3

12.1 Introduction 12-4

12.2 Legislative and policy context 12-4

12.3 Assessment methodology 12-9

12.4 Baseline 12-24

12.5 Potential effects 12-31

12.6 Mitigation measures 12-36

12.7 Residual effects 12-42

12.8 Cumulative effects 12-43

Tables

Table 12-1 Groundsure data used within assessments 12-11
Table 12-2 Approach adopted 12-13
Table 12-3 Criteria for classifying the value (sensitivity) of environmental resources/receptors 12-17
Table 12-4 Magnitude of impact and typical description 12-19
Table 12-5 Significance matrix 12-21
Table 12-6 Summary of stakeholder consultation 12-23
Table 12-7 Summary of geological units 12-24
Table 12-8 Abstractions and discharges 12-24
Table 12-9 Hydrology 12-26
Table 12-10 Locations of Local Wildlife Sites 12-27
Table 12-11 Main potential sources of contamination 12-28
Table 12-12 Potentially significant effects during construction (prior to mitigation) 12-34
Table 12-13 Potentially significant effects during operation (prior to mitigation) 12-36
Table 12-14 Mitigation measures to address potential significant effects during construction and operation 12-39
Table 12-15 Potential inter-Scheme cumulative effects 12-45

12. GEOLOGY, SOILS AND LAND CONTAMINATION

Summary of principal findings

This chapter presents the geology, soils and land contamination assessment associated with the construction and operation of the Huddersfield to Westtown (Dewsbury) section ("the Scheme") of the Transpennine Route Upgrade (TRU) Programme. This chapter covers the assessment of the entirety of the Scheme.

The Scheme passes through urban and rural areas, with the potential for a wide range of contamination sources (including past and present industrial activities, landfill, chemical works, Artificial Ground[1] etc.), as well as potential geohazards associated with existing ground conditions and historical mining activities.

Potential construction phase impacts are associated with ground stability, erosion and mineral resources, as well as impacts to human health, controlled waters and property.

Potential impacts during the operational phase relate to possible spills/leaks of chemicals, fuels etc. that may be used (for instance during maintenance activities).

Effects prior to mitigation are typically assessed as Neutral/Slight adverse (and therefore not significant) in both the construction and operational phases. Potentially significant adverse effects (Moderate or greater) are anticipated in localised areas of the Scheme where geohazards of sufficient magnitude coincide with specific structures (e.g. coal mine entries/shallow workings at Hillhouse Sidings), or where ground contamination/gas might pose an unacceptable risk to an identified receptor (e.g. new foundations/excavations mobilising contamination from landfill waste into a below aquifer at the new Ravensthorpe Station forecourt area).

With the implementation of embedded mitigation measures and standard environmental control measures, as well as the additional mitigation measures (detailed in Section 12.4), no significant adverse effects are predicted for any receptor during either construction or operation of the Scheme. Potential significant beneficial effects have been identified in relation to areas where more severe geohazard and coal/mining-related risks would be mitigated by way of remediation and/or ground improvements as part of the Scheme development.

[1] "Artificial ground" is the term used by the British Geological Survey for those areas where the ground surface has been significantly modified by human activity. It includes deposits such as embankments and spoil heaps, areas where the ground has been cut away e.g. quarries (including those where the ground has been wholly or partially backfilled), areas where the surface has been reshaped, and areas of ill-defined shallow or near-surface mineral workings. The term Made Ground is also used to describe areas of artificial ground.

12.1 Introduction

12.1.1 This chapter presents the geology, soils and land contamination assessment associated with the construction and operation of the Huddersfield to Westtown (Dewsbury) section of the Transpennine Route Upgrade (TRU) Programme. This chapter covers the assessment of the entirety of the Huddersfield to Westtown (Dewsbury) Route hereafter referred to as "the Scheme").

12.1.2 The assessment is set out as follows:

- Legislative and policy context – relevant international, national and local policy requirements, legal requirements and guidance which have been used to define the assessment approach are outlined;
- Assessment methodology – the methodology the assessment follows is defined including the justification for the study area and the approach for determining significance of effects;
- Baseline – establishing the baseline conditions for the Scheme with respect to geology, mineral resources, ground instability, soils, hydrology, hydrogeology, land contamination (including the potential for unexploded ordnance and ground gases) and historical uses;
- Potential effects – the potential impacts and effects (both beneficial and adverse) on receptors during construction and operation are characterised;
- Mitigation measures – agreed avoidance, mitigation, compensation and enhancement measures are described;
- Residual effects – the significance of residual effects (both beneficial and adverse) on receptors following the implementation of mitigation measures is assessed; and
- Cumulative effects – the potential likely cumulative effects of the Scheme are described and assessed.

12.1.3 A detailed description of the Scheme is provided in Chapter 2 (Scheme description) in Volume 2i of the Environmental Statement (ES). All appendices and figures referred to in this chapter are provided in Volumes 3 and 4 of the ES respectively.

12.1.4 The geology, soils and land contamination assessment is further broken down into six Route Section Assessments in Volume 2ii of this ES which provide additional detail to this chapter.

12.2 Legislative and policy context

12.2.1 Legislative policy and guidance considered within this assessment is detailed as follows. The list is not intended to be exhaustive but includes the main documents relevant to the assessment of the potential geology, soils and land contamination impacts associated with the Scheme.

Legislative framework

12.2.2 The legislative framework applicable to this assessment is summarised as follows:

Environmental Protection Act (EPA) 1990[2]

12.2.3 The EPA 1990 defines, within England, Wales and Scotland, the fundamental structure and authority for waste management and control of emissions into the environment.

12.2.4 Part 2A of the EPA 1990 (issued in 1995) introduced a statutory regime for the identification

[2] United Kingdom Parliament, 1990. Part 2A of the Environmental Protection Act

and remediation of 'Contaminated Land'. It introduced, for the first time in the UK, a statutory definition of 'Contaminated Land' based on the pollution or likely pollution of controlled waters (all groundwater, inland waters and estuaries, excluding water perched above the zone of saturation), or significant harm or the likelihood of significant harm to other receptors (including human health, property and ecosystems).

12.2.5 Local authorities are the primary regulators under the EPA 1990 Part 2A regime, with a duty to identify whether the land in their area is 'Contaminated Land', although provision is made for consultation and co-ordination with the Environment Agency (EA) in situations when pollution of controlled waters is an issue.

Contaminated Land (England) Regulations 2006[3] and associated guidance

12.2.6 The 2006 Regulations set out provisions relating to the identification and remediation of contaminated land under Part 2A of the Environmental Protection Act 1990. An amendment to these regulations was issued in 2012[4] that included an update to the provisions on special sites and to take into account the updated definition of "controlled waters" in section 78A(9) of the Environmental Protection Act 1990.

12.2.7 Contaminated Land Statutory Guidance 2012[5] was issued to explain how local authorities should implement the above regulations, including how they should go about deciding whether land is contaminated land in the legal sense of the term. It also elaborates on the remediation provisions of Part 2A and explains specific aspects of the Part 2A liability arrangements.

12.2.8 The guidance also sets out Government objectives with respect to land contamination policy and the EPA 1990 Part 2A regime as:

- Identify and remove unacceptable risks to human health and the environment;
- Seek to ensure that contaminated land is made suitable for its current use; and
- Ensure that the burdens faced by individuals, companies and society as a whole are proportionate, manageable and compatible with the principles of sustainable development.

12.2.9 These three objectives underlie the 'suitable for use' approach to the assessment and remediation of 'land contamination'. This approach recognises that the risks presented by any given level of land contamination will vary greatly according to the use of the land and a wide range of other factors, such as the sensitivity of the underlying geology and the receptors which may be affected. The 'suitable for use' approach consists of three elements:

- Ensuring that land is suitable for its current use;
- Ensuring that land is made suitable for any new use; and
- Limiting requirements for remediation to the work necessary to prevent unacceptable risks to human health or the environment in relation to the current use or future use of the land.

12.2.10 The Contaminated Land regime, as implemented through EPA 1990 Part 2A and the planning process, does not address the risks to construction or maintenance workers or other occupations which may have direct exposure to land contamination. The risks to these human receptors should be managed through health and safety legislation, such as the Control of Substances Hazardous to Health (COSHH) Regulations 2002[6] (as amended) and the

[3] United Kingdom (UK) Parliament, 2006. Contaminated Land (England) Regulations (SI 2006/1380)
[4] United Kingdom (UK) Parliament, 2012. Contaminated Land (England) (Amendment) Regulations (SI 2012/263)
[5] Department for Environment Food and Rural Affairs. Environmental Protection Act 1990: Part 2A. Contaminated Land Statutory Guidance. April 2012.
[6] UK Parliament, 2002 (as amended). The Control of Substances Hazardous to Human Health Regulations (SI 2002/2677)

Construction (Design and Management) Regulations 2015[7]. These regulations require the employer to carry out an assessment of the risks associated with exposure to hazardous substances (including those that might be found in the ground) and then to prevent or reduce those risks, and, if this is not reasonably practicable, to adequately control such exposures (e.g. use of personal protective equipment).

The Water Resources Act (WRA) 1991 (as amended)[8]

12.2.11 The WRA introduced water quality classifications and explained the standards expected for controlled waters and what is considered as water pollution.

Water Framework Directive[9]

12.2.12 The Water Framework Directive implements goals to help protect and improve water quality (surface water and groundwater) and drives sustainable use of water.

12.2.13 Regulations 27 and 28 *Environment (Legislative Functions from Directives) (EU Exit) Regulations 2019* creates legislative powers for the Secretary of State or the appropriate devolved authority, in order to replace the functions previously conferred upon the Commission.

12.2.14 The WFD is transposed into UK Law by the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017, amended by the Floods and Water (Amendment etc.) (EU Exit) Regulations 2019. The Reduction and Prevention of Agricultural Diffuse Pollution (England) Regulations 2018 implement Article 11(3)(h) of the WFD.

The Environmental Permitting (England and Wales) Regulations 2016[10]

12.2.15 The Regulations put in place requirements to ensure that sites that produce certain materials and undertake certain activities (such as the storage, use or treatment of waste) have a permit or exemption from the regulator (i.e. the EA).

12.2.16 Permit or exemption details of all sites that manage waste from the Scheme will be checked to ensure waste is being managed in accordance with all applicable legislation and policies and in accordance with good practice.

Building Regulations (2010)[11]

12.2.17 The construction or extension of buildings (as opposed to other structures/built development) is subject to Building Control under the Building Regulations (2010)[12]. Requirement C1(2) states 'reasonable precautions shall be taken to avoid danger to health and safety caused by contaminants on or in the ground covered, or to be covered by the building and any land associated with the building'.

12.2.18 Contamination in the ground has the potential to attack and weaken building materials which may consequently lead to a breach of Part A of these Regulations which relates to structural safety. In addition, ingress of ground gases can lead to adverse impacts to property and occupants and is considered in Part C of the Regulations. The following approach is

[7] UK Parliament, 2015. Construction (Design & Management) Regulations (SI 2015/51)
[8] UK Parliament, 1991 (as amended). The Water Resources Act
[9] European Parliament, 2000. Water Framework Directive (Directive 2000/60/EC)
[10] UK Parliament, 2016 (as amended). The Environmental Permitting (England and Wales) Regulations (SI 2016/1154)
[11] United Kingdom Parliament, 2010. The Building Regulations (SI 2010/2214)
[12] United Kingdom Parliament, 2010. The Building Regulations (SI 2010/2214). Part C: Site preparation and resistance to contaminants and moisture.

prescribed to address ground contamination:

- Ground investigations (GI) should be carried out to determine the extent and nature of any contamination;
- Any ground covered by a building must be free from any material that might damage the building or affect its stability;
- Reasonable precautions must be taken to avoid danger to health and safety caused by contaminants on or in the ground covered by a building or any land associated with that building; and
- Precautions must be taken against ground gases such as landfill gases, radon, vapours etc.

Other Regulations

12.2.19 Consideration has also been given to the following legislative requirements during the assessment, these are considered further within Chapter 11 (Water environment) and Chapter 13 (Waste and materials) of this ES:

- Waste Framework Directive 2008[13] (this is transposed by the Waste (England and Wales) Regulations 2011 and amended by the Waste (Miscellaneous Amendments) (EU Exit) (No 2) Regulations 2019); and
- Hazardous Waste (England and Wales) Regulations 2005 (as amended)[14].

National policies

National Planning Policy Framework

12.2.20 The National Planning Policy Framework (NPPF)[15] sets out the Government's planning policies for England and how these are expected to be applied.

12.2.21 The NPPF states that planning policies and decisions should ensure that a site is suitable for its proposed use taking account of ground conditions and any risks arising from land instability and contamination. To achieve this, the Government requires every local authority in England to draft and adopt a local plan.

12.2.22 The plans set out local planning objectives, policies and identify how land is currently utilised. The government requires all local councils to develop a long-term plan which sets out how and where land can be developed:

- The natural and local environment are protected and enhanced, including protection and enhancement of valued landscapes, geological interests and soils, and remediation and mitigation of despoiled, degraded, derelict, contaminated and unstable land;
- Unacceptable risks from pollution and land instability are prevented, by ensuring that a development is appropriate for its location;
- Sites are suitable for their proposed new use, taking account of ground conditions and land instability, including from natural hazards or former activities. Once developed, the land should not be capable of being determined as Contaminated Land under Part 2A of the EPA 1990; and
- Mineral resources should be protected from development through the formulation of mineral safeguarding areas.

[13] European Parliament, 2008. Waste Framework Directive (2008/98/EC)
[14] UK Parliament, 2005 (as amended). The Hazardous Waste (England and Wales) Regulations (SI 2005/894)
[15] Ministry of Housing, Communities and Local Government, 2019. National Planning Policy Framework

National Networks National Policy Statement (NPS)

12.2.23 The NPS[16] may also be a material consideration in decision making for applications that fall under the Town and Country Planning Act 1990 or any successor legislation. Whilst the Scheme is seeking consent under the Transport and Works Act, given the nature of the Scheme as rail infrastructure it is considered appropriate that weight should be given to the principles set out in the NPS.

12.2.24 The NPS comments that where a project is subject to Environmental Impact Assessment (EIA), the ES should clearly set out any likely significant effects on internationally, nationally and locally designated sites of geological conservation importance.

12.2.25 The policy sets out the need to include appropriate mitigation measures as an integral part of their proposed development, including identifying where and how they are proposed to be secured.

12.2.26 The NPS also includes the requirement to consider the risk posed by land contamination, with mitigation measures proposed to address any such risk.

Local policies

Kirklees Local Plan (adopted 27 February 2019)

12.2.27 The Kirklees Local Plan[17] states that 'when considering development proposals Kirklees Council will take a positive approach that reflects the presumption in favour of sustainable development' Policy LP1 states that a strategic objective of the Council is to promote 'the use of brownfield land to meet development needs and support the regeneration of areas'.

12.2.28 Policy LP7 notes that 'to ensure the best use of land and buildings, proposals … should give priority to despoiled, degraded, derelict and contaminated land provided that it is not of high environmental value'.

12.2.29 Policy LP30 states that the council 'will seek to protect and enhance the … geodiversity of Kirklees, including the range of international, national and locally designated … geological sites…'.

12.2.30 Policy LP34 states that 'proposals must … ensure no deterioration of water courses or water bodies (including groundwater)' and that proposals must also 'ensure Source Protection Zones are protected from contamination'.

12.2.31 Policy PL52 states that any proposals with the potential to increase pollution levels must be accompanied by evidence showing that impacts have been evaluated and mitigation measures taken to prevent or reduce the pollution to prevent the development having unacceptable impact on the environment.

12.2.32 Policy LP53 states that 'development on land that is unstable, currently contaminated or suspected of being contaminated … will require the submission of an appropriate … risk assessment. For developments identified as being at risk of instability, or where there is evidence of contamination, measures should be incorporated to remediate the land and/or incorporate other measures to ensure that the contamination/instability does not have the potential to cause harm to people or the environment'.

[16] Department for Transport. 2014. National Policy Statement for National Networks
[17] Kirklees Council, Kirklees Local Plan - Strategy and Policies, adopted February 2019

Other guidance documents

Contamination: Risk Management (LC:RM)[18] and the Guiding Principles for Land Contamination (GPLC)[19]

12.2.33 Primary guidance for assessing and managing land contamination is presented in Land Contamination: Risk Management (LC:RM)[18] and the Guiding Principles for Land Contamination (GPLC)[19]. These documents provide a technical framework for the identification and remediation of contamination through the application of a risk management process.

12.2.34 The following additional guidance documents relevant to geology, soils and land contamination have also been considered when undertaking this assessment:

- Design Manual for Roads and Bridges (DMRB) LA 104 – environmental assessment and monitoring, produced by Highways England, Revision 1, July 2019;
- DMRB LA 109 – Geology and soils, Revision 0, October 2019;
- DMRB LA 113 – Road drainage and the water environment, Revision 0, August 2019;
- Department of the Environment (DoE) 1995 – Industry Profiles for previously developed land, Environment Agency;
- Construction Industry Research and Information Association (CIRIA) C552 – Contaminated Land Risk Assessment – A Guide to Good Practice 2001;
- National House Building Council (NHBC) and EA report R&D66 – guidance for the safe development of housing on land effected by contamination, 2008;
- CIRIA C665 – Assessing Risks Posed by Hazardous Ground Gases to Buildings, 2007;
- CIRIA C681 – Unexploded Ordnance (UXO) – A Guide for the Construction Industry, 2009;
- CIRIA C785 – UXO – Risk Management Guide for Land-Based Projects; 2019;
- CIRIA C733 – Asbestos in Soil and Made Ground: A Guide to Understanding and Managing Risks, 2014;
- CIRIA C682 – The Volatile Organic Contaminants (VOCs) Handbook, 2009;
- British Standard (BS) 10175:2011+A2:2017. Investigation of potentially contaminated sites. Code of practice. 2017;
- BS 5930:2015 + A1:2020. Code of practice for ground investigations, 2020; and
- BS 8485:2015+A1:2019. Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings 2019.
- CL:AIRE Definition of Waste: Development Industry Code of Practice, 2011.

12.3 Assessment methodology

Study area

12.3.1 The study area considered for this assessment includes the Scheme boundary (referred to in this assessment as “on-site”), plus a 250m buffer (referred to as “off-site”). The 250m buffer around the Scheme boundary is included in recognition that the potential impacts related to geology, soils and land contamination may extend some distance from the Scheme itself. A buffer of 250m is commonly used within the land contamination assessment industry, which is based on professional judgement and experience on a variety of sites where contamination/ gas does not generally pose an unacceptable risk further than 250m from a site and is the

[18] Environment Agency. Land Contamination Risk Management. 2020
[19] Environment Agency. GPLC1 – Guiding Principles for Land Contamination. March 2010

distance noted by Network Rail as required when assessing historical and environmental information related to a site[20]. The Scheme boundary and study area is shown in Figure 12-1.

12.3.2 Marginal updates have been made to the Scheme boundary since the procurement of environmental data used as part of the consideration of the baseline nature of the study area (the "Enviro+Geo Insight" reports referred to below). Such differences typically amount to only a few metres, but even where more significant differences are noted (for instance, in the Ravensthorpe Area and Westtown area in Route Section 6), it is considered that these changes do not introduce additional significant impacts (or materially change the impacts described) and therefore it is considered that the assessment undertaken remains valid.

Data sources

12.3.3 Establishing the baseline conditions for the Scheme has relied on existing data from a number of sources, including environmental database information and historical records. The following sources have been reviewed as part of the baseline assessment:

- Groundsure "Enviro+Geo Insight" reports (hereafter referred as "Groundsure report")[21], which includes historical maps and a range of environmental data;
- British Geological Survey (BGS) online data[22];
- A detailed UXO assessment by 1st Line Defence (February 2018);
- The Coal Authority, Interactive map viewer[23];
- Kirklees Council records;
- Environment Agency (EA) records;
- West Yorkshire Geological Trust records; and
- Network Rail "Mine Entries" and ground investigation records.

12.3.4 Walkover surveys were conducted on land, not currently owned by Network Rail, that will be acquired to enable the construction of permanent structures (e.g. widening of embankments/cuttings, new access for maintenance, new viaduct with associated embankments). A walkover survey was also conducted at the proposed Hillhouse construction compound site, which whilst already owned by Network Rail, will be subject to a significant change in use between baseline, construction and operation phases. Key observations from the walkover survey records that might indicate a potential source of contamination (e.g. tanks, fly tipped materials) have been included within the assessment.

12.3.5 Where land is required for temporary access or use as a construction compound, a walkover survey to confirm baseline conditions will be undertaken by a land contamination consultant prior to the Scheme Contractor taking possession of the land. This requirement is detailed within the mitigation section of this ES Chapter, see paragraph 12.6.6.

12.3.6 Table 12-1 contains details of the Groundsure data that have been referred to within Volumes 2i and 2ii of the ES.

[20] Network Rail document NR/L2/ENV/015 "Environmental and Social Minimum Requirements for Projects – Design and Construction", issue 8, dated 2nd March 2019)
[21] Groundsure Enviro and Geo Insight reports obtained in June, July and August 2020
[22] British Geological Survey, GeoIndex OnShore webpage, http://mapapps2.bgs.ac.uk/geoindex/home.html [accessed in August 2020]
[23] Coal Authority, Interactive Map webpage, https://mapapps2.bgs.ac.uk/coalauthority/home.html [accessed in August 2020]

Table 12-1 Groundsure data used within assessments

Section of assessment	Groundsure data referred to
Historical potentially contaminative land uses	Historical industrial land uses Historical tanks Historical energy features Historical petrol stations Historical garages Historical military land Historical licensed industrial activities
Recorded historical waste facilities and landfills	Historical landfill – Local Authority mapping/records Historical landfill – EA mapping/records Historical waste facilities
Recent industrial land uses	Recent industrial land use Current or recent petrol stations
Waste management sites	Active or recent landfill Licensed waste sites Pollution inventory waste transfers

Assumptions and limitations

Data limitations

12.3.7 The majority of the data sets were obtained and/or viewed online in summer 2020, with some online sources revisited and supplementary Groundsure data purchased at later dates as a result of refinements to the Scheme boundary. Much of the information contained within these data sets are historical in nature and unlikely to change (e.g. 1800s-1900s maps, locations of historical landfills, coal mine workings or geological features). There is a possibility that after the data was purchased/viewed, the primary datasets could have been updated. It is considered that any new data would not alter the conclusions of the ES.

12.3.8 It is possible that a new groundwater abstraction might be registered between the publication of the ES and completion of construction, the impact of which would be dependent on the proximity of the abstraction to the Scheme (in conjunction with magnitude of potential contamination source that might be disturbed by the works). Pre-commencement checks of any updates to abstraction points will be undertaken (as detailed in Part A of the Code of Construction Practice (CoCP) in Appendix 2-1). It is considered that any effects that may be identified would be addressed through industry standard mitigation measures as set out in paragraph 12.6.3.

12.3.9 This assessment has been informed predominantly by desk-based information, supported by data obtained from ongoing intrusive GI that was designed to collect data to inform detailed design. Results from the GI undertaken to date has been used to inform this assessment where available, however whilst GI data is not currently available for the whole of the Scheme, it is not considered that aspects would be identified that could not be addressed through industry standard mitigation measures as set out in Section 12.6. The EIA is typically based on a desk-based study and supporting walkover survey. The GI data strengthens the analysis where available, and therefore it is considered that where GI data is unavailable at this stage, the desk-based data are sufficient to inform this EIA.

Assumptions

12.3.10 This chapter assumes that risks to construction or maintenance workers do not need to be considered, as the assessment presented herein relates to the long-term (chronic) risk posed by contamination, not short-term exposure (acute risk) which is applicable to construction workers and which will be managed through the application of suitable health and safety

assessments and working methods.

12.3.11 It is assumed that members of the public and current occupiers (e.g. of houses/gardens, commercial units that are located within the Scheme boundary) will be isolated from construction working areas, , which is standard practice on construction sites and therefore considered as embedded mitigation. Additional measures to ensure this, such as barriers, alternative walkways and dust sheeting, are detailed in Part A of the CoCP as outlined in paragraph 12.6.3 in Section 12.6. The potential contamination/gas risks and related impacts to human receptors within the Scheme boundary, but who are excluded from the construction areas, are included within the assessment undertaken for off-site human receptors.

Approach

12.3.12 The general approach to assessing the impact of the Scheme is presented in Chapter 4 (EIA methodology), which states that if a recognised methodology/guidance exists for a technical discipline, then that should be used.

12.3.13 The EIA guidance documents (DMRB series) published by Highways England have been adopted as the potential impacts to geology/soils from road schemes are similar to that of railway schemes (i.e. linear infrastructure).

12.3.14 However, not all receptors/resources and associated impacts related to the Scheme are included in the DMRB series and for these receptors the DMRB approach has been adapted/expanded for this assessment using professional judgement, to ensure consistency in approach. The approach taken for the various receptors/resources is indicated in Table 12-2.

Table 12-2 Approach adopted

Receptor/resource (associated effect)	Guidance document	Comments
Human health (from contamination/gas already in the sub-surface)	DMRB LA 109	Receptor values (sensitivity) and magnitudes from LA 109 tables have been used in this chapter.
Surface water and groundwater/aquifers (from contamination already in the sub-surface)	DMRB LA 113	This chapter only considers the impact of contamination on controlled water receptors, all other impacts are considered in Chapter 11 (Water environment). For consistency, the receptor importance (sensitivity) and magnitude criteria presented in Chapter 11 (Water environment) were used in this chapter to assess the potential impacts to controlled waters receptors. LA 113 and the preceding DMRB guidance[24] were used to define the criteria for the Scheme.
Crops*, livestock* and buildings*/ infrastructure* (from contamination in ground/groundwater and gas)	DMRB LA 109 and professional judgement	The effect on crops and livestock is assessed in Chapter 19 (Agriculture) of this ES. However, the effect of contaminants that might be present in the ground/groundwater on the health of livestock and crops is assessed in this chapter.
Geologically important features (e.g. Sites of Special Scientific Interest (SSSI), Local Geological Sites (LGS)) and soil resources (e.g. from compaction, erosion).	DMRB LA 109	Receptor values (sensitivity) and magnitudes from LA 109 tables have been used in this chapter. The loss and/or impact on the quality of soil in farmland is assessed in Chapter 19 (Agriculture) of this ES.
Superficial and bedrock geology and buildings/ infrastructure founded therein (from instability related to mining and natural hazards, e.g. landslide)	DMRB LA 109 and professional judgement	LA 109 states that risks from geotechnical hazards and land instability are assessed in accordance with DMRB CD 622[25] (which focuses on assessing and addressing risks to road design and does not provide methodology for EIA).
Mineral resources (that might be lost, destroyed or sterilised by the Scheme)	DMRB LA 109, DMRB LA 110 and professional judgement.	DMRB LA 110** relates to what mineral resources the Scheme might use and what wastes it might produce. It does not mention the sterilisation of mineral resource under the Scheme. LA 110 has been consulted for informative purposes only and has not been used to undertake the assessment due to limited relevance.

[24] DMRB Volume 11, Section 3, Part 10, HD 45/09, Road Drainage and the Water Environment, November 2009
[25] DMRB CD 622 Managing geotechnical risk, Highways England, Revision 0, August 2019

Receptor/resource (associated effect)	Guidance document	Comments
Ecologically sensitive receptors (e.g. SSSI, Local Wildlife Site (LWS) from contamination in ground/groundwater	DMRB LA 109 and professional judgement.	-
Topography (landform)	Not applicable	LA 109 states "Effects on geomorphology, notably effects associated with landform, should be reported in landscape and visual effects". Therefore, potential impacts of the Scheme are considered in Chapter 10 (Landscape, townscape and visual) of this ES.
* all considered "property" in land contamination guidance ** Highways England, material assets and waste, August 2019		

Loss of resources and instability related to mining and geohazards

12.3.15 The geohazard classification system used by BGS designates hazards as Class A through to Class E. The precise description of the hazard in each class varies between different hazard types, but are generally as shown:

- Class A – negligible/very low hazard;
- Class B – low hazard;
- Class C – moderate hazard;
- Class D – high hazard; and
- Class E – very high hazard.

12.3.16 The geohazards considered by this classification are collapsible deposits, compressible deposits, running sand, landslides (slope instability), shrink swell and soluble rocks.

12.3.17 The value of the mineral deposits/soils and sensitivity of building/infrastructure to geohazards (e.g. landslides, mining) has been evaluated qualitatively, as has the magnitude of impact, using the criteria set out in Table 12-3 and Table 12-4.

Land contamination and gas

12.3.18 The assessment of the potential impacts of the Scheme on land contamination and conversely the potential impacts of these aspects on the Scheme itself, is undertaken in two phases:

- Land contamination risk assessment – The methodology is described in paragraphs 12.3.19 to 12.3.22 and in Appendix 12-1. The risk assessment is presented in Appendix 12-2, within the Conceptual Site Models (CSM). The sources, pathways and receptors presented in the CSM are summarised in paragraphs 12.4.12 to 12.4.26).
- Environmental Impact Assessment – The methodology is described in paragraphs 12.3.23 to 12.3.31 and the summary of the impact assessment is presented in Section 12.5.

12.3.19 The approach for the initial land contamination risk assessment is based on the LCRM guidance document. This document is considered the primary guidance in England and provides a technical framework for the application of a risk management process through a series of stages. The first stage comprises the development of an Initial Conceptual Site Model (CSM) and undertaking a preliminary (qualitative) risk assessment. Information from the organisations listed in paragraph 12.3.3 and walkover surveys was reviewed to identify potential contamination hazards/sources, migration pathways and receptors relevant to the Scheme. Where all three are present, or considered likely to be present, these are described as potential contaminant linkages (PCLs).

12.3.20 The assessment of risks related to the identified contamination PCLs is based on the methodology presented in the NHBC/EA report R&D66 (that follows the principles presented in CIRIA's C552), which provide guidance on the development and application of a consequence and probability matrix for land contamination risk assessment. Although R&D66 was produced to inform residential developments, the methodology and criteria for assessing contamination risks is applicable to other types of developments and provides more detailed criteria descriptions than C552. Definitions of probability, consequence and the classified risks adopted for this assessment are provided in Appendix 12-1.

12.3.21 CSMs have been prepared that include the baseline, construction and operation stages of the Scheme. Where the qualitative contamination risk assessment has identified potentially unacceptable risks in the construction stage consideration is given as to what additional stages of investigation and assessment, or procedures, would be required to establish risk levels and, if necessary, what might be needed to reduce the contamination/gas risks to an

acceptable level. The risk level during construction after the additional measures have been taken/implemented is also provided for comparison.

12.3.22 An assessment of the Scheme impacts related to waste (including waste soils and excavation arisings) is contained in Chapter 13 (Waste and materials) of this ES. It is understood that wherever practicable construction arisings will be reused within the Scheme, through processes such as the Environmental Permitting Regulations 2016 or in accordance with the Contaminated Land: Applications in Real Environments (CL:AIRE) Code of Practice Definition of Waste: Code of Practice (CoP)[26].

Impact assessment criteria

12.3.23 The value (sensitivity) of receptors has been determined following the criteria presented in Table 12-3 (which has been taken from Table 3.11 in DMRB LA 109 and expanded). The importance (sensitivity) of surface and groundwater receptors has been determined using criteria presented in Chapter 11 (Water environment) of this ES.

12.3.24 The magnitude of impact has been determined using the criteria shown in Table 12-4.

[26] CL:AIRE, 2011. The Definition of Waste: Development Industry Code of Practice.

Table 12-3 Criteria for classifying the value (sensitivity) of environmental resources/receptors

Receptor value (sensitivity)	Description
Very High	Geology: very rare and of international importance with no potential for replacement (e.g. UNESCO World Heritage Sites, UNESCO Global Geoparks, SSSI and Geological Conservation Review (GCR) sites where citations indicate features of international importance). Geology meeting international designation citation criteria which is not designated as such. *Economically important minerals valuable as a national resource.* Soils: directly supporting an EU designated site (e.g. Special Areas of Conservation, Special Protection Areas, RAMSAR sites). Contamination: 1. Human health: very high sensitivity land use such as residential or allotments. 2. *Property: residential. Crops/livestock (for human consumption)* 3. *Flora/fauna: EU designated site* *Instability: residential property*
High	Geology: rare and of national importance with little potential for replacement (e.g. geological SSSI/Area of Special Scientific Interest (ASSI), National Nature Reserves (NNR)). Geology meeting national designation citation criteria which is not designated as such. *Areas of regionally important economic mineral deposits.* Soils: soils directly supporting a UK designated site (e.g. SSSI) Contamination: 4. human health: high sensitivity land use such as public open space or school playing fields. 5. *Property: schools, hospitals* 6. *Flora/fauna: UK designated site* *Instability: schools and regionally important infrastructure (roads, railway)*
Medium	Geology: of regional importance with limited potential for replacement (e.g. Regionally important geological sites (RIGS)). Geology meeting regional designation citation criteria which is not designated as such. *Areas of locally important economic mineral deposits.*

Receptor value (sensitivity)	Description
	Soils: soils supporting non-statutory designated sites (e.g. Local Nature Reserves (LNR), LGS, Sites of Nature Conservation Importance (SNCI)). Contamination: 1. Human health: medium sensitivity land use such as commercial or industrial 2. Property: commercial/industrial, farm outbuildings and pets/horses 3. Flora/fauna: non-statutory designated sites Instability: commercial/industrial and locally important infrastructure (minor roads)
Low	Geology: of local importance/interest with potential for replacement (e.g. non designated geological exposures, former quarries/mining sites). Absence of economic mineral deposits or minimal areas of locally important deposits. Soils: soils supporting non-designated notable or priority habitats. Contamination: 1. Human health: low sensitivity land use such as highways and rail 2. *Property: roads, railways* 3. *Flora/fauna: non-designated notable or priority habitats* *Instability: agricultural land*
Negligible	Geology: no geological exposures, little/no local interest. Soils: previously developed land formerly in 'hard uses' with little potential to return to agriculture. Contamination: 1. Human health: undeveloped surplus land/no sensitive land use proposed 2. *Property: undeveloped surplus land* 3. *Flora/fauna: minimal ecological value* Instability: undeveloped surplus land
Text in italics is bespoke to the Scheme and is not in LA 109.	

Table 12-4 Magnitude of impact and typical description

Magnitude of impact	Typical description
Major	Geology: loss of geological feature/designation and/or quality and integrity, severe damage to key characteristics, features or elements. *Significant sterilisation of mineral resources.* Soil: physical removal or permanent sealing of soil resource. Contamination/gas: 1. Human health *and ecological receptors*: significant contamination identified. Contamination levels significantly exceed background levels and relevant generic screening criteria with potential for significant harm. Contamination heavily restricts future use of land. 2. *Human/Property: ingress of gas at sufficient volume/concentration where an explosion/asphyxiation is likely.* *Significant ground instability that is permanent in nature and causes catastrophic failure of buildings/infrastructure (resulting in closure of structures).*
Moderate	Geology: partial loss of geological feature/designation, potentially adversely affecting the integrity; partial loss of/damage to key characteristics, features or elements. *Moderate sterilisation of a mineral resource.* Soils: permanent loss/reduction of one or more soil function(s) and restriction to current or approved future use (e.g. through degradation, compaction, erosion of soil resource.) Contamination/gas: 1. Human health *and ecological receptors*: contaminant concentrations exceed background levels and are in line with relevant generic screening criteria. Significant contamination can be present. Control/remediation measures are required to reduce risks/make land suitable for intended use. 2. *Human/Property: occasionally ingress of gas might be sufficient volume/concentration where an explosion/asphyxiation might occur (but this is not certain).* *Moderate ground instability that is permanent that causes damage to buildings/infrastructure (resulting in short term closure until repairs undertaken).*
Minor	Geology: minor measurable change in geological feature/designation attributes, quality or vulnerability; minor loss of, or

Magnitude of impact	Typical description
	alteration to, one (maybe more) key characteristics, features or elements. *Minor sterilisation of a mineral resource.* Soils: temporary loss/reduction of one or more soil function(s) and restriction to current or approved future use (e.g. through degradation, compaction, erosion of soil resource.) Contamination/gas: 1. Human health *and ecological receptors*: contaminant concentrations are below relevant screening criteria. Significant contamination is unlikely with a low risk to receptors. Best practice measures can be required to minimise risks to human health. 2. *Human/Property: gas volume/concentrations indicate unlikely an explosion/asphyxiation would occur.* *Limited medium-term ground instability that causes minor damage to buildings/infrastructure (but not enough to result in any closures – minor repairs).*
Negligible	Geology: very minor loss or detrimental alteration to one or more characteristics, features or elements of geological feature/designation. Overall integrity of resource not affected. Soils: no discernible loss/reduction of soil function(s) that restrict current or approved future use. Contamination: 1. Human health *and ecological receptors*: contaminant concentrations substantially below levels outlined in relevant screening criteria. No requirement for control measures to reduce risks / make land suitable for intended use. 2. *Human/Property: gas volume/concentrations indicate very unlikely an explosion/ asphyxiation would occur.* *No measurable impact on ground instability or impacts to soil (e.g. erosion) that are only temporary in nature (<5 years).*
No change	Geology: no temporary or permanent loss/disturbance of characteristics features or elements. Soils: no loss/reduction of soil function(s) that restrict current or approved future use. Contamination: Human health *and ecological receptors*: reported contaminant concentrations below background levels. *Gas: Scheme will not alter current risk levels.* No change in ground stability.
Text in italics is bespoke to the Scheme and is not in LA 109.	

12.3.25 The classification of significance of effects is based on the criteria defined in DMRB LA 104 and is presented in Table 12-5. Where two significance categories are indicated within the matrix, professional judgement has been utilised to determine the appropriate level of significance.

Table 12-5 Significance matrix

		Environmental value sensitivity				
		Very High	**High**	**Medium**	**Low**	**Negligible**
Magnitude of impact	**Major**	Very Large	Large or Very Large	Moderate or Large	Slight or Moderate	Slight
	Moderate	Large or Very Large	Moderate or Large	Moderate	Slight	Neutral or Slight
	Minor	Moderate or Large	Slight or Moderate	Slight	Neutral or Slight	Neutral or Slight
	Negligible	Slight	Slight	Neutral or slight	Neutral or Slight	Neutral
	No Change	Neutral	Neutral	Neutral	Neutral	Neutral

12.3.26 For the purposes of this assessment and in line with LA 104, effects of Moderate and above (adverse or beneficial) are considered significant in terms of EIA.

12.3.27 The design process has enabled the development of appropriate design adaptations, referred to as embedded mitigation. These remove the risk of impacts to geology, soils and land contamination and, where this is not possible, they reduce these risks and minimise the associated consequences to acceptable levels. Examples include the works to overhead power lines in proximity to an area of contamination (Route Section 5). The following assessment is undertaken with consideration of embedded mitigation.

12.3.28 Appropriate additional mitigation measures to reduce and, wherever possible, avoid identified adverse effects will be explored and discussed within this ES chapter.

12.3.29 During construction, many of these measures are likely to be associated with good site practice and preparation of robust work packages. Such measures, as set out in paragraph 12.6.3, are incorporated into a CoCP. Part A of the CoCP is included in Appendix 2-1.

12.3.30 During operation, these measures will be part of the design of the Scheme and will look to avoid likely significant effects and provide betterment where possible.

12.3.31 Any residual effects of the Scheme following the inclusion of mitigation measures (embedded and additional) will be identified.

Cumulative effects

12.3.32 The assessment of potential cumulative effects of the Scheme has included the combined effects that result from incremental changes caused by other past, present and reasonably foreseeable human induced changes (Reasonably Foreseeable Future Projects (RFFPs)) on the existing environment within 100m of the Scheme boundary during both construction and operation.

12.3.33 The 100m assessment distance has been selected on the basis that beyond this it is likely that differences in land-use, geology etc. will mean that impacts related to ground remediation, or construction mitigation measures etc. are unlikely to have a combined impact. Developments which will be completed prior to the commencement of the Scheme have been included as potential receptors in the impact assessment.

12.3.34 Details of the cumulative effects are discussed Chapter 22 (Cumulative effects) of the ES.

Scoping and consultation

12.3.35 Local authorities, Government agencies and local organisations were contacted for relevant information in relation to geology and land contamination, as summarised in Table 12-6.

Table 12-6 Summary of stakeholder consultation

Organisation	Contact date	Response date	Response	Addressed in ES
Kirklees Council	25/06/2019*	18/07/2019	"Much of this railway route falls within high risk areas associated with former coal mining activity. It is therefore considered that any supporting ES must fully consider the following coal mining legacy issues: • The location and stability of abandoned mine entries • The extent and stability of shallow mine workings • Outcropping coal seams and unrecorded mine workings • Hydrogeology, mine water and mine gas In addition, consideration should be afforded as part of development proposals and the ES to the following: • If surface coal resources are present, whether prior extraction of the mineral resource is practicable and viable; • Whether Coal Authority permission is required to intersect, enter, or disturb any coal or coal workings during site investigation or development work".	Considered in the assessment of land instability
	27/06/2019	26/07/2019	Confirmation that no private water supplies are recorded within 1km of railway.	Noted in ES
	30/01/2020	N/A	Consultation meeting with the Environmental Health Officer (EHO). EHO confirmed agreement of the approach to contamination assessment adopted in the ES. EHO's main concern relates to cross-contamination between land plots (i.e. excavation of made ground from an industrial site, temporary stockpiling on a field and then placement within earthworks, potentially resulting in contaminants being released to ground at two areas). EHO provided comments on several key areas where contamination suspected from past activities.	Mitigation measures include soil testing and risk assessment to inform re-use. A Materials Management Strategy is included at Appendix 13-1. A Materials Management Plan (MMP) will be developed under Part B of the CoCP, as detailed in paragraph 12.6.4 in Section 12.6.
	11/02/2020	02/03/2020	Subsequent to above meeting, an email was issued to Kirklees Council requesting information (e.g. officer's site visit notes, old GI reports, remediation records) relating to landfill sites, chemical works, animal burial pits and Huddersfield Depot. Kirklees Council responded with an invitation to visit their offices to review paper records and Kompass database, however this did not take place due to COVID-19 restrictions.	Response not received at time of writing due to COVID-19 restrictions. However, given that other data sources have also been reviewed in detail (geological mapping, historical mapping, Groundsure records, planning portal details etc.) it is considered unlikely that significant aspects would be identified within Kirklees Council records that are not held elsewhere and which would materially and significantly alter the outcomes of the assessments undertaken.
Calderdale Council	November 2019	N/A	Information on private water supply records and details of any known animal burial pits data was requested. No response was received.	As above, given the nature of the Scheme and the environmental setting, whilst information has not been received from Calderdale Council, it is considered unlikely that its absence materially affects the assessment undertaken.
Environment Agency	25/06/2019*	22/07/2019	Commented that they were satisfied with the inclusion of a chapter in the ES for geology, soils and land contamination and agree with the proposed scope. Additionally, noted that CLR11 has been retired and replaced with updated guidance "Land contamination: risk management" (LCRM), and that this should be followed rather than CLR11.	LCRM used within this ES.
	17/03/2020	17/03/2020	Telephone meeting to discuss landfill/waste management facilities within the area, plus water abstractions, cross-checking information against EA data/records.	See below in relation to abstraction.
	23/03/2020	27/03/2020	Contacted EA to confirm whether any new abstraction permits had been issued since the Groundsure data was purchased. EA provided information on an abstraction that had become active in December 2019.	Abstraction is beyond the 250m buffer from the Scheme boundary.
West Yorkshire Geology Trust	26/06/2019	26/06/2019	Following a request for details on Local Geological Sites (LGS), West Yorkshire Geology Trust confirmed there are no LGS within 1km of the railway.	Included in ES
	26/01/2021	03/02/2021	A subsequent request based on the Scheme boundary confirmed there are no Local Geological Sites within 250m of the Scheme boundary.	Included in ES
Animal and Plant Health Agency (APHA)	09/10/2019	26/11/2019 and 08/01/2020	APHA commented that there is no register of historical animal burial sites.	Noted in ES
Canal & River Trust	19/10/2020	N/A	A summary of the potential impacts and effects of the Scheme was presented to the Canal & River Trust environmental advisors. No comments were received in respect of land contamination.	Not required
Coal Authority	Oct. 2019	N/A	Technical consultation pack sent to The Coal Authority. No response has been received to date.	Not required
*responses obtained by Transport and Works Act Order (TWAO) Unit during environmental scoping				

12.4 Baseline

12.4.1 Data were collected from the information sources outlined in paragraph 12.3.3 to establish the baseline geology, soils and land contamination conditions for the Scheme through desk-based review. The key environmental baseline conditions for the Scheme are summarised as follows, with the detail presented in the Route Section Assessments in Volume 2ii of the ES.

12.4.2 Artificial Ground is recorded over much of the Scheme (based on BGS data) and generally comprises re-worked natural deposits, ash/clinker and/or colliery spoil, as shown in Figure 12-1. A summary of the natural geology underlying the Scheme is presented in Table 12-7 and further details are shown on Figure 12-2 (Superficial deposits) and Figure 12-3 (Bedrock).

Table 12-7 Summary of geological units

Unit	Comments
Head[27] (clay, sand, silt and gravel)	Present in discrete areas within the Scheme boundary in Route Sections 1, 2 and 5 and off-site in Route Section 4.
Alluvium[28] (clay, sand and gravel)	Present in all Route Sections, both on- and off-site.
River Terrace Deposits (sand and gravel)	Only present within Route Section 6 (both on- and off-site)
Glaciofluvial[29] deposits (sand and gravel)	Only present on-site in Route Section 2 and off-site in Route Section 1 and Route Section 2.
Pennine Lower Coal Measures Formation (mudstone, siltstone and sandstone, with coal seams outcropping at surface)	Present in all Route Sections, both on- and off-site.
Rough Rock (Millstone Grit Group)	Only present in the western end of Route Section 1 (both on- and off-site).

12.4.3 The majority of the geological units reported beneath the site are classified as Secondary A Aquifers by the EA, with the exception of Head deposits which are classed as Secondary Undifferentiated. The Scheme is not situated within a groundwater Source Protection Zone (SPZ) and there are no SPZs located within the study area. As detailed in Table 12-6, Kirklees Council has confirmed there are no private water supplies within 1km of the existing railway. Abstraction and discharge permits located on- or off-site are presented in Table 12-8.

Table 12-8 Abstractions and discharges

Type	Route Section 1	Route Section 2	Route Section 3	Route Section 4	Route Section 5	Route Section 6
Groundwater abstraction (active)	One off-site	One off-site	n/a	One off-site	Two off-site	One off-site
Surface water abstraction (active)	One off-site	Three off-site	n/a	Three off-site	One off-site	One on-site and one off-site
Discharge to groundwater	n/a	n/a	n/a	n/a	n/a	n/a

[27] The BGS defines Head Deposits as angular rock debris, clayey hill-wash and/or soil creep, mantling a hillslope and deposited by the slow viscous downslope flow of waterlogged soil and the slow flow of fluidised superficial deposits during the thawing of seasonally frozen ground.
[28] Alluvium is defined by the BGS to be the unconsolidated detrital material deposited by a body of running water.
[29] Glaciofluvial deposits as sediments laid down primarily by waters issuing from ice sheets and glaciers

Type	Route Section 1	Route Section 2	Route Section 3	Route Section 4	Route Section 5	Route Section 6
Discharge to land (e.g. from septic tanks)	n/a	n/a	n/a	Four* Off-site	n/a	Two on-site and two off-site*
* two permit numbers but two versions per permit						

12.4.4 No LGS, GCR sites or geological SSSI have been identified within 250m of the Scheme boundary.

12.4.5 The majority of the Scheme is located within an area where less than 1% of homes are at, or above, the radon action level. Discrete areas of the Scheme and much of Heaton Lodge Curve in Route Section 4 and larger parts of Route Section 6 (eastern, south-eastern and northern areas) are located within areas where 1% to 3 % of homes are at or above the radon action level. A discrete area of Route Section 6 is also located within an area where 3% to 5 % of homes are at or above the radon action level. Figure 12-4 the shows the radon classifications for the study area.

12.4.6 BGS data indicate a negligible to low hazard level for collapsible deposits, shrink/swell and soluble rocks within the Scheme boundary. The potential hazard level for compressible deposits and running sand is indicated to be predominantly negligible to low, with some localised moderate to high hazard areas. The majority of the Scheme has a low hazard level for landslide (slope instability), with localised moderate to high hazard areas and very high hazard indicated within Route Section 2. Further details on collapsible deposits, compressible deposits, running sand, landslides and shrink swell are shown on Figures 12-5 to 12-9 respectively.

12.4.7 The Coal Authority records indicate mine entries and shallow coal workings (recorded or probable) are present within or in close proximity to the Scheme boundary, with the exception of Route Sections 3 and 5, respectively. Mine workings related to other minerals (not coal) are recorded in discrete areas of Route Sections 1 and 5 (on-and off-site) and only off-site in Route Section 2. Old quarries/pits (many now infilled) are recorded on- and off-site in the majority of Route Sections, with the exception of Route Sections 1 and 3, where such workings are only recorded off-site. Mining related features including Brits Pits, underground workings, quarries etc. and non-coal mining, mine shafts and other entries, plus past and probable past shallow coal mining and coal seams, are shown on Figures 12-10 to 12-13 respectively.

12.4.8 Information regarding mineral resources indicates that Mineral Safeguarding Areas (MSA) are present throughout the study area, variously associated with surface coal reserves, sandstone, sand/gravel and clay/shale. It is noted that the MSA extend significantly beyond the study area. Historical mineral planning areas are indicated within Route Sections 2, 4, 5 and 6 (both on- and off-site) and are shown on Figure 12-13.

12.4.9 Table 12-9 provides a summary of the variety of surface water features present on-site or in close proximity to the Scheme boundary. The two canals are also classified as LWS, which together with several woodlands, are the only sensitive ecological receptors (to contamination/gas) present within the study area as indicated in Table 12-10. Locations of surface water features are shown on Figure 11-1.

Table 12-9 Hydrology

Type	Route Section 1	Route Section 2	Route Section 3	Route Section 4	Route Section 5	Route Section 6
Unnamed watercourses	n/a	On-site (Field House Culvert (MVL3/98A)	On-site (Bradley Culvert (MVL3/102A))	Two on-site	n/a	n/a
Gledholt Beck	On-site	n/a	n/a	n/a	n/a	n/a
Hebble Beck	On-site	n/a	n/a	n/a	n/a	n/a
Ponds/ artificial lakes	n/a	n/a	Several off-site	Three on-site	Several off-site	One on-site
Calder and Hebble Navigation	n/a	n/a	n/a	On-site	Off-site adjacent	On-site
Huddersfield Narrow Canal	Off-site (adjacent)	n/a	n/a	n/a	n/a	n/a
Huddersfield Broad Canal	Off-site	On-site	Off-site (adjacent)	On-site	n/a	n/a
River Colne	Off-site	Off-site	Off-site	On-site	n/a	n/a
River Calder	n/a	n/a	n/a	On-site	On-site	On-site

Table 12-10 Locations of Local Wildlife Sites

Feature	Route Section 1	Route Section 2	Route Section 3	Route Section 4	Route Section 5	Route Section 6
Huddersfield Broad Canal	Off-site	Adjacent (off-site)	Adjacent (off-site)	On- and off-site	n/a	n/a
Huddersfield Narrow Canal	Adjacent (off-site)	n/a	n/a	n/a	n/a	n/a
Gledholt Woods	On- and off-site	n/a	n/a	n/a	n/a	n/a
Whitley Woods	n/a	n/a	n/a	n/a	Adjacent (off-site)	n/a
Jordan Wood and Oliver Wood	n/a	n/a	n/a	n/a	n/a	Off-site
Lower Spen Wildlife Area	n/a	n/a	n/a	n/a	n/a	Off-site

12.4.10 A detailed unexploded ordnance (UXO) assessment for the Scheme concluded the railway route and a 'buffer zone' (comprising a general corridor either side of the railway) was in a low risk area and recommended site-specific UXO awareness briefings are given to all personnel conducting intrusive works.

12.4.11 The main potential sources of contamination have been identified from review of historical maps and the Groundsure database (e.g. landfills, permitted activities, petrol stations). Table 12-11 provides a summary of the various contamination sources recorded on- and off-site in the six Route Sections. The locations of these potential sources of contamination are variously shown on Figures 12-14 to 12-20 and the 1:1250 and 1:2500 scale historical maps, which are included in Appendices 12-3 and 12-4.

Table 12-11 Main potential sources of contamination

Potential sources of contamination (historical and recent identified from database and maps provided by Groundsure)	Present in Route Section											
	Route Section 1		Route Section 2		Route Section 3		Route Section 4		Route Section 5		Route Section 6	
	On-site	Off-site	On-site	Off-site	On-site	Off-site	On-site	Off-site	On-site	Off-site	On-site	Off-site
Made Ground associated with construction of the existing railway infrastructure and historical leakage of contaminants from rolling stock, mainly in sidings. Ash, clinker, slag recorded on-site in boreholes.	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	
Developments associated with the historical and current use of the railway line (including engine shed, tramway, tanks, wagon repair shops, depot and warehouse works)		✓	✓		✓	✓			✓			
Mills and unspecified works	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
Garages (including vehicle respraying and vehicle recovery unit)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Fuel distributors/suppliers/works (including fuel tanks)			✓		✓					✓		
Service Station						✓						
Petrol station (active or obsolete)	✓	✓		✓				✓		✓		✓
Scrap metal, vehicle depollution facility and/or car breaking	✓	✓		✓						✓	✓	✓
Scrap yards (with fuel tanks, empty chemical tanks and road planings)			✓					✓	✓			✓
Bus and/or tram depots		✓				✓						
Burning of waste oil (historical and current)	✓											✓
National Shell Factory from World War I	✓											
Coal mining activities (including collieries, coal seam sub-crops, pits, and heaps, ground workings, and probable shallow mine workings)	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
Infilled canal	✓	✓										✓
Infilled ponds/infilled mill race or stream		✓							✓			✓
Abattoir	✓	✓		✓								✓
Tannery												✓
Power station											✓	✓
Electrical substations, gasometer, and/or electrical works	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Graveyard	✓											
Medical and pharmaceutical supplier/producer		✓										✓
Biocide production												✓
Former COMAH site (chemical and dye works)		One			One	Five			One	One		
Various permitted activities*	One	✓	Two	✓	Two	✓		✓		✓	Four	✓
Fire station		✓										
Infirmary (probably had a boiler house)		✓										
Timber yard/timber production and coating		✓		✓		✓			✓	✓		✓
Stone preparation and wholesalers, use of bulk cement, road maintenance equipment, use of concrete products/works			✓								✓	✓
Malt kiln								✓	✓	✓		
Boat building yard/dock yard								✓	✓			
Commercial yards with tanks (containing fuel, cleaning fluids, oil, etc.)											✓	✓
Smithy					✓							✓
Tankers Yard (steam cleaning, refuelling, paint spraying and servicing/repair of tankers)									✓			
Laundry and/or dry cleaners		✓										
Landfills (historical and/or authorised)		One	Three	Three	One	Five	One	Two	One **	Two	Three	Two
Incinerator and sanitary depot			✓									✓
Waste transfer sites (including truck repair/depollution centre, ELV facilities, and household, commercial and industrial), waste recycling			✓	✓		✓	✓	✓	✓	✓	✓	✓
Refuse/material heaps			✓	✓	✓				✓	✓		
Brick/tile/fire clay works			✓								✓	
Dye works									✓	✓		

Potential sources of contamination (historical and recent identified from database and maps provided by Groundsure)	Present in Route Section											
	Route Section 1		Route Section 2		Route Section 3		Route Section 4		Route Section 5		Route Section 6	
	On-site	Off-site	On-site	Off-site	On-site	Off-site	On-site	Off-site	On-site	Off-site	On-site	Off-site
Water works, printing, joinery and dripping factory		✓						✓				
Industrial coatings/finishings												✓
Textile printing and coating												✓
Sewage works (including filter beds and tanks)						✓	✓	✓	✓		✓	✓
Allotments				✓								
Quarries not related to coal mining (including infilled)				✓				✓				
Foundry								✓		✓	✓	✓
Fly tipped materials			✓								✓	
Radon from natural sources											✓	
Pollution incidents (various pollutants to air, land, and water)		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Land determined as Contaminated Land	No	No	No	No	No	No	No	No	Yes (Dr. Reddy's)	Yes (Dr. Reddy's)	No	No

*various permitted activities including: Hazardous substance storage/usage, licensed industrial activities (Part A(1)), licensed pollutant release (Part A(2)/B), Radioactive Substance Authorisations, pollutant release to surface waters (Red List), List 1 & 2 Dangerous Substances and Pollution Inventory Substances (including several waste incinerators)

** The ground investigation report attached to planning application reference 2009/93133, viewed on Kirklees Council's website, contains a letter dated October 2007 that indicates a landfill is present in the vicinity of the Kingdom Hall car park adjacent to and possibly beneath the eastern most arch of Mirfield Viaduct Underbridge (MVN2/192). The map attached to the letter did not show the landfill boundary. This landfill is not shown in the historical landfill dataset that originates from Kirklees Council (via Groundsure). The proposed Ledgard Bridge (Mirfield Viaduct) construction compound is located within/adjacent to the Kingdom Hall carpark. However, as no excavations are proposed it is considered that the Scheme would not disturb this potential landfill.

Conceptual Site Model

12.4.12 Following review of the baseline information CSMs have been prepared in order to allow the assessment of risk posed by land contamination/ground gas to receptors in the baseline and the construction and operation phases of the Scheme. The CSMs identify the potential or known sources and receptors of contamination, and the potential pathways between them. The associated preliminary risk assessment, using the methodology presented in Appendix 12-1, is presented in Appendix 12-2. The development of the CSM and risk assessment comprise the first step in assessing the impact of the Scheme on ground contamination/gas (in order to assess the potential impact, the degree of risk posed by contamination needs to be understood). A summary of sources, pathways and receptors identified for the Scheme is provided in the following sections.

Potential contamination sources

12.4.13 The Scheme is located in a mixed urban and rural setting, with a range of current and historical potentially contaminating activities. Full details of these land uses, and the potential contaminants that may be associated with them, are contained in Chapter 12 (Geology, soils and land contamination) of each Route Section Assessment and summarised in Table 12-11.

12.4.14 Potential contaminants related to some or all of these activities include metals/metalloids, inorganic substances (acids, alkalis, ammonia, sulphate, etc.), petroleum hydrocarbons, organic compounds (e.g. solvents), asbestos, ground gases (predominantly radon, methane and carbon dioxide) and pathogens.

12.4.15 Notable potential sources of contamination include the historical Halliday Chemical Works in Route Section 4, former Mirfield Chemical Works (now Dr Reddy's Laboratories) that is Contaminated Land[30] (within Route Section 5) and Thornhill Quarry Landfill (within Route Section 6).

Potential receptors and contaminant exposure/migration pathways

12.4.16 The following potential receptors and associated exposure/migration pathways have been identified to be present for the Scheme.

Human receptors

12.4.17 On-site receptors include railway staff and workers at in-station retail outlets etc., members of the public, farm and quarry workers, users of playing fields, occupiers of residential/ commercial premises, workers in fields and woodland/scrub areas.

12.4.18 Off-site human receptors include occupants of residential housing, occupiers of educational and commercial/industrial properties, members of the public/workers accessing the surrounding area, workers on nearby agricultural land, visitors to Ladywood Lakes and users of sports fields.

12.4.19 The principal contaminant exposure pathways for human health receptors include dermal contact and/or ingestion of contaminants in wind-blown soil-derived dusts and fibres, and inhalation of ground gases and/or vapours.

[30] Land that has been formally investigated by the local authority and determined under Part 2A of the EPA1990 as Contaminated Land due to contaminants within the ground/groundwater causing or very likely to cause significant harm/pollution to human health, property and/or the environment.

Controlled waters

12.4.20 Multiple surface water bodies have been identified within the study area and are summarised in Table 12-9.

12.4.21 Secondary Undifferentiated and Secondary A Aquifers have been identified underlying the study area. There are also a number of active surface water and groundwater abstractions located within the study area.

12.4.22 The principal contaminant exposure pathways for controlled waters receptors include surface run-off, infiltration, leaching and vertical migration from soil into groundwater, lateral migration in groundwater and migration following preferential pathways (e.g. track drainage, new piled foundations).

Property receptors

12.4.23 On-site property receptors have been identified to include existing and proposed railway infrastructure, stations, a few residential properties and commercial/industrial buildings. Off-site property receptors include all of the above plus farmyards and schools. In addition, property receptors include livestock and crops present within and adjacent to the Scheme boundary.

12.4.24 The principal contaminant exposure pathways for property receptors include direct contact with contaminants in soils and groundwater and migration of ground gases or vapours along preferential pathways and accumulation in enclosed spaces. For receptors such as livestock and crops, exposure pathways include absorption of contaminants, dermal contact and/or ingestion of contaminants in soil and within/on plants and inhalation of contaminants in soils/dust.

Ecological receptors

12.4.25 Both the Huddersfield Broad Canal and the Huddersfield Narrow Canal are LWS. Gledholt Woods, Whitley Woods, Lower Spen Wildlife Area, Jordan Woods and Oliver Woods are also recorded as LWS. Table 12-10 shows the locations of these with regard to each Route Section.

12.4.26 The principal contaminant exposure pathways for ecological receptors include absorption of contaminants via roots or from dust on foliage, dermal contact and/or ingestion of contaminants in soil and within/on plants, and inhalation of contaminants in soils/dust and ground gas.

12.5 Potential effects

12.5.1 This section considers potential effects on ground conditions, geology as a valuable resource, and ground contamination related to the construction and operation of the Scheme based on the available baseline information. Section 12.5 includes the second phase in assessing the impact of the Scheme on ground contamination/gas. The effects have then been categorised as either temporary or permanent, adverse or beneficial and significant (Moderate or above) or not significant (Slight or Neutral).

12.5.2 The ongoing design of the engineering aspects of the Scheme has been informed by the EIA and has sought to avoid predicted environmental impacts wherever possible. Where the design has been altered to mitigate a particular impact, this is considered to be embedded mitigation. For example, in Route Section 5 the design initially indicated overhead power lines to the west of Wheatley's Underbridge (MVN2/196) would need to be diverted and buried, which would have necessitated the purchase of land within a chemical works. During data

gathering to inform the baseline it was established the land was very likely to be grossly contaminated with hydrocarbons, which would have resulted in a potential significant effect being identified for which mitigation measures would be required. The designers reconsidered the options and in consultation with stakeholders altered the design.

12.5.3 Further details on the design options considered is provided in Chapter 3 (Consideration of Alternatives) of the Scheme-wide Assessment.

12.5.4 It is assumed that during operation the Scheme and associated facilities will be operated in accordance with the relevant regulations, which is therefore also considered embedded mitigation.

12.5.5 The potential impacts and effects during construction and operation of the Scheme reported in the following section have taken such embedded mitigation and the assumptions presented earlier in this chapter into consideration.

Construction

12.5.6 During the construction phase of the Scheme, the following potential effects have been identified:

- Erosion (and loss) of soil and superficial deposits (e.g. during stripping/removal of topsoil, vegetation clearance and whilst vegetation re-establishes on new slopes);
- Increasing instability of existing geohazards (e.g. mine shafts/voids, landslides, collapsible soils, etc.) resulting in failure of a geological unit and damage to buildings/infrastructure;
- Loss or sterilisation of mineral resources; and
- Disturbance and mobilisation of existing contamination and ground gas/vapour, which impacts upon human health, controlled waters, property and ecological receptors (e.g. introducing new pathways for contaminated water in shallow ground to migrate into a deeper aquifer).

12.5.7 MSA are present throughout the study area, variously associated with surface coal reserves, sandstone, sand/gravel and clay/shale. The majority of the permanent construction works will occur within or in close proximity to existing properties/roads/railways where these resources are already inaccessible, or where economically viable resources have previously been extracted (e.g. sand/gravel at Thornhill Quarry Landfill). The baseline information indicates the Scheme is not located within 250m of any sensitive geological sites (e.g. SSSI). The impact assessments in the Route Section Assessments concluded the potential impacts to mineral resource were Neutral to Slight and therefore not significant.

12.5.8 Areas where construction activities are proposed will be enclosed by fencing to restrict access to the construction workforce and permitted visitors only, which is standard practice on all construction sites. Once an area has been fenced off the baseline receptors identified within the Scheme boundary (e.g. occupiers of industrial units, residents within properties or users of public rights of way) will no longer be present on-site and the Scheme is considered to have a Negligible impact (not significant) upon these receptors.

12.5.9 The land contamination risk assessment undertaken for each route section identified potential contaminant linkages where construction of the Scheme might potentially increase the risk posed by contamination/gas to various receptors. The assessment concludes that the effect of the majority of the potential contaminant linkages is considered to be Neutral to Slight and therefore not significant.

12.5.10 Where the impact assessment identified significant effects during the construction and operation phases these are presented in Tables 12-12 and 12-13, respectively. Further detail

is presented in the Route Section Assessments in Volume 2ii of this ES.

12.5.11 Where impacts related to geohazards were considered to give rise to potential significant effects these are detailed in Table 12-12. No significant effects were identified with respect to soil erosion and so it is excluded from this table.

Table 12-12 Potentially significant effects during construction (prior to mitigation)

Receptor/resource	Impact	Significance of effect						
		Route Section 1	Route Section 2	Route Section 3	Route Section 4	Route Section 5	Route Section 6	Comments
Stability of the geological units within and adjacent to the Scheme boundary (and associated buildings/structures thereon)	Collapse of shallow mine workings or shafts due to construction activities	Very Large adverse and permanent for structures. Large adverse and temporary for compounds.	Very Large adverse and permanent for structures. Large adverse and temporary for compounds.	Very Large adverse and permanent for structures.	-	Large adverse and temporary for compounds.	Very Large adverse and permanent for structures. Large adverse and temporary for compounds.	Individual compounds/structures with significant effects are detailed in Section 12.3 (Potential effects) of each Route Section Assessment.
	Instability of geohazards (landslides, compressible ground and running sands) caused or worsened during construction	Moderate adverse and permanent for structures. Moderate adverse and temporary for compounds.	Large adverse and permanent for structures. Moderate adverse and temporary for compound.	Moderate adverse and permanent for structures. Moderate adverse and temporary for compound.	Moderate adverse and permanent for structures. Moderate adverse and temporary for compound.	Moderate adverse and permanent for structures. Moderate adverse and temporary for compounds.	Moderate adverse and permanent for structures. Moderate adverse and temporary for compounds.	
On-site public utilising temporary rail platform	Contamination mobilised during construction	n/a	Large adverse and temporary (Hillhouse construction compound only)	n/a	n/a	n/a	n/a	Relates to use of an area of Hillhouse construction compound as a temporary platform.
Off-site: Occupiers of adjacent properties and members of the public using PRoW etc.	Contamination mobilised during construction	-	Large adverse and temporary (at Hillhouse construction compound and landfills)	Large adverse and temporary (at landfill)	-	-	Large adverse and temporary (residents near historical landfill and commercial units near Thornhill Quarry Landfill)	Predominantly relates to sites where works are planned to areas of landfill
	Migration/accumulation of ground gas (from landfills and/or shallow mines) resulting in explosion	-	-	-	-	-	Large adverse and permanent (housing near historical landfill)	
Secondary A Aquifers (superficial deposits and/or bedrock)	Contamination mobilised during construction and/or migrating via new preferential pathways, e.g. piles or service/drainage	-	Moderate adverse and permanent (at Hillhouse construction compound and landfills)	Moderate adverse and permanent (at landfill and chemical works)	Moderate adverse and permanent (at new cutting)	Moderate adverse and permanent (at chemical works only)	Moderate adverse and permanent (landfills only)	
River Calder	Contamination mobilised during construction and/or migrating via new preferential pathways, e.g. new drainage	n/a	n/a	n/a	Very Large adverse and permanent (at new cutting)	Large adverse and temporary/potentially permanent (at chemical works only)	-	
River Colne and Huddersfield Broad Canal		-	-	-	Very Large adverse and permanent (at new cutting)	n/a	n/a	
Future structures and services associated with the Scheme.	Contamination mobilised during construction: Contact of concrete/plastic with ground contamination	-	Moderate adverse and permanent (Hillhouse construction compound only)	-	-	-	Moderate adverse and permanent (Power Supply Unit from landfill/mine gas and aggressive chemical conditions)	
	Migration/accumulation of ground gas resulting in explosion from on and/or	Moderate adverse and permanent (only DNO equipment,		-	-	-		

Receptor/resource	Impact	Significance of effect						
		Route Section 1	Route Section 2	Route Section 3	Route Section 4	Route Section 5	Route Section 6	Comments
	offsite contamination/gas sources	underground tank, services and lift pits at Station)						
Off-site: Existing residential houses and commercial units	Migration/accumulation of ground gas resulting in explosion from on-site landfill and shallow mining	-	-	-	-	n/a	Large adverse and permanent (houses) Moderate adverse and permanent (commercial units)	

n/a Receptor is not present on-site or off-site in this Route Section
\- Effects for this Route Section are assessed as Neutral to Slight and therefore not significant

Operation

Physical effects and effects on geology as a valuable resource

12.5.12 Whilst some of the impacts are related to the permanent works on the railway, the impacts and subsequent effects are deemed to occur once construction works commence and so are included in the previous section. No additional effects (significant or otherwise) have been identified during the operational phase of the Scheme.

Effects associated with ground contamination

12.5.13 There is the potential for spills, leaks, etc. of chemicals associated with the railway during the operational phase (for instance fuels, solvents etc.) which could have impacts on receptors including human health and controlled waters. However, the use of bi-modal/electric trains is expected as having less potential for leaks/spills when compared to existing diesel-powered units.

12.5.14 The majority of impacts that might occur to receptors during operation are the same as those that were identified during construction and will be mitigated during construction (e.g. potential for piles to create a new migration pathway for contamination to reach deeper groundwater). Exception to this are the potential impacts related to ground contamination to humans and livestock/crops that return to land on-site that was included in the construction areas. The impacts were generally considered to be insignificant with the exception of several discrete areas of the Scheme as detailed in Table 12-13.

Table 12-13 Potentially significant effects during operation (prior to mitigation)

Receptor/ resource	Impact	Significance of effect (in each Route Section)			
		Route Sections 1 – 3	Route Section 4	Route Section 5	Route Section 6
Workers in fields/on nearby agricultural land (used as compounds or for access)	Contamination disturbed during construction and/or mixed with near surface soils.	n/a	Large adverse and permanent (historically a colliery, in vicinity of new cutting only)	n/a	n/a
Livestock and crops on land (used as compounds or for access)	As above	n/a	Large adverse permanent (historically a colliery, in vicinity of new cutting only)	n/a	n/a

12.6 Mitigation measures

Construction

12.6.1 Where significant effects are identified in Tables 12-12 and 12-13, mitigation measures are proposed. As identified in paragraph 12.5.14 there is some overlap between the construction and operational effects and therefore mitigation for the operational phase may need to take place during the design/construction phase and so is reported in this section.

12.6.2 In accordance with the risk mitigation hierarchy these mitigations prioritise avoiding risks, reducing risks, rescuing or restoring the receptor, offsetting the impact and then compensation. These measures are presented in Table 12-14. Where measures are

proposed to be implemented during detailed design of particular structures, or within a particular area of the Scheme, or during construction (e.g. verification of gas precaution measures) these will not alter the overall proposals of the Scheme design, alignment or boundary and area likely to include works such as foundation/pile details adjusted in construction specifications.

12.6.3 Mitigation measures to be incorporated into the construction process in order to address potentially significant effects are set out in the CoCP. Part A of the CoCP is provided in Appendix 2-1 and includes mitigation measures to reduce the impact of the Scheme on the environment, in line with industry good practice and include such measures as:

- Preparation/utilisation of health and safety risk assessments, method statements and appropriate Personal Protective Equipment (PPE) for the protection of construction workers, taking particular account of areas of likely higher risk (i.e. landfills, chemical works etc.);
- Pre-commencement checks of any updates to abstraction points will be undertaken;
- Implementing appropriate fuel storage (i.e. bunded tanks, allocated re-fuelling areas etc.) and pollution control measures (i.e. plant drip trays and spill kits) during construction; and
- The use of hardstanding or compacted aggregate where practicable to minimise infiltration and the generation of dust that might contain contaminants.

12.6.4 Relevant to this chapter, Part B of the CoCP will include a Pollution Prevention and Incident Control Plan (PPICP), Materials Management Plan (MMP), a Waste Management Plan (WMP) and an Environmental Design Plan (EDP) (Land Contamination and Hydrogeology). The content of these documents will be submitted to and agreed by the local authority (Kirklees Council) pursuant to a planning condition to be attached to the deemed planning permission[31], prior to construction works commencing on each relevant phase.

12.6.5 In addition to the mitigation measures required to address the potentially significant effects identified, there will also be industry standard measures that will be applied to reduce risks posed by hazards typically encountered on a rail scheme, as follows.

12.6.6 Prior to construction, where land is required for temporary access or use as a construction compound, a walkover survey to confirm baseline conditions will be undertaken by a land contamination consultant prior to the Scheme Contractor taking possession of the land. Details will be included in the EDP (Land Contamination and Hydrogeology) under Part B of the CoCP.

12.6.7 For construction compounds and access routes where land is to be excavated, soil samples will be collected from the upper 1m for laboratory testing to provide an indication of contamination baseline levels. Deeper sampling and/or installation of monitoring wells to collect groundwater may be required if evidence of substantial contamination is encountered, but this will be considered on a site-by-site basis. If a proposed compound area or access route is covered in hardstanding that will remain intact during construction works, then sampling may not be necessary. Details of required works will be set out in the EDP (Land Contamination and Hydrogeology) under Part B of the CoCP.

12.6.8 Where piling works are required, a piling risk assessment will be undertaken in general accordance with EA guidance[32], and where necessary implementation of piling techniques deemed appropriate to manage potential risks related to the creation of pathways to

[31] On making an order under the Transport and Works Act 1992, the Secretary of State may direct that planning permission shall be deemed to be granted, subject to such conditions (if any) as may be specified in the direction.
[32] EA. Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention National Groundwater. Report NC/99/77. 2001.

groundwater and/or ground gas or mine gas migration. Details will be outlined in the EDP (Land Contamination and Hydrogeology) under Part B of the CoCP.

12.6.9 Where GI and associated risk assessments have indicated the potential for unacceptable risk, remediation of soil/groundwater contamination will be undertaken, pursuant to a condition to be attached to the deemed planning permission, to reduce risks to human health, property and controlled waters. Following completion of the remediation activities a verification report will be prepared.

12.6.10 Table 12-13 identifies the main areas where remediation might be required based on this assessment; these are highlighted as potential significant effects. However once the Scheme-wide GI and associated risk assessments have been completed (as per paragraphs 12.6.2 and 12.6.3), further areas may be identified as needing remediation; (this may include areas not identified as experiencing a significant effect based on professional judgement). Irrespective, based on the current knowledge of the Scheme and its geo-environmental setting and history, it is anticipated that potential unidentified impacts could be mitigated through readily available industry standard techniques that are frequently and successfully applied to a wide range of construction schemes and are detailed above in respect of this Scheme. The risk of encountering significant unexpected contamination will be managed pursuant to a condition to be attached to the deemed planning permission.

Table 12-14 Mitigation measures to address potential significant effects during construction and operation

Receptor/resource	Impact	Route Section	Mitigation measures
Stability of the geological units within and adjacent to the Scheme boundary (and associated buildings/ structures thereon)	Collapse of shallow mine workings or shafts due to construction activities Instability of geohazards (landslides, compressible ground and running sands) caused or worsened during construction	All Route Sections. Mitigation measures are proposed for those compounds/structures where adverse effects of Moderate or greater significance have been identified in Section 12.3 (Potential effects) of each Route Section Assessment.	The following measures will be set out in the EDP (Land Contamination and Hydrogeology) under Part B of the CoCP. Ground investigation will be undertaken as part of the detailed design phase to confirm the nature of geohazards and coal-related features, in order to assess the potential for adverse impacts to be realised. Dependent on the findings, mitigation measures employed will include; the use of ground improvement techniques and/or appropriate foundation/structure design. The assessment of geotechnical risk and design decisions will be recorded in design statements and/or the geotechnical design reports.
Public using temporary platform during construction on-site.	Contamination mobilised during construction	Route Section 2 – Hillhouse construction compound	As detailed in Part A of the CoCP, hoardings or fencing with dust sheets will be installed around the temporary platform and dust suppression measures deployed as necessary. Asbestos was recorded in one soil sample from the Hillhouse construction compound. If asbestos contamination is considered to pose an unacceptable risk then a remediation options appraisal/strategy will be prepared, submitted to and approved in writing by the local authority, pursuant to a condition to be attached to the deemed planning permission.
Residents and/or workers in fields/on nearby agricultural land, or livestock/ crops, on land used as compounds/ access	Contamination disturbed during construction and/or mixed with near surface soils	• Route Section 4 – in that was a colliery, in vicinity of new cutting; • Route Section 6 – historical landfill only.	Following completion of the GI and risk assessment, if contamination is considered to pose an unacceptable risk then a remediation options appraisal/strategy will be prepared, submitted to and approved in writing by the local authority, pursuant to a condition to be attached to the deemed planning permission. Any required remediation must be carried out in accordance with the approved remediation strategy,

Receptor/resource	Impact	Route Section	Mitigation measures
			with evidence collated for inclusion in a verification report to demonstrate the remediation has been completed. Further details on these mitigation measures will be included in the EDP (Land Contamination and Hydrogeology) under Part B of the CoCP.
Off-site: Occupiers of adjacent properties and members of the public using PRoW etc.	Contamination mobilised during construction	• Route Section 2 – Hillhouse construction compound and landfills; • Route Section 3 – landfill only; • Route Section 6 – landfills only.	As above, plus: Thornhill Quarry Landfill site, in Route Section 6, is known to contain asbestos waste. The detailed design of the various structures proposed on the landfill will be undertaken with the aim of minimising disturbance of the asbestos. It might not be possible to completely avoid excavating into the asbestos waste, so specialists will be consulted to prepare procedures to mitigate the potential risk of asbestos release to air during construction (such precautions will be detailed in the EDP (Land Contamination and Hydrogeology) under Part B of the CoCP). If asbestos contamination is considered to pose an unacceptable risk then a remediation options appraisal/strategy will be prepared, submitted to and approved in writing by the local authority, pursuant to a condition to be attached to the deemed planning permission.
	Migration/accumulation of ground gas (from on-site landfills and/or shallow mines) resulting in explosion	Route Section 6 – landfills only	Following completion of the GI and risk assessment (to include risks posed by piling*), if contamination/gas are considered to pose an unacceptable risk then a remediation options appraisal/strategy will be prepared, submitted to and approved in writing by the local authority pursuant to a condition to be attached to the deemed planning permission. Any required remediation must be carried out in accordance with the approved remediation strategy, with evidence
River Calder	Contamination mobilised during construction and/or migrating via new preferential pathways, e.g. new drainage in cutting	• Route Section 4 – new cutting; • Route Section 5 – chemical works.	
Huddersfield Broad Canal and River Colne		Route Section 4 – new cutting	

Receptor/resource	Impact	Route Section	Mitigation measures
Secondary A Aquifers (superficial deposits and/or bedrock)	Contamination mobilised during construction and/or migrating via new preferential pathways, e.g. piles or service/drainage	• Route Section 2 – Hillhouse construction compound and landfills; • Route Section 3 – landfill and chemical works; • Route Section 4 – cutting; • Route Section 5 – chemical works; • Route Section 6 – landfills.	collated for inclusion in a verification report to demonstrate the remediation has been completed. Further details on these mitigation measures will be included in the EDP (Land Contamination and Hydrogeology) under Part B of the CoCP.
Future structures and services associated with the Scheme.	Contact of concrete/plastic with ground contamination	• Route Section 2 – Hillhouse construction compound and landfills; • Route Section 6 – Power Supply Unit from landfill/mine gas.	Data from the GI will be used to inform the selection of materials to be used in these areas. The assessment of risk and design decisions will be recorded in design statements and/or the geotechnical design reports. Further details on these mitigation measures will be included in the EDP (Land Contamination and Hydrogeology) under Part B of the CoCP.
	Migration/accumulation of ground gas resulting in explosion from on and/or offsite contamination/gas sources	• Route Section 1 – new DNO equipment, underground tank, services and lift pits at Huddersfield Station • Route Section 2 – Hillhouse construction compound and landfill; • Route Section 6 – Power Supply Unit from landfill/mine gas.	Following completion of the GI and risk assessment, if gas hazards are considered to pose an unacceptable risk then a remediation options appraisal/strategy will be prepared, submitted to and agreed by the local authority pursuant to a condition to be attached to the deemed planning permission. Any required remediation must be carried out in accordance with the approved remediation strategy, with evidence collated for inclusion in a verification report to demonstrate the remediation has been completed. Further details on these mitigation measures will be included in the EDP (Land Contamination and Hydrogeology) under Part B of the CoCP.
Off-site: Existing residential houses and commercial units	Migration/accumulation of ground gas resulting in explosion from on-site gas sources	Route Section 6 – Landfills and shallow mining only.	
* Where any piling is proposed, a risk assessment will also be undertaken in accordance with the EA's "Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention National Groundwater", Report NC/99/77 dated 2001.			

12.6.11 Although not associated with a potentially significant effect, many of the contamination/gas sources identified by the baseline study are located in close proximity to construction activities and will need to be investigated/assessed to confirm risk levels and whether any remedial measures will be required during construction. This is required in order to ensure the risks posed by contamination and ground/mine gas are adequately assessed and reduced to acceptable levels in accordance with the UK and Network Rail land contamination regulations/guidance detailed earlier in this chapter.

12.6.12 Boreholes and trial pits have been proposed across the Scheme to provide data on the diverse potential contamination/gas sources and to confirm anticipated ground conditions to inform the detailed design of the Scheme (e.g. what concrete class will be required, what gas protection measures, if any, will be needed in new buildings, does a particular geological unit have sufficient strength to support a proposed structure, or whether pile design needs to be altered to minimise risk to groundwater). Soil test data will also be needed to inform the management and re-use of construction arisings within the Scheme (see Materials Management Strategy (MMS) in Appendix 13-1 for further details). The MMS will inform the Materials Management Plan to be produced under Part B of the CoCP.

12.6.13 There is the potential that data from the remaining GI locations may record different conditions. However, based on the information reviewed to date and professional experience on similar sites, it is not considered that the soil/groundwater data from the remaining boreholes would affect the validity of the conclusions of the EIA.

12.6.14 A coal mining risk assessment will be undertaken to inform the detailed design of those areas of the Scheme that are located in a Development High Risk Area in order to identify the remedial measures required, which is standard practice in former coal mining areas. Details of the risk assessment process will be presented within the EDP (Land Contamination and Hydrogeology) under Part B of the CoCP.

12.6.15 The additional assessments outlined in paragraphs 12.6.11 to 12.6.14 and the mitigation measures set out in Section 12.6 will provide adequate solutions for any effects that may be identified.

Operation

12.6.16 Following consideration of embedded mitigation and the identified potential significant effects being mitigated during construction; no further significant effects are anticipated during operation and no mitigation measures are required.

12.7 Residual effects

Construction

12.7.1 Following the application of the mitigation measures, residual construction phase effects are assessed as neutral, slight adverse or slight beneficial, and therefore not significant. The only potential significant effects remaining after mitigation relate to particular geohazards and are beneficial. For example, if necessary, the treatment of mineshafts within the Hillhouse construction compound would result in an improvement of ground stability from baseline, thereby reducing the risk of damage to nearby or new structures.

12.7.2 If treatment of the geohazards identified within the six Route Sections is undertaken, this would result in beneficial effects up to Very Large in localised areas. The magnitude of the residual beneficial significant effects is comparable with the magnitude of the pre-mitigation effects (the individual compounds/structures with effects of Moderate or greater significance are detailed in Section 12.3 (Potential effects) of each Route Section Assessment).

Operation

12.7.3 Following the implementation of mitigation measures during construction to address potentially significant adverse effects that might occur during operation, a potentially significant Moderate beneficial effect was identified. This relates to workers in fields/on nearby agricultural land and livestock/crops that might return to land that was part of a colliery, after temporary use as compound/access in Route Section 4 (in the vicinity of the new cutting). Where works are proposed within the former colliery area, the GI and subsequent risk assessment might indicate that remedial measures are required to make the land suitable for agricultural use (pursuant to a condition to be attached to the deemed planning permission). If remediation is required there will be significant benefit in relation to the condition of the land as a result of the Scheme during operation. However, it is also possible the GI and risk assessment might not identify an unacceptable risk to agricultural receptors. If this were the case, remediation would not be required and there would be no change in risk level between baseline and operation, i.e. the impact would remain unchanged.

12.8 Cumulative effects

12.8.1 Cumulative effects can include intra-Scheme effects and inter-Scheme effects.

- Intra-Scheme effects (or in-combination synergistic effects) are the combined impact from a single project on a single receptor or resource;
- Inter-Scheme effects are the combined impact of a number of different projects within the vicinity (in combination with the Scheme) on a single receptor.

Intra-Scheme (synergistic) impacts

12.8.2 Potential intra-scheme effects may occur from interaction with other environmental topics.

12.8.3 Potential synergistic impacts have been identified that correspond to geology, soils and land contamination, particularly from the water environment and waste and materials assessments.

12.8.4 The waste and materials and water resources assessments have identified with mitigation, Neutral or Slight residual adverse effects (not significant) during both the construction and operational phases. This chapter also concludes that no significant adverse effects are anticipated and the potential significant beneficial effects would not have a synergistic relationship with the topics outline above; it is therefore considered that no synergistic impacts are likely to be generated.

Inter-Scheme effects

12.8.5 Inter-Scheme cumulative effects may occur from interaction with other proposed developments (Reasonably Foreseeable Future Projects (RFFPs)) located near the Scheme. When combined with the works in the Scheme area these could cumulatively affect sensitive receptors. Inclusion of RFFPs includes their proximity to the Scheme, likely impacts and timing of construction and operation.

12.8.6 Potential impacts related to RFFPs are similar to those associated with the Scheme. For example:

- Contamination mobilised during excavations and/or migrating via dust entrainment or along new preferential pathways, such as piles/service trenches to controlled water receptors
- Migration/accumulation of ground gas (from infilled land and/or shallow mines) resulting in explosion

- Collapse of shallow mine workings or shafts due to construction activities. Instability of geohazards (landslides, compressible ground and running sands) caused or worsened during construction.

12.8.7 When considering whether the combined potential impacts of the RFFPs and the Scheme could result in a significant effect, the potential magnitude/type of contamination or geohazard was considered in conjunction with the anticipated degree of ground disturbance in both the RFFP and the closest parts of the Scheme. The potential inter-Scheme cumulative effects in relation to geology, soils and land contamination are set out in Table 12-15.

Table 12-15 Potential inter-Scheme cumulative effects

Route Section	Planning Application ref.	Development description	Location	Planning status	RFFP environmental information (relevant to geology, soils and land contamination only)	Potential cumulative effects	
						Construction	Operation
1 – Huddersfield	2020/90014	Demolition of existing building and erection of car sales and speculative B1/B2 unit with associated parking and access	11 The Triangle, HD1 4RN Adjacent to Scheme boundary	Conditional Full Permission – March 2020	No supporting environmental information	The Scheme comprises realignment of track, gantries and a temporary compound in this area. Minimal excavations are anticipated in association with these works and no major contamination sources were identified in this area. No significant cumulative effects are predicted.	No significant cumulative effects are predicted
1 – Huddersfield	Strategic highway scheme	Highways improvements to the junction of Huddersfield Ring Road/Southgate and Northumberland Street.	This junction is located east of Huddersfield Station.	Strategic Scheme	No information available.	All of these highway works/junctions are located over 200m from the major areas of excavation/piling in Route Sections 1 and 2. No significant cumulative effects are predicted.	No significant cumulative effects are predicted.
1 – Huddersfield	Strategic highway scheme	Highways improvements to the junction of Leeds Road/Lower Fitzwilliam Street/Gasworks Street.	This junction is located north-east of Huddersfield Station.	Strategic Scheme	No information available.		
1 – Huddersfield 2 – Hillhouse and Fartown	Strategic highway scheme	A62 Smart Corridor (Leeds Road - Phase 1)	A62 is located to south-east and parallel to the railway	Strategic Scheme	No information available.		
1 – Huddersfield 2 – Hillhouse and Fartown	Strategic highway scheme	Highways improvements to the junction of Leeds Road/Thistle Street/Hillhouse Lane.	This junction is located south-east of Hillhouse construction compound.	Strategic Scheme	No information available.		
2 – Hillhouse and Fartown	Strategic highway scheme	Highways improvements to the junction of Leeds Road/Old Fieldhouse Road.	This junction is located south-east of Field House Overbridge (MVL3/98) adjacent to the Scheme boundary	Strategic Scheme	No information available.		
3 – Deighton and Bradley	2017/91111	Outline application for erection of industrial development for B1 (business), B2 (general industry), and B8 (storage and distribution) uses	Station Road, Bradley, HD2 1UT Within Scheme boundary	Conditional Outline Permission August 2017	No EIA but application is supported by a contaminated land assessment	The Scheme includes construction of a new footbridge (Wheatley's Overbridge (MVL3/103)), minor alterations to Bradley's No.2 (BBW/1) Overbridge (MVL3/105) and temporary compounds, which either coincide with the RFFP development boundary or are immediately adjacent to it. A spoil heap (in which previous GI recorded sewage sludge, is located beneath the proposed development and adjacent to the new footbridge (no major contamination sources are located within the footprints of the bridges). Ground disturbance during construction of the proposed development could increase mobilisation of contaminants/gas but no significant cumulative effects are predicted.	No significant cumulative effects are predicted
3 – Deighton and Bradley 4 – Colne Bridge and Battyeford	2016/93896	Erection of 4 dwellings and associated works	Site off, Station Road, HD2 1US Within Scheme boundary	Conditional Full Permission – February 2017	No EIA – application is supported by a Design and Access Statement.	The Scheme includes minor excavations and new DNO equipment, which either coincide with the new RFFP boundary or are immediately adjacent to it (no major contamination sources present). No significant cumulative effects are predicted.	No significant cumulative effects are predicted

Route Section	Planning Application ref.	Development description	Location	Planning status	RFFP environmental information (relevant to geology, soils and land contamination only)	Potential cumulative effects	
						Construction	Operation
4 – Colne Bridge and Battyeford	2017/91208	Outline application for erection of industrial development of up to 3684 sqm B1c/B2/B8, with means of access (to, but not within, the site) from Colnebridge Road	Land adjacent to Colnebridge WWTW, Bradley 30m south-west of Scheme boundary	Conditional Outline Permission – Nov 2017	No contamination/ geological information available.	The proposed development is located over a historical landfill (sludge drying beds). However, it is unlikely there will be any ground disturbance associated with the Scheme within close proximity to this development (only an access route for construction traffic, along existing roads is proposed within the Scheme boundary). No significant cumulative effects are predicted.	No significant cumulative effects are predicted
4 – Colne Bridge and Battyeford	Strategic highway scheme	A62/A644 Wakefield Road (Cooper Bridge)	The junction of A62 Cooper Bridge/A644 Wakefield Road/A62 Leeds Road Within the Scheme boundary	Strategic Scheme	No information available.	The A62/A644 Wakefield Road (Cooper Bridge) development is located over 250m from the main excavations being undertaken for the Scheme. No significant cumulative effects are predicted.	No significant cumulative effects are predicted
4 – Colne Bridge and Battyeford	Strategic housing scheme	Kirklees Local Plan Allocation HS11 – housing allocation for 1,460 dwellings with potential for a further 498 dwellings beyond the plan period	Land north of Bradley Road, Bradley 900m north-west of the Scheme		No information available.	HS11 is located over 900m from the Scheme boundary. It is unlikely that any contamination that might be mobilised from works in HS11 would reach the Scheme or vice versa. No significant cumulative effects are predicted.	No significant cumulative effects are predicted.
6 – Ravensthorpe and Westtown	2017/94119	Demolition of existing building, erection of new building for educational classroom, cafe and toilets, upgraded access road, car parking, cycle parking, picnic and play areas.	Land off Sands Lane, Mirfield, WF14 Within the Scheme boundary	Conditional Full Permission – May 2018	No contamination/ geological information available.	The development coincides with a proposed access route for the Scheme. However, as minimal excavations are anticipated within the Scheme at this location and the lack of contamination sources identified in the locality, it is considered unlikely that ground disturbance would result in sufficient contaminant release to adversely impact receptors. No significant cumulative effects are predicted.	No significant cumulative effects are predicted.
6 – Ravensthorpe and Westtown	2017/90443	Erection of 3 units for B1 (light industrial) and B8 use, erection of two storey office building and alterations to existing building	Ratcliffe Mills, Forge Lane, Thornhill Lees, Dewsbury, WF12 9BU Within the Scheme boundary	Conditional Full Permission – Nov 2017	No contamination/ geological information available.	The development coincides with a proposed access route and compound area for the Scheme. Minimal ground disturbance is anticipated within the Scheme at this location and minimal geohazards and low-level contamination sources have been identified in the locality (e.g. old mill). No significant cumulative effects are predicted.	No significant cumulative effects are predicted.
6 – Ravensthorpe and Westtown	2016/94241	Non-Material Amendment to previous permission 2007/91742 for erection of 7 terraced industrial units	Calder Bank Road, Thornhill Lees, Dewsbury Adjacent to Scheme boundary	NMA Approved – May 2017	A ground investigation and contamination risk assessment report is appended to the 2007/91742 application.	A new access road to a residential property is proposed within the Scheme, which will involve shallow ground excavations. The only potential source of contamination identified is ash/clinker within the Made Ground of the development site. It is unlikely sufficient contamination would be mobilised to adversely impact receptors. Minimal geohazard risk has been identified. No significant cumulative effects are predicted.	No significant cumulative effects are predicted.

Route Section	Planning Application ref.	Development description	Location	Planning status	RFFP environmental information (relevant to geology, soils and land contamination only)	Potential cumulative effects	
						Construction	Operation
6 – Ravensthorpe and Westtown	2016/94118	Outline application for residential development	Land off Ravensthorpe Road, Dewsbury Within the Scheme boundary	Conditional Outline Permission – April 2017	No EIA but application is supported by a contaminated land assessment (desk study).	This residential development partly coincides with the proposed Ravensthorpe Station forecourt area and the historical landfill in this location. The desk study submitted with the planning application highlighted the potential risks posed to the development from land instability related to mine workings and contamination/gas originating from the landfill/mines. Conditions 9 to 13 of the outline planning permission 2016/94118 relate to land instability and contamination. If the ground investigation and risk assessment (recommended by the desk study) conclude remediation is required, then a remediation strategy and subsequent verification report will need to be submitted to Kirklees Council to confirm unacceptable risks have been addressed. The same staged approach will be followed to assess the risks posed by the landfill and mine workings to the Scheme (which follows the NPPF and LCRM guidance). Following implementation of remedial measures during construction of both developments (e.g. gas protection in housing, placement of geomembrane/soil over landfill waste, design of Scheme/housing foundations to avoid risk of creating new pathways) neither the proposed residential development or the Scheme should pose an unacceptable risk to the environment. No significant cumulative effects are predicted.	No significant cumulative effects are predicted.
6 – Ravensthorpe and Westtown	2016/94117	Outline application for 120 residential units at Lees Hall Road	Land off Lees Hall Road, Dewsbury 400m east of the Scheme boundary	Conditional Outline Permission	No EIA but application is supported by a contaminated land assessment (desk study, which is the same report as submitted for 2016/94118)	The proposed development is located over 400m from the Scheme boundary. It is unlikely that contamination, which might be mobilised by construction works, would reach the Scheme or vice versa. No significant cumulative effects are predicted.	No significant cumulative effects are predicted.
6 – Ravensthorpe and Westtown	2017/94080	Erection of precast concrete production unit, demolition of existing casting shed and ancillary buildings, associated site works to modify external storage areas and installation of gantry cranes – condition to vary plans and specs (2019/92570)	C R Longley and Co Ltd, Ravensthorpe Road, Thornhill Lees Within the Scheme boundary	Conditional Full Permission – July 2018 (approval of condition November 2019)	No EIA but application is supported by a ground investigation report and contamination risk assessment.	Minimal excavations are anticipated for the Scheme in this area (access required alongside railway land and for works to overhead power cables). The proposed development is located over an old landfill. The old GI report associated with this planning application indicates the waste is mostly demolition rubble, which is unlikely to contain significant contamination. No significant cumulative effects are predicted.	No significant cumulative effects are predicted
6 – Ravensthorpe and Westtown	Strategic housing scheme	Kirklees Local Plan Allocation HS61 (Dewsbury Riverside) – housing allocation for 4000 units (1869 units during plan period, with potential for a further 2131 beyond the plan period).	Land off Ravensthorpe Road, Dewsbury Within the Scheme boundary	-	Dewsbury Riverside Masterplan document is available.	HS61 coincides with the proposed Ravensthorpe Station forecourt area and the associated new cutting slope (all of which are located within an area of historical landfill). It is assumed that the RFFP will consider issues such as land contamination/gas assessments and remediation activities in any full planning application, any assessments and associated mitigation by the developer should ensure the RFFP would not pose an unacceptable risk to humans or the environment. No significant cumulative effects are predicted.	No significant cumulative effects are predicted

12.8.8 It is anticipated that any developments brought forward will be subject to National and Local Policy as well as legislative requirements and application of best practice measures and will be required to ensure that mitigation and control measures are adopted during construction and operation of the various developments.

12.8.9 There is a low potential for cumulative impacts during either construction or operation and therefore no significant cumulative effects are anticipated.