A614/A6097 Major Road Network Improvement Environmental Statement

Volume 1C
Scheme Specific Assessment - Lowdham Roundabout

Via East Midlands Ltd

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1. INTRODUCTION

1.1.1 Lowdham Roundabout is one of the six Schemes which comprise the A614/A6097 Major Road Network Improvement Project (hereafter referred to as the 'Project').

1.1.2 This volume of the Environmental Statement (ES) reports the findings of the Environmental Impact Assessment (EIA) that has been undertaken in compliance with the Town and Country Planning (EIA) Regulations 2017 (as amended 2018) (hereafter referred to as the 'EIA Regulations') (Her Majesty's Stationery Office (HMSO), 2017).

1.1.3 The assessment has considered the likely significant environmental effects of the Lowdham Roundabout Scheme in isolation through construction and operation, as well as the proposed mitigation measures recommended to avoid, prevent, reduce or offset any significant adverse effects on the environment.

1.1.4 Volume 1 of the ES provides information which is pertinent to the assessment reported herein, but has not been repeated. This includes:

- The background to the Project, the purpose and structure of the ES and the legislative and policy framework which applies to the Project (Volume 1 Chapter 1: Introduction).
- An overview of the need for the Project and a description of the Project and the other Schemes which are proposed to be delivered (Volume 1 Chapter 2: The Project). A specific description of works proposed at Lowdham Roundabout are provided herein.
- An assessment of the reasonable alternatives considered to the Project (Volume 1 Chapter 3: Assessment of Alternatives). Design development relevant to this Scheme is reported herein.
- The general methodology and approach to the environmental assessment (Volume 1 Chapter 4: Environmental Assessment Methodology). The specific methodology applied for the assessment is provided herein.
- Relevant legislation and policy are noted in full within Chapters 5 to 14 of Volume 1.

1.1.5 Volume 1 of the ES also provides the assessment of the cumulative impacts of the Schemes on each environmental topic when considered as one Project (Volume 1 Chapters 5-12) and the assessment of in-combination and cumulative effects in conjunction with other projects (Volume 1 Chapters 13 and 14).

1.1.6 Supporting figures can be found within Volumes 2 and 2C, and appendices are within Volumes 3 and 3C.

2. THE SCHEME

2.1 Existing Situation

2.1.1 Currently Lowdham Roundabout is a standard four-arm roundabout. The A6097 Epperstone Bypass entering the junction from the north and south are both of dual-carriageway standards. The adjoining Nottingham Road A612 to the south-west and Nottingham Road to the north-east are both single carriageway roads.

2.1.2 The roundabout is located on the outskirts of the village of Lowdham. Residential dwellings have been constructed to the east and south of the junction along the A612. A recreational ground incorporating a cricket pitch is located to the north of the junction, whilst the north-west of the junction is bordered by agricultural land. This area provides flood storage for flooding associated with the Cocker Beck.

2.1.3 Footways have been provided around the junction and splitter islands are available to assist pedestrians crossing. There is a PROW footpath (Lowdham FP2) which starts approximately 100 m to the south of the junction between property numbers 2 and 4 Nottingham Road.

2.1.4 The junction currently experiences significant journey delays (especially during the morning and evening peak periods) because of insufficient capacity to cater for current traffic demands and is considered to be a capacity restraint which has resulted in limits on nearby planning applications (Teal Park).

2.1.5 Current speed limits approaching the roundabout are as follows:

- A6097 Epperstone Bypass of roundabout – 40 mph;
- Nottingham Road/Southwell Road – 30 mph; and
- A612 Nottingham Road – 40 mph.

2.1.6 Key environmental constraints include but are not limited to:

- residential properties in close proximity to the junction;
- a noise important area (NIA), ID 11650 located within the assessment boundary extending south on the A6097, a second NIA, ID 11649, located approximately 370 m to the north on the A6097;
- flood zone 2 and 3 areas within the assessment boundary associated with the nearby Cocker Beck; and
- Lowdham Conservation Area lies approximately 460 m to the north-west of the assessment boundary.

2.1.7 Key environmental constraints and receptors are illustrated in figures associated with each topic chapter (Chapters 5 to 12) in Volume 2C.

Future Situation

2.1.8 Without improvement, the current congestion and journey reliability problems experienced on the A614/A6097 are expected to persist and worsen over time as noted in the Transport Assessment (AECOM, 2021).

2.2 Scheme Description

2.2.1 The Lowdham Roundabout general arrangement plan (located in Appendix 2-1 of Volume 3) illustrates the Scheme layout and its key components and features.

2.2.2 It is proposed that an enlarged four-arm elliptical roundabout be constructed to replace the existing roundabout. The Inscribed Circle Diameter (ICD) of the roundabout would be increased from 43 m to 65 m. This would have a two-lane circulatory carriageway and include a third left turn filter lane on the A612 Nottingham Road (eastbound) approach to the roundabout. It is proposed that the speed limit at the roundabout would be reduced from 40 mph to 30 mph. The 30 mph speed limit would also extend approximately 140 m from the junction on the north-western leg of the A6097 and approximately 100 m from the junction on the south-western leg of the A612.

2.2.3 A new access road would be provided from the A612 Nottingham Road to access the four properties on the south side of the road, closest to the roundabout.

2.2.4 Street lighting would be upgraded to align with current design standards and all sodium lanterns would be replaced by LED type.

2.2.5 All footways on the north side of the junction would be ‘shared use’, meaning this is a route which is available for use by both pedestrians and cyclists. Toucan crossing points (a crossing with signal controls) would be provided for both pedestrians and cyclists on both carriageways of the A6097 Epperstone Bypass north-west of the roundabout.

2.2.6 Accommodation works would be carried out by NCC as the acquiring authority, by agreement with landowners and affected parties. At Lowdham Roundabout, accommodation work would largely consist of boundary treatments at the four residential properties on Nottingham Road and treatment associated with the proposed service road for the aforementioned properties such as the provision of anti-dazzle fencing between opposing traffic flows.

2.2.7 This Scheme would require permanent land take associated with the westbound arm of the A612 Nottingham Road and the new access road.

2.2.8 The total area needed for the Scheme construction and operation is approximately 3.1 hectares (ha) as shown on the red line planning boundary on the general arrangement plans in Appendix 2-1 of Volume 3.

Land Take

2.2.9 Construction of the Scheme requires both permanent and temporary land take outside of the current highway boundary. Permanent and temporary land take is shown on the Land Affected plans within Appendix 2-3 of Volume 3C. Where permanent land take is required outside of the current highway boundary this would be acquired by negotiation or a Compulsory Purchase Order.

2.2.10 Where permanent land take is required outside of the current highway boundary this would be acquired by negotiation or through the use of a Compulsory Purchase Order.

2.2.11 Temporary and permanent land take includes two large sections of agricultural land. A small amount of hedge associated with four residential properties on the A612 Nottingham Road may need to be removed to facilitate turning movements. Temporary land would be restored to current condition or better on return to the landowner.

2.2.12 A new highway boundary formed that would encapsulate the required permanent land take for the Scheme.

Earthworks and Landform

2.2.13 As part of this junction improvement, earthworks would be undertaken to accommodate the new left turn lane on the outbound A612 approach arm to the A6097 north. The embankment height for the new section of carriageway would be a maximum of 0.5 m with a gradient of 1:3 to address the level difference between the highway and the adjacent agricultural field.

2.2.14 Excavations from the construction of the adjacent balancing pond would be utilised to facilitate this construction. Surplus material from the balancing pond excavation would be used to create bunding around the pond itself. The extent of vegetation clearance is shown Appendix 2-1 in Volume 3C.

2.2.15 There is no significant change in carriageway level within the junction design.

Drainage

2.2.16 The surface water collected from all roads will be collected by either gullies or kerb drains connected with carrier pipes and would discharge into the existing system which will in turn discharge into existing drains and ditches. A new length of ditch would be provided

2.2.17 An attenuation pond would be provided north-east of 21 Nottingham Road, collecting surface waters from the A613 approach arm south-west of the roundabout. The pond would then attenuate the surface water, releasing surface water via a flow control chamber into a carrier pipe which would in turn discharge into the Cocker Beck.

2.2.18 The entire A612 exit arm and the new access road would have gullies connected with carrier pipes which would discharge into an attenuation tank under the new access road. The attenuation tank would then attenuate the surface water, releasing surface water via a flow control chamber into a carrier pipe which would in turn discharge into the Cocker Beck.

Lighting and Signage

2.2.19 Street lighting design at Lowdham Roundabout has been designed in line with current design standards taking into account required Sight Stopping Distance and proposed speed limits. LED lanterns would be installed.

2.2.20 Lighting columns would be situated approximately 2 m to 3 m back from carriageway edge in the highway verge. All LED lanterns specified have a colour temperature of 4000K (Neutral White) which would be maintained around the periphery of the roundabout as this is the focal area of any potential conflict zone[1].

2.2.21 New post mounted verge signage would be provided at the junction, as well as new road markings/lining in the carriageway.

2.2.22 It is proposed that all bollards on splitter islands would be lit. Not all new signs would be illuminated; in line with the Traffic Signs Regulations and General Directions (2016).

2.2.23 The lighting design is shown on Figure 8-2 in Volume 2C.Fencing and Boundary Treatment

2.2.24 New boundary treatments would consists of a post and four rail timber fence as a minimum and would generally be supplemented by the planting of species rich hedgerow, tying into existing where necessary. A landscape design has been

[1] Conflict zones are areas where traffic, either motorised or pedestrian, converges from many directions.

prepared (see Appendix 2-2 in Volume 3C).

2.2.25 Some boundary treatments would be specific to the location and subject to further detailing of the design alongside discussions and agreement with landowners and affected parties.

Non-motorised User Provisions

2.2.26 Toucan crossing points (a crossing with signal controls) for both pedestrians and cyclists would be provided on both carriageways of the A6097 Epperstone Bypass north-west of the roundabout to provide a link between the proposed shared use facilities to the north of the junction.

2.2.27 Uncontrolled dropped kerb crossing points are also proposed at the A6097 south arm to allow access from the four residential properties on the A612 Nottingham Road to the east of the roundabout.

2.3 Environmental Design and Enhancement

2.3.1 The cricket pitch and recreational ground act as an attenuation and storage area for water during periods when the Cocker Beck is in flood. The Scheme design has been redeveloped to result in no impact on the flood storage area and eradicated the need for any tree removal in the vicinity of the recreational ground, therefore reducing the impact on the local environment.

2.3.2 The potential for adverse effects on landscape and visual amenity have been recognised as part of the iterative Scheme designs to avoid or reduce adverse effects or to offset or compensate for unavoidable adverse effects, providing replacement vegetation and habitat to compensate for any loss of trees, grassland and hedgerows. A minimal footprint for the Scheme has been developed to avoid encroachment onto neighbouring properties and the green area around the Lowdham War Memorial. Landscaping design at Lowdham Roundabout includes specific planting to support the local environment and control flooding risk. A landscape design has been prepared (see Appendix 2-2 in Volume 3C).

2.3.3 The proposed planting supports feedback received during the Scoping exercise and includes flowering native dry meadow grassland, wet grassland, herbaceous meadow and woodland mix around an area of pond which would act as an attenuation feature for the surface water storage.

2.3.4 Tar-bound material has been identified in the A6097 carriageway at various locations along the route. Where possible the detailed designer and Principal Contractor would work to reduce the amount of this type of waste removed from site using innovative methods including in-situ recycling of tar-bound material in any new footway construction. It is also intended that any existing suitable carriageway construction (including kerbs) removed during site clearance would be recycled and used as sub-base in new carriageway construction, subject to the appropriate consents.

2.3.5 Where possible, sites would be identified for the trial of any emerging and innovative sustainable construction methods and materials, should they be considered suitable during the detailed design stage.

2.4 Construction, Operation and Long-Term Management

2.4.1 The approach to construction described below is indicative and subject to change during detailed design but it is representative of the likely approach to be adopted.

Construction Compound Location

2.4.2 The construction compound would be located within an arable field to the north-west of the roundabout accessed from the A612 Nottingham Road to the west of the roundabout. This is expected to include temporary offices, compounds, vehicle parking and storage areas.

2.4.3 A second smaller compound would be situated in the field to the west of Number 21 Nottingham Road, to facilitate construction of the service road.

Construction Programme and Phasing

2.4.4 Scheme construction is expected to commence in Summer/Autumn 2024 and take approximately 36 weeks.

2.4.5 Construction of the Scheme is likely to follow the following phasing:

- installation of the construction compound including temporary offices and welfare facilities, construction vehicle parking, material storage areas, worksites and accesses;
- vegetation clearance and soil removal;
- utilities diversions, drainage and ducting works;
- infrastructure construction activities;
- installation of kerbing and road pavements;
- capping in stone;
- resurfacing, including high friction surfaces, white lining and any required topsoiling;
- installation of lighting and signage; and
- landscaping works.

Workforce and Working Hours

2.4.6 During the construction phase, the core working hours would be as defined in Table 2-1.

Table 2-1: Working hours

	Core working hours
All works including earth works	07.30 – 16:00 Monday to Friday 07.30 – 13:00 Saturdays with no working on Bank Holidays

2.4.7 Any night-time working would be conducted between the hours of 20:00 to 06:00 to avoid peak traffic flow periods.

Construction Activities

2.4.8 Scheme construction activities are anticipated to require the following activities:

- installation and use of the construction compound, including temporary offices and welfare facilities, construction vehicle parking, material storage areas and worksites;

- installation and use of temporary accesses and movement of vehicles;
- vegetation clearance and soil removal;
- removal of existing infrastructure;
- ground and excavation works (also known as earthworks);
- infrastructure construction activities, including installation of new road infrastructure and drainage and resurfacing;
- routing of services and utilities;
- accommodation work - installation of new access road off the A612 Nottingham Road for houses to the south of the junction; and
- installation of verge furniture (e.g. new lighting and new or replacement signage) and planting of vegetation.

Earthworks

2.4.9 Earthworks activities would be planned to release materials from sections of the Scheme where there is a surplus of materials to allow it to be placed into areas where fill is required. This would reduce the requirement to import and export material from the site and reduce the extent of material storage required.

2.4.10 The general sequence of earthworks activities would be as follows:

- Strip topsoil and place into topsoil storage areas. Topsoil would only be stored to a maximum height of 2 m from existing ground level.
- Pre-earthworks drainage assets would be installed next, wherever practicable.
- Areas where the levels are to be changed to the largest extent would then be worked, including any ground improvement (stabilisation) which needs to be undertaken. If practicable, drainage works would be undertaken prior to levels being lifted. This is to achieve the safest working method possible by avoiding deep excavation works.
- Areas requiring surcharge fill and monitoring would be constructed as soon as practicable to allow maximum programme efficiencies.
- Once earthworks materials placement is completed, capping material and Type 1 material[2] would be placed in readiness for road pavement construction to take place.
- Once all works are completed, topsoil shall be placed as per the detailed landscape design specification, with any surplus materials removed from site for reuse where possible.

2.4.11 Dust control procedures would be in place during periods of dry weather, specifically with the earthworks operations. Damping down would be via water suppressant likely from a bowser. If required, roads would be swept using a road sweeper.

2.4.12 Although fuel storage facilities would be at the main compound, it is anticipated that re-fuelling of earthworks plant may need to be undertaken using a mobile facility. The re-fuelling plant would be kept at the main construction site compound and be stored and used in accordance with the Control of Substances Hazardous to Health Regulations 2002, and the Control of Pollution (Oil Storage) (England) Regulations 2001.

[2] Type 1 material is a granular material with a maximum permitted top size of 63mm, graded down to dust, which is used to provide a stable sub-base for road surfaces and pathways.

Highways Works

2.4.13 The general sequence of works is envisaged as follows for highways works:

- complete service diversions, if not yet completed;
- install deep drainage, if not yet completed;
- install gullies;
- install ducting and associated infrastructure;
- install kerbs and edgings;
- final trim to stone in readiness for pavement laying;
- lay base and binder course;
- set all ironworks to final level including gullies;
- lay surface course;
- install road markings and high friction surfacing if required; and
- commission traffic signals where applicable.

2.4.14 Wherever practicable, concrete wash out facilities would be installed at the point of work. Suitable facilities for concrete wash water (e.g. geotextile wrapped sealed skip, container or earth bunded area) would be adequately contained, prevented from entering any drain, and removed from the Site for appropriate disposal at a suitably permitted waste facility.

2.4.15 All vehicles would be supervised to ensure they wash out before driving onto the live carriageway. All compound areas would have a concrete wash out facility.

Structures Works

2.4.16 Headwalls would be constructed to replace the existing features on the new alignment associated with the ditch around the balancing pond. A headwall would also be constructed for the new culvert along the southern side of the A612.

Plant

2.4.17 The following is a list of the types of construction equipment expected to be used during construction of the Scheme. This list is not exhaustive, and may be subject to change, but has been prepared to inform this ES:

- prime moving excavators – earthworks plant, size anticipated up to approximately 40 tonnes (t);
- secondary moving excavators – earthworks plant up to approximately 20t;
- articulated dump trucks up to approximately 40t;
- eight-wheel road wagons;
- excavators up to approximately 30t;
- mini diggers;
- dumpers up to approximately 9t;
- cranes;
- concrete pumps;
- vacuum excavation machine;

- road paver;
- mobile re-fuelling trucks;
- fuel bowsers;
- water bowsers;
- compaction plant – rollers, trench compactors etc;
- abrasive wheels including cut-off saws;
- mulchers, chainsaws and site clearance equipment;
- traffic management equipment including mobile variable messaging signs; and
- impact protection vehicles for traffic management.

Temporary Traffic Management

2.4.18 To enable the construction of the junction improvement, the proposed traffic management would include phased lane closures, narrow lane running and use of multiway temporary traffic lights. The type of traffic management used would depend on the construction activity that needs to be accommodated. For example, the narrow lane running would enable maximum through-put of traffic while enabling construction activities to be undertaken.

2.4.19 Some night-time work and possible road closures may be required during construction, however the detail of this is currently uncertain and would be defined at a later date in the detailed design process.

2.4.20 Construction of Lowdham Roundabout would commence on completion of the Kirk Hill Junction improvements, meaning the diverted traffic would benefit from the completed improvements at the Kirk Hill Junction.

2.4.21 The A614 and A6097 is used as a diversion route for planned and unplanned activities on the strategic road network (SRN) including the A1(T) to the north of Ollerton Roundabout and the A46(T) east of the Kirk Hill Junction.

2.4.22 Close liaison and collaboration with the Network Management and Road Space Booking team at National Highways (formerly Highways England) would inform the programme of construction activities to avoid closures of the A614 when the route would be needed to support the SRN. Similarly, should closures be required, the Contractor would work closely with National Highways to ensure there are no network clashes.

2.4.23 NCC's Network Management team is currently involved in the planning and development of the Project and are working collaboratively with designers to confirm traffic management proposals and diversion routes as the detail of the Scheme and construction phasing emerges.

Construction Environmental Management Plan

2.4.24 An ISO 14001 (or equivalent) compliant Construction Environmental Management Plan (CEMP) is to be prepared by the Principal Contractor prior to the start of construction works. The CEMP would be based on the required mitigation as outlined within this ES (including Volumes 1 and 1A to 1D).

2.4.25 The aim of the CEMP is to provide an overarching and strategic framework for the management of environmental effects and the implementation of measures prior to, and during, the demolition and construction phase of the Scheme. The CEMP will be a 'live' document and will be continually reviewed and updated by the Principal

Contractor.

2.4.26 The CEMP will include (but not be limited to) the following information:

- Site information:
  - location of the works, including a site plan, showing construction site boundaries and any sensitive receptors (e.g. retained trees, water courses, local residents etc);
  - detailed management structure and key contacts (such as the appointed Site Environmental Manager, the relevant NCC contacts and contacts at the Environment Agency in the event of an emergency); and
  - procedures for environmental training of all permanent and temporary site staff, which staff will be covered within the 'Toolbox Talks', a series of training sessions relating to specific health and safety issues relating to the construction industry.
- Construction information:
  - a description of the works to be undertaken and a detailed programme of the construction activities;
  - proposed working hours during construction, including any abnormal hours;
  - details of the main haulage routes and site access points;
  - proposed dates and sequence of the works;
  - equipment and plant to be used; and
  - method of delivery / removal of materials and plant.
- Environmental management:
  - an internal environmental audit programme, e.g. ISO 14001 or details of policies specific to the Applicant;
  - an Environmental Mitigation Register with associated procedures, which show how environmental risks will be addressed for each activity;
  - schedule of potential environmental effects relating to each activity (based on the effects identified in the ES);
  - procedure for neighbourhood liaison and dealing with complaints;
  - measures to exclude the public from the vicinity of the site during construction and ensure maintenance of public safety;
  - measures to reduce visual impact of the construction site, including nuisance from construction lighting;
  - arrangements for the removal of contaminated material, where appropriate;
  - arrangements for the storage of raw materials on-site (including potentially contaminative material, such as fuels);
  - waste storage and removal arrangements (either as part of the CEMP or a separate Resource Management Plan;
  - measures to be followed to minimise noise, dust and vibration levels during demolition and construction, including limits to be complied with for certain activities, as appropriate;
  - measures to minimise effects on ecology;

- measures to deal with waste water generated during construction activities, to minimise the risk of potentially contaminative material entering the local drainage network; and
- emergency procedures to be followed in the event of an environmental incident (e.g. spillage).

- Monitoring:
  - targets for continuous improvement on construction environmental performance, such as energy and water use, carbon emissions and waste;
  - monitoring requirements and procedures for recording and reporting the results and for taking remedial action in the event of a non-compliance with specified limits (if appropriate);
  - monitoring proposals, which should include details on the receptors for which monitoring will be undertaken; frequency of monitoring; factors against which the monitoring results will be analysed; threshold levels; list of organisations/ individuals to whom results will be distributed; and actions to be taken in the event that thresholds are breached;
  - procedures for monitoring construction processes against the project environmental objectives and for the appropriate action if thresholds have been breached; and
  - procedures for co-ordinating the monitoring results to ensure that the combined effect of the works in different locations does not trigger threshold levels.
- Legal requirements:
  - schedule of appropriate environmental legislation and good practice that will be adhered to, which is both current at the time of contract and which may come into force during the course of the contract;
  - a list of specific objectives and targets that have been imposed by planning conditions and agreed in consultation with third parties; and
  - a register of permissions and consents required, with responsibilities allocated and a programme for obtaining them.

2.4.27 The CEMP will be updated and developed throughout the construction phases in consultation with NCC where necessary. The CEMP will be regularly monitored during the construction works and revised to reflect any changes to programme or events and activities on-site.

2.4.28 Further details on specific measures to be included within the CEMP to mitigate potential effects identified within this ES are provided within Volume 1 and Volumes 1A to 1D.

Construction, Excavation and Demolition Waste

2.4.29 Waste arising from earthworks and construction is expected to include mainly excavated soils, road arisings and metal.

2.4.30 Any clean excavated material that cannot be reused on-site will be removed by licensed waste carriers and sent for reuse at another permitted development site or for disposal at appropriately licenced facilities (these are expected to be inert waste landfill sites).

2.4.31 All relevant contractors will be required to investigate opportunities to minimise and reduce waste generation in line with the Waste and Resources Action Programme

(WRAP) 'Halving Waste to Landfill' initiative by:

- agreeing with material suppliers to reduce the amount of packaging or to participate in a packaging take-back scheme;
- implementing a 'Just In Time' material delivery system to avoid materials being stockpiled, which increases the risk of their damage and disposal as waste;
- using standard size components in design detailing to eliminate risk at source where possible to do so;
- paying attention to material quantity requirements to avoid over-ordering and generation of waste materials;
- re-using materials wherever feasible, e.g. re-use of excavated soil for landscaping (the Government has set broad targets of the use of reclaimed aggregate, and in keeping with best practice, contractors will be required to maximise the proportion of materials recycled);
- segregating waste at source where practical;
- re-using and recycling materials off-site where re-use on-site is not practical (e.g. through use of an off-site waste segregation facility and re-sale for direct re-use or re-processing);
- colour coding and signposting skips to reduce risk of cross contamination and covered to prevent dust and debris blowing around the site, these will be cleared on a regular basis; and
- not burning waste or unwanted materials on-site.

2.4.32 The Principal Contractor and subcontractors will be required to carry out works in such a way that, as far as is reasonably practicable, the amount of spoil and waste to be disposed of by landfill is minimised. Any waste arisings from the site are to be transported and disposed of in accordance with relevant legislation including the following:

- the Environmental Permitting (England and Wales) Regulations 2018 (as amended) (HMSO, 2018);
- the Waste (England and Wales) Regulations 2011 (as amended) (HMSO, 2001);
- the Waste Management (England and Wales) Regulations 2006 (HMSO, 2006c); and
- the Clean Neighbourhoods and Environment Act 2005 (HMSO, 2005).

2.4.33 Whilst the Site Waste Management Plan (SWMP) Regulations (2008) were revoked as of the 1 December 2013, the Principal Contractor will prepare an SWMP as good practice to promote the waste hierarchy of avoid, reduce, reuse, recycle and recovery of waste rather than disposal. This will improve efficiency and profitability, reduce fly-tipping; and increase environmental awareness.

2.4.34 The SWMP will set out the principles for construction waste management, identify measures to minimise waste by design, estimate construction waste quantities, set targets for waste minimisation and a framework for construction waste monitoring that the Principal Contractor will be required to implement on site. Furthermore, the SWMP will set out measures required for compliance with waste legislation and relevant planning policies.

Considerate Constructors Scheme

2.4.35 The Project will be registered with the 'Considerate Constructors Scheme'. This is a national initiative through which construction sites and companies registered with the scheme are monitored against a Code of Considerate Practice. This code is designed to encourage environmental and social best-practice during the construction period beyond statutory requirements.

Neighbour and Public Relations

2.4.36 A key aspect of the successful management of the Scheme will be the maintenance of good relations with neighbours and the general public. The project team is engaged in consultation with a range of stakeholders and neighbours and this will continue through the various phases of the Scheme.

2.4.37 To manage neighbour and public relations during demolition and construction works, the following actions will be undertaken:

- Initial contact: Prior to any works being undertaken, the project team will make formal contact with the nearest neighbours and those who would be affected by the Scheme; and
- Contact during the works period: A single point of contact will be established, with a senior member of the project team nominated for the role. This person would usually be the Construction or Logistics Manager. Outside normal working hours, site security will act as the main point of contact via a dedicated phone number. Security will alert the Construction or Logistics Manager if necessary (available 24 hours). Any complaints will be logged, fully investigated and reported to the relevant department within NCC as soon as possible. The complainant will be informed as to what action has been taken.
- Contact with neighbours and the general public will be proactively maintained throughout the construction period.

Management of Sub-Contractors

2.4.38 Individual contracts will incorporate relevant requirements in respect of environmental control, based largely on the standard of 'good working practice' as outlined within the CEMP, as well as statutory requirements. All sub-contractors will be required to demonstrate how they will adhere to procedures set out within the CEMP, satisfying regulations and industry standard practices regarding environmental control.

3. ASSESSMENT OF ALTERNATIVES

3.1.1 The assessment of alternatives is provided in Volume 1, Chapter 3.

4. ENVIRONMENTAL ASSESSMENT METHODOLOGY

4.1.1 The general environmental assessment methodology is provided in Volume 1, Chapter 4.

4.1.2 An EIA Scoping Report (AECOM/Via, 2021) (hereafter referred to as the 'Scoping Report') was submitted in to NCC in June 2021. A Scoping Opinion was provided by NCC Planning for each Scheme (See Appendix 1-1 of Volume 3). As per Regulation 18 (4)(a) this ES is based on be based on the scoping opinion issued by NCC. Further information relating to agreed scope of the assessments can be found in Section 4.1 of Volume 1.

4.1.3 The Scoping Opinion and the comments from consultees have been considered in undertaking the EIA and in preparing this ES. A table of the Scoping Opinion comments and consultee comments received, and responses to these are provided in Appendix 4-1 of Volume 3.

4.1.4 The study area and assessments of environmental effects have been undertaken in accordance with the DMRB LA 104 Environmental Assessment and Monitoring Revision 1 (Highways England, 2020b), other relevant DMRB guidance documents and other published guidance as applicable.

4.1.5 It should be noted that whilst an opening year of 2023 was used for the purposes of assessment, the whole Project would not be open to traffic at this point. This is considered to be a worst-case assumption for the purposes of the assessment within this ES. Air quality is forecast to improve over time as a result of vehicle technology improvements, therefore 2023 would be a reasonable worst-case year for the operational air quality assessment. In terms of the operational noise assessment, a future year is included in the assessment (2027) to consider any worsening that background traffic growth would give rise to.

5. AIR QUALITY

5.1 Introduction

5.1.1 This chapter provides a study of the potential changes in local air quality associated with the Scheme.

5.1.2 The Scheme has the potential to affect air quality during both the construction and operational phases. During the construction phase, potential effects may arise from nuisance dust as well as health effects associated with particulate matter. During the operational phase potential air quality effects would be associated with vehicle exhaust emissions and the impact on pollutant concentrations (nitrogen dioxide (NO_2) and particulate matter (PM_{10})) at sensitive receptors.

5.1.3 This chapter should be read in conjunction with Figures 5-1 and 5-2 within Volume 2C, and Appendix 5-1 of Volume 3.

5.2 Legislation and Policy

5.2.1 Full details of relevant legislation and policy are provided in Chapter 5: Air Quality of Volume 1.

5.3 Consultation

5.3.1 In September 2020, NSDC's Environmental Health Technical Officer (EHTO) was consulted with regards to the proposed air quality assessment methodology and more specifically the use of one monitoring site to verify the model for all Schemes. Communication was via email between AECOM's air quality specialist and NSDC's EHTO, 9th September 2020. NSDC's EHTO replied on 10th September and agreed with our approach.

5.3.2 A summary of the air quality related responses from the Scoping Opinion is included in Table 5-1.

Table 5-1 Scoping Response Summary

Stakeholder	Comment made	Response and where addressed in the ES
Natural England	The assessment should take account of the risks of air pollution and how these can be managed or reduced. Further information on air pollution impacts and the sensitivity of different habitats/designated sites can be found on the Air Pollution Information System (APIS) (UK Centre for Ecology and Hydrology, 2021a). Further information on air pollution modelling and assessment can be found on the Environment Agency website.	The assessment has taken into account the risks of air pollution as reported in Section 5.7 of this chapter. The relevant information for designated habitats has been obtained from APIS.
Nottinghamshire Wildlife Trust	I note that only 1 actual monitoring location will be used to field test the modelling, at Ollerton Roundabout, but given the potential impacts on the SAC and ppSPA, NWT would expect to see further monitoring undertaken in a key protected habitats site such as the SAC or a heathland SSSI, to ensure that the modelling is correct for the areas of potential greatest irreversible habitat impact. This is because emissions modelling was incorrect for several years in using a predicted falling baseline of NO_x that did not occur in reality, and this information is therefore crucial in such a sensitive area to the impacts of NO_2 and N. The results should be closely monitored, with a plan in place for how it could be rectified if a problem is shown to have arisen. The latest APIS data on critical load for N deposition of 7.9 kg N ha^{-1} a^{-1} for acid grassland 8.8 kg N ha^{-1} a^{-1} for heathland should be used.	There are not expected to be any designated sites at risk with this Scheme, therefore no monitoring is proposed. The relevant information for the specific designated habitats has been obtained from APIS.

5.4 Assessment Methodology

Baseline Conditions

5.4.1 The air quality baseline conditions have been determined with reference to the following sources of information:

- NSDC 2020 Air Quality Annual Status Report (NSDC, 2020);
- Defra's 2018-based background concentration maps (Defra, 2020a);
- Defra's 2020 Pollution Climate Mapping (PCM) Model (Defra, 2020b);
- Ordnance Survey Mastermap (Ordnance Survey, 2021a), Ordnance Survey Addressbase Plus (Ordnance Survey, 2021b), and Google Earth (Google, 2020) mapping and imagery were used to identify receptor point locations;
- The Air Pollution Information Service (APIS) (UK Centre for Ecology and Hydrology, 2021a) for habitat types, background nitrogen deposition rates for sites and site specific critical loads;
- The designated habitats within the study area were identified using the insight mapping website (Nottingham City Council, 2020); and
- Consultation with the competent expert for biodiversity.

Study Area

Construction Phase

5.4.2 The study area for the construction dust assessment is defined as the area within 200 m of dust-generating activities.

5.4.3 The assessment boundary for the Scheme has been chosen as a proxy for the area within which dust-generating activities will occur. This is a cautious assumption as dust generating activities are unlikely to occur right at the assessment boundary.

5.4.4 The construction dust assessment study area is illustrated in Figure 5-2 of Volume 2C.

5.4.5 Assessment of air quality impacts due to construction traffic has been scoped out of the assessment as described in paragraph 5.4.15 of this chapter.

Operational Phase

5.4.6 The following screening criteria for the changes in traffic between the Do Minimum (DM) scenario (without the Scheme) and the Do Something (DS) scenario (with the Scheme) in the opening year of 2023 were applied to determine the study area for the local air quality assessment for the operation of the Scheme:

- road alignment will change by 5 m or more;
- annual average daily traffic (AADT) flows will change by 1,000 or more;
- heavy duty vehicle (HDV) (vehicles greater than 3.5 tonnes, including buses and coaches) flows will change by 200 AADT or more; or
- there will be a change in speed band.

5.4.7 Volume 1 Chapter 4: Environmental Assessment Methodology contains further explanation with regards the traffic modelling undertaken, and why the opening year is set to 2023 for the assessment.

5.4.8 The roads which trigger these criteria make up the Affected Road Network (ARN)

for the local air quality assessment of the operation of the Scheme.

5.4.9 The resultant study area is within the local authority area of NSDC.

5.4.10 The operational phase local air quality assessment study area is illustrated in Figure 5-1 of Volume 2C.

General Assessment Methodology

5.4.11 The methodology for the air quality assessment follows the guidance set out within the DMRB LA 105 Air Quality Revision 0 (Highways England, 2019). The assessment includes the following elements:

- construction dust assessment to identify areas that could be affected by construction-phase activities;
- local air quality assessment for the construction of the Scheme for public exposure and designated habitats;
- local air quality assessment for the operation of the Scheme for public exposure and designated sites; and
- compliance risk assessment for NO_2.

5.4.12 The overall aim of the assessment of the elements listed above is to identify potential likely significant air quality effects and the effect of the Scheme on the UK's ability to comply with the Air Quality Directive.

5.4.13 Key methodology documents of relevance to the air quality assessment are as follows:

- DMRB LA 105 Air quality; and
- Defra (2018), Air Quality Management Technical Guidance (TG16) (LAQM.TG(16)).

Methodology for Determining Construction Effects

Scoping

5.4.14 A construction phase dust assessment has been undertaken. The key pollutants considered for the construction phase dust assessment are particulate matter with an aerodynamic diameter of less than 10µm (PM_{10}) and dust (i.e. larger particles) with the potential to settle around construction sites and cause soiling/deposition effects on surfaces.

5.4.15 Consideration of the potential effects from construction traffic has been scoped out of the assessment. As set out in DMRB LA 105, the impact of traffic generated by construction activities shall be assessed where construction activities are programmed to last for more than two years. If the construction activities are less than two years it is unlikely that the construction activities would constitute a significant air quality effect or impinge on the UK's reported ability to comply with the Air Quality Directive given the short-term duration of the construction activities as opposed to the long-term operation of the Project.

5.4.16 The construction programme is anticipated to last for approximately 10-12 months for the Lowdham Roundabout Scheme and therefore consideration of the potential air quality effects associated with construction vehicle emissions was scoped out of this assessment.

Methodology

5.4.17 The construction phase assessment requires the air quality assessor to determine

the construction dust risk potential of the Scheme to the receiving environment, which informs the appropriate level of mitigation.

5.4.18 The construction dust risk potential is determined based on the following criteria:

- Large: large smart motorway projects, bypass and major motorway junction improvements; and
- Small: junction congestion relief project i.e. small junction improvements, signalling changes, short smart motorway projects.

5.4.19 Sensitive receptor locations were then identified within 0-50 m, 50-100 m and 100–200 m from construction activity. The receiving environment sensitivity to construction dust is then determined according to Table 5-2.

Table 5-2: Receiving environment sensitivity to construction dust.

Construction dust risk potential	Distance from Construction Activities		
	0 to 50 m	50 to 100 m	100 to 200 m
Large	High	High	Low
Small	High	Low	Low

Methodology for Determining Operational Effects

Scoping

5.4.20 Determination of the appropriate level of air quality assessment required for the operational phase has been carried out following the methodology illustrated in DMRB LA 105 and as detailed below.

5.4.21 The screening criteria for the changes in traffic between the Do Minimum (DM) scenario and the Do Something (DS) scenario in the opening year of 2023 were applied to establish if the Scheme may cause changes in air quality. These are set out in Paragraph 5.4.6.

5.4.22 These criteria have been triggered on roads within and surrounding the Scheme, and therefore an air quality assessment is required. The roads which trigger these criteria make up the ARN for the local air quality assessment of the operation of the Scheme. The ARN is illustrated in Figure 5-1 of Volume 2C.

5.4.23 Traffic was modelled using a series of isolated junction models as opposed to a strategic model. As such, only links with traffic moving directly towards or away from the roundabout were modelled. Links along each road from the roundabout were extended to either 1 km from the roundabout or, less than 1 km away if there was a T-junction. The purpose of the Scheme is to reduce congestion at the roundabout and therefore reduce queue lengths. As such the speed band change criteria was met; however, AADT and HDV flows remained unchanged, with or without the Scheme operating.

5.4.24 To determine the appropriate level of assessment, both the potential of the project to result in changes to air quality and sensitivity of receiving environment have been considered. As the Scheme involves changes in road layout and speed bands on roads approaching the roundabout with sensitive receptors in close proximity, a detailed air quality assessment has been undertaken.

5.4.25 Representative worse case sensitive receptors were selected within 200 m of the junction and queue links. This constitutes the air quality study area for the local air quality assessment of the operation of the Scheme.

5.4.26 The PCM model is a collection of models designed to fulfil part of the UK's Air Quality Directive requirements to report on the concentrations of particular pollutants in the atmosphere. No road links which are part of Defra's 2020 PCM model (Defra, 2020b) and are within the ARN were identified. Therefore, an assessment to evaluate the effect of the Scheme on the UK's ability to comply with the Air Quality Directive was not required.

Methodology

5.4.27 The operational assessment has predicted annual mean NO_2 concentrations for the baseline year (2018) and the opening year (2023) with the Scheme (Do Something) and without the Scheme (Do Minimum).

5.4.28 A detailed air quality assessment constitutes the following elements:

- traffic input in the form of period flows (morning peak (AM), inter-peak (IP), afternoon peak (PM), and overnight (OP));
- the use of a detailed air quality dispersion modelling;
- identification of sensitive receptors; and
- model verification.

5.4.29 Traffic data has been provided for road links for a base year, and for the opening year both with and without the Scheme in place. Data was provided for each of the AM, IP, PM and OP time periods and consisted of:

- number of vehicles per hour;
- percentage of HDVs; and
- speed bands as defined by DMRB LA 105.

5.4.30 Queue lengths were provided for links with a speed band of light or heavy congestion. Following discussions with the project transportation team, where a queue length was less than two car lengths it was not considered to be a queue. For the section of the link which was considered to be queueing, the speed band of light or heavy congestion was assigned by the traffic team and applied to this data. For the remainder of the link i.e. non-queuing section, a speed band of free flow was applied.

5.4.31 Using the traffic data provided, air quality predictions were made for the following scenarios:

- Baseline year 2018;
- Do Minimum opening year 2023 without the Scheme (DM); and
- Do-Something opening year 2023 with the Scheme (DS).

5.4.32 The assessment used the latest version of the ADMS-Roads (v5) detailed dispersion model (Cambridge Environmental Research Consultant (CERC) Ltd., 2020) to calculate the air quality road contribution to pollutant concentrations. ADMS-Roads is a modern dispersion model that has an extensive published track record of use in the UK for the assessment of local air quality impacts, including model validation and verification studies.

5.4.33 ADMS-Roads calculates concentrations of pollutants emitted from roads at specified receptor locations using the following parameters:

- spatial information of the modelled roads (location, geometry and road widths);

- emission factors which account for vehicle numbers, composition, and speed; and
- meteorological information from a suitable nearby meteorological station.

5.4.34 Detailed information on the inputs used within the modelling for the local air quality assessment are provided in Appendix 5-1 of Volume 3.

5.4.35 The outputs of ADMS-Roads are road-contributions to annual mean NO_X concentrations (in µg/m^3) and annual mean road-contributions of PM_{10} (in µg/m^3) concentrations at selected sensitive receptor locations.

Model performance

5.4.36 When using modelling techniques to predict concentrations, it is necessary to make a comparison between the modelling results and available roadside monitoring data, to ensure that the model is reproducing actual observations. Where systematic bias is evident in the base year verification, the modelled results are factored to better match the monitoring data and reduce the overall uncertainty in the model predictions.

5.4.37 LAQM.TG(16) guidance (Section 'Model Validation, Verification, Adjustment and Uncertainty', Paragraphs 7.519-7.547) was followed. Annual mean NO_2 concentrations were predicted at one monitoring site within the Project study area in the base year of 2018 and was compared against the monitored concentration for that year. The adjustment factor was derived to bring modelled concentrations into line with the monitored concentration. The adjustment factor was 5.5 and used to adjust raw model NO_X outputs at all receptors.

5.4.38 The high factor is likely due to an additional local source that was not accounted for in the Defra modelled background contribution. The application of a high adjustment factor to the raw model NO_x outputs will likely overpredict impacts at receptors and therefore it is considered to be a cautious approach.

5.4.39 In the absence of appropriate PM_{10} monitoring within the study area, the adjustment factor calculated for NO_2 was applied to modelled PM_{10} outputs, as recommended in LAQM.TG(16).

5.4.40 Further details regarding model verification and adjustment are provided in Appendix 5-1 of Volume 3.

Public exposure receptors

5.4.41 Sensitive receptors are those where the AQOs apply, for example residential properties, schools, and hospitals. Sensitive receptors were chosen to represent locations where pollutant concentrations are expected to be highest (those closest to the road) and where changes due to the Scheme are expected to be greatest. Model predictions are made at 1.5 m height to be representative of human exposure (or 4.5 m to be representative of human exposure at a first-floor residence).

5.4.42 Predictions of total pollutant concentrations at receptors were calculated by combining the verified modelled road pollutant contributions with background concentrations. Background concentrations are those from many sources not explicitly modelled which individually may not be significant, but collectively, over a large area, need to be considered. Details of how background concentrations have been derived and used in this assessment are provided in Section 5.5.

5.4.43 The following post-processing methods were applied to the dispersion model outputs:

- Adjustment factors derived via model verification (Appendix 5-1 of Volume 3) were applied to bring modelled concentrations into line with monitored concentrations.
- Road contribution NO_X concentrations as outputted by ADMS-Roads were converted to NO_2 concentrations using Defra's NO_X to NO_2 Calculator (Defra, 2020d) for comparison against the AQO for NO_2.
- Highways England LTT_{E6} projection factors were applied to the modelled Do Minimum and Do SomethingNO_2 concentrations to account for the observed gap between projected vehicle emission reductions and the estimated annual rate of improvement in annual mean NO_2. Further details are provided in the Assessment Assumptions and Limitations section.
- Road contribution PM_{10} concentrations as outputted by the model were adjusted and added to background concentrations to determine total PM_{10} concentrations.

5.4.44 The modelled annual average pollutant concentrations were compared against the relevant AQOs and predicted exceedances identified. As set out in DMRB LA 105, annual mean PM_{10} concentrations are presented for the base year to demonstrate that pollutant concentrations are well below the objective value and therefore there is no risk of exceedance of these thresholds due to the Scheme.

5.4.45 Research projects completed on behalf of Defra and the Devolved Administrations (Laxen and Marner, 2003; AEAT, 2008) concluded that the hourly average NO_2 AQO is unlikely to be exceeded if annual average concentrations are predicted to be less than 60 µg/m^3. Therefore, this assessment has evaluated the likelihood of exceeding the hourly average NO_2 objective by comparing predicted annual average NO_2 concentrations at all receptors to an annual average equivalent threshold of 60 µg/m^3. Where predicted concentrations are below this value, it can be concluded that the hourly average NO_2 objective is likely to be achieved.

Significance Criteria

5.4.46 Where a receptor is predicted to experience concentrations of NO_2 below the AQOs in both the Do Minimum and the DS scenario, it will not inform the judgement of significance.

5.4.47 Where annual mean concentrations of NO_2 at receptors are predicted to exceed the AQOs in the Do Minimum and/or Do Something, magnitude of change descriptors will be applied in line with DMRB LA 105 guidance as shown in Table 5-3.

Table 5-3: Definitions of the magnitude of change criteria

Magnitude of change criteria	Concentration range applicable to
Imperceptible	The change in concentration of NO_2 between DM and DS is less than or equal to 0.4 µg/m^3 (≤1% of the AQO).
Small	The change in concentration of NO_2 between DM and DS is greater than 0.4 µg/m^3 but less than or equal to 2.0 µg/m^3 (1-5% of the AQO).
Medium	The change in concentration of NO_2 between DM and DS is greater than 2.0 µg/m^3 but less than or equal to 4.0 µg/m^3 (5-10% of the AQO).
Large	The change in concentration of NO_2 between DM and DS is greater than 4.0 µg/m^3 (>10% of the AQO).

5.4.48 The number of receptors assigned to ‘small’, ‘medium’ and ‘large’ change descriptors, for both worsening and improvement, will be tabulated as shown in Table 5-4.

5.4.49 Table 5-4 defines guideline bands that are used to inform whether the project triggers a significant air quality effect. Where the total number of receptors are greater than the upper guideline band in any of the magnitude categories, the project shall trigger a significant air quality effect. Where the total number of receptors are smaller than the lower guideline band in any of the magnitude categories, the project is unlikely to trigger a significant air quality effect.

Table 5-4: Guideline band for the number of properties informing a judgement of significant air quality effects.

Magnitude of change in annual mean NO_2 ($\mu g/m^3$)	Total number of receptors with:	
	Worsening of an air quality objective already above the objective or the creation of a new exceedance	Improvement of an air quality objective already above the objective or the removal of an existing exceedance
Large (>4)	1 to 10	1 to 10
Medium (>2)	10 to 30	10 to 30
Small (>0.4)	30 to 60	30 to 60

5.4.50 Where the total number of receptors falls within the guideline bands in any of the magnitude categories the following criteria will be considered to inform the judgement of significance:

- the absolute concentration at each receptor i.e. is the modelled concentration 40 $\mu g/m^3$ or 60 $\mu g/m^3$;
- how many receptors are there in each of the magnitude of change criteria i.e. does the Scheme create more worsening than improvements; and
- the magnitude of change in concentration at each receptor e.g. a modelled change in concentration of 1.8 $\mu g/m^3$ would carry more weight than a change of 0.6 $\mu g/m^3$ despite both falling within the 'small' magnitude of change category.

Designated Habitats

5.4.51 As well as impacts on human health, some air pollutants also have an effect on vegetation. Concentrations of pollutants in air and deposition of particles can damage vegetation directly or affect plant health and productivity. Deposition of pollutants to the ground and vegetation can alter the characteristics of the soil, affecting the pH and nitrogen availability that can then affect plant health, productivity and species composition. Increased greenhouse gas emissions on a global scale can affect the global climate, such that the ability of existing species to tolerate local conditions can change.

5.4.52 Internationally, nationally and locally designated sites of ecological conservation importance on protected species and on habitats and other species identified as being of principal importance for the conservation of biodiversity (known as designated sites) are also considered in the operational phase assessment. Designated habitats include ‘Ramsar’ sites, Special Protection Areas (SPA), Special Areas of Conservation (SAC), Sites of Special Scientific Interest (SSSI), Local Nature Reserves (LNR), Local Wildlife Sites (LWS), Nature Improvement Areas (NIA), Ancient Woodland (AW) and veteran trees.

5.4.53 There is one veteran tree located within the study area as illustrated on Figure 5-1 of Volume 2C.

5.4.54 The competent expert for biodiversity confirmed that this site is sensitive to nitrogen deposition and therefore is considered in the assessment.

5.4.55 The pollutant of most concern for sensitive vegetation near roads is NO_X with a concentration of 30 µg/m^3 (annual mean) forming the critical load for designated habitats. Furthermore, critical loads for the deposition of nitrogen (N) representing the exposure below which there should be no significant harmful effects on sensitive elements of the ecosystem have been established for certain habitats and are expressed in deposition units of kg N/ha/year.

5.4.56 At the site of the veteran tree, annual mean NO_X concentrations were predicted for the base year, Do Minimum and Do Something in the opening year. The road NO_X concentration is converted to road NO_2 concentrations and then converted to dry nutrient nitrogen (N) deposition rate (kg N/ha/yr) using conversion rates outlined in the DMRB LA 105. The road N deposition rate is added to background N deposition rates derived from the APIS (UK Centre for Ecology and Hydrology, 2020a) to determine total N deposition rates. These rates have then been compared to the critical loads for each designated site.

5.4.57 The process for assessing the significance of air quality effects at designated habitats from DMRB LA 105 was followed. This states that if the total nitrogen deposition rate is under the critical load for the designated site in both Do Minimum and Do Something scenarios, or the change in total nitrogen deposition rate is less than 1% of the critical load, the effect is not significant. If these criteria are not met, further ecological assessment is required to determine whether the air quality effect is significant; these details are provided in Chapter 8: Biodiversity.

Overall significance determination

5.4.58 The overall significance of the Scheme with respect to air quality is determined for the construction phase and the operation phase.

5.4.59 In each case, the assessment of significance is informed by:

- the effects on human health (as determined by the significance of the local air quality assessment for public exposure receptors);
- the effects on designated habitats (as determined by the significance of the local air quality assessment for designated habitats); and
- the outcomes of the compliance risk assessment.

Assumptions and Limitations

5.4.60 Model verification has been carried out to minimise, where possible, uncertainties in the modelling and adjustment of the model output has been undertaken to account for local factors unable to be represented in the modelling. Model performance has been assessed and results are provided in Appendix 5-1 of Volume 3. The accuracy of the future year modelling results is relative to the accuracy of the base year results, therefore greater confidence can be placed in the future year concentrations where good agreement is found for the base year.

5.4.61 There is only one monitoring location in the Project study area, at Big Fish Roundabout, Ollerton (now a Costa Coffee). The verification factor derived from this location has been used for all Schemes. This was considered an appropriate approach as the traffic data for all Schemes were generated using the same workbooks, the isolated junction models are unaltered from previous forecasts and

the environmental setting of each Scheme was similar i.e. rural location, with junction improvements to the A614/A6097 corridor.

5.4.62 The air quality modelling uses a traffic dataset consisting of the most likely forecast traffic flows. Uncertainty associated with traffic data has been minimised by using validated traffic models. Details regarding the traffic modelling undertaken to support the Scheme are detailed in the Transport Assessment (AECOM, 2021).

5.4.63 The use of the latest version of the Defra background concentrations and tools available when the assessment was undertaken has also minimised the uncertainty associated with the air quality predictions presented.

5.4.64 Uncertainties associated with vehicle emissions data have been minimised by using the speed band emission factors described within DMRB LA 105, which is based on version 10.1 of Defra's Emissions Factors Toolkit (EFT) (Defra, 2020c). Speed bands are assigned on a link-by-link basis as informed by the pivoted speeds provided by the appointed traffic consultant.

5.4.65 The forecasting method used to predict future NO_2 concentrations is the gap analysis methodology as described in DMRB LA 105. The gap analysis is the application of adjustment factors which take into consideration the assumed roadside rates of reduction in NO_X and NO_2 by Defra's modelling tools compared to observed roadside trends. This prediction methodology is more cautious than the projections used by Defra.

5.4.66 The construction air quality assessment is based on the construction information that is currently available. As with all construction air quality assessments, the exact details of construction activities will not be known before a specific contractor is appointed to complete the works. Once appointed, the Principal Contractor would determine their exact construction methods and programme during the detailed design stage.

5.4.67 The base year traffic data provided by the traffic consultants was for 2018, therefore a base year of 2018 has been used for the air quality assessment.

5.5 Baseline Conditions

5.5.1 The base year of 2018 was considered for the purpose of the air quality assessment.

Air Quality Monitoring

5.5.2 Monitoring undertaken by NSDC has indicated that there are no records of exceedances of NO_2 within the study area.

5.5.3 NSDC undertakes monitoring at one location in the study area at the Ollerton Roundabout (monitoring site name 'Big Fish Roundabout, Ollerton' (Big Fish is now Costa Coffee. Annual mean NO_2 concentrations at this location have remained below the AQO since 2016. As this is the only monitoring location in the Project study area, this location has been used for verification for all Schemes. Details of this monitoring location are shown in Table 5-5.

Table 5-5 NO_2 Monitoring in Newark and Sherwood District 2016 – 2019.

Site ID	X	Y	Location	NO_2 Annual Mean Concentration ($\mu g/m^3$)			
				2016	2017	2018	2019
18N	465090	367595	A614, North of Big Fish Roundabout, Ollerton	36.0	34.6	33.9	32.1

Source: NSDC, ASR 2020

5.5.4 No monitoring of particulate matter is undertaken by NSDC within the study area.

Pollutant Background Maps

5.5.5 Annual mean background pollutant concentration estimates for 1 km grid squares throughout the UK are available from Defra for the years 2018 – 2030 based on 2018 reference year projections (Defra, 2020a). Background concentrations have been sourced from Defra's 2018-based background maps for the study area for NO_2 and PM_{10}.

5.5.6 Contributions from motorways, trunk A-roads and primary A-roads within the grid squares of the background maps have been removed from the mapped concentrations using the Sector Removal Tool provided by Defra (Defra, 2020c), as these sources are explicitly modelled in the assessment.

5.5.7 The range of background concentrations for each 1 km x 1 km square intersecting the study area for the baseline is presented in Table 5-6. Background concentrations are predicted to be below the AQOs in all areas.

5.5.8 In years subsequent to 2018, background concentrations are predicted to decrease year-on-year. This trend is reflected in the projected background concentrations for the opening year of 2023, which are also presented in Table 5-6.

Table 5-6 Summary of estimated background pollutant concentrations across the study area in the base year and opening year.

Coordinates	Background Annual Mean NO_2 ($\mu g/m^3$)		Background Annual Mean PM_{10} ($\mu g/m^3$)	
	2018	2023	2018	2023
467500_345500	10.4	8.7	15.2	14.3
466500_345500	10.6	8.9	15.5	14.6
467500_346500	10.5	8.8	14.1	13.2
466500_346500	10.4	8.7	15.6	14.7

Designated Habitats

5.5.9 A veteran tree is located within the air quality study area, with details of the critical load and deposition rate for this site provided in Table 5-7.

5.5.10 The critical load applied to the assessment is appropriate to use at detailed assessment stage, as defined by APIS. As described in DMRB LA 105, the deposition rate varies depending on the vegetation in each designated habitat. For grassland and similar habitats the rate is 0.14 kg N/ha/yr, while for forests and similar habitats a rate of 0.29 kg N/ha/yr is applied.

Table 5-7 Designated habitats within the air quality study area.

Site Name	Critical load (kg N/ha/yr)	Background nitrogen deposition (kg N/ha/yr)	Deposition conversion rate (kg N/ha/yr)
Veteran Tree	10	23.1	0.29

5.6 Design, Mitigation and Enhancement Measures

5.6.1 The Scheme would be subject to measures and procedures as defined within the CEMP for the Scheme. These would include a range of Best Practicable Means (BPM) associated with mitigating potential environmental impacts. A CEMP would be developed by the selected Principal Contractor and implemented for the duration of the Scheme construction phase.

5.6.2 The CEMP would include a range of industry standard good practice construction phase dust mitigation measures required during all works undertaken based on the level of construction dust risk at sensitive receptors.

5.6.3 Environmental considerations have been accounted for during the development of the Scheme design, to avoid and reduce potential impacts upon nearby sensitive receptors.

5.6.4 Changes to speed limits are proposed with the speed limit reduced from 40 mph to 30 mph at the roundabout. The 30 mph speed limit will also extend ~140 m from the junction on the north-western leg of the A6097 and ~100 m from the junction on the south-western leg of the A612. There are no proposed changes to the other approaches to the roundabout.

5.6.5 The Scheme design aims to reduce congestion at the junction which will reduce the risk of air quality impacts at receptors where the road alignment remains unchanged.

5.7 Assessment of Likely Significant Effects

Construction

5.7.1 The Scheme has the potential to affect air quality during construction, in the following ways:

- by increased emissions of dust during construction of the Scheme from dust-generating activities on site;
- by emissions associated with non-road mobile machinery (NRMM) undertaking construction works; and
- by changes in vehicle activity (flows, speeds and composition) during construction, as a result of temporary traffic management measures and/or additional vehicles travelling to and from the construction site transporting materials, plant and labour.

5.7.2 The types of activities with the potential to generate dust during the construction phase include:

- installation and use of the construction compound, including material storage areas and worksites;
- movement of vehicles;

- vegetation clearance and soil removal;
- removal of existing infrastructure;
- earthworks;
- installation of new road infrastructure and drainage;
- surfacing works; and
- installation of verge furniture (such as lighting and signage) and planting of vegetation.

5.7.3 There is the potential for adverse dust effects during the construction of the Scheme, although any effects would be temporary (i.e. during the period of the construction works only) and could be suitably minimised by the application of industry standard mitigation measures.

5.7.4 There are a number of sensitive public health and designated habitat receptors located within 200 m of the Scheme as illustrated on Figure 5-2 of Volume 2C. The construction dust risk potential is considered to be 'small' for the Scheme as it is a small roundabout realignment. Therefore, the sensitivity to potential dust effects is considered to be 'High' for receptors located within 50 m of the construction activity and 'Low' for receptors located between 50 and 200 m.

5.7.5 There are approximately 40 properties along Nottingham Road, Southwell Road and the A6097, south of the junction, within 50 m of the assessment boundary. Numerous properties are located between 50 m and 200 m of the assessment boundary along Nottingham Road, Southwell Road and the A6097.

5.7.6 There are no designated habitats located within 50 m of the assessment boundary.

5.7.7 As the potential dust effects is identified as 'high' for receptors located within 50 m of the assessment boundary, best practice mitigation measures suitable for this level of risk must be identified as outlined in DMRB LA 105. These will be set out in the CEMP for the Scheme that will be prepared by the Principal Contractor.

Operation

5.7.8 The Scheme has the potential to affect air quality during operation (positively or negatively), in the following ways:

- by changes in vehicle activity (flows, speeds and composition) as a result of the Scheme in proximity to air quality sensitive receptors; and
- by changes in the separation distances between road sources of emissions and air quality sensitive receptors.

Public Exposure Receptors

5.7.9 Predicted annual mean NO_2 and PM_{10} concentrations for the baseline year and opening year and changes in concentrations attributable to the Scheme operation are presented in Table 5-8.

5.7.10 No receptors are predicted to experience concentrations of NO_2 or PM_{10} above the AQOs in the modelled scenarios and therefore the air quality impacts at public exposure receptors are considered to be not significant.

Table 5-8. Predicted annual mean NO_2 concentrations and magnitude of change bands at public exposure receptors used to inform the judgement of significance

Receptor ID	Height (m)	2018 Base Total PM_{10} concentration ($\mu g/m^3$)	2018 Base Total NO_2 concentration ($\mu g/m^3$)	2023 DM Total NO_2 concentration ($\mu g/m^3$)	2023 DS Total NO_2 concentration ($\mu g/m^3$)	2023 change in total NO_2 concentration due to Scheme ($\mu g/m^3$)
R1	1.5	18.5	33.0	29.2	28.6	-0.6
R2	1.5	17.1	22.9	19.9	18.9	-1.0
R3	1.5	18.0	39.7	35.1	31.7	-3.4
R4	1.5	17.5	36.5	32.2	29.0	-3.1
R5	1.5	17.2	22.7	19.8	19.0	-0.8
R6	1.5	16.8	20.9	18.2	17.3	-0.9
R7	1.5	16.2	25.5	22.2	22.0	-0.2

5.7.11 All receptors are predicted to experience a decrease in annual mean NO_2 concentrations as a result of the Scheme. The greatest decrease is anticipated to occur at receptor R3 (located along Nottingham Road approximately 200 m south-west of the roundabout), at which a decrease of -3.4 $\mu g/m^3$ has been predicted. This is due to the roundabout moving slightly further away from the property and therefore increasing the distance to the emission source (traffic) as well as a reduction in queuing at the junction on Southwell Road, during the AM peak period.

5.7.12 As the annual mean concentrations of NO_2 are below 60 $\mu g/m^3$ at all receptors in both the Do Minimum and the Do Something scenario, it is concluded that the hourly average NO_2 AQO is unlikely to be exceeded in either scenario.

5.7.13 No receptors are predicted to experience an exceedance of the AQO for annual mean NO_2. Therefore in line with paragraph 2.90 of DMRB LA 105, a conclusion of no likely significant air quality effects for human health receptors has been made.

Designated Habitats

5.7.14 Predicted annual mean NO_x concentrations and nitrogen deposition rates, and changes in NO_x concentrations and nitrogen deposition rates attributable to the Scheme operation are presented in Table 5-9 for the veteran tree.

5.7.15 At the veteran tree, the air quality effect is not significant because “the change in nitrogen deposition associated with the Scheme will not lead to the loss of one species” DMRB LA 105.

5.7.16 Therefore, a conclusion of no likely significant air quality effect for designated habitats sites is recorded. Further information can be found in Chapter 8: Biodiversity.

Overall Significance of Effects

5.7.17 The conclusion of the construction dust assessment is that there would be no likely significant air quality effect for human health during the construction of the Scheme with appropriate best practice mitigation measures.

5.7.18 The conclusion of the operational local air quality assessment is that there would be no likely significant air quality effect for human health or designated habitat during the operation of the Scheme.

5.7.19 The conclusion of the compliance risk assessment is that the Scheme would not affect the UK's reported ability to comply with the Air Quality Standards (Amended) Regulations 2016 in the shortest timescale possible due to either the construction or the operation of the Scheme.

5.7.20 Therefore, the effect of the Scheme is considered to be 'not significant' for air quality for both the construction and operational phases. The Scheme is also considered to be consistent with relevant national and local air quality policy.

Table 5-9: Predicted NO_x concentrations and nitrogen deposition rates at designated habitat transects.

Designated Habitat	Distance from road (m)	X	Y	Site Critical Load (kg N/ha/yr)	LTT DM Total NO_x concentration ($\mu g/m^3$)	LTT DS Total NO_x concentration ($\mu g/m^3$)	Change in LLT Total NO_x concentration ($\mu g/m^3$)	LTT DM Total Nitrogen Deposition (kg N/ha/yr)	LTT DS Total Nitrogen Deposition (kg N/ha/yr)	Change in LTT DS Total Nitrogen Deposition (kg N/ha/yr)
Veteran Tree	99	467176	346064	10	20.8	20.3	-0.5	25.3	25.2	-0.1

Note: Nitrogen deposition exceeded the critical load in the Do Minimum and Do Something scenarios at all modelled receptors. Annual mean NOx concentrations were below the objective at all modelled receptors.

5.8 Additional Mitigation

Construction Phase

5.8.1 No mitigation measures are considered to be required for the construction phase of the Scheme as no significant effects are predicted.

Operation Phase

5.8.2 No mitigation measures are considered to be required for the operational phase of the Scheme as no significant effects are predicted.

5.9 Residual Effects

5.9.1 The residual effect of the Scheme is considered to be ‘not significant’ for air quality for both the construction and operational phases.

6. CULTURAL HERITAGE

6.1 Introduction

6.1.1 This chapter discusses the findings of an assessment of the likely significant effects on cultural heritage as a result of the proposed Lowdham Roundabout.

6.1.2 The chapter details the legislation and policy context, methodology of the assessment, the baseline conditions and the assessment of the effects of the Scheme on designated and non-designated heritage assets. The physical effects on heritage assets are assessed together with the effects to the value of heritage assets caused by changes to their setting.

6.1.3 Note that planning policy considers the 'significance' of heritage assets in terms of their value. To avoid confusion with the significance of effects, the term 'value' has been used in this chapter.

6.1.4 The chapter is supported by an aerial photograph and map regression exercise produced by Trent and Peak Archaeology (Appendix 6-2 of Volume 3). This chapter includes the detailed assessment of the baseline conditions and an assessment of the value of the heritage assets which may be affected by the Scheme. As required by the National Planning Policy Framework (NPPF) (MHCLG, 2021), only heritage assets affected by the Scheme are assessed in terms of heritage value. This chapter should be read in conjunction with Figure 6-1 in Volume 2C.

6.2 Legislation and Policy

6.2.1 Information relating to relevant cultural heritage legislation and policy can be viewed in Volume 1, Chapter 6.

6.3 Consultation

6.3.1 Consultation with NCC was undertaken on 1st April 2021 and possible mitigation was suggested for each junction. The minutes of the consultation are included in Appendix 6-1 of Volume 3. Consultation was also carried out with the Senior Practitioner of Historic Buildings from NCC on 6th January 2022 to discuss potential impacts and mitigation for built heritage assets.

6.3.2 A summary of the cultural heritage related responses from the Scoping Opinion which relate to the Scheme at Lowdham and responses from NCC's Senior Practitioner for Historic Buildings are included in Table 6-1.

Table 6-1 Scoping Response Summary

Stakeholder	Comment made	Response and where addressed in the ES
NCC (Scoping Opinion) and NCC Archaeological and Building Conservation Team	The setting of heritage assets, impacts and mitigation will need careful consideration. Particular regard should be given to the recommendations of Historic England.	The impact to heritage assets, including their setting, is considered in this chapter.
	Lowdham War Memorial is the closest of all the assets and the backdrop and setting of this public monument includes the area of the junction. It will be imperative that the setting of this and the other HAs [heritage assets] in the vicinity are carefully considered. Harm to designated heritage assets (including their settings) is in some cases avoidable through carefully considered design. For instance, noise and light pollution can be considered at the design stage to ensure that they do not impact adversely on these heritage assets.	The impact to the Lowdham War Memorial is considered in this assessment.
	Early consultation with the NCC building conservation section and conservation officers at the local district council should take place before designs are fully developed. This is to ensure that there is opportunity to avoid adverse impacts and, where possible, introduce suitable enhancements to the Scheme that can demonstrably mitigate these.	Likely significant effects have been considered to heritage assets within this chapter, including additional lighting and impacts relating to noise. Consultation was undertaken with the County Archaeologist during the preparation of the EIA, as minuted in Appendix 6-1 of Volume 3.
NCC Senior Practitioner for Historic Buildings	It would appear that the only impact on this green area is a replacement sign (this should be confirmed in the final submission). It was determined during discussion that the new sign would be best placed exactly where the existing one is (not forwards of it as shown on the shared plan) and the tree canopy adjusted if necessary, to minimise the impact on the setting of the war memorial.	The signing details around the war memorial will be considered further through detailed design and will be shared with NCC's built heritage specialists.
	It is important to consider the setting at different times of the year, the background to the war memorial contains mature trees that visually shelter it for some of the year, but during annual Remembrance Day ceremony these trees have no leaves and the A6097 is much more impactful in the setting of the memorial at a particularly significant moment in its function as a war memorial.	This has been considered within Section 6.7.
Historic England	In line with the NPPF, we would expect the ES to contain a thorough assessment of the likely effects which the Scheme might have upon those elements which contribute to the significance of these assets.	This is included within the assessment in this chapter.

Stakeholder	Comment made	Response and where addressed in the ES
	We would expect the ES to proportionately consider the potential impacts on non-designated features of historic, architectural, archaeological or artistic interest.	Non-designated assets have been included within the assessment, and effects on these are reported in this chapter.
	The assessment should also take account of the potential impact which associated activities (such as construction, servicing and maintenance, and associated traffic) might have upon perceptions, understanding and appreciation of the heritage assets in the area.	Impacts from associated activities have been considered in Section 6.7 Assessment of Likely Significant Effects in this chapter.
	The assessment should also consider, where appropriate, the likelihood of alterations to drainage patterns that might lead to in situ decomposition or destruction of below ground archaeological remains and deposits, and can also lead to subsidence of buildings and monuments.	Impacts from associated activities have been considered in Section 6.7 Assessment of Likely Significant Effects in this chapter.

6.4 Assessment Methodology

Baseline Conditions

6.4.1 An archaeological map regression and aerial photography study was produced by Trent & Peak Archaeology for the project. The report includes the Nottinghamshire Historic Environment Record (HER) (NCC, 2021) data of the study area, aerial photographs, LiDAR and historic mapping (Trent & Peak Archaeology, 2021; refer to Appendix 6-2 in Volume 3) and has been used to help inform the heritage baseline of this assessment.

6.4.2 The designated heritage assets within this assessment are identified with their National Heritage List for England (NHLE) (Historic England, 2021) reference number. The non-designated heritage assets are identified with their HER reference number which uses the prefix 'MNT'.

6.4.3 A site visit was carried out on 11th June 2021 by an appropriately trained and experienced AECOM Archaeological Consultant. Photographs of the site (the area within the assessment boundary) taken during the walkover survey are presented in Section 6.5. The main considerations of the site walkover were:

- to visually inspect the area and assess the heritage assets, including their setting, that have the potential to be impacted by the Scheme;
- to identify non-designated built heritage assets not identified during desk-based research; and
- to record current land use, ground conditions, and visible evidence of ground disturbance to assess how current and former land use may have affected the archaeological potential of the site.

Study Area

6.4.4 A study area of 500 m from the assessment boundary has been used in order to identify designated and non-designated heritage assets which may be affected by the Scheme (refer to Figure 6-1 in Volume 2C). These potential effects are discussed in the impact assessment in Section 6.7.

Methodology for Determining Construction Effects

6.4.5 Temporary construction impacts lasting for all or part of the construction phase of the Scheme may include the following:

- the presence and movement of construction plant and equipment has the potential to impact on the value of heritage assets within the study area, caused by changes to their setting;
- the siting of construction compounds and activities within working areas, including associated construction noise and lighting, have the potential to impact on the heritage value of heritage assets within the study area, caused by changes to their setting; and
- the use of traffic management and increased volumes of traffic on the local road network, which may impact on the value of heritage assets caused by changes to their setting.

6.4.6 Permanent construction impacts lasting beyond the construction phase may include the following:

- impacts on the setting of heritage assets within the study area, associated with the introduction of the physical form and appearance of the Scheme;
- the potential to encounter, disturb or truncate to the depth of construction buried archaeology, particularly within undeveloped areas of agricultural fields. Works within areas of undeveloped agricultural land either side of the current carriageway for road junctions and temporary construction compounds as part of this Scheme have the potential to impact on any archaeological remains located within previously undisturbed ground that has been in long-term agricultural use;
- compaction of archaeological deposits due to plant movement etc.; and
- changes to groundwater levels and possible desiccation of waterlogged archaeological deposits.

6.4.7 These impacts have been assessed through an appraisal of the designated and non-designated heritage baseline supported by a site visit to assess potential impacts on these assets. These effects can be either temporary or permanent.

Methodology for Determining Operational Effects

6.4.8 Operational impacts of the Scheme may include:

- changes to traffic movements (and associated vehicle lighting), which could affect the setting of heritage assets;
- changes in road noise from vehicle movements, which may affect the setting of heritage assets; and
- the operation of road lighting at junctions and on junction approaches, which may affect the setting of heritage assets.

6.4.9 These have been assessed through an appraisal of the designated and non-designated heritage baseline supported by a site visit to assess potential impacts on these assets.

Significance Criteria

6.4.10 Guidance contained with the DMRB Cultural Heritage Assessment Revision 1 (LA 106) (Highways England, 2020c) and Environmental Assessment and Monitoring Revision 1 (LA 104) (Highways England, 2020b) has been applied in the assessment to identify the value of archaeological remains, historic buildings and historic landscapes and to identify and evaluate the impacts and effects that construction and operation of the Scheme would likely have on these assets.

6.4.11 The value of a building, monument, area, site, place or landscape reflects its value as a historic asset, and therefore its sensitivity to change.

6.4.12 Certain types of heritage asset have a level of value that justify official designation, such as scheduled monuments and listed buildings; however, the absence of designation does not necessarily mean heritage assets are of lower value.

6.4.13 The NPPF defines the significance (value) of heritage assets as “The value of a heritage asset to this and future generations because of its heritage interest” (NPPF, Annex 2 Glossary). In addition, the NPPF sets out criteria which should be considered when assessing the value of cultural heritage assets, which include archaeological, architectural, artistic and historic interests. The value of each asset is described in these terms and the contribution the setting of the heritage assets makes to its value is also assessed. The Chartered Institute for Archaeologists guidance (CIfA, 2020) also requires the value of heritage assets to be assessed.

6.4.14 Professional judgement based on knowledge and experience of similar schemes, has been used to identify the value of assets, guided by legislation, national policy, standards, official designations and the following criteria contained within DMRB LA104, reproduced in Table 6-2.

Table 6-2: Environmental value (sensitivity) and descriptions

Value (sensitivity) of receptor / resource	Typical description
Very High	Very high importance and rarity, international scale and very limited potential for substitution.
High	High importance and rarity, national scale, and limited potential for substitution.
Medium	Medium or high importance and rarity, regional scale, limited potential for substitution.
Low	Low or medium importance and rarity, local scale.
Negligible	Very low importance and rarity, local scale.

Source: DMRB LA 104, Table 3.2N

6.4.15 Impacts have been identified by reviewing the identified sites, features and areas within the study area against the form and extent of the Scheme, in order to establish which assets would be affected by its construction and operation.

6.4.16 Impacts identified in the assessment relate to the predicted changes to key elements of an asset and/or its setting. These can, for example, derive from temporary or permanent actions such as the physical destruction of buried archaeology during construction works, and the introduction of new highway infrastructure into the historic setting of a building or conservation area.

6.4.17 The identification of impacts takes account of all embedded and standard mitigation measures described in Section 6.6.

6.4.18 The methodology contained in DMRB LA 104 suggests that when assessing magnitude of impact the following descriptions described in Table 6-3 were applied.

Table 6-3 Magnitude of impact and typical descriptions

Magnitude	Impact	Description
Major	Adverse	Loss of resource and/or quality and integrity of resource; severe damage to key characteristics, features or elements.
	Beneficial	Large scale or major improvement of resource quality; extensive restoration; major improvement of attribute quality.
Moderate	Adverse	Loss of resource, but not adversely affecting the integrity; partial loss of/damage to key characteristics, features or elements.
	Beneficial	Benefit to, or addition of, key characteristics, features or elements; improvement of attribute quality.
Minor	Adverse	Some measurable change in attributes, quality or vulnerability; minor loss of, or alteration to, one (maybe more) key characteristics, features or elements.

Magnitude	Impact	Description
	Beneficial	Minor benefit to, or addition of, one (maybe more) key characteristics, features or elements; some beneficial impact on attribute or a reduced risk of negative impact occurring.
Negligible	Adverse	Very minor loss or detrimental alteration to one or more characteristics, features or elements
	Beneficial	Very minor benefit to or positive addition of one or more characteristics, features or elements.
No change		No loss or alteration of characteristics, features or elements; no observable impact in either direction.

Source: DMRB LA 104, Table 3.4N

6.4.19 The significance of effects must be reported within Environmental Statements in accordance with the EIA Regulations. The approach to assigning significance of effect relies on reasoned argument, the professional judgement of competent experts and using effective consultation to ensure the advice and views of relevant stakeholders are taken into account. The approach to deriving effects significance from receptor value and magnitude of impacts is based on Table 6-4. Where Table 6-4 includes two significance categories, evidence has been provided to support the reporting of a single significance category.

Table 6-4 Significance matrix

		Magnitude of impact (degree of change)				
		No change	Negligible	Minor	Moderate	Major
Environmental Value (Sensitivity)	**Very high**	Neutral	Slight	Moderate / large	Large or very large	Very large
	High	Neutral	Slight	Moderate / slight	Moderate / large	Large / very large
	Medium	Neutral	Neutral / slight	Slight	Moderate	Moderate / large
	Low	Neutral	Neutral / slight	Neutral / slight	Slight	Slight / moderate
	Negligible	Neutral	Neutral	Neutral / slight	Neutral / slight	Slight

Source: DMRB LA 104 Table 3.8

6.4.20 The matrix has been used to guide the identification and assessment of effects on cultural heritage; however, where professional judgement has resulted in a deviation from the thresholds contained in the matrix these are explained within the relevant sections of the chapter and are supported by appropriate evidence and explanation.

6.4.21 The methodology contained in DMRB LA 104 suggests when assigning significance of effects, the following descriptions in Table 6-5 were applied by the assessment.

6.4.22 Significant effects typically comprise residual effects that are within the moderate, large or very large categories.

Table 6-5 Significance categories and typical descriptions

Significance category	Typical description
Very large	Effects at this level are material in the decision-making process.
Large	Effects at this level are likely to be material in the decision-making process.
Moderate	Effects at this level can be considered to be material decision-making factors.
Slight	Effects at this level are not material in the decision-making process.
Neutral	No effects or those that are beneath levels of perception, within normal bounds of variation or within the margin of forecasting error.

Source: LA 104 Table 3.7.

Assessment of Harm to Designated Heritage Assets

6.4.23 The NPPF sets out requirements to consider whether the impacts of a development on a designated heritage asset amounts to substantial harm to or total loss of, or less than substantial harm to its value.

6.4.24 There is no direct correlation between the significance of effect reported in this chapter and the level of harm on the value of designated heritage assets resulting from the Scheme. Notwithstanding this:

- A very large or large (significant) effect on a heritage asset (including total loss of value) would typically form the basis by which to determine that the level of harm to the value of a designated asset would be substantial. However, substantial harm is considered to be a high test (in other words extensive changes to value) and a case-by-case assessment should be made.
- A moderate (significant) effect is unlikely to meet the test of substantial harm and would therefore typically form the basis by which to determine that the level of harm to the value of a designated asset would be less than substantial.
- A minor or negligible (not significant) effect would typically amount to less than substantial harm to the value of a designated asset.
- A neutral effect amounts to no harm on the value of a designated asset.

6.4.25 In all cases, the determination of the level of harm to the value of a designated heritage asset arising from construction or operation of the Scheme has been led by professional judgement.

6.4.26 The assessment of harm on designated heritage assets resulting from the Scheme in respect of the policy requirements of the NPPF are detailed in Section 6.7.

Assumptions and Limitations

6.4.27 Data was acquired for the study area from the Nottinghamshire HER by Trent and Peak Archaeology in January 2021. Any subsequent additions to the HER after this date have not been included.

6.5 Baseline Conditions

6.5.1 There are seven listed buildings, one conservation area and 40 non-designated heritage assets recorded within the study area. The designated heritage assets are recorded with their NHLE number and the non-designated assets are recorded with

their HER number. The heritage assets are recorded in Appendix 6-1 of Volume 3C and are shown on the known heritage assets figure (See Figure 6-1 of Volume 2C).

Designated Assets

6.5.2 There are seven listed buildings and one conservation area within the study area. The seven listed buildings are all Grade II listed. Of the listed buildings and structures, the closest to the site is the Lowdham War Memorial (1456226) located 40 m north-east of the site, near Station Road. The monument consists of a stone obelisk, square in plan, upon a plinth. It was unveiled in 1921 and amended following the Second World War.

6.5.3 There are also three further listed buildings to the north-east of the site. These comprise 2, Southwell Road (1194512), Numbers 4, 6, 8 and 10 Southwell Road (1045497) and Merevale House (1194564), all of which are early 19th century in date and built of red brick.

6.5.4 Lowdham Railway Station (1370192) lies to the south-east of the site, constructed in the mid-19th century of yellow brick with ashlar quoins and decorative bargeboards along the gables. There are also two framework knitter workshops located to the north-west of the site at the edge of the study area (1194577; 1045496). These are two single storey, early 19th century former workshops.

6.5.5 Lowdham Conservation Area also lies approximately 460 m to the north-west of the Scheme.

Non-designated Assets

6.5.6 There are 40 non-designated heritage assets recorded within the study area, including various post-medieval and modern buildings to the north and east of the site and earthwork features in the immediate vicinity of the site.

6.5.7 There is one asset which lies partially within the assessment boundary. The edge of an area of ridge and furrow falls within the northern edge of the roundabout within the assessment boundary (MNT27228).

Archaeological and Historical Background

Prehistoric (Up to AD43)

6.5.8 There are no assets of prehistoric date recorded within the study area. Evidence of early prehistoric periods are often confined to individual find spots of stone tools, often around river valleys. Correspondingly, within Nottinghamshire evidence of these periods has been found more frequently around the Trent Valley, although finds have been recorded throughout the County (Bishop, 2000a).

6.5.9 Evidence of later prehistoric evidence is more extensive in the wider area. During the Neolithic period (4000-2500BC), the introduction of farming brings a more sedentary way of life, which allows for evidence of permanent settlements. Other features of the later prehistoric include funerary monuments.

6.5.10 Approximately 1.6 km south-east of the site is a Neolithic scheduled henge (1017562), consisting of a sub-circular flat platform measuring approximately 53 m in diameter which is enclosed by a ditch averaging 15 m wide and approximately 1.5 m deep.

6.5.11 The Iron Age (800BC-AD43) evidence within Nottinghamshire has identified a landscape of settlements notably around the Trent Valley, with numerous cropmark remains as well as find spots of metalwork and pottery recorded (Bishop, 2000b).

Roman (AD43-410)

6.5.12 There are no assets of Roman date recorded within the study area. During the Roman period, Nottinghamshire saw a number of settlements established across the County, although more extensively noted within the Trent Valley and southern Nottinghamshire (Bishop, 2000c). Paleoenvironmental evidence, in addition to the extent of settlement evidence, indicates that the landscape was well-cleared of woodland and used for farming during this period (Bishop, 2000c).

6.5.13 Although there are no Roman remains recorded in the study area, there is evidence of Roman occupation within the wider landscape. Approximately 5.3 km south-west of Lowdham Roundabout is a Roman settlement. Margidunum Roman Station (1006395) was a Roman settlement located along Fosse Way, between the Roman towns of Leicester and Lincoln. Remains of at least 22 buildings have been recorded during excavations in the 1920s and 1960s and were dated between the first and fourth centuries AD.

6.5.14 Approximately 7.2 km north-west of Lowdham Roundabout are also the scheduled buried remains of two Roman camps situated on the west side of the valley of the Dover Beck, a tributary of the River Trent (1018264). Both camps are sub-rectangular in shape but are of very different sizes with the smaller one being enclosed by the larger.

Early Medieval (410-1066) and Medieval (1066-1540)

6.5.15 There are no assets of early medieval date recorded within the study area. Lowdham was recorded in the Domesday Book in 1086, indicating a settlement was present from at least the later early medieval period. The settlement is recorded as containing three households as well as ploughland and meadow (Open Domesday, 2011).

6.5.16 There are two assets of medieval date recorded within the study area. These comprise medieval pottery (MNT12115) and ridge and furrow (MNT27228).

Post-Medieval (1540-1900)

6.5.17 There are 11 assets of post-medieval date recorded within the study area, including six listed buildings and five non-designated assets.

6.5.18 The non-designated assets include buildings along Station Road (MNT22312; MNT22313; MNT22262) a brick kiln (MNT13572), and post-medieval artefacts recovered from Lowdham (MNT12116).

6.5.19 The earliest historic mapping, Bankes, 1609, records the site as undeveloped land to the south of the settlement of Lowdham. By Chapman, 1774 and Sanderson, 1835 a road runs through the site aligned north-east to south-west. Buildings are recorded to the north-east while agricultural fields cover much of the surrounding land. Throughout the late 19th century, the town begins to develop further, extending closer to the site (see Appendix 6-2 in Volume 3 for historic maps).

Modern (1900-present)

6.5.20 There are 23 modern assets recorded within the study area, comprising one listed building and 22 non-designated assets.

6.5.21 Many of the non-designated assets are extant buildings including houses (MNT22264; MNT22320; MNT9257; MNT22263; MNT22268; MNT22259; MNT22267; MNT22316; MNT22265; MNT22266; MNT22317; MNT22314; MNT22315; MNT22319; MNT22350; MNT22351) as well as Public Houses (MNT22310; MNT22260) and a Methodist Chapel (MNT25118). Other post-medieval and modern features include a pillbox (MNT10477), signal box (MNT26493) and a wind pump (MNT13666).

6.5.22 During the 20th century, Lowdham continues to expand, with a road running north-west to south-east through the site first appearing on the 1955 OS map. By 1970 the roundabout at Lowdham Roundabout is present, with rows of buildings recorded to the east, south and west.

Unknown

6.5.23 There are also 11 assets of unknown date recorded within the study area, comprising earthworks (MNT10253; MNT10253; MNT10248; MNT10256), hachures (MNT1973), lynchet (MNT2015), banks (MNT10250; MNT10251) and linear features (MNT1748; MNT10252; MNT8105).

Site Visit

6.5.24 This junction is located within Lowdham with the town located to the east of the junction, agricultural fields to the north, west and south and a row of houses to the south-west. The field to the west was in arable cultivation while the north was in use as playing fields and the south as pasture. The listed war memorial and the listed buildings along Southwell Road were mostly screened from the junction. No ridge and furrow was visible within the assessment boundary in the field to the north during the site visit.

Plate 6-1 Lowdham War Memorial (1456226)

Plate 6-2 View to the east of the junction, showing the green around Lowdham War Memorial

Plate 6-3: Numbers 4-10 Southwell Road (1045497), looking east.

Plate 6-4: View west from the listed buildings along Southwell Road towards Lowdham Roundabout.

Plate 6-5: Field to the north of Lowdham Roundabout, with a landscaped embankment around the southern corner of the field near the junction.

Plate 6-6: Agricultural field to the west of Lowdham Roundabout.

Future Baseline

6.5.25 In the absence of the Scheme, it is considered that the site would remain as existing. No future baseline developments have been identified within the study area that would affect the future baseline.

6.6 Design, Mitigation and Enhancement Measures

6.6.1 As described in Chapter 2: The Scheme, the design has taken into consideration the setting of the listed War Memorial and the triangular green around the memorial would be retained in order to preserve its setting.

6.6.2 During detailed design the position of new and replacement signage will be considered further as requested by NCC's Senior Practitioner for Historic Buildings.

6.7 Assessment of Likely Significant Effects

Construction

6.7.1 Ridge and furrow has been recorded in fields located to the north (MNT27228) and west (MNT2015) of the junction. The features to the north also extend into the assessment boundary. The ridge and furrow possesses archaeological and historical interest for the information they provide on medieval agricultural practices and highlighting former land use. The remains are considered to be of low heritage value.

6.7.2 There may be surviving ridge and furrow remains in the field to the north although the Scheme only extends slightly into the south-eastern corner of this field beyond the existing road boundary and is unlikely to significantly impact any surviving ridge and furrow within this field. At most this would have a negligible magnitude of impact, resulting in a neutral of effect.

6.7.3 There is also potential for previously unrecorded archaeology to survive within the

assessment boundary, in the agricultural land to the north-west and south-west of the A614, which may be physically impacted during the construction of the Scheme. While the value of any previously unrecorded remains that may survive within the site cannot be determined at the time of writing, any remains may possess historic and archaeological interest deriving from their potential to contribute to our understanding of past human activity guided by local, regional, and national research priorities. This is likely to be of low heritage value.

6.7.4 Any construction work may remove surviving archaeological remains within these areas of the site, resulting in a moderate magnitude of impact. On an asset of low heritage value, this would result in a slight adverse (not significant) effect.

6.7.5 Lowdham War Memorial is a Grade II listed building located approximately 50 m north-east of the Scheme. The war memorial for the First and Second World Wars consists of a stone obelisk, square in plan, above a tall square plinth on a single-stepped base. The monument is situated at the eastern corner of a triangular green with mature trees between Southwell Road, Station Road and Nottingham Road. The surrounding green includes flowerbeds and mature deciduous trees, the latter of which provides shelter to the memorial during part of the year and helps to create a more tranquil surrounding for the war memorial within the urban landscape. This setting contributes to its value. The memorial possesses architectural and historical interest as a surviving early 20th century war memorial with importance to the local community as a place of remembrance and the site of the annual Remembrance Day ceremony and is of high heritage value.

6.7.6 There would be no physical impacts to the war memorial although the setting of the war memorial may be altered by the construction of the Scheme. A small section at the south-western end of the triangular green is situated within the assessment boundary but would not be removed by construction activity. The existing roads are already present around the war memorial and the construction would not remove the war memorial from its position at the road junction, although it may experience an increase in noise during construction.

6.7.7 Chapter 10: Noise and Vibration covers the potential impacts from noise and vibration. The chapter highlights that for receptors within 50 m of the Scheme along Nottingham Road, there may be ‘significant adverse’ temporary construction noise within the noise assessment. This would include the listed war memorial, located approximately 50 m north-east of the Scheme. It is also noted that the impact is based on the distance from the nearest construction works to the receptor and that much of the construction work for the Scheme would be located at a greater distance from the listed building. Chapter 10 also highlights the high levels of pre-existing ambient noise levels around the Lowdham Roundabout, thus reducing the potential impact of increased noise during construction.

6.7.8 The trees located between the war memorial and Southwell Road are deciduous, meaning the war memorial would be less well screened from the Scheme during the late autumn and winter in comparison to summer months. Thus, any impact on the setting of the memorial caused by the presence of construction equipment may be greater during this time. This is notable as the Remembrance Day ceremony in November is a key aspect of the memorial, although the working hours for the construction of the Scheme recorded in Table 2-1 in Chapter 2: The Scheme indicate there would be no construction work on Sundays, therefore any ceremony conducted on Remembrance Sunday at the War Memorial would not encounter any increased noise associated with the construction. There may still be some greater change to the setting at this time due to the presence of construction equipment during the construction period, although this would be temporary. Construction activity should not take place and equipment should be removed from the area for

Remembrance Sunday.

6.7.9 Given the temporary nature of the impact from the construction noise and presence of construction equipment as well as the high levels of pre-existing ambient noise in the area, it is considered that it would have a minor magnitude of impact, resulting in a slight adverse (not significant) effect.

6.7.10 Merevale (1194564), number 2 Southwell Road (1194512), and numbers 4-10 Southwell Road (1045497 are all Grade II listed buildings, located to the north-east of the Scheme, the closest of which (2, Southwell Road) is approximately 110 m north-east of the Scheme. The buildings are all early 19th century in date, constructed of red brick and include a shop, two pairs of cottages and a house. The setting of the buildings comprises their position along Southwell Road within Lowdham, which contributes to their value. The buildings possess architectural and historical interest as surviving 19th century buildings. They are of high heritage value.

6.7.11 The buildings are screened from the Scheme by mature deciduous trees and thick hedging to the south-west of the buildings and are set back from the road. There may be some increased noise along Southwell Road associated with the construction of the Scheme, although views of the Lowdham Roundabout from the buildings are limited as the hedging screens views of Merevale year round and the remaining buildings are also screened by the vegetation to the south-west. Chapter 10: Noise and Vibration covers potential impacts from noise and vibration. For receptors over 75 m from the Scheme, including the listed buildings Merevale (1194564), number 2 Southwell Road (1194512) and numbers 4-10 Southwell Road (1045497), the noise assessment states that the magnitude of impact from construction noise is considered to be ‘negligible to minor adverse’.

6.7.12 This would have a negligible magnitude of impact, resulting in a slight adverse (not significant) effect.

Operation

6.7.13 Lowdham War Memorial is a Grade II listed building located approximately 50 m north-east of the Scheme. Chapter 10: Noise and Vibration notes that during operation, for receptors within 50 m of the Scheme, impacts from noise are expected to range from ‘negligible beneficial to negligible adverse’ in the short and long term. Proposed lighting along Southwell Road associated with the design is presented in Figure 8.2 in Volume 2C. The proposed lighting columns are located in the position of existing street lighting and are designed to avoid light spillage. Figure 8.2 shows as smaller amount of lighting spill towards the monument than with the current arrangement. Thus there would be no change to the setting from the proposed lighting. A road sign is proposed to be replaced to the west of the memorial, in the position of the existing sign in this location. Due to the negligible change in operational noise, there would be a slight adverse (not significant) effect on this high value receptor during operation.

6.7.14 Merevale (1194564), number 2 Southwell Road (1194512), and numbers 4-10 Southwell Road (1045497 are all Grade II listed buildings, located to the north-east of the Scheme, the closest of which (2, Southwell Road) is approximately 110 m north-east of the Scheme. Proposed lighting columns along Southwell Road associated with the design (see Figure 8.2 in Volume 2C) are located in the position of existing street lighting. There would be no change to the setting from the proposed lighting. Operational road traffic noise impacts (see Chapter 10: Noise and Vibration) are expected to range from ‘negligible beneficial to negligible adverse’ in the short and long term within the noise assessment. This indicates that permanent changes in road traffic noise would not affect the ability to understand

the buildings. As such there would be no change on this high value receptor during operation.

6.7.15 There are no further expected operational effects to heritage arising from the Scheme.

6.8 Additional Mitigation

6.8.1 A watching brief would be required to identify any surviving archaeological remains within the assessment boundary, notably within the agricultural field to the west of the junction.

6.8.2 Construction activity should not take place and equipment should be removed from the area near the Lowdham War Memorial for Remembrance Sunday.

6.9 Residual Effects

6.9.1 The residual effects of the Scheme in relation to cultural heritage are outlined in Table 6-6. No significant residual effects are expected.

Table 6-6: Residual Effects

Description of Effect	Sensitivity of Receptor	Nature of Effect/ Geographic Scale	Magnitude of Impact	Initial Classification of Effect (with embedded mitigation)	Additional Mitigation	Residual Effect Significance
Physical impacts to ridge and furrow	Low	Local	Negligible	Neutral	None proposed	Neutral
Physical impacts to surviving archaeological remains	Low	Local	Moderate	Slight adverse	A watching brief is proposed to identify any buried archaeology within the fields surrounding the existing junction, which fall within the assessment boundary.	Slight adverse
Setting changes to Lowdham War Memorial (1456226)	High	National	Minor	Slight adverse	Construction activity should not take place and equipment should be removed from the area near the Lowdham War Memorial for Remembrance Sunday.	Slight adverse
Setting changes from increased noise and traffic during construction to Merevale (1194564), Number 2 Southwell Road (1194512), numbers 4-10 Southwell Road (1045497) listed buildings	High	National	Negligible	Slight adverse	None proposed	Slight adverse
Setting changes to Lowdham War Memorial (1456226) from operational road traffic noise	High	National	Negligible	Slight adverse	None proposed	Slight adverse

7. LANDSCAPE AND VISUAL

7.1 Introduction

7.1.1 This chapter reports the findings of an assessment of the likely significant effects on landscape and visual receptors as a result of the Scheme.

7.1.2 Landscape effects relate to changes to the landscape as a 'resource', including physical changes to the fabric or individual elements of the landscape, its aesthetic or perceptual qualities and landscape character. This relates to both rural landscapes and townscapes.

7.1.3 Visual effects relate to changes to existing views of identified visual receptors ('people'), from the loss or addition of features within their view as a result of the Scheme.

7.1.4 This chapter reviews the relevant policies in respect of landscape and visual matters, published landscape character assessments and supporting evidence base documents and the findings from fieldwork.

7.1.5 From this review, a proportionate number of representative landscape and visual receptors are identified for the assessment. The review also enables the landscape and visual work to inform the iterative design process, so that relevant design measures (e.g. new planting) are embedded in the Scheme as primary mitigation.

7.1.6 Following identification of the landscape and visual receptors, likely significant effects on them are assessed through combination of the sensitivity of the receptors and the magnitude of impact (change) from the Scheme during the construction phase (winter), year 1 of operation (winter) and year 15 of operation (winter and summer). This chapter also includes a qualitative night-time lighting assessment to assess the likely impacts and effects from new lighting on the relevant landscape and visual receptors and the character of the night sky.

7.1.7 The LVIA has also been undertaken with reference to the biodiversity assessment (Chapter 8: Biodiversity) and the cultural heritage assessment (Chapter 6: Cultural Heritage). These should be read in combination with this ES chapter.

7.2 Legislation and Policy

7.2.1 Information relating to relevant landscape and visual legislation and policy can be viewed in Volume 1, Chapter 7.

7.3 Consultation

7.3.1 Table 7-1 sets out specific landscape related consultation responses received from stakeholders.

Table 7-1: Consultation Responses re Landscape or Visual Matters

Stakeholder	Stakeholder Comments	Scheme Response
Natural England	Landscape and Visual Impacts The consideration of landscape impacts should reflect the approach set out in the Guidelines for Landscape and Visual Impact Assessment (Landscape Institute and the Institute of Environmental Assessment and Management, 2013, 3rd edition), the Landscape Character Assessment Guidance for England and Scotland (Scottish Natural Heritage and The Countryside Agency, 2002) and good practice.	The LVIA methodology within Section 7.4 uses the Guidelines for Landscape and Visual Impact Assessment 3rd Edition (Landscape Institute, 2013).
Natural England	Access and Recreation The ES should include a thorough assessment of the development's effects upon public rights of way and access to the countryside and its enjoyment through recreation. With this in mind and in addition to consideration of public rights of way, the landscape and visual effects on Open Access land, whether direct or indirect, should be included in the ES. Natural England would also expect to see consideration of opportunities for improved or new public access provision on the site, to include linking existing public rights of way and/or providing new circular routes and interpretation. We also recommend reference to relevant Right of Way Improvement Plans (ROWIP) to identify public rights of way within or adjacent to the proposed site that should be maintained or enhanced.	There is limited land affected, none of which is access or public open land. No National Trails have been noted as being present near to any of the Schemes being considered. As such, no significant effects were anticipated and therefore the EIA has not assessed the impacts on accessibility. However, the design has still taken these into account as noted within the descriptions of each Scheme (see Chapter 2: The Scheme). Visual effects are considered within this assessment.

7.4 Assessment Methodology

7.4.1 This assessment has been prepared with reference to DMRB LA 107 Landscape and visual effects (Revision 2) (Highways England, 2020d) and, where appropriate, the Guidelines for Landscape and Visual Impact Assessment 3rd Edition (GLVIA3), (Landscape Institute, 2013). DMRB LA 107 indicates that assessment should identify likely significant landscape and visual effects.

7.4.2 The detailed plans and elevations that define the Scheme have been reviewed and form the basis of the assessment of likely significant effects on landscape and visual receptors.

7.4.3 Information sources for the LVIA are:

- OS and aerial on-line mapping;
- Published landscape character assessments, associated studies and relevant policy as set out in the respective sections of the LVIA; and
- Fieldwork, to verify the desk-based reviews and identify representative views from publicly accessible locations, as set out in the LVIA.

Methodology for Determining Baseline Conditions and Sensitive Receptors

7.4.4 With reference to the assessment of landscape effects, DMRB LA 107 states that the study area should be proportionate in relation to the project boundary, wider landscape setting, extent of the area visible and the full extent of adjacent or affected landscape receptors of special value.

7.4.5 With reference to the assessment of landscape effects, DMRB LA 107 states that the study area should be proportionate in relation to the project boundary, wider landscape setting, extent of the area visible and the full extent of adjacent or affected landscape receptors of special value.

7.4.6 In relation to the assessment of visual effects, DMRB LA 107 states that the study area should be proportionate in terms of the visual footprint, wider visual envelope, the extent of representative viewpoints visible and the extent of adjacent or affected visual receptors and the visual amenity of the area.

7.4.7 Further to the above, GLVIA3 states that the assessment area should include the full extent of the wider landscape that the development may influence in a significant manner. This is usually based on the extent of Landscape Character Areas likely to be significantly affected, directly or indirectly; but also may be based on the extent of the area where the development may be visible, defined as the Zone of Theoretical Visibility (ZTV); or a combination of the two.

7.4.8 Both guidance documents advocate a proportionate approach to the LVIA process, with emphasis placed on the potential for significant effects.

Study Area

7.4.9 A 2 km study area was initially defined at the Scoping stage, determined by desk-based reviews of landform and vegetation patterns, the generation of a ZTV and fieldwork.

7.4.10 Following site surveys and reviews of the revised design, it was considered appropriate to reduce the study area to 750 m. The relatively small scale of the Scheme, combined with screening provided by a combination of existing landform and built form, are considered to negate the potential for significant landscape and

visual effects beyond this range.

7.4.11 The baseline scenario for the assessment is the 'present-day' landscape character and features across the site and study area and the existing 'present day' visibility as recorded by the fieldwork. This landscape and visual baseline is described in the following sections of this chapter.

7.4.12 The landscape receptors were determined through reviewing published landscape character assessments and undertaking fieldwork to verify the published studies and identify local landscape character areas where relevant to add a further level of detail.

7.4.13 The visual receptors were also identified from a review of mapping, ZTVs, fieldwork from publicly accessible locations and professional judgement, to establish a representative range of people's views.

7.4.14 The methodology for the presentation of the Type 1 viewpoint photography and the Type 4 photomontages has been undertaken in accordance with Technical Guidance Note 06/19: Visual Representation of Development Proposals (Landscape Institute, 2019).

Methodology for Determining Construction Effects

7.4.15 The assessment of the construction impacts is based upon the assumption that all of the construction activity occurs across the site at the same time, to represent a worst-case scenario of peak activity.

7.4.16 The construction assessment is based on winter conditions when existing deciduous vegetation is not in leaf and therefore the extent of visibility and perception of the Scheme is greater in comparison to summer conditions.

7.4.17 The potential construction impacts in relation to the LVIA are:

- removal of vegetation, both inside and outside the highway boundary;
- re-grading of landform, including top-soil strips and storage;
- main and satellite compounds consisting of offices, welfare facilities, materials storage, machinery, car-parking, security fencing, fuel storage and lighting;
- barriers and hoardings across the site as required for security and standard construction operating practices;
- temporary access routes between the site, construction areas and compounds;
- temporary traffic management measures; and
- machinery (diggers, excavators).

Methodology for Determining Operational Effects

7.4.18 The assessment of the operation impacts is undertaken at two stages.

7.4.19 The first stage is the 'year 1' assessment, which assumes that the Scheme is built in its entirety and operational. The year 1 assessment is considered for both winter and summer conditions but in particular highlights winter, when existing deciduous vegetation is not in leaf and therefore the extent of visibility and perception of the Scheme is greater in comparison to summer conditions. It represents the worst-case scenario where visibility is greater.

7.4.20 The year 1 assessment also assumes that new planting is immature and at the planted height specified in the landscape mitigation proposals, typically ranging

between 0.5 m and 3 m in height.

7.4.21 The potential year 1 impacts in relation to the LVIA are:

- change in land use;
- alteration to vegetation cover; and
- additional highways infrastructure, including shared cycle/footways, lighting, traffic signals and signage.

7.4.22 The potential year 15 impacts in relation to the LVIA would reflect those stated above. The difference from the year 1 assessment is that the year 15 assessment assumes the successful establishment of the proposed planting, such that the planting would be taller in height, ranging between 1 m and 8m in height.

7.4.23 The year 15 assessment is considered for both winter and summer conditions, informed by whether deciduous vegetation is in leaf or not.

Significance Criteria

7.4.24 The significant effects are identified for both landscape and visual effects through a combination of sensitivity and magnitude, based on the criteria presented in DMRB LA 104, together with professional judgment. The approach to assigning significance of effect relies on reasoned argument, the professional judgement of competent experts and using effective consultation to ensure the advice and views of relevant stakeholders are taken into account.

Landscape Sensitivity

7.4.25 Landscape sensitivity has been determined in accordance with DMRB LA 107.

7.4.26 Relevant tables from the above guidance clarifying the terms used to describe landscape sensitivity and the corresponding typical landscape descriptions are set out in Table 7-2.

Table 7-2 Landscape Sensitivity (Susceptibility and Value) and Typical Descriptions

Landscape sensitivity (susceptibility and value) of receptor/resource	Typical description
Very high	Landscapes of very high international/national importance and rarity or value with no or very limited ability to accommodate change without substantial loss/gain (i.e. national parks, internationally acclaimed landscapes - UNESCO World Heritage Sites).
High	Landscapes of high national importance containing distinctive features/elements with limited ability to accommodate change without incurring substantial loss/gain (i.e. designated areas, areas of strong sense of place - registered parks and gardens, country parks).
Medium	Landscapes of local or regional recognition of importance able to accommodate some change (i.e. features worthy of conservation, some sense of place or value through use/perception).
Low	Local landscape areas or receptors of low to medium importance with ability to accommodate change (i.e. non-designated or designated areas of local recognition or areas of little sense of place).
Negligible	Landscapes of very low importance and rarity able to accommodate change.

Source: DMRB LA 107 Table 3.22

Visual Sensitivity

7.4.27 Visual sensitivity has been determined in accordance with DMRB LA 107.

7.4.28 Relevant tables from the above guidance clarifying the terms used to describe visual sensitivity and the corresponding typical receptor descriptions are set out in Table 7-3.

Table 7-3 Visual Sensitivity (Susceptibility and Value) and Typical Descriptions

Sensitivity (susceptibility and value)	Typical descriptions
Very high	Static views from and of major tourist attractions: Views from and of very important national/international landscapes, cultural/historical sites (e.g. National Parks, UNESCO World Heritage sites); Receptors engaged in specific activities for enjoyment of dark skies.
High	1) Views by users of nationally important PRoW / recreational trails (e.g. national trails, long distance footpaths); 2) Views by users of public open spaces for enjoyment of the countryside (e.g. country parks); 3) Static views from dense residential areas, longer transient views from designated public open space, recreational areas; 4) Views from and of rare designated landscapes of national importance.
Moderate	1) Static views from less populated residential areas, schools and other institutional buildings and their outdoor areas; 2) Views by outdoor workers; 3) Transient views from local/regional areas such as public open space, scenic roads, railways or waterways, users of local/regional designated tourist routes of moderate importance; 4) Views from and of landscapes of regional importance.
Low	1) Views by users of main roads or passengers in public transport on main arterial routes; 2) Views by indoor workers; 3) Views by users of recreational/formal sports facilities where the landscape is secondary to enjoyment of the sport; 4) Views by users of local public open spaces of limited importance with limited variety or distinctiveness.
Negligible	1) Quick transient views such as from fast moving vehicles; 1) Views from industrial area, land awaiting re-development; 2) Views from landscapes of no importance with no variety or distinctiveness.

Source: DMRB LA 107 Table 3.41

Landscape Impacts

7.4.29 The magnitude and nature of impacts on the Landscape has been determined in

accordance DMRB LA 107.

7.4.30 Relevant criteria from the above guidance clarify the terms which are used to describe the magnitude of change (the impact) and the corresponding typical descriptions as set out in Table 7-4.

Table 7-4 Magnitude of Impact on Landscape and Typical Descriptions

Magnitude of impact (change)		Typical descriptions
Major	Adverse	Total loss or large-scale damage to existing landscape character or distinctive features or elements; and/or addition of new uncharacteristic, conspicuous features or elements (i.e. road infrastructure).
	Beneficial	Large scale improvement of landscape character to features and elements; and/or addition of new distinctive features or elements, or removal of conspicuous road infrastructure elements.
Moderate	Adverse	Partial loss or noticeable damage to existing landscape character or distinctive features or elements; and/or addition of new uncharacteristic, noticeable features or elements (i.e. road infrastructure).
	Beneficial	Partial or noticeable improvement of landscape character by restoration of existing features or elements; or addition of new characteristic features or elements or removal of noticeable features or elements
Minor	Adverse	Slight loss or damage to existing landscape character of one (maybe more) key features and elements; and/or addition of new uncharacteristic features and elements.
	Beneficial	Slight improvement of landscape character by the restoration of one (maybe more) key existing features and elements; and/or the addition of new characteristic features.
Negligible	Adverse	Very minor loss, damage or alteration to existing landscape character of one or more features and elements.

Visual Impacts

7.4.31 The magnitude of visual impacts on the landscape has been determined in accordance DMRB LA 107.

7.4.32 Relevant criteria from the above guidance clarify the terms which are used to describe the magnitude of change (the impact) and the corresponding typical descriptions as set out in Table 7-5.

Table 7-5 Magnitude of Impact on Visual Receptors and Typical Descriptions

Magnitude of impact (Change)	Typical descriptions
Major	The Scheme, or a part of it, would become the dominant feature or focal point of the view.
Moderate	The Scheme, or a part of it, would form a noticeable feature or element of the view which is readily apparent to the receptor.
Minor	The Scheme, or a part of it, would be perceptible but not alter the overall balance of features and elements that comprise the existing view.
Negligible	Only a very small part of the Scheme would be discernible or being at such a distance it would form a barely noticeable feature or element of the view.
No change	No part of the Scheme would be discernible.

Assumptions and Limitations

7.4.33 A site visit was undertaken by Landscape Architects from Via during February and July 2021 and by Landscape Architects from AECOM in October and November 2021 to assess the existing character of the landscape and record views from representative photoviewpoints covering winter and summer periods. These views were identified and recorded at locations within the study area (refer to Figure 7-1 of Volume 2C).

7.4.34 No major technical difficulties or practical problems were encountered in carrying out the LVIA. Potentially significant differences between seasonal views have been outlined where relevant within the assessment and taken into consideration in assessing the impacts and reaching conclusions. The site visit was undertaken in good weather visibility of at least 5 km.

7.5 Landscape Baseline Conditions

The Site

7.5.1 The site, including any areas required for temporary construction works, consists of a busy four-arm roundabout between the A6097 Epperstone Bypass/Lowdham Road and A612 Nottingham Road. It is located around 300 m south of the historic centre of Lowdham, and within the footprint of the wider built-up village area.

7.5.2 The A6097 is a four-lane dual-carriageway. To the north, the wide, grassed central reservation with occasional trees and a noticeable lack of barriers and highways infrastructure is reflective of the 1920s origin of the road, as an early example of a bypass. Footways to both sides are separated by a narrow grass verge.

7.5.3 To the south the A6097 has a more functional, narrow, macadam central reserve, with grass verges and a footway to the east side only. Belts of mixed deciduous trees and shrubs, form the highway boundary, partly screening adjacent houses and gardens. Dualling of this 1930s-built section of road and construction of the roundabout took place in the late 1950s/early 1960s.

7.5.4 The A612 is a two-lane single carriageway with grass verges and footways to both sides. The roundabout itself comprises grass with small areas of ornamental shrub planting and sponsorship signs.

7.5.5 To the north-west of the roundabout is an arable field bounded by a low, managed hedge: mainly beech along the A612 and hawthorn along the A6097, with occasional sections of timber post-and-rail fence visible.

7.5.6 To the north-east of the roundabout is an area of mown grass, used by Lowdham Cricket Club, with pitch markings and a pavilion to the far corner, at around 140 m distance. A crescent of mature horse chestnut trees curves around the corner of the field, forming a prominent feature and screening views. Adjacent to the roundabout is a low, mown grass bund with ornamental shrub planting; this continues north along the A6097 as a managed hawthorn hedge. Lighting columns are present along the A612. Otherwise, signage is generally low-key and unobtrusive. A single timber bench faces the A612 north-east of the roundabout.

7.5.7 To the south-west and south-east of the roundabout, along the south side of the A612, are residential properties, largely 1930s ribbon development of two-storey brick houses with hedgerows and parking access to the front and longer rear gardens. North of the A612 there is a row of large, detached c.1930s houses set in large gardens with mature trees and shrubs to the front. A public footpath runs north between two of the properties. Arable land abuts the housing to the north of the A612 adjacent to the roundabout. Similarly, beyond the houses to the south-east of the roundabout, there is open arable land. The boundary along the A612 comprises a mixed native hedge, with a verge of rough grass and no footway.

7.5.8 Although the roundabout is busy, the character is more reflective a suburban or village-edge. There is an open aspect to the north-east, across the field, towards woodland and the Public House World's End.

Landform and Hydrology

7.5.9 The site and study area are located where the transition from the flat Trent Valley flood plain to rising land in the north-west is punctuated by the Cocker Beck, which flows from the villages of Lambley and Lowdham, then into the Trent at Gunthorpe.

7.5.10 The site and immediate area is generally level and around 21 m above ordnance datum (AAOD). Land rises most prominently to the north-east, towards a ridge between Lambley and Burton Joyce, reaching around 70 m AOD. To the north-east, beyond the Cocker Beck and above the old centre of Lowdham village, the land also rises to around 50 m AOD.

Vegetation and Land Cover

7.5.11 Vegetation within the assessment boundary includes mown grass to verges and the central reservation; ornamental shrub planting; and mixed, generally native hedges, trees and shrubs along the road boundary. The assessment boundary also includes the mown amenity grass in the cricket ground and two arable fields.

7.5.12 Gardens associated with residential properties are largely well-maintained with mature planting that includes trees and hedges that screen adjacent roads. Mature horse chestnut trees, along with smaller ornamental specimens, are prominent features within the cricket ground. The recreation ground in Lowdham extends north along the Cocker Beck to include football pitches and a bowling green.

7.5.13 Outside the site, the study area is similarly varied, with a balance of arable fields, bounded by hedgerows; woodland; and housing set in large plots with mature vegetation. Aside from the field to the north-west, this vegetation pattern, combined with built form and rising ground further north-west and to the north-east, results in an enclosed and wooded character, which in turn limits the wider inter-visibility with the site.

Land Use, Infrastructure and Settlement Pattern

7.5.14 Lowdham is the main settlement, which historically developed along Main Street to the north-east of the site and as larger, wooded plots around Red Lane, to the north. Main Street was bypassed in the 1920s/1930s by what is now the A6097. The opening of the railway station in the mid-19th century resulted in localised development to the south-east. Ribbon development took place along the A612 around the 1930s, with late 20th century infill housing estates.

7.5.15 Around 300 m south of the site is the Nottingham to Newark/Lincoln railway: a double tracked route served by at least hourly passenger services, most of which call at Lowdham station. The railway is bounded by a belt of trees along the northern side and runs level with adjacent fields.

7.5.16 The predominant layout of land use in the study area is one of housing interspersed with fields and woodland, such that there is frequently a rural aspect even along main roads and adjacent to 20th century housing estates.

Public Rights of Way

7.5.17 With reference to third-party online public right of way (PRoW) mapping (Rowmaps, 2021) there are a number of PRoW across the study area. Those relevant to the site are as follows:

- PRoW Lowdham FP2 (footpath) between nos. 4 and 6 Nottingham Road (A612) and Red Lane at World's End;
- PRoW Lowdham FP3 (footpath) across the recreation ground and along Cocker Beck, between the A6097 and A612;
- PRoW Lowdham FP4 (footpath) linking the A6097 and FP5, across the recreation ground to the Cocker Beck;
- PRoW Lowdham FP5 (footpath) between the A6097 and Main Street, across both the recreation ground and the Cocker Beck;
- PRoW Lowdham FP8 (footpath) Neighbours Lane, from Main Street over high ground and linking with Gonalston FP7;
- PRoW Lowdham FP20 (footpath) between the A6097 and Red Lane at World's End;
- PRoW Lowdham FP21 (footpath) between the A6097 and Red Lane at World's End, via the end of Plough Lane; and
- PRoW Lowdham FP22 (footpath) to the rear of houses on the A6097 and Plough Lane.

Designations

International and National Designations

7.5.18 The site is not covered by any statutory landscape designations (e.g. National Park or Area of Outstanding Natural Beauty), and there are no statutory designated landscapes within the study area.

Local Landscape Designations

7.5.19 The site and study area are not covered by any local landscape designations - such as those supported by Local Plan policies - that relate to landscapes with special qualities or value, historic landscapes or protected views.

Cultural Heritage Designations

7.5.20 Scheduled monuments, listed buildings and Conservation Areas, whilst not specific

landscape designations, may reflect landscape and architectural quality or value and are relevant to development proposals that may impact upon them.

7.5.21 With reference to the Chapter 6: Cultural Heritage, there are several listed structures within the study area. The nearest are all Grade II and located to the north-east along Southwell Road and include Lowdham War Memorial (the nearest, around 100 m from the site); Merevale No. 2 Southwell Road; No.s 4, 6, 8 and 10 Southwell Road with a sunken pavement. Other Grade II listed buildings are located to the north along Ton Lane; and Lowdham railway station, to the south-east. The Grade II* listed Old Hall and Grade I Church of St. Mary are more distant, around 800 m to 1 km to the north.

7.5.22 The boundary to the Lowdham Conservation Area (see Figure 7-3 of Volume 2C) lies approximately 350 m north of the site at the nearest point, along the boundary to the arable fields south of Red Lane and World's End. No published appraisal is available for the designation; such reports frequently identify key views, elements or qualities that are worthy of preservation.

Green Belt

7.5.23 The site and adjacent agricultural land outside the settlement boundary to Lowdham is within the Nottingham Green Belt.

7.5.24 The Green Belt is protected through both national and local planning policy with purposes that include the prevention of sprawl; merging of towns; encroachment of the countryside; and preservation of the setting and special character of historic towns. The essential characteristics of the Green Belt are their openness and their permanence.

7.5.25 Unlike other designations and character assessments, the Green Belt designation is not informed by any moderated, evidence-based evaluation of landscape character, quality, condition or value. Some areas designated as Green Belt are of distinctly poor landscape and visual quality. There is no legal definition of 'openness', a concept which continues to be the subject of planning case law and High Court challenges.

7.5.26 For these reasons, the Green Belt designation is not considered as part of the evaluation of landscape sensitivity, nor are landscape and visual impacts upon it assessed in their own right.

Tranquillity

7.5.27 The tranquillity across the study area varies. Near the site, it is substantially reduced by road traffic noise, but away from the roundabout and the two main roads it is more suburban and rural, with only occasional passing trains.

Published Landscape Character Assessments

7.5.28 The site and study area are covered by several published landscape character assessments. Local planning authorities use their published landscape character assessments as part of their planning policy evidence base and the published assessments often provide specific guidance or recommendations on managing landscape change.

7.5.29 The following section summarises those aspects of the published studies that are relevant to the study area and the site and should be read in combination with Figure 7-2 of Volume 2C, which illustrates the published landscape character assessment boundaries.

National: Natural England, National Character Area 48 (NCA 48): Trent and Belvoir Vales

7.5.30 The site and study area are within NCA 48: Trent and Belvoir Vales (Natural England, 2013), which is characterised by undulating, strongly rural and predominantly arable farmland, with stated key characteristics relevant to the site and study area as follows:

- "*A gently undulating and low-lying landform in the main, with low ridges dividing shallow, broad river valleys, vales and flood plains. …;*
- *Agriculture is the dominant land use, with most farmland being used for growing cereals, oilseeds and other arable crops..*"
- *A regular pattern of medium to large fields enclosed by hawthorn hedgerows, and ditches in low-lying areas, dominates the landscape*
- *Very little semi-natural habitat remains across the area...*
- *Extensive use of red bricks and pantiles in the 19th century has contributed to the consistent character of traditional architecture within villages and farmsteads across the area. Stone hewn from harder courses within the mudstones, along with stone from neighbouring areas, also feature as building materials, especially in the churches*
- *A predominantly rural and sparsely settled area with small villages and dispersed farms linked by quiet lanes, contrasting with the busy market towns of Newark and Grantham, the cities of Nottingham and Lincoln, the major roads connecting them and the cross-country dual carriageways of the A1 and A46.*"

7.5.31 Relevant Statements of Environmental Opportunity (SEO) include:

- *"Enhance the woodland and hedgerow network through the planting of small woodlands, tree belts, hedgerow trees and new hedgerows to benefit landscape character, habitat connectivity and a range of ecosystem services, including the regulation of soil erosion, water quality and flow; and*
- *Maintain and enhance the character of this gently undulating, rural landscape. Promote and carefully manage the many distinctive elements that contribute to the overarching sense of place and history of the Trent and Belvoir Vales."*

7.5.32 Relevant stated landscape attributes are:

- *"The River Trent and its network of tributaries, valleys, corridors and flood plains along with the other rivers and watercourses are key features in this undulating landscape;*
- *A strong sense of history and time depth through-out the landscape; and*
- *Hedgerows and field patterns."*

7.5.33 Landscape opportunities include:

- *"Conserve the rural settlement pattern by ensuring that new development is complementary to intrinsic local character …;*
- *Ensure new developments are integrated well with adequate, well designed, green infrastructure. Resist new road development which threatens tranquillity; and*
- *Restore and manage hedgerows, where they have been lost, to strengthen the historical field patterns, improve wildlife networks and enhance landscape character.*

- *Enhance tree cover throughout the NCA following the recommendations of the East Midlands Woodland Opportunity Mapping Guidance for each of the sub areas within the NCA through, for example, extensive planting of hedgerow trees. This is particularly important in view of the threat from ash dieback disease as ash is a characteristic species in the NCA."*

County: Greater Nottingham Landscape Character Assessment (GNLCA), 2009

7.5.34 With reference to Figure 7-2 of Volume 2C, the site is covered by two GNLCA (NCC, 2009) Regional Landscape Character Areas (RLCA) and three Policy Zones (PZ).

7.5.35 Mid-Nottinghamshire Farmlands RLCA, which extends from Nottingham to near Retford and encompasses elevated farmland to the west of the River Trent. Within the assessment boundary the Policy Zones directly affected include:

- PZ MN40 Epperstone Village Farmlands with Ancient Woodlands, which includes the open spaces north of the roundabout and extends around much of Lowdham, along the valley of the Cocker Beck and north towards Epperstone.
- PZ MN42 Lowdham Grange Village Farmlands, which includes a small part of the field to the north-west of the roundabout, then extends west to encompass the high ground north of the A612 towards Bulcote.

7.5.36 Trent Washlands RLCA, which extends from Nottingham to near Retford and encompasses elevated farmland to the west of the River Trent. Within the assessment boundary the Policy Zones directly affected include:

- PZ TW08 Gunthorpe and Hoveringham Village Farmlands, which includes the arable field south of the A612 and extends towards Burton Joyce, south of the A612.

7.5.37 Analysis of the LCA and policy zone mapping indicates that only two Policy Zones are directly affected to any appreciable extent and these were taken forward for further assessment, as set out in Table 7-6 which summarises the key characteristics within the published landscape character assessments.

Table 7-6: Summary of published Landscape Character Assessments

LCA	Key Characteristics
Mid-Nottinghamshire Farmlands RLCA	A rural agricultural region characterised by small nucleated red brick villages, narrow country lanes, ancient woodlands, wooded "dumble" streams and a variable pattern of fields.
Trent Washlands RLCA	A low-lying agricultural region associated with the broad valleys of the Trent and Soar, characterised by productive arable farming, meadowlands, small, nucleated villages, market towns and cities, power stations and quarries.

PZ MN40 Epperstone Village Farmlands with Ancient Woodlands

Key Characteristics

PZ MN40 contains medium scale arable fields with smaller scale pastoral areas close to villages and within the valley of Dover Beck and Cocker Beck. Woodland areas tend to be small areas of mixed deciduous woodland or riparian woodland. The pattern of elements is generally small scale and consists of a mixture of arable farmland, pasture and small broadleaved woodlands.

Human influence is concentrated along transport routes passing through the area such as the A612 and A6097.The PZ includes the settlements of Epperstone and the older area of Lowdham to the north-west of the A6097.

This PZ is formed by the valley of Dover Beck and Cocker Beck. The surrounding Mid Nottinghamshire Farmlands PZs 39,42 have a more elevated topography, otherwise these adjacent areas are well connected to this PZ. Views are constrained to the north-west by topography but are more expansive to the south-east across the Trent Valley.

Value

- No landscape designations
- Green Belt – planning designation
- Designated ecological interest with many LWS within the Policy Zone
- Heritage features include Conservation Areas in Epperstone and Lowdham which include many Listed Buildings such as the Grade 1 listed Church of St Mary in Lowdham and the Grade II listed Epperstone Manor.
- Recreational interest is linked to the many PRoWs in the area.

Overall: Taking the key characteristics and indicators of value into account PZ MN40 is assessed as medium landscape value.

PZ TW08 Gunthorpe and Hoveringham Village Farmlands

Key Characteristics

This PZ contains the large scale intensively farmed arable fields of the Bulcote Farm/Stoke Bardolph estate. There are smaller pasture fields close to the village of Bulcote. There is little woodland within the PZ with vegetation largely being confined to road hedge lines and field boundaries. The pattern of elements is not complex and consists predominantly of arable farmland at the northern fringe of the Trent Floodplain.

Human influence is concentrated along transport routes passing through the area such as the A612 and the main railway line. The PZ includes the village of Bulcote which has a Conservation Area at its centre.

TW06 is a flat area at the northern edge of the floodplain. The surrounding Mid Nottinghamshire Farmlands PZs 39,40, 42, and 44 have a more elevated topography otherwise these adjacent areas are well connected to this PZ.

Views to the north-west are constrained by topography but there are expansive views across the Trent Valley Floodplain to the south-east.

Value

- No landscape designations
- Green belt - planning designation
- Heritage features include Bulcote village Conservation Area with some listed buildings including the Grade II listed Manor House and Bulcote Lodge.
- Recreational interest linked to PRoW Bridleway Bulcote 1

Overall: Taking the key characteristics and indicators of value into account PZ TW06 is assessed as medium landscape value.

Future Baseline

7.5.38 In the absence of the Scheme, it is considered that the site would remain as existing. No future baseline developments have been identified within the study

area that would affect the future baseline.

7.6 Design, Mitigation and Enhancement Measures

7.6.1 The landscape design proposals are shown on Appendix 2-2 in Volume 3C. The objectives of the landscape design are to:

- mitigate unavoidable loss of landscape elements by the replication of characteristic features within the landscape design proposals;
- reduce or mitigate effects on landscape character and visual amenity by the use of planting and seeding to integrate the junction as far as possible, given the nature of the Scheme;
- to achieve and maximise biodiversity opportunities within land taken for the Scheme; and
- provide a long-term appropriate setting for the junction which is functional but also appropriate for the largely rural context.

7.6.2 Elements which achieve these objectives at the Lowdham Roundabout include:

- use of species rich hedgerow of native trees and shrubs to establish new highway boundaries and integrate the junction into the landscape context;
- groups of individual and hedgerow trees north of the A612 acting as a screen for the junction from locations to the north, including the Lowdham Conservation Area;
- shrub planting on the roundabout for amenity value; and
- wildflower and wetland areas to provide biodiversity value and extend the habitat range adjacent to the junction.

7.7 Assessment of Landscape Effects

7.7.1 Effects on the landscape character of the Mid-Nottinghamshire Farmlands RLCA and Trent Washlands RLCA will be of a scale and extent that they would effectively be of neutral significance, at the scale of the regional landscape character area, at all stages.

7.7.2 Effects at the Policy Zone scale are assessed in Table 7-7.

Table 7-7: Assessment of Landscape Effects in Construction

PZ MN40 Epperstone Village Farmlands with Ancient Woodlands

Susceptibility
The pattern of elements in PZ MN40 is generally small scale and consists of a mixture of arable farmland, pasture and small broadleaved woodlands. Human influence is concentrated along transport routes passing including the A612 and A6097. Construction would increase human activity and directly impact landscape character and appear incongruous in a small-scale landscape of natural elements. However, given the context of a busy highway, susceptibility to this particular Scheme is assessed as low.
Sensitivity
Taking medium value and low susceptibility into account PZ MN40 is assessed as medium sensitivity to the Scheme in construction.
Nature of Effect: Size/Scale, Geographical Extent, Duration and Reversibility
Changes in construction would include removal of a hedgeline and a mature tree to the north of the A612 to allow for an additional left turn lane to be incorporated into the Scheme. There would be an increase in the amount of activity and human influence at Lowdham roundabout junction as a result of the presence of

machinery, traffic management and loss of key characteristics of the PZ. However, changes would be short-term, and temporary and in most respects reversible on removal of the construction activity. Loss or damage to existing landscape character would be of negligible scale and extent, comprising a short section of mature hedgeline and a mature tree. The geographical extent of direct change in the PZ would be very localised and indirect effects on the PZ would be of very limited geographical extent. Overall, there would be a minor magnitude of effect on PZ MN40 during construction.

Significance of Effect

Overall, taking the medium sensitivity and minor magnitude of effect into account there would be an **adverse effect of slight significance** on PZ MN40 during construction.

PZ TW08 Gunthorpe and Hoveringham Village Farmlands

Susceptibility

This PZ comprises large scale intensively farmed arable fields with little woodland and a simple pattern. Transport routes such as the A612 and the main railway line, influence landscape character. Given the context, susceptibility to this particular Scheme in construction is assessed as low.

Sensitivity

Taking medium value and low susceptibility into account PZ TW08 is assessed as medium sensitivity to the Scheme in construction.

Nature of Effect: Size/Scale, Geographical Extent, Duration and Reversibility

Construction would involve removal of a hedge line to south of A612 to create a maintenance access route for properties to the south of A612. There would be an increase in the amount of activity and human influence at Lowdham roundabout junction as a result of the presence of machinery, a temporary compound, and traffic management. However, changes would be short-term, and temporary and in most respects reversible on removal of the construction activity. Loss or damage to existing landscape character would be of negligible scale and extent, comprising a short section of mature hedgeline and temporary use of the compound area. The geographical extent of direct change in the PZ would be very localised and indirect effects on the PZ would be of very limited geographical extent. Overall, there would be a negligible magnitude of effect on PZ TW08, during construction.

Significance of Effect

Overall, taking the medium sensitivity and negligible magnitude of effect into account there would be an **adverse effect of slight significance** on PZ TW08 during construction.

Table 7-8: Assessment of Landscape Effects in Operation Year 1/Operation Year 15

PZ MN40 Epperstone Village Farmlands with Ancient Woodlands

Susceptibility

Influence of transport routes on landscape character occurs in the baseline from the A612 and A6097. The Scheme would not increase traffic or introduce new uncharacteristic elements but there would be some intensification of highway elements such as signage and lighting. The Scheme is located in the corner of the PZ. Given the context, susceptibility to this particular Scheme in operation is assessed as low both in Year 1 and Year 15.

Sensitivity

Taking medium value and low susceptibility into account PZ MN40 is assessed as low sensitivity to the Scheme in operation in Year 1 and Year 15.

Nature of Effect: Size/Scale, Geographical Extent, Duration and Reversibility

Changes in operation Year 1 would include highway intensification derived from the larger footprint and presence of the modified roundabout, splitter islands, increased lighting and signage. Changes would be long-term and permanent. However, the addition of highway infrastructure would be of negligible scale and extent within the PZ. Indirect effects on the PZ would be of very limited geographical extent. The Scheme would include the addition of vegetation to replace that lost in construction, including a new hedge line to the north-west of A612 and a wetland area with tree planting. In year 1 these would remain immature and contribute little to landscape character. Overall, there would be a negligible magnitude of effect on PZ MN40 during Year 1.

At Year 15, the landscape mitigation elements of hedgerow species characteristic of the landscape character area, tree planting, and creation of wetland area to north-west of the A612 will have matured such that they

contribute positively to the landscape context of the roundabout within PZ MN40. Effects from the highway elements would remain as described for Year 1 with some benefit derived from greater integration within the baseline. Balancing these factors, there would be a negligible magnitude of effect on PZ MN40 at Year 15.

Significance of Effect

Overall, taking the medium sensitivity and negligible magnitude of effect into account there would be a **slight adverse effect** on PZ MN40 in operation Year 1 and a **neutral effect** at Year 15.

PZ TW08 Gunthorpe and Hoveringham Village Farmlands

Susceptibility

This PZ comprises large scale intensively farmed arable fields with little woodland and a simple pattern. Transport routes such as the A612 and the main railway line, influence landscape character. The Scheme would not increase traffic or introduce new uncharacteristic elements but there would be some intensification of highway elements such as signage and lighting. The Scheme is located in the corner of the PZ. Given the context, susceptibility, to this particular Scheme, in operation is assessed as low both in Year 1 and Year 15.

Sensitivity

Taking medium value and low susceptibility into account PZ TW08 is assessed as medium sensitivity to the Scheme in operation.

Nature of Effect: Size/Scale, Geographical Extent, Duration and Reversibility

Changes in operation Year 1 would include only very localised change to a footway and indirect change from views of highway intensification derived from the larger footprint and presence of the modified roundabout, splitter islands, increased lighting and signage. Changes would be long-term and permanent. Additional highway infrastructure would be of less than negligible scale and extent within this PZ and indirect effects on the PZ would be of very limited geographical extent, given visibility and the location on the periphery of the PZ. The Scheme would include addition of vegetation to replace that lost in construction, including a new hedge line to the south of the A612 and areas of native floral meadow. In year 1 the hedgerows would contribute little to landscape character. Overall, there would be a neutral magnitude of effect on PZ TW08 during Year 1.

At Year 15, the landscape mitigation elements of hedgerow species characteristic of the landscape character area will have matured such that they contribute positively to the landscape context within PZ TW08, albeit only very locally. Effects from the highway elements would remain as described for Year 1 with some benefit derived from greater integration within the baseline. Balancing these factors, there would be a neutral effect on PZ TW08 at Year 15.

Significance of Effect

Overall, taking the medium sensitivity and neutral effect into account there would be a **neutral effect** on PZ TW08 in operation Year 1 and a **neutral effect** at Year 15.

7.8 Visual Baseline Conditions

7.8.1 Figure 7-1 of Volume 2C illustrates a range of representative viewpoints which form the basis of the LVIA.

7.8.2 There are several potential visual receptors in and around the study area (all distances are taken from the assessment boundary). These include:

- residents at properties within Lowdham Conservation Area;
- residents at properties in other locations in Lowdham (outside of the Conservation Area);
- residents at other individual isolated residential properties;
- users of various local PRoW; and
- viewers on minor roads.

7.8.3 Following production of a ZTV of the proposed Scheme, photoviewpoints were recorded from a total of six locations within the study area (see Volume 2C Figure 7-1 for location, Figures 7-4 for viewpoints and Figures 7-5 for photomontages) and

were selected to represent a range of location types and viewing distances. The photoviewpoints are displayed at a viewing distance of a comfortable arm's length within in accordance with the Landscape Institute's Technical Guidance Note 06/19: Visual Representation of Development Proposals. The photoviewpoint are Type 1 viewpoint photography and the photomontages are Type 4 visualisations.

7.8.4 As the ZTV was based on a bare earth survey, some photoviewpoints have not been taken forward due to the limited nature of views in these locations, when visited on site. Assessment of baseline characteristics of the representative viewpoints is set out in Table 7-9.

Table 7-9: Representative Viewpoints Baseline Characteristics

Photoviewpoint 1: World's End (Lowdham Conservation Area), public footpaths Lowdham FP2 and FP20

Grid reference	Elevation (m AOD)	Receptor type	Approx. distance	Photoplan	Date of Visit
466633, 346272	37.5	Residential/ Recreational	275 m	Figure 7-5-1	July-Nov 2021

Description of the baseline view

Description of the existing view: View looking south-east across agricultural land, which is sloping downhill towards the existing Lowdham Roundabout, from an elevated viewpoint. This viewpoint reflects the views available to users of the PRoW (Lowdham FP2 and F20) and residents in terraced houses and a detached property at the end of Red Lane (World's End). The location is on the edge of the Lowdham Conservation Area.

Range of view – to the left-hand side of the view is the A6097 with strong hedgelines and with mature vegetation on Lowdham Recreation area beyond. In the foreground is arable agricultural land, in the mid ground – residential properties close to the existing roundabout and traffic on the approaches, in the far distance is the escarpment beyond the River Trent to the south-east which forms a prominent ridge line. To the right-hand side of the view is mature vegetation bordering PRoW Lowdham Footpath 2 which is along the boundary of the detached property – No. 22 Burton Road.

There will be rear upper storey views from terraced properties and a detached property at the edge of the Lowdham Conservation Area, ground level views will be partially filtered by existing hedgerows.

Degree of filtering – there is some filtering of views of the existing roundabout by hedgerows, detractors in the view include lamp columns, highway signage, and moving traffic.

Value of the View	Value
The viewpoint is not within an area subject to any landscape designations, but the whole study area is within the Green Belt. The Lowdham Conservation area extends as far as the edge of the built area, which is bounded by PRoW Lowdham Footpath 20, Footpath 2 links this footpath to Burton Road at the base of the escarpment. The amenity value is high due to the open space and the agricultural setting, the immediate surroundings include very mature trees and well-maintained hedgerows, the value of the view is assessed as medium.	**Medium**

Photoviewpoint 2: Neighbour's Lane, public footpath Lowdham 8

Grid reference	Elevation (m AOD)	Receptor type	Approx. distance	Photoplan	Date of Visit
467158, 346607	49.2	Recreational	410 m	Figure 7-4-1	July-Nov 2021

Description of the baseline view

Description of the existing view: View looking south across agricultural land from a PRoW, which is sloping downhill towards the existing Lowdham Roundabout, from an elevated viewpoint.

Range of view –a series of strong hedgelines cross the panorama, creating a well wooded middle ground of mature vegetation with long views to the escarpment beyond the River Trent to the south-east which forms a prominent ridge line. In the foreground is agricultural land under pasture. Residential properties in Lowdham are glimpsed as minor elements between gaps in the vegetation. The existing roundabout and traffic on the approaches is not visible.

Degree of filtering – there is complete screening of views of the existing roundabout by hedgerows and this would remain the case in winter due to the density of intervening vegetation.

Value of the View	Value
The viewpoint is not within an area subject to any landscape designations, but the whole study area is within the Green Belt. The amenity value is high due to the elevated nature of the viewpoint providing a long view, the composition of landscape elements and absence of detractors within a rural panorama of mature trees and hedgerows. The value of the view is assessed as medium.	**Medium**

Photoviewpoint 3: Lowdham Recreation Area, public footpath Lowdham 8

Grid reference	Elevation (m AOD)	Receptor type	Approx. distance	Photoplan	Date of Visit
466947,346287	21.3	Recreational	60 m	Figure 7-4-2	July-Nov 2021

Description of the baseline view

View looking south across the recreation area towards the existing Lowdham Roundabout from PRoW Lowdham Footpath 3. The viewpoint reflects the views available to users of the PRoW, users of the recreational facilities and residential views.

Range of view – To the left-hand side of the viewpoint is the PRoW with mature vegetation to its southern boundary. In the immediate foreground is the Lowdham recreational area used for cricket and football. In the middle distance is mature tree planting between the existing roundabout and the recreation area, in the far distance are mature trees beyond the existing roundabout. To the right-hand side of the view is the strong hedge line along the A6097 which forms the boundary to the recreation area.

Between the viewpoint and the built edge of Lowdham village is the Cocker Beck water course which is in an open channel lined with naturally regenerating vegetation. Behind the watercourse are the rear gardens of properties off Main Street, Lowdham. Views are possible towards the roundabout from the rear upper storeys of three of these properties, views from lower levels are obscured by garden vegetation and vegetation on the boundary of the properties.

Filters and detractors - Views of the existing roundabout are obscured by mature vegetation to the north of the roundabout, although moving vehicles on the A6097 and A612 Southwell approaches are visible in the view. Detractors in the view include highway signage and lamp columns.

Value of the View	Value
The viewpoint is not subject to any landscape designations although it is within the Green Belt. It is however located on a well-used PRoW, there are recreational facilities close by. The village centre of Lowdham is also nearby and accessible via PRoW Lowdham footpath 4. The amenity value is high due to the mature vegetation within the recreation area, and along the water course. Value is assessed as medium.	**Medium**

Photoviewpoint 4: Nottingham Road, Lowdham War Memorial

Grid reference	Elevation (m AOD)	Receptor type	Approx. distance	Photoplan	Date of Visit
467129, 346163	20.5	Highway/ Residential	460 m	Figure 7-5-2	July-Nov 2021

Description of the baseline view

View looking south-west along Nottingham Road towards the existing roundabout. The viewpoint reflects the views available to vehicles on Nottingham Road and residential views from the environs of the properties rather than from the property windows which face north-west.

Range of view – To the left-hand side of the view are two-storey houses on Nottingham Road. In the foreground is Nottingham Road - a no-through-road. In the middle distance is the existing roundabout and houses to the south-west of the roundabout on Burton Road, In the far distance the skyline is formed by mature trees on Burton Road and woodland on the slope up to the Lowdham Conservation Area. To the right-hand side of the view is a highway verge area with mature trees surrounding the Lowdham War Memorial.

The houses on Nottingham Road are oriented north-west to south-east with the principal view to the north-west, there are no gable end views to the south-west (including No. 13).

Filters include mature vegetation and strong boundary planting to houses on Nottingham Road which restricts the field of view. Detracting features include moving traffic on the A612 Southwell Road and the A612 Burton Road, highway signage, lighting columns, and telegraph poles.

Value of the View	Value
The viewpoint is not subject to any landscape designations although it is within the Green Belt. There are recreational facilities close by and the village centre of Lowdham is nearby. Although adjacent to the Grade II listed war memorial, the view itself is ordinary, albeit enhanced due to mature vegetation on the verge between Southwell Road and A612 Southwell Road. Value is assessed as low.	**Low**

Photoviewpoint 5: A6097 travelling north-west

Grid reference	Elevation (m AOD)	Receptor type	Approx. distance	Photoplan	Date of Visit
467105, 345996	20.6	Highway	15 m	Figure7-4-3	July-Nov 2021

Description of the baseline view

View looking-north-west along the A6097 towards the existing roundabout. The viewpoint reflects the views available to vehicles on the A6097 on the south-eastern approach to the existing roundabout.

Range of view – To the left-hand side of the view is a mature hedge and trees at the edge of the A6097, and on the boundary of detached property No.8 Victoria Avenue. In the foreground is the A6097 carriageway and in the mid ground the existing roundabout. The skyline is formed by mature trees on the high ground at the southern edge of the Lowdham Conservation Area. To the right-hand side of the viewpoint in mature vegetation to the south-east edge of the A6097.

Views from houses at the south-west end of Victoria Avenue to the north-east of the A6097 will be screened from views of the Scheme by dense vegetation to the road footage and an area of mature vegetation to the rear of No.9 to the north-west side of Victoria Avenue.

Filters in the view include mature vegetation to the edges of the viewpoint. Detractors include tourist signage and highway signage, lamp columns, traffic cameras, and moving traffic on the approaches to the existing roundabout.

Value of the View	Value
The viewpoint is not subject to any landscape designations although it is within the Green Belt and is predominantly highway focussed within an ordinary view, enclosed and restricted by highway vegetation. Visual value is assessed as low.	**Low**

Photoviewpoint 6: A612 Burton Road

Grid reference	Elevation (m AOD)	Receptor type	Approx. distance	Photoplan	Date of Visit
466928, 345992	20.7	Residential/highway	0 m	Figure 7-5-3	July-Nov 2021

Description of the baseline view

View looking north-east along A612 Burton Road towards the existing roundabout. The viewpoint reflects the views available to vehicles on Burton Road and residential views from the environs of the properties rather than from the property windows.

Range of view – to the left-hand side of the view is mature vegetation along the boundary of houses at the north-eastern end of A612 Burton Road and an agricultural field, including large mature trees. The near view is formed by the south-western approach to the existing roundabout. The skyline is formed by mature vegetation surrounding the recreation area to the north of the existing roundabout, and the built edge of Lowdham. To the left-hand side of the view are houses on the south-east side of the A612 Burton Road, and a poor-quality roadside hedge.

Residential properties on Burton Road are oriented north-west to south-east with the principal view south-east or north-east, with no or very limited gable end views looking towards the roundabout, views of the Scheme will be from the environs of the properties rather than from within them.

Filters – include the mature vegetation to the left-hand side of A612 Burton Road, and a hedgerow to the right-hand side. Detractors include road signage, tourist signage, lighting columns, telephone poles, splitter islands and moving traffic approaching the existing roundabout.

Value of the View	Value
The viewpoint is not subject to any landscape designations although it is within the Green Belt. The village centre of Lowdham and recreational facilities are close by. The amenity value is reduced due to the proximity to Burton Road and overall it is an ordinary view unlikely to be visited to appreciate it in its own right. Visual value is assessed as low.	**Low**

7.8.5

7.9 Assessment of Visual Effects

Table 7-10: Assessment of Visual Effects at Representative Viewpoints

Photoviewpoint 1: World's End (Lowdham Conservation Area), Lowdham Footpaths FP2 and FP20 (Refer to Photomontage 7-5-1)

Susceptibility of Receptor to Specific Change	Susceptibility
All stages: Receptors at this location comprise PRoW users and views from residential properties within the Lowdham Conservation Area (predominantly from upper floors). Both are at the higher range of susceptibility to visual intrusion from construction as a result of the expectation of appreciation of views and being typically engaged in active enjoyment of the view. The A6097 highway forms a minor element of the existing view. PRoW users at this location are assessed as being of moderate susceptibility to change arising from construction activity within a highway context, given an expectation of enjoyment of views and the absence of similar activity in the baseline. Taking the medium value of the view with the moderate susceptibility to visual intrusion of construction into account, PRoW users are assessed as being of moderate sensitivity. Views of the proposed Scheme in operation would potentially be incongruous in the context of this view in which the A6097 highway forms only a minor part of the baseline, and users of PRoWs have any expectation of enjoyment of the view in this context. Users of the PRoW are therefore of medium susceptibility to the operational highway. Considering the medium value of the view against the medium susceptibility to views of the Scheme in year 1, PRoW users are assessed as being of moderate sensitivity to the operational Scheme as both experience an existing highway view.	**Moderate**
Sensitivity	**Sensitivity**
All stages:	**Moderate**
Nature of Effect: Size/Scale, Geographical Extent, Duration and Reversibility	
During construction: Construction activity to construct the revised junction, including a site compound to the north of the A6097, would occupy the middle ground and include localised removal of vegetation (hedgelines along the A6097 and A612) and excavation of an attenuation pond centrally within the view. The introduction of traffic management/construction activity and machinery would add to adverse elements within the view. A second site compound, to the south of the A6097, is likely to be partially visible in the right of the view. For residents adjacent to the viewpoint, views would be largely from upper floors and for both residents and users of the PRoW, the construction activity would be viewed as a localised element, in the context of the existing highway and edge of Lowdham village and as a limited element within a wide panorama. The geographical extent of the view would be localised and be experienced from a small number of houses and as a transient element by PRoW users, oblique to their direction of travel. Given the relatively short duration and reversibility of construction activity and the nature of the view there would be minor adverse magnitude of change during construction of the Scheme.	**Minor**
Year 1 of operation: The Scheme would be openly visible as a permanent, irreversible change as a result of loss of vegetation, mitigation planting yet to mature, and introduction of increased highway infrastructure in middle-ground views. Although occurring within an existing highway context, the change caused by the Scheme would result in more open views, including additional highway infrastructure with a larger footprint, both apparent as a result of the elevated nature of the viewpoint. Views from properties would be largely from upper floors. The foreground and most of the middle ground would remain largely unchanged but the revised junction would be more	**Minor**

perceived more openly in the far middle ground. Lighting columns in the baseline view are visible locally adjacent to the junction, seen against a wooded backdrop. In operation, columns will extend northwards and southwards along the A6097 adding approximately eight additional columns in each direction. There will be increased visibility of lighting columns compared to the baseline, extending approximately 150 m along the A6097 in both directions, although from VP1 they will be predominantly viewed against the edge of Lowdham and a wooded backdrop. At night there will a localised increase in visual intrusion from the additional lighting, albeit this will be seen against the lighting within Lowdham. This change in the view will be partially offset by the use of LED low light spill lighting, including for the replacement of existing columns. Overall, at night therefore the perception of lighting will extend further within the view but the intensity of lighting/extraneous light spill will be similar to or less than in the baseline. The lighting design and lux plans for the Scheme (Figure 8-2 in Volume 2B) indicate that lighting will not illuminate, to any significant extent, beyond the immediate highway corridor. Overall, both in daytime and at night the geographical extent of the change in views from this location, including from along the PRoW and from within the Lowdham Conservation Area would be limited. The perceptible increase in the scale and extent of the highway would result in a minor adverse magnitude of change for both receptor groups at this location in Year 1. (Refer to Photomontage 7-4-1)

Negligible

Year 15 of operation: Landscape mitigation planting, including hedges and trees, within the footprint of the Scheme would be substantially mature (in the case of hedgerows) and partially nature (in the case of trees) by year 15 and contribute to reduction in effects on visual amenity, compared to Year 1, and integration into the view. The mitigation within the highway boundary would substantially create landscape elements in the view which replicate the baseline (replacement hedgelines for those removed). Effects from lighting columns and lighting at night would remain. Overall, changes in visual amenity for residents and highway users as a result of modification of the view the negligible increase in highway dominance within a localised section of a wide panorama during the day and effects of negligible magnitude at night. The overall magnitude of the impact would be negligible adverse.

Significance of Effect	**Significance**
During construction:	**Slight adverse**
Year 1 of operation:	**Slight adverse**
Year 15 of operation:	**Slight adverse**

Photoviewpoint 2: Neighbour's Lane, public footpath Lowdham 8

Significance of Effect	**Significance**
Intervening vegetation and landform are such that the construction or operational Scheme will be indiscernible within the panorama or of such short duration that the effects on visual amenity would be neutral at all stages.	**Neutral**

Photoviewpoint 3: Lowdham Recreation Area, public footpath Lowdham 3

Susceptibility of Receptor to Specific Change	**Susceptibility**
All stages: Receptors at this location comprise users of a recreational area to the east of the A614 and upper storey views from a small number of residential properties. The recreational area primarily consists of sports pitches for football/but also a walk along Cocker Beck. As active recreation not primarily associated with appreciation of the view is the principal use in the vicinity of the viewpoint, the majority of users are at the lower range of susceptibility to visual intrusion from construction/highway operation. However the viewpoint is located on a public footpath where users may be engaged in active enjoyment of the view, walking along the Beck; it is also partly representative of residents' view. Overall, susceptibility is assessed as moderate. The majority of users will access the recreational area for active sports during the day, such that lighting effects will not be experienced. Taking the medium value of the view with the moderate susceptibility to visual intrusion of construction into account, viewers at this location are assessed as being of moderate sensitivity.	**Moderate**
Sensitivity	**Sensitivity**

All stages:	**Moderate**
Nature of Effect: Size/Scale, Geographical Extent, Duration and Reversibility	**Magnitude**
During construction: Hedgerows which screen the majority of the existing A6097 highway would be retained in the middle ground. Construction activity to construct revised junction would therefore be largely confined to glimpses of the upper sections of machinery such as hydraulic excavators creating the new attenuation pond or constructing the additional highway and signage/lighting. The intervening hedge would be a less effective screen in winter but will remain a substantial screen of the localised activity in the left-hand side of the panorama. The introduction of traffic management/construction activity and machinery would therefore be predominantly screened. The site compound to the south of the A612 would be screened by intervening housing and the highway hedge to be retained. For residents adjacent to the viewpoint, views would be largely from upper floors, predominantly oblique to the view. Given the relatively short duration and reversibility of construction activity combined with the very limited scale and extent of construction within the view there would be negligible adverse magnitude of change during construction of the Scheme.	**Negligible**
Year 1 of operation: The retention of the existing intervening hedgerow would result in any changes within the view being solely related to taller highway elements such as signage and lighting. In operation, columns will extend northwards along the A6097 adding approximately 8 additional columns within this view, hence there will be increased visibility of lighting columns compared to the baseline, extending approximately 150 m along the A6097. At night there will a localised increase in visual intrusion from the additional lighting. This change in the view will be partially offset by the use of LED low light spill lighting, including for the replacement of existing columns. Overall, at night therefore the perception of lighting will extend further within the view, but the intensity of lighting/extraneous light spill will be similar to or less than in the baseline. The lighting design and lux plans for the Scheme (Figure 8-2 in Volume 2B) indicate that lighting will not illuminate, to any significant extent, beyond the immediate highway corridor. The degree to which these elements would add to the view, given they are also in the baseline is very limited. Although effects at this stage would be considered permanent, adverse effects on the view and viewers would be of negligible magnitude, being very localised within a largely unchanged panorama and hence adverse effects would be slight.	**Negligible** **Negligible**
Year 15 of operation: Mitigation would not materially change the view from this direction and effects would remain negligible at Year 15 and beyond.	

Significance of Effect	**Significance**
During construction:	**Slight adverse**
Year 1 of operation:	**Slight adverse**
Year 15 of operation:	**Slight adverse**

Photoviewpoint 4: Nottingham Road, Lowdham War Memorial (Refer to Photomontage 7-5-2)

Susceptibility of Receptor to Specific Change	**Susceptibility**
All stages: Receptors at this location comprise users of the A612 Nottingham Road and residents accessing/egressing and within the curtilage of a small number of residential properties. Use of roads is not primarily associated with appreciation of the view and hence the majority of users at this location are at the lower range of susceptibility to visual intrusion from construction or highway operation. However, it is acknowledged that some users in this location may be engaged in active enjoyment of the view, for example residents within gardens and therefore susceptibility is assessed as moderate. Taking the low value of the view with the moderate susceptibility to visual intrusion of construction into account, viewers at this location are assessed as being of moderate sensitivity.	**Moderate**

Sensitivity	**Sensitivity**
All stages:	**Moderate**
Nature of Effect: Size/Scale, Geographical Extent, Duration and Reversibility	**Magnitude**
During construction: Vegetation removal, traffic management and construction activity and machinery would be visible in the vicinity of the existing junction in the middle ground. Vegetation	**Minor**

either site of Nottingham Road, within the gardens and on land between it and the A612 Southwell Road, would be retained. The intervening properties to the south of Nottingham Road, in conjunction with vegetation to be retained would screen works on the southern section of the A6097. Construction activity to construct the revised junction would therefore be largely confined to a small section of the central middle ground. Machinery, traffic management localised vegetation removal north of the western arm of the A612 and removal of existing lighting columns and installation of new signage/lighting would be visible. The site compound would be screened by intervening housing. For residents adjacent to the viewpoint, views would be largely from upper floors, predominantly oblique to the view. Given the relatively short duration and reversibility of construction activity combined with the limited scale and extent of construction within the view there would be minor adverse magnitude of change during construction of the Scheme.	**Negligible**
Year 1 of operation: The view would largely resemble the baseline, although the short section of hedgerow to the rear of the junction would be absent. The attenuation pond would not register within the view and the visibility of lighting columns would largely correspond to the number and locations in the baseline. At night, the lighting design and lux plans for the Scheme (Figure 8-2 in Volume 2B) indicate that the extent of illumination will be similar to or less than the existing situation, and with less light spill/glow into the sky. The degree to which the highway elements would intensify in the view, given they are also in the baseline is very limited. Although effects at this stage would be considered permanent, adverse effects on the view and viewers would be of negligible magnitude, being very localised within a largely unchanged panorama and hence significance would be neutral. (Refer to Photomontage 7-4-2)	**Negligible**
Year 15 of operation: Mitigation would not materially change the view from this direction and effects would remain negligible at Year 15 and beyond.	

Significance of Effect	**Significance**
During construction:	**Slight adverse**
Year 1 of operation:	**Neutral**
Year 15 of operation:	**Neutral**

Photoviewpoint 5: A6097 travelling north-west

Susceptibility of Receptor to Specific Change	**Susceptibility**
All stages: Receptors at this location comprise users of the A6097. Use of roads is not primarily associated with appreciation of the view and hence the majority of users at this location are at the lower range of susceptibility to visual intrusion from construction or highway operation. Taking the low value of the view with the low susceptibility to visual intrusion of construction into account, viewers at this location are assessed as being of low sensitivity.	**Low**

Sensitivity	**Sensitivity**
All stages:	**Low**

Nature of Effect: Size/Scale, Geographical Extent, Duration and Reversibility	**Magnitude**
During construction: Vegetation removal of the hedge north of the A612 Burton Road, traffic management and construction activity and machinery would be visible in the vicinity of the existing junction in the middle ground. Vegetation either site of the A6097, within the gardens and highway boundary would be retained. Construction activity to construct the revised junction would therefore be largely confined to a small section of the central middle ground. Machinery, traffic management and removal of existing lighting columns and installation of new signage/lighting would be visible. The site compound would be screened by intervening vegetation. Given the relatively short duration and reversibility of construction activity combined with the limited scale and extent of construction within the view there would be minor adverse magnitude of change during construction of the Scheme.	**Minor**
Year 1 of operation: As for VP4, the view would largely resemble the baseline, although the short section of hedgerow to the rear of the junction would be absent. The attenuation pond would be visible with the immature hedgerow to the rear. Lighting columns will extend southwards along the A6097 adding approximately eight additional columns within this view,	**Negligible**

hence there will be increased visibility of lighting columns compared to the baseline, extending approximately 150 m along the highway. At night this would include peripheral increase of lighting on the edge of adjacent properties, such that there will a localised increase in visual intrusion from the additional lighting. The lighting design and lux plans for the Scheme (Figure 8-2 in Volume 2B) indicate that lighting will not illuminate, to any significant extent, beyond the immediate highway corridor. The degree to which the highway elements would intensify in the view, given they are also in the baseline is very limited. Although effects at this stage would be considered permanent, adverse effects on viewers, including local residents, would be of negligible magnitude, being very localised within a similar panorama experienced predominantly by highway users.	**Negligible**
Year 15 of operation: Mitigation would not materially change the view from this direction and effects would remain negligible at Year 15 and beyond.	

Significance of Effect	**Significance**
During construction:	**Slight adverse**
Year 1 of operation:	**Slight adverse**
Year 15 of operation:	**Slight adverse**

Photoviewpoint 6: A612 Nottingham Road (Refer to Photomontage 7-5-3)

Susceptibility of Receptor to Specific Change	**Susceptibility**
All stages: Receptors at this location comprise users of the A612 and residents of a small number of residential properties adjacent to it. Use of roads is not primarily associated with appreciation of the view and hence the majority of users at this location are at the lower range of susceptibility to visual intrusion from construction or highway operation. However, it is acknowledged that some users in this location may be engaged in active enjoyment of the view, for example residents within gardens and therefore susceptibility is assessed as moderate. Taking the low value of the view with the moderate susceptibility to visual intrusion of construction into account, viewers at this location are assessed as being of moderate sensitivity.	**Moderate**

Sensitivity	**Sensitivity**
All stages:	**Moderate**

Nature of Effect: Size/Scale, Geographical Extent, Duration and Reversibility	**Magnitude**
During construction: Vegetation removal, traffic management and construction activity and machinery would be visible in the vicinity of the existing junction in the fore to middle ground. Sections of hedges either side of A612 Burton Road, within the gardens and on land between it and the A6097, would be removed. Construction of the new access to the south of the A612 and the site compound and access to it would be visible in the right- hand side of the view. Construction activity to construct the revised junction would therefore be prominent within the central middle ground. Machinery, traffic management localised vegetation removal north and south of the western arm of the A612 and removal of existing lighting columns and installation of new signage/lighting would be visible. For residents adjacent to the viewpoint, views would be largely from upper floors, predominantly oblique to the view. Given the relatively short duration and reversibility of construction activity combined with a localised and geographically limited view there would be minor adverse magnitude of change during construction of the Scheme.	**Minor**
Year 1 of operation: The view would contain less vegetation and more lighting columns as well as a perceptible intensification of highway infrastructure. The attenuation pond would not register within the view and mitigation planting would be immature and contribute little in comparison with that lost to the Scheme. The visibility of lighting columns would largely correspond to the number and locations in the baseline. At night, the lighting design and lux plans for the Scheme (Figure 8-2 in Volume 2B) indicate that the extent of illumination will be similar to, or less than, the existing situation, and with less light spill/glow into the sky. The degree to which the highway elements would intensify in the view, given they are also in the baseline is limited. Although effects at this stage would be considered permanent, adverse effects on the view and viewers would be of minor magnitude, being localised within	**Minor**

a slightly modified panorama comprising similar elements to the baseline but less vegetation. (Refer to Photomontage 7-4-3)	**Negligible**
Year 15 of operation: Mitigation would reinstate vegetation as a softening element within the view, reinstating a hedge on the right-hand side which by Year 15 would screen the revised access arrangement to the south of the A612. The perception of the wider highway on the approach to the junction would remain, and the attenuation pond and associated hedge would be largely screened by vegetation to the left of the view which is retained. Consequently, effects on visual amenity would be of negligible magnitude at Year 15 and beyond.	

Significance of Effect	**Significance**
During construction:	**Slight adverse**
Year 1 of operation:	**Slight adverse**
Year 15 of operation:	**Slight adverse**

7.10 Additional Mitigation

7.10.1 No additional mitigation is considered to be required.

7.11 Residual Effects

7.11.1 The residual effects of the Scheme in relation to landscape and visual effects are outlined in Table 7-11, Table 7-12 and Table 7-13 below. No significant residual effects are expected.

Table 7-11: Residual Effects: Construction

Receptor	Sensitivity of Receptor	Magnitude of Impact	Initial Classification of Effect (with embedded mitigation)	Additional Mitigation	Residual Effect Significance
Mid-Nottinghamshire Farmlands RLCA	Medium	No change	Neutral	n/a	**Neutral**
Trent Washlands RLCA	Medium	No change	Neutral	n/a	**Neutral**
PZ MN40 Epperstone Village Farmlands with Ancient Woodlands	Medium	Negligible	Slight	n/a	**Slight adverse**
PZ TW08 Gunthorpe and Hoveringham Village Farmlands	Medium	Negligible	Slight	n/a	**Slight adverse**
Photoviewpoint 1: Lowdham Conservation Area/PRoW	Moderate	Minor	Slight	n/a	**Slight adverse**
Photoviewpoint 2: PRoW	n/a	No change	Neutral	n/a	**Neutral**
Photoviewpoint 3: Lowdham Recreation Area	Moderate	Negligible	Slight	n/a	**Slight adverse**
Photoviewpoint 4: Nottingham Road, Lowdham	Moderate	Minor	Slight	n/a	**Slight adverse**
Photoviewpoint 5: A6097 travelling north-west	Low	Minor	Slight	n/a	**Slight adverse**
Photoviewpoint 6: A612 Burton Road	Moderate	Minor	Slight	n/a	**Slight adverse**

Table 7-12: Residual Effects: Year 1

Receptor	Sensitivity of Receptor	Magnitude of Impact	Initial Classification of Effect (with embedded mitigation)	Additional Mitigation	Residual Effect Significance
Mid-Nottinghamshire Farmlands RLCA	Medium	No change	Neutral	n/a	**Neutral**
Trent Washlands RLCA	Medium	No change	Neutral	n/a	**Neutral**

Receptor	Sensitivity of Receptor	Magnitude of Impact	Initial Classification of Effect (with embedded mitigation)	Additional Mitigation	Residual Effect Significance
PZ MN40 Epperstone Village Farmlands with Ancient Woodlands	Medium	Negligible	Slight	n/a	**Slight adverse**
PZ TW08 Gunthorpe and Hoveringham Village Farmlands	Medium	No change	Neutral	n/a	**Neutral**
Photoviewpoint 1: Lowdham Conservation Area/PRoW	Moderate	Minor	Slight	n/a	**Slight adverse**
Photoviewpoint 2: PRoW	n/a	No change	Neutral	n/a	**Neutral**
Photoviewpoint 3: Lowdham Recreation Area	Moderate	Negligible	Slight	n/a	**Slight adverse**
Photoviewpoint 4: Nottingham Road, Lowdham	Moderate	Negligible	Neutral	n/a	**Neutral**
Photoviewpoint 5: A6097 travelling north-west	Low	Negligible	Slight	n/a	**Slight adverse**
Photoviewpoint 6: A612 Burton Road	Moderate	Minor	Slight	n/a	**Slight adverse**

Table 7-13: Residual Effects: Year 15

Receptor	Sensitivity of Receptor	Magnitude of Impact	Initial Classification of Effect (with embedded mitigation)	Additional Mitigation	Residual Effect Significance
Mid-Nottinghamshire Farmlands RLCA	Medium	No change	Neutral	n/a	**Neutral**
Trent Washlands RLCA	Medium	No change	Neutral	n/a	**Neutral**
PZ MN40 Epperstone Village Farmlands with Ancient Woodlands	Medium	Negligible	Slight	n/a	**Neutral**
PZ TW08 Gunthorpe and Hoveringham Village Farmlands	Medium	Negligible	Slight	n/a	**Neutral**

Receptor	Sensitivity of Receptor	Magnitude of Impact	Initial Classification of Effect (with embedded mitigation)	Additional Mitigation	Residual Effect Significance
Photoviewpoint 1: Lowdham Conservation Area/PRoW	Moderate	Negligible	Slight	n/a	**Slight adverse**
Photoviewpoint 2: PRoW	n/a	No change	Neutral	n/a	**Neutral**
Photoviewpoint 3: Lowdham Recreation Area	Moderate	Negligible	Slight	n/a	**Slight adverse**
Photoviewpoint 4: Nottingham Road, Lowdham	Moderate	Negligible	Neutral	n/a	**Neutral**
Photoviewpoint 5: A6097 travelling north-west	Low	Negligible	Slight	n/a	**Slight adverse**
Photoviewpoint 6: A612 Burton Road	Moderate	Negligible	Slight	n/a	**Slight adverse**

8. BIODIVERSITY

8.1 Introduction

8.1.1 This chapter considers the biodiversity impacts as a consequence of the construction and operation of the Scheme by using the assessment methodology described in the DMRB LA 108 Biodiversity Revision 1 (Highways England, 2020e).

8.1.2 A number of ecological surveys and assessments have been undertaken in support of the biodiversity assessment of this Scheme, and as such this chapter is supported by the following documents:

- Ecological Appraisal (Baker Consultant, 2020) – found in Appendix 4-5 Volume 3;
- Biodiversity Net Gain (BNG) Assessment (Baker Consultants, 2021a) – found in Appendix 4-2 of Volume 3; and
- Shadow Habitats Regulations Assessment (sHRA) (Baker Consultants, 2021b) – found in Appendix 4-4 of Volume 3.

8.2 Legislation and Policy

8.2.1 Information relating to relevant biodiversity legislation and policy can be viewed in Volume 1, Chapter 8.

8.3 Consultation

8.3.1 A summary of the biodiversity related responses from the Scoping Opinion, which relate to the Scheme at Lowdham Roundabout, is included in Table 8-1. A full set of responses to all comments received during the scoping process is provided within Appendix 4-1 of Volume 3.

Table 8-1: Scoping Response Summary

Stakeholder	Comment made	How and where addressed in the ES
Nottinghamshire County Council (Scoping Opinion)	Noise change impacts on sensitive species (roosting and foraging bats and nesting birds) will need to be assessed.	The methodology for the assessment of the impact of artificial lighting and noise can be found in Section 8.4. Lux diagrams and noise contour plans are provided (see Figures 8-2, 8-3 and 8-4 in Volume 2C). Embedded and additional mitigation, and the assessment are reported in Sections 8.6 and 8.7.
	Biodiversity Net Gain, funding and management should be addressed in the submission.	The Project has been developed with consideration for BNG requirements, and is predicted to achieve a net gain in all three metrics (see Appendix 4-3 of Volume 3). All net gain requirements will be within the revised highway boundary. Funding and management will be the responsibility for NCC.
NCC Ecology Natural Environment Manager	In relation to bats and potential roost sites, it is noted that in some cases buildings adjacent to the proposed works areas were not surveyed, therefore, it will need to be demonstrated through the assessment process that there will not be significant indirect impacts on potential roost locations as a result of noise, lighting or general disturbance.	The methodology for the assessment of the impact of artificial lighting and noise can be found in Section 8.4. Lux diagrams and noise contour plans are provided (see Figures 8-2, 8-3 and 8-4 in Volume 2C). Embedded and additional mitigation, and the assessment are reported in Sections 8.6 and 8.7.
	The creation of habitat should be delivered at each location, as far as possible.	The design has sought to maximise habitat creation at each Scheme location as noted in the BNG Assessment (Baker Consultants Ltd, 2021a) located in Appendix 4-2 of Volume 3.
Nottinghamshire Wildlife Trust	No methodology is proposed for how the impacts of changes to noise, light and disturbance will be assessed. For example: Bat activity surveys will be required in order to be able to assess the predicted noise changes on bat foraging activity. The Noise chapter does not describe how the impacts of changes in noise will be assessed for sensitive species.	The methodology for the assessment of the impact of artificial lighting and noise can be found in Section 8.4. Lux diagrams and noise contour plans are provided (see Figures 8-2, 8-3 and 8-4 in Volume 2C). Embedded and additional mitigation, and the assessment are reported in Sections 8.6 and 8.7.

Stakeholder	Comment made	How and where addressed in the ES
	Further monitoring undertaken in a key protected habitats site such as the SAC or a heathland SSSI required, to ensure that the modelling is correct for the areas of potential greatest irreversible habitat impact.	This is not applicable to Lowdham as there are no SAC or SSSI within the Zone of Influence for Air Quality – refer to Chapter 5, Air Quality.
	Impacts of dust on some SSSIs and LWS in close proximity to the junctions, should be closely monitored, with a plan in place for how it could be rectified if a problem is shown to have arisen.	The impacts of dust would be mitigated through BPM to be included within the CEMP.
	The ppSPA should be included in the HRA, and the likely in-combination effects should be assessed.	A sHRA (Baker Consultants Ltd, 2021b) has been undertaken (see Appendix 4-4 in Volume 3).
	Further surveys in the field are required as follows, to supplement those already undertaken for Phase 1 habitats, reptiles, HSI and eDNA:	
	Bats - survey of all possible structures that may support roosts, including both day time visual inspections and evening emergence surveys undertaken at the correct times of year by suitably licensed persons	No direct or indirect impacts to suitable bat roosting locations are anticipated, as detailed within Section 8.5, 8.6 and 8.7.
	Badgers - surveys of the whole site and adjacent land (up to 250 m) for field signs and setts.	Sub-optimal badger habitat is present within Scheme red-line boundary. Further details can be found within Ecological Appraisal (Baker Consultants, 2020) – Appendix 4-5 of Volume 3 and Section 8.5
	Birds - breeding bird surveys to standard methodologies for at least 100 m around the periphery of the sites, where there may be noise impacts.	There are likely to be negligible noise impacts as detailed within Section 8.7, therefore no breeding bird surveys have been undertaken.
	Water voles and other riparian mammals – Searches for water vole and other riparian mammal field signs to standard methodologies should be undertaken on any potentially affected watercourses.	There is no impact to watercourses within the assessment boundary.
	Particular consideration should be given to the potential direct and indirect impacts of: ▪ Habitat loss or degradation ▪ Noise ▪ Hydrological/hydrogeological changes ▪ Dust, NO_x, GHG	Noted, refer to Section 8.7 for the assessment considering these aspects where relevant.

Stakeholder	Comment made	How and where addressed in the ES
	▪ Vibration ▪ Disturbance to sensitive species	
	BNG calculation for the Scheme should be undertaken with the aim of delivering at least 20% BNG. There should be an assurance of long-term funding for management of the habitats, so that they can be retained in perpetuity.	A BNG metric assessment has been undertaken for the Project (as can be found in Appendix 4-2 of Volume 3). Post-development, the Project is expected to deliver an 18.07% gain in habitat units, a 71.75% gain in hedgerow units and a 67.14% gain in river units. All net gain requirements will be within the revised highway boundary. Funding and management will be the responsibility for NCC.

8.4 Assessment Methodology

Baseline Conditions

8.4.1 Baseline information associated with the Scheme has been gathered between 2018 and 2021 and has informed the Scheme design and assessment process. Baseline ecological conditions associated with the Scheme are described in Section 8.5. A combination of desk study and field surveys has been used to adequately define baseline conditions for assessment purposes.

Desk Study

8.4.2 The following organisations were contacted to obtain information on existing ecological information (i.e. information on statutory and non-statutory designated sites and records of protected and notable species and habitats) up to 2 km from the Scheme:

- Nottinghamshire Biological and Geological Records Centre (NBGRC) (Nottingham City Council, 2021);
- Multi-Agency Geographic Information Centre (MAGIC) (Defra, 2021); and
- Spectrum Spatial Analyst – internal mapping system.

Field Surveys

8.4.3 The field surveys and associated reports, related to the Lowdham Roundabout Scheme, are outlined in Table 8-2.

8.4.4 Baker Consultants Ltd was commissioned by Via to undertake the following works in relation to the Scheme:

- a desk-based study using the organisations detailed above;
- a Phase 1 habitat survey undertaken in 2019, and further updated in 2020 to record the nature and extent for vegetation and habitats within and adjacent to the Scheme; and
- appraisals and targeted surveys for protected and/or notable flora and fauna.

Table 8-2: Baseline Field Surveys and Associated Methodology

Survey Target	Survey Type and Survey Area	Date Undertaken and Consultancy	Description of Assessment Undertaken	Methodology
Habitats, botany and suitability for protected and notable species	Extended Phase 1 Habitat Survey, within and up to 50 m from the Scheme boundary.	20th February 2019, Baker Consultants Ltd	Vegetation and habitats present were described and mapped during a walkover of the site. Habitats within the site and surrounding land were appraised for their suitability to support protected and notable species.	Joint Nature Conservation Committee (JNCC) 2010 Full details can be found in Ecological Appraisal (Baker Consultants, 2020) – Appendix 4-5 of Volume 3

Survey Target	Survey Type and Survey Area	Date Undertaken and Consultancy	Description of Assessment Undertaken	Methodology
Habitats, botany and suitability for protected and notable species	Updated Extended Phase 1 Habitat Survey, within up to 50 m from the Project Scheme boundaries	3rd December 2020, Baker Consultants Ltd	Vegetation and habitats present were described and mapped during a walkover of the site. Habitats within the site and surrounding land were appraised for their suitability to support protected and notable species.	JNCC (2010) Full details can be found in Ecological Appraisal (Baker Consultants, 2020) – Appendix 4-5 of Volume 3
Bats	Bat Roost/Habitat Survey, within the Scheme boundaries.	During Extended Phase 1 Habitat Surveys, Baker Consultants Ltd	Habitats within the survey area were assessed for their potential to support roosting, commuting and foraging bats	Collins, J. (ed.) (2016) Full details can be found in Ecological Appraisal (Baker Consultants, 2020) – Appendix 4-5 of Volume 3
Invasive Species (Himalayan balsam)	Site walkover to determine presence / likely absence of Himalayan balsam and other invasive species, if present.	11th October 2021, Via	All accessible areas of the site were walked by the surveyor during daylight hours, with a visual search for the target species undertaken. Particular focus was given to areas where the target species were most likely to be found.	No standard method exists for invasive plant species survey. The survey was based on an ecological walkover survey approach. Details found within Section 8.5.

8.4.5 The ecological assessment undertaken takes into account standard guidance from a variety of sources including the:

- Guidelines for Ecological Impact Assessment in The UK and Ireland: Terrestrial, Freshwater, Coastal and Marine (CIEEM 2018);
- Guidelines of Ecological Report Writing (CIEEM, 2015);
- Guidelines for Preliminary Ecological Appraisal (CIEEM, 2017);
- BS42020:2013 Biodiversity – Code of Practise for Planning and Development (British Standards Institute, 2013); and

- Protected species and development: advice for local planning authorities (GOV.UK, 2021).

Study Area

8.4.6 To define the total extent of the study area for ecological assessment, the Scheme has been reviewed in order to identify the spatial scale at which ecological features could be affected. In accordance with the DMRB LA 108 and the 'Guidelines for Ecological Impact Assessment in the UK and Ireland' issued by the Chartered Institute of Ecology and Environmental Management (CIEEM, 2018), the study area has been defined by determining a Zone of Influence (ZoI) encompassing all likely biophysical changes that would occur as a result of the Scheme. This will include direct effects and indirect effects.

8.4.7 Differing ZoI have been used to collate desk study data for designated sites and protected and/or notable habitat and species as follows:

- statutory and non-statutory designated sites within 2 km of each Scheme;
- ancient woodlands and notable habitats (outside of designated sites) within 1 km of each Scheme; and
- protected and/or notable species recorded within 1 km of each Scheme (unless stated otherwise).

8.4.8 Notable habitats and species are those considered as being of principal importance in England, as listed under Section 41 of the Natural Environment and Rural Communities (NERC) Act 2006 (HMSO, 2006a).

8.4.9 In accordance with DMRB LA 115 Habitat Regulations Assessment (Highways England, 2020i), desk study information has been collated for sites designated at an International/ European level, including Special Protection Areas (SPAs), potential SPAs (pSPAs); Special Areas of Conservation (SACs), candidate or possible (cSAC/pSAC) sites and Ramsar sites (wetlands of international importance) using the following criteria:

- the European Site or its functionally linked land are located within 2 km from the Scheme;
- the European Site is designated for bats and is located within 30 km of the Scheme;
- the Scheme crosses or lies adjacent to, upstream of, or downstream of, a watercourse which is designated part or wholly as a European Site;
- there is potential for hydrological or hydrogeological linkages to a European Site that may require further assessment in accordance with DMRB LA 113 Road Drainage and the Water Environment (Highways England, 2020h); and/ or
- there is the possibility that the affected road network will require assessment for effects on a European Site in accordance with DMRB LA 105 Air Quality.

Methodology for Determining Construction and Operational Effects

8.4.10 The assessment of impacts and effects and their significance follows the guidance set out in DMRB LA 108, and CIEEM best practice guidance (CIEEM, 2018). This outlines the process for the reporting of baseline information, evaluation of features and the assessment of impacts and effects.

8.4.11 In accordance with this guidance the assessment of construction and operational effects on biodiversity is informed by collection of relevant baseline information as

described within earlier sections of this chapter. Baseline conditions are described, including a summary of legislation/ policy relevant to the baseline conditions. The assessment covers both the current baseline, as determined by the desk study and ecological field surveys, and the future baseline. Environmental factors from other assessments including air quality; noise and vibration; and road drainage and the water environment are also considered. Separate methodologies for determining light and noise impacts have been used and are detailed in the following paragraphs.

Lighting

8.4.12 The operational lighting scheme has been designed to the '5 second rule' which forms part of the Institution of Lighting Professionals document PLG02 (ILP, 2013) and DMRB TD 501 Road lighting design (DMRB, 2020). The Scheme design has been modelled using data provided by the manufacturer, and Lighting Reality software (Lighting Reality Ltd, 2021) to provide lux contour plans showing the spill to 1 lux. The data has been modelled to 1 lux as it is considered that natural conditions, such as a twilight, or full moon can result in this lux level (ILP and BCT, 2018). Any suitable roosting, commuting or foraging habitat subject to an increase in lighting levels above that of the baseline, has been subject to further assessment, where applicable.

Noise

8.4.13 Noise modelling data was obtained for the Scheme to determine the changes in noise levels during the operational phase. The modelling followed the methodology in DMRB LA 111 Noise and Vibration (Highways England, 2020g). Further detail can be found within Chapter 10: Noise and Vibration. The modelling was used to provide an indication of the noise level change as a result of the Scheme. The change in noise levels between the current baseline, and the predicted changed post-development were then compared and reviewed using relevant literature. Behavioural patterns / stress responses and fitness (feather development and body size) were assessed, where applicable, to determine the impacts of increase in noise levels.

8.4.14 Anthropogenic disturbance is known to alter animal behavioural patterns. Physiological responses to noise exposure in animals include hearing loss, elevated stress hormone levels and hypertension. These responses begin to appear at exposure levels of 55-60 dB (Barber, Crooks, Fristrup, 2009). The effects of noise on fitness levels (feather development and body size) are considered to have a positive impact to bird species with noise levels up to 70 dB (Kleist, Guralnick, Cruz, Lowry and Francis, 2017). Examples of perceived sound intensity determine that 20 dB sound levels are just audible to a bat, owl or fox. With 10 dB being the sound of leaves rustling. Analysis of transportation noise impacts based on perceived loudness often assert that increases of up to 3 dB have negligible effects (Barber, Crooks, Fristrup, 2009).

8.4.15 The changes in noise levels have been compared in relation to the studies undertaken above in the assessment in Section 8.7.

8.4.16 The level of impact upon ecological features as a result of the Scheme and the associated effects takes into consideration the following characteristics based upon the CIEEM best practice guidance (CIEEM, 2018) and DMRB LA 108:

- positive or negative – whether the impact will result in loss or degradation of an important ecological feature or whether it would improve or enhance it;
- magnitude – the size and intensity of the impact measured in relevant terms, e.g. number of individuals lost or gained, area of habitat lost or created, the degree of change to existing conditions;

- extent – the spatial scope of the impact;
- reversibility – the extent to which impacts are reversible, either spontaneously or through mitigation;
- duration – the length of time over which the impact occurred; and
- timing and frequency – consideration of the timing of events in relation to ecological change; some effects might be of greater significance if they took place at certain times of year.

8.4.17 Subsequently the impact assessment considers embedded avoidance and mitigation measures that are inherent to the design (e.g. the retention of a hedgerow), including the use of best practice construction methods (e.g. implementation of methods to supress dust generation or avoid pollution of water courses).

8.4.18 Additional (essential) mitigation, compensation and enhancement measures are described in Section 8.8, followed by the impact after mitigation and significance of residual effects in Section 8.9. A summary of the assessment is presented together with relevant conclusions.

8.4.19 For each phase of the Scheme (e.g. construction, operation), the assessment is structured and reported by ecological receptor with relevant potential impacts on that feature described in turn, and then the overall effect arising from those impacts reported. For example, any impacts on bat roosting habitat and light disturbance on retained roosts are documented, before a conclusion is reached on the overall effect on the conservation status of the of the local bat population concerned.

Significance Criteria

8.4.20 The relative importance of the biodiversity resources has been established using the guidance provided in Table 8-3 as based upon DMRB LA 108.

Table 8-3: Biodiversity Resource Importance

International or European importance

Sites	Sites including: ▪ European sites: ▪ Sites of Community Importance (SCIs); ▪ Special Protection Areas (SPAs); ▪ Potential SPAs (pSPAs); ▪ Special Areas of Conservation (SACs); ▪ Candidate or possible SACs (cSACs or pSACs); and ▪ Wetlands of International Importance (Ramsar sites). ▪ Biogenetic Reserves, World Heritage Sites (where recognised specifically for their biodiversity value) and Biosphere Reserves. ▪ Areas which meet the published selection criteria for those sites listed above but which are not themselves designated as such.
Habitats	N/A
Species	Resident, or regularly occurring, populations of species which can be considered at an international or European level where: ▪ The loss of these populations would adversely affect the conservation status or distribution of the species at an international or European scale; or ▪ The population forms a critical part of a wider population at this scale; or ▪ The species is at a critical phase of its life cycle at an international or European scale.

UK or national importance

Sites	Sites including: ▪ Sites of Special Scientific Interest (SSSIs) or Areas of Special Scientific Interest (ASSIs); ▪ National Nature Reserves (NNRs); ▪ National Parks; ▪ Marine Protected Areas (MPAs) including Marine Conservation Zones (MCZs); or ▪ Areas which meet the published selection criteria for those sites listed above but which are not themselves designated as such.
Habitats	Habitats including: areas of UK BAP priority habitats; ▪ habitats included in the relevant statutory list of priority species and habitats; and ▪ areas of irreplaceable habitats including: ▪ ancient woodland; ▪ ancient or veteran trees; ▪ blanket bog; ▪ limestone pavement; ▪ sand dunes; ▪ salt marsh; ▪ lowland fen; and ▪ areas of habitat which meet the definition for habitats listed above but which are not themselves designated or listed as such.
Species	Resident, or regularly occurring, populations of species which can be considered at an international, European, UK or national level where: ▪ the loss of these populations would adversely affect the conservation status or distribution of the species at a UK or national scale; or ▪ the population forms a critical part of a wider population at this scale; or ▪ the species is at a critical phase of its life cycle at a UK or national scale.

Regional importance

Sites	Designated sites (non-statutory) including heritage coasts.
Habitats	Areas of habitats identified (including for restoration) in regional plans or strategies (where applicable).
Species	Species including: ▪ resident, or regularly occurring, populations of species which can be considered at an international, European, UK or national level where: ▪ the loss of these populations would adversely affect the conservation status or distribution of the species at a regional scale; or ▪ the population forms a critical part of a wider regional population; or ▪ the species is at a critical phase of its life cycle; ▪ Species identified in regional plans or strategies.

County or equivalent authority importance

Sites	Wildlife / nature conservation sites designated at a County (e.g. Nottinghamshire) level including: ▪ Local Wildlife Sites (LWS); ▪ Local Nature Conservation Sites (LNCS); ▪ Local Nature Reserves (LNRs); ▪ Sites of Importance for Nature Conservation (SINCs); ▪ Sites of Nature Conservation Importance (SNCIs); ▪ County Wildlife Sites (CWSs).

Habitats	Areas of habitats identified within the Nottinghamshire Local Biodiversity Action Plan.
Species	Species including: ▪ resident, or regularly occurring, populations of species which can be considered at an international, European, UK or national level where: ▪ the loss of these populations would adversely affect the conservation status or distribution of the species at a County or unitary authority scale; or ▪ the population forms a critical part of a wider County or equivalent authority area population, e.g. metapopulations; or ▪ the species is at a critical phase of its life cycle. Species identified within the Nottinghamshire Local Biodiversity Action Plan.
Local importance	
Sites	Wildlife / nature conservation sites designated at a local level including: ▪ Local Wildlife Sites (LWS); ▪ Local Nature Conservation Sites (LNCS); ▪ Local Nature Reserves (LNRs); ▪ Sites of Importance for Nature Conservation (SINCs); ▪ Sites of Nature Conservation Importance (SNCIs); ▪ Sites of Local Nature Conservation Importance (SLNCIs).
Habitats	Areas of habitat considered to appreciably enrich the habitat resource within the local context including features of importance for migration, dispersal, or genetic exchange.
Species	Populations / communities of species considered to appreciably enrich the habitat resource within the local context including features of importance for migration, dispersal or genetic exchange.

8.4.21 When determining the level of impacts on biodiversity resources are reported in accordance with the criteria in Table 8-4, based upon DMRB LA 108.

Table 8-4: Level of Impact and Typical Descriptions

Level of Impact (change)		Typical Description
Major	Adverse	Permanent/irreversible damage to a biodiversity resource; and the extent, magnitude, frequency, and/or timing of an impact negatively affects the integrity or key characteristics of the resource.
	Beneficial	Permanent addition of, improvement to, or restoration of a biodiversity resource; and the extent, magnitude, frequency, and/or timing of an impact positively affects the integrity or key characteristics of the resource.
Moderate	Adverse	Temporary/reversible damage to a biodiversity resource; and the extent, magnitude, frequency, and/or timing of an impact negatively affects the integrity or key characteristics of the resource.
	Beneficial	Temporary addition of, improvement to, or restoration of a biodiversity resource; and the extent, magnitude, frequency, and/or timing of an impact positively affects the integrity or key characteristics of the resource.
		Permanent/irreversible damage to a biodiversity resource; and

	Adverse	the extent, magnitude, frequency, and/or timing of an impact does not affect the integrity or key characteristics of the resource.
Minor	Beneficial	Permanent addition of, improvement to, or restoration of a biodiversity resource; and the extent, magnitude, frequency, and/or timing of an impact does not affect the integrity or key characteristics of the resource.

8.4.22 The importance of the resource, and level of impact is used to determine the significance of effect based on Table 8-5 and the principles of DMRB LA 104 Environmental assessment and monitoring (Highways England, 2020b). Significant effects typically comprise effects that remain within the moderate, large or very large categories once mitigation has been taken into account.

Table 8-5: Significance Matrix

Resource importance	Level of impact				
	No change	Negligible	Minor	Moderate	Major
International or European importance	Neutral	Slight	Moderate or large	Large or very large	Very large
UK or national importance	Neutral	Slight	Slight or moderate	Moderate or large	Large or very large
Regional importance	Neutral	Neutral or slight	Slight	Moderate	Moderate or large
County or equivalent authority importance	Neutral	Neutral or slight	Neutral or slight	Slight	Slight or moderate
Local importance	Neutral	Neutral	Neutral or slight	Neutral or slight	Slight

8.4.23 The level of impact is informed by the outcomes of the modelling and assessment of other environmental factors, where relevant.

Assumptions and Limitations

8.4.24 The information presented in this chapter reflects that obtained and evaluated at the time of reporting.

8.4.25 This assessment is based upon the design and detail regarding construction and operation as provided in Chapter 2: The Scheme.

8.4.26 It is important to note that even where data is returned for a desk study, a lack of records for a defined geographical area does not necessarily mean that there is a lack of ecological interest since the area may be under-recorded.

8.4.27 Whilst every effort was made in the field surveys to provide a comprehensive description of the site, no investigation can ensure the complete characterisation and prediction of the natural environment. Also, natural and semi-natural habitats are subject to change, species may colonise the site after the surveys have taken place and results included within the baseline data may become less reliant over time.

8.4.28 The month of February 2019, when the initial extended Phase 1 habitat survey was undertaken, and December 2020 when the updated Phase 1 habitat survey was

undertaken, are not optimal to detect signs of some protected species, and annual plants will not be present. However, it is considered that sufficient information was able to be gathered during both of the surveys to determine accurate baseline conditions.

8.4.29 Two areas at Lowdham Roundabout were not accessible during the December 2020 updated Phase 1 habitat surveys. However, these areas were visible for assessment from adjacent fence lines and sufficient information was obtained.

8.4.30 The timescale used to assume the period for the created habitat to reach maturity and desired condition are based on the BNG report (Baker Consultants, 2021) in Appendix 4-2 in Volume 3.

8.5 Baseline Conditions

Statutory and Non-Statutory Designated Sites and Ancient Woodland

8.5.1 Designated sites identified within the study area are detailed in Table 8-6. Some additional information is provided in the subsequent text. The location of designated sites can be viewed on Figure 8-1 in Volume 2C.

Table 8-6: Designated Statutory and Non-Statutory Sites located within the Lowdham Roundabout Study Area

Name	Status	Location/distance	Interest
Lowdham Pasture	Local Wildlife Site (LWS)	750 m to the north-east	Botanical – species-rich sloping pasture
Caythorpe Grassland	LWS	750 m to the east	Botanical – ridge and furrow, species-rich
Caythorpe Damp Meadow	LWS	1.1 km to the south-east	Botanical – species-rich grassland
Ivy Cottage Pastures	LWS	1.1 km to the north	Botanical – two herb-rich pastures with sizeable communities of hydrophilic species along Dover Beck
Gonalston Lane Pit	LWS	1.2 km to the north-east east	Botanical, birds – Gravel pit with a notable aquatic and marginal flora
Gunthorpe Lakes	LWS	1.2 km to the south	Bat, botanical – A large area of abandoned gravel workings of botanical and zoological importance
Gonalston Marsh	LWS	1.3 km to the north-east	Botanical – Marshy grassland community in a pasture
Gonalston Road Grassland, Epperstone	LWS	1.4 km to the north north-west	Botanical – A species-rich damp grassland with valuable drains
Dover Beck, Caythorpe	LWS	1.5km to the north-east	Botanical – Noteworthy section of lowland stream.

8.5.2 There were no European protected sites within 30 km of the Scheme for which bats were listed as a qualifying feature.

8.5.3 No records of ancient woodland were identified within the study area.

8.5.4 A veteran tree is located approximately 140 m from the Scheme boundary.

Habitats

8.5.5 The following habitats were recorded within and up to 50 m of the assessment boundary during the extended Phase 1 Habitat Survey undertaken in February 2019 and updated in December 2020 by Baker Consultants Ltd (Baker Consultants, 2020) – found in Appendix 4-5 of Volume 3.

Amenity Managed Grassland

8.5.6 Areas of amenity managed grassland present across the site. Species-poor with low ecological value.

Scattered Trees

8.5.7 Semi-mature and mature broadleaved trees including common lime *Tilia x europaea*, ash *Fraxinus excelsior*, horse chestnut *Aesculus hippocastanum* and beech *Fagus sylvatica*.

Species-poor Hedgerow with Trees

8.5.8 Alongside the Recreation Ground, trimmed, intact 2 m high, dry ditch with bramble *Rubus fruiticosus*, hawthorn *Crataegus monogyna* and ash.

Neutral Grassland

8.5.9 Species-poor tussocky and weedy roadside verges. Parts of the verges were moved, others left unmanaged. Species comprised perennial rye-grass Lo*lium perenne*, cock's-foot *Dactylis glomoerata*, Yorkshire fog *Holcus lanatus*, red fescue *Festuca rubra*, cow parsley *Anthriscus sylvestris*, common nettle *Urtica dioica*, tansy *Tanacetum vulgare*, teasel *Dipsacus fullonum*, yarrow *Achillea millefolium*.

Species-poor Hedgerow

8.5.10 Untrimmed, 2.5 m high x 1.5 m wide, hawthorn only, intact arable field boundary.

Species-poor Hedgerow with Associated Ditch

8.5.11 Untrimmed, 2.5 m high x 1.5 m wide, hawthorn only. Associated ditch runs to the north-west of the species poor hedgerow. It is an artificial drainage ditch which take flow from the highway. It is not connected at the upstream extent and is likely to be dry for large period of the year.

Dense scrub / Tall Ruderal

8.5.12 Dense, mature hawthorn scrub includes relic section of hawthorn hedgerow. Open areas dominated by common nettle.

Arable Land

8.5.13 Located to the east of Lowdham roundabout. Low ecological interest and lack of notable species.

Ornamental Planting

8.5.14 Island of ornamental planting within Lowdham Roundabout

Wet / Dry Ditch

8.5.15 Ditch subject to periodic / seasonal wetting alongside arable field margin. Held approximately 1-2 feet of water, and was dominated by water starwort *Callitrich stagnalis agg*., with watercress *Nasturtium officinale agg*. and water forget-me-not *Myosotis scorpiodides*.

Protected and Notable Species

8.5.16 Table 8-7 presents the protected and notable species, including invasive non-native plant species, that have been identified as present or potentially present within the Scheme boundary and relevant ZoI. The baseline conditions have drawn upon various sources of information as stated in Section 8.4.

Table 8-7: Summary of Baseline Details for Protected and Notable Species within the Lowdham Roundabout Study Area

Species	Baseline Detail
Bats	Desk Study: The desk study returned 30 bat records of at least four species including soprano pipistrelle, common pipistrelle, noctule and an unknown Myotis bat; the nearest records being 150 m away. None of the desk study records were confirmed roosts. Field Study: Within the survey area, no residential properties were assessed for their suitability to support roosting bats. All of the trees assessed from the ground were devoid of any features considered to be suitable to support roosting bats. The lines of trees associated with the recreation ground. The hedgerows on the south section of the A6097 and dense scrub have some potential to provide foraging and dispersal habitat for bats, but some of the trees contain artificial lights and street lighting is also present.
Badger	Desk Study: The desk study returned three badger roadkill records, the nearest being 600 m distance from the Scheme. Field Study: No signs of badger were located during the field survey and the residential areas, recreation ground and arable field are considered to be sub-optimal habitat for badger.
Other Mammals	Desk Study: The desk study returned six hedgehog records, the nearest being 300 m distance from the site. The desk study returned a single Western polecat Mustela putorius record from a garden approximately 450 m from the Scheme. Field Study: No signs of hedgehog were located during the field surveys, but the timing was sub-optimal to detect the species. The dense scrub, residential gardens and unmown grassland verges provide potential habitat for hedgehog. No signs of polecat were observed during the survey and the site was considered to be sub-optimal because of disturbance from management and pedestrians. Suitable resting habitat for the species is also absent.
Amphibians	Desk Study: The desk study returned 17 records of common frog *Rana temporaria* within the search area, originating from garden ponds, drains and rough grassland. Field Study: During February 2019, all the roadside drains were dry and most of the grassland verges were mown apart from the verges to the south-west of the roundabout. It was considered that suitable breeding habitat for amphibians was not present and terrestrial habitat was very limited within the survey area. During the December 2020 survey, an isolated ditch was noted that held approximately 1-2 feet of water. This short section of standing water was isolated from the other ditches at the junction, had very little field margin to provide cover and it was considered that the road serves as a significant barrier to dispersal. Further details can be found within Appendix 4-5 of Volume – Phase 1 habitat survey.
Reptiles	Desk Study:

Species	Baseline Detail
	The desk study did not return any records of reptiles within the search area. Field Study: Habitats within the survey area are considered to be sub-optimal because of a lack of cover and potential hibernacula, together with disturbance caused by mowing and pedestrians using the tarmac footpaths alongside the roads. As such, reptiles are not considered any further at this site in this report.
Birds	Desk Study: No bird records were requested for Lowdham roundabout within Ecological Appraisal Report (Baker Consultants, 2020). Field Study: Robin *Erithacus rubecula* and blackbird *Turdus merula* were observed during the Phase 1 Habitat Survey. The hedgerows, scattered trees and dense scrub provide potential nesting habitat, but noise traffic could affect the suitability of the site.
Invasive, non-native plant species	Desk Study: The desk study returned 25 records for Himalayan balsam and two records of Japanese knotweed *Fallopia japonica.* Field Study: Himalayan balsam and Japanese knotweed were not noted during the initial Phase 1 Habitat Survey in February 2019, or during the updated survey in December 2020. The roadside ditches were noted for their suitability to support Himalayan balsam during the initial Phase 1 habitat survey. Therefore, an additional site visit was undertaken, within the optimal survey window to determine the presence / likely absence from the assessment boundary. The additional site walkover to investigate invasive species was undertaken on the 11th October 2021. No signs of Himalayan Balsam, or any other invasive species were noted during this survey, therefore have been scoped out of the assessment at this stage.
Invertebrates	No records of invertebrates were noted in the desk study or during the Phase 1 Habitat Survey.

Importance of Ecological Features

8.5.17 The importance of ecological features within the study area that are scoping into the assessment have been assessed in accordance with the guidance detailed in Section 8.4.

8.5.18

8.5.19 Table 8-8 summarises the ecological features identified in the study area and, along with rationale, detailed the ecological importance assigned to each.

Table 8-8: Summary of Ecological Importance

Statutory designated site / non-statutory designated site/ habitat/ species	Ecological Feature	Rationale	Importance
Statutory Designated and Non-Statutory Designated Sites			
	Veteran Tree	Irreplaceable habitat	UK or National
Local Wildlife Site	Details on all LWS can be found in table 8-6.	Areas of land that are especially important for their wildlife.	County
Habitats			
Grassland	Unimproved neutral grassland	Nottinghamshire LBAP habitat	County
	Amenity grassland	No notable or protected habitat. Common habitats found within the local area, of limited ecological interest.	Local
Hedgerow	Species-poor hedgerow	Habitat of 'Principal Importance' in England Hedgerows provide wildlife dispersal corridors and provide connectivity to the wider landscape beneficial for fauna.	Local
	Species-poor hedgerow with associated ditch	Habitat of 'Principal Importance' in England Hedgerows provide wildlife dispersal corridors and provide connectivity to the wider landscape beneficial for fauna.	Local
	Species poor hedgerow with trees	Habitat of 'Principal Importance' in England This habitat supports butterflies, moths and other invertebrates, birds, bats, hedgehog, hares, reptiles, amphibians and other mammals.	Local

Statutory designated site / non-statutory designated site/ habitat/ species	Ecological Feature	Rationale	Importance
Cultivated / disturbed land	Arable Land	Nottinghamshire LBAP habitat Common habitat found within the surrounding area, of limited / negligible ecological interest.	County
	Ornamental planting	No notable or protected habitats. Common habitats found within the surrounding area, of limited / negligible ecological interest.	Local
Ditch	Seasonally wet ditch	Nottinghamshire LBAP habitat No notable or protected habitats. Common habitats found within the surrounding area, of limited / negligible ecological interest	County
Trees	Scattered Trees	This habitat may be of value to local wildlife including nesting birds and bats	Local
Legally Protected and Notable Species			
Bats	Foraging and Commuting bats	Seven species of bat are Species of 'principal importance' in England. Five species of bat including within Nottinghamshire LBAP Linear features present within Scheme boundary that will be subject to small localised losses	Up to County
Birds	Common nesting bird species across the Scheme	49 species of bird are Species of 'Principal Importance' in England 88 species of birds included within Nottinghamshire LBAP All nesting birds are protected under the Wildlife and Countryside Act 1981 (as amended)	Up to County

Statutory designated site / non-statutory designated site/ habitat/ species	Ecological Feature	Rationale	Importance
		Hedgerows have the potential to support nesting birds	
Hedgehog	Suitable habitat for hedgehog within the Scheme boundary	Nottinghamshire LBAP species Hedgehogs are a Species of 'Principle Importance' in England	County

Future Baseline

8.5.20 In the absence of the Scheme, it is considered that the site would remain as existing. No future baseline developments have been identified within the study area that would affect the future baseline.

8.6 Design, Mitigation and Enhancement Measures

8.6.1 Environmental elements have been considered during the development of the Scheme design, to avoid and reduce potential impacts on biodiversity. This approach has led to a range of mitigation measures capable of reducing the magnitude of impacts being embedded within the Scheme design or captured within the proposed construction and operational practices. Measures specifically related to the protection of ecological sites and habitats, and protected species are detailed in the following sections.

Scheme Design

8.6.2 The following mitigation measures have been incorporated into the Scheme design.

Habitats

8.6.3 The following mitigation measures have been incorporated into the Scheme design:

- **Loss and replacement of hedgerows:** the loss of hedgerow will be replaced and further enhanced with a species-rich hedgerow, comprising of common hazel *Corylus avellana*, hawthorn *Crataegus monogyna*, dogwood *Cornus sanguinea*, holly *Ilex aquifolium*, privet, *Ligustrum vulgare*, blackthorn *Prunus spinosa*, dog rose *Rosa canina*, buckthorn *Rhamnus cathartica* and wayfaring tree *Viburnum opulus*. All species selected are in keeping with the landscape character area.
- **Loss of grassland verges:** the loss of grassland verges will be reinstated on a like-for-like basis, and in some areas further enhanced by incorporating a native species-rich wildflower meadow. The grassland will be sensitively managed to allow for it to be of at least moderate value, with only the visibility splays to be managed to a shortly mown sward.
- **Loss of arable land:** an area of arable land will be lost as part of the Scheme development. The area will be enhanced to include a range on new habitat types, including scattered trees, hedgerows, wetland areas, wet grassland and a scrape.
- **Loss of scattered trees:** Replacement tree planting will mitigate the loss of trees. Proposed species include field maple *Acer campestre*, common alder *Alnus glutinosa*, hawthorn, holly, crab apple Malus sylvestris, wild cherry Prunus avium, aspen *populus tremula*, blackthorn, English oak *Quercus robur*, white willow *Salix alba*, crack willow *Salix fragilis* and osier *salix viminalis* all which are in keeping with the local character area.
- The **wet ditch** will be realigned and maintained as per the existing wet ditch.

8.6.4 Further detail can be found within the landscape proposals in Appendix 2-2 in Volume 3C.

Species

- **Birds:** To mitigate the unavoidable loss of habitat of value to foraging and nesting birds across the Scheme, trees and hedgerows, in keeping with the character assessment of the area, will be planted as part of the landscape design.

- **Bats (roosting, foraging and commuting):** The Scheme lighting has been designed to minimise impacts to bats. This includes the use of light emitting diodes (LEDs) to ensure more directional and controlled light source. In addition, the LED lanterns will have rear shielding, to reduce the amount of light spill and lower the lux levels into surrounding habitat.

Essential Mitigation - Construction

8.6.5 Construction of the Scheme would be subject to measures and procedures as defined within a CEMP for the Scheme. The CEMP will be produced by the Principal Contractor prior to construction commencement. The CEMP will include a range of measures to mitigate potential impacts on ecological habitats, protected species and the water environment, which accord with legal compliance and good practice guidance. The CEMP would include measures to minimise dust deposition, air pollution, pollution incidents, light spillage and noise and vibration which would all assist in minimising impacts upon biodiversity receptors.

Non-Statutory Designated Sites and Habitats

8.6.6 The following mitigation measures would be put in place to reduce the effects of potential significant Scheme construction phase impacts on non-statutory designated sites (where applicable) and habitats:

- **Pollution prevention control measures**: Water pollution prevention control measures and standard best practice measures to control construction dust, noise and lighting would be implemented during the construction phase via the CEMP (refer to Chapter 5: Air Quality; Chapter 10: Noise and Vibration; Chapter 11: Road Drainage and the Water Environment).

8.6.7 A veteran tree is located within approximately 140 m of the assessment boundary. Although it is not considered to be directly impacted by the Scheme, it is within the air quality ZoI. Further details can be found within Chapter 5: Air Quality. No specific air quality mitigation measures have been incorporated into the Scheme, but best practice measures will be incorporated into the CEMP as detailed in this chapter, Chapter 5: Air Quality and Chapter 10: Noise and Vibration.

8.6.8 The following mitigation measures would be put in place to reduce the effects of

Species

8.6.9 The following mitigation measures would be in place to reduce the effect of potentially significant Scheme construction impacts on ecological species:

- **Bats (foraging and commuting):** Measures would be implemented during the construction phase to minimise impacts on foraging and commuting bats – this includes keeping lighting to a minimum by limited night-time working, where possible, and reducing lighting within habitat of value to bats. Any lighting used would be directional and positioned sympathetically to minimise light spill.
- **Birds:** Vegetation clearance during the core bird breeding season (March to August, inclusive) should be avoided. Where this is not possible, nesting bird checks will be carried out by the ECoW to determine whether there are any active nests.
- **Hedgehogs:** The removal of dense vegetation will be carried out under the supervision of the ECoW. Suitable habitat will be identified in advance of any clearance works in the local area to release any captured hedgehogs. If clearance work is carried out during winter months, provision will be made for captured hedgehogs to be overwintered in captivity.
- **ECoW:** ECoW will be required for nesting birds (if clearance works are undertaken during the breeding bird season) and hedgehogs.

Essential Mitigation - Operation

Habitats

8.6.10 Landscape design plans illustrate the essential biodiversity mitigation and compensation that have been incorporated into the Scheme design to meet specific species and habitat requirements within the wider framework of other environmental measures for landscape and visual.

8.6.11 Ongoing 5-year management to ensure that the habitat implemented as part of the Scheme design, within the highway boundary, will be undertaken by NCC to ensure that the habitats are maintained to their desired condition and habitat type.

8.6.12 Ongoing 30-year management to ensure that the habitats implemented as part of the Scheme design directly related to the BNG will be undertaken by NCC to ensure that the habitats are maintained to their desired condition. Further detail is provided within the BNG Assessment in Appendix 4-2 of Volume 3.

8.6.13 Both the habitat creation / enhancement within the highway boundary, and as part of the scheme design and BNG requirements will be funded by NCC.

Species

8.6.14 **Bats (roosting, foraging and commuting):** The Scheme lighting has been designed to minimise the impacts to bats.

Enhancements

8.6.15 As detailed within the Scheme design, the landscape design has incorporated enhancements to ensure net gain is achieved, where possible, within the Scheme assessment boundary. This includes incorporating:

- Species-rich hedgerows with species in line with the character assessment of the area;
- Species-rich flowering native dry meadow grassland;
- Additional scattered trees with species in line with the character assessment of the area; and
- a range on new habitat types, including wetland areas, wet grassland and a scrape.

8.6.16 Further detail can be found within the landscape proposals – see Appendix 2-2 in Volume 3C.

8.6.17 Additionally, BNG calculations have been undertaken across the wider project, incorporating all Schemes associated within the Major Network Junction Improvement project. On-site mitigation has been calculated and it is considered that the project achieves the following net gains:

- 18.07% increase in habitat units;
- 71.75% increase in hedgerow units; and
- 67.14% increase river units.

8.6.18 More information regarding the requirements to achieve these gains can be found within the BNG Assessment in Appendix 4-2 of Volume 3.

8.7 Assessment of Likely Significant Effects

8.7.1 The prediction of impacts and the assessment of effects has taken account of the mitigation measures and the compensation measures identified within Section 8.6.

8.7.2 Impacts and effects on biodiversity are reported for both the construction and operational phases of the Scheme and are presented first under the headings of designated sites (international, national and other), then habitats, and finally species. The effects of all of the impacts are considered individually and then collectively for each of the biodiversity features assessed.

Construction

Non-Statutory Designated Sites and Veteran Tree

8.7.3 A total of eight LWSs are located within the search area. The LWSs are separated from the Scheme by a large arable field and a main road. Given the geographical separation of farmland, urban and road between the sites and the roundabout and the localised development footprint, an adverse impact on the scientific interest of the LWSs is not anticipated.

Indirect effects – dust and air emissions.

8.7.4 Figure 8-3 in Volume 2C shows the veteran tree in relation to the Scheme.

8.7.5 The Scheme has the potential to affect air quality during construction, in the following ways:

- by increased emissions of dust during construction of the Scheme from dust-generating activities on site;
- by emissions associated with non-road mobile machinery (NRMM) undertaking construction works; and
- by changes in vehicle activity (flows, speeds and composition) during construction, as a result of temporary traffic management measures and/or additional vehicles travelling to and from the construction site transporting materials, plant and labour.

8.7.6 There is the potential for adverse dust and pollution effects to the veteran tree during the construction of the Scheme as it is within the ZoI for air quality. However, any effects would be temporary (i.e. during the period of the construction works only) and could be suitably minimised by the application of industry standard mitigation measures which will be set out in the CEMP. Therefore, it is considered that any impacts would be mitigated for resulting in a negligible impact on a receptor of UK or national value, resulting in a neutral effect (not significant).

Habitats

Direct effects – habitat loss from vegetation clearance

8.7.7 The construction of the Scheme would result in both losses and gains of habitat. The permanent habitat gains are those classified as habitats created as part of the Scheme. Table 8-9 provides a summary of all habitat losses and gains within the Scheme boundary. It does not correspond to the total area of land required for the Scheme because it does not include highway or other built infrastructure.

Table 8-9: Habitat losses and gains

Existing habitat	Habitat loss (ha)	Importance	New habitat	Habitat gains (ha)	Net permanent gains
Unimproved neutral grassland	0.25	County	Neutral grassland	0.386	+0.136
Amenity grassland	0.09	Local	Amenity grassland	0.045	-0.045

Existing habitat	Habitat loss (ha)	Importance	New habitat	Habitat gains (ha)	Net permanent gains
			Ornamental planting	0.007	+0.007
Arable land	0.38	County	Arable land	0.0	-0.38
			Neutral grassland	Inc. in unimproved neutral grassland area (0.386)	Inc. in unimproved neutral grassland permanent gains (+0.136)
			Mixed scrub	0.067	+0.067
Bare Ground	0.09	N/A	Bare ground	0.0	-0.09
			Developed land – road network	0.258	+0.258
			Neutral grassland	Inc. in unimproved neutral grassland area (0.386)	Inc. in unimproved neutral grassland permanent gains (+0.136)
Species-poor hedgerow / Species poor hedgerow with associated ditch	160 m	Local	Species-rich hedgerow	0.179 km	0.019 km
			Species-rich hedgerow with trees	0.151 km	+0.151 km
			Ditch will be culverted	0.03km	-0.03km
Seasonally wet ditch	0.12 km	County	Seasonally wet ditch	0.104	-0.016 km

Unimproved neutral grassland

8.7.8 Approximately 0.25 ha of unimproved neutral grass verges will be lost as part of construction which is likely to be adverse at local level due to parts of the grassland which support a range of species. However, most of the verges are ‘weedy’ with common species indicative of disturbance rather than sustained grassland management. However, following completion of the construction works, this site would be subject the creation of 0.386 ha of neutral native / floral meadow grassland, as detailed within the landscape design. It is considered, that in the long-term the proposed embedded mitigation will result in a moderate beneficial impact on a receptor of County value, resulting in slight beneficial (not significant) effect.

8.7.9 It will take approximately 10 years for the replacement / created habitat to mature are reach its desired condition. Therefore, it is considered that in the short-term, there will be a moderate adverse impact on a receptor of County value, resulting in a slight adverse (not significant) effect.

Amenity grassland

8.7.10 0.09 ha of amenity grassland will be lost during the construction phase of the Scheme. The landscape design proposed to replace 0.045 ha of amenity grassland post construction, therefore resulting in the permanent loss of 0.045 ha. The grassland is considered to lack ecological value due to the small areas to be lost and lack of species diversity present within the habitat. Therefore, the loss of this habitat will result in a negligible impact on a receptor of local value, resulting in a neutral effect (not significant).

Species-poor hedgerow/ species poor hedgerow with associated ditch

8.7.11 Approximately 160 m of species-poor hedgerow / species poor hedgerow with associated ditch will be lost during the construction of the Scheme. The landscape design includes approximately 330 m of hedgerow to be planted to compensate for the loss of habitat. Each new hedgerow planted will be species rich comprising of common hazel *Corylus avellana*, hawthorn *Crataegus monogyna*, dogwood *Cornus sanguinea*, holly *Ilex aquifolium*, privet, *Ligustrum vulgare*, blackthorn *Prunus spinosa*, dog rose *Rosa canina*, buckthorn *Rhamnus cathartica* and wayfaring tree *Viburnum opulus*. All species selected are in keeping with the landscape character area, further details can be found within the landscape design – Appendix 2-2 in Volume 3C. It is considered that once established, this would constitute a moderate beneficial impact on a receptor of local value, resulting in a slight beneficial (not significant) effect.

8.7.12 It will take up to approximately 20 years for the replacement / created habitat to mature and reach its desired condition. Therefore, it is considered that in the short-term, there will be a moderate adverse impact on a receptor of local value, resulting in a slight adverse (not significant) effect.

8.7.13 The ditch associated with hedgerow to the south-west of the Scheme will be permanently culverted to facilitate construction of the new accesses for properties on the A612 Nottingham Road. The ditch is an artificial drainage ditch made of PVC pipe which takes flow from the highway. It is considered to provide limited ecological value due to the artificial nature of the ditch, and poor-quality water associated with highway runoff. Therefore, loss of this ditch is considered to result in a negligible impact on a receptor of local value, resulting in a neutral effect (not significant).

Arable land

8.7.14 An area of approximately 0.38 ha of arable land will be permanently lost to the Scheme. The arable field margins or arable field that would be affected are not considered to be notable due to its low ecological interest and lack of notable species in associated with this habitat. The area will be replaced with a scrape which will contain an area of regularly wet grassland and herbaceous meadow. Additionally, areas of mixed scrub habitats and proposed flowering native dry meadow grassland will also be created to provide an above ground flood storage system and also a mosaic of habitat types considered to provide ecological benefits. Therefore, it is considered that once these habitat types have been established, this would constitute a moderate beneficial impact on a receptor of County value, resulting in a slight beneficial (not significant) effect.

8.7.15 It will take up to approximately 10 years for the replacement / created habitat to mature and reach its desired condition. However, as the arable land is if low ecological interest, it is considered that the loss of this habitat in the short-term would result in a minor adverse impact on a receptor of County value, resulting in a neutral effect (not significant).

Seasonally wet ditch

8.7.16 A wet drainage ditch is located along the arable field, to the west of Lowdham roundabout. This ditch will be re-aligned along the new boundary, post-construction, but will result in a permanent loss of 16 m. As the ditch will be further enhanced by maintaining permanent water, and planting >10 emergent species it is considered that this would constitute in the long-term to a minor beneficial impact on a receptor of County value, resulting in a neutral effect (not significant).

8.7.17 It will take approximately 10 years for the re-instated habitat to mature and reach its desired condition. Therefore, in the short-term, it is considered that the construction of the Scheme would constitute a moderate adverse impact on a receptor of County value, resulting in a slight adverse (not significant) effect.

Scattered trees

8.7.18 The construction of the Scheme will result in the temporary loss of 2 trees. The landscape proposals include planting 24 replacement trees. The proposed species include field maple *Acer campestre*, common alder *Alnus glutinosa*, hawthorn, holly, crab apple *Malus sylvestris*, wild cherry *Prunus avium*, aspen *Populus tremula*, blackthorn, English oak *Quercus robur*, white willow *Salix alba*, crack willow *Salix fragilis* and osier *salix viminalis*. All species are suitable and in keeping with the local character assessment. Therefore, it is considered that in the long-term the loss of any trees will be mitigated for through the creation of native scattered trees within the assessment boundary which is considered to constitute to a moderate beneficial impact on a receptor of local value, resulting in a slight beneficial (not significant) effect.

8.7.19 It will take up to approximately 20 years for the replacement / created habitat to mature and reach its desired condition. However, as the Scheme will result in a small number of trees to be lost, it is considered that the loss of this habitat in the short-term would result in a minor adverse impact on a receptor of local value, resulting in a neutral effect (not significant).

Species

Bats

Direct effect – habitat loss

8.7.20 No roosting opportunities were identified within the Scheme boundary, therefore no impacts are anticipated on roosting bats

8.7.21 There will be a small and localised loss of hedgerows at the edges of fields which has the potential to interfere with bat foraging and dispersal. However, the hedgerows are subject to high levels of artificial lighting from both street lighting and residential housing. The landscape design mitigates the loss of these hedgerows by reinstating and further enhancing post development. Therefore, it is considered that the removal of suitable foraging and commuting habitat as part of the Scheme would be temporary and therefore would have a minor adverse impact on a receptor of up to County value, resulting in a neutral effect (not significant).

Indirect effect – lighting and noise impacts

8.7.22 As detailed in Section 8.6, best practice construction measures would be implemented during the construction phase to minimise disturbance to bats through minimising night-time working and avoiding direct illumination of habitats of value to bats. With the implementation of such measures, it is considered that there would be a negligible impact on a receptor of up to County value, resulting in a neutral effect (not significant).

8.7.23 At this stage, precise information on the construction works are not available,

therefore the noise assessment has been based on the likely road construction activities. It is anticipated that the contractor will employ standard best practice controls to manage noise and vibration levels during the construction phase and such measures would be detailed within the CEMP. It is considered that as the construction of the Scheme would result in temporary fluctuation in noise, which will be managed via the CEMP such that the impacts would be a negligible impact on a receptor of up to County value, resulting in a neutral effect (not significant).

Birds

Direct effect – habitat loss

8.7.24 Site clearance during the construction phase of the Scheme will result in the loss of hedgerows and scattered trees, habitats which are likely to provide nesting opportunities for a variety of bird species during the breeding season. The loss is considered to be temporary as new suitable habitats, provided in the landscape proposals will provide replacement nesting opportunities for those lost. Furthermore, suitable nesting habitat is present within the wider area.

8.7.25 Provided the mitigation measures, detailed within the CEMP are followed during the clearance works, and the suitable habitat is replaced and further enhanced as detailed within the landscape plan, it is considered that the works would have a negligible impact on a receptor of up to County value, resulting in a neutral effect (not significant).

Indirect effect –noise impacts

8.7.26 As discussed above, precise information on the construction works is not available at the time of writing this chapter. However, given the mitigation measures detailed, and the temporary nature of the construction, it is considered that the noise impacts would be a negligible impact on a receptor of up to County value, resulting in a neutral effect (not significant).

Hedgehog

Direct effect – habitat loss

8.7.27 The hedgerows and grassland within the Scheme boundary provide potential habitat for hedgehog. Best practice measures for habitat clearance will be detailed within the CEMP. Ensuring this is followed during the clearance works, it is considered that the works would have a negligible impact on a receptor of County value, resulting in a neutral effect (not significant).

Indirect effect – construction activities

8.7.28 General construction activities within the Scheme development are likely to include ground works, excavations and storage of materials, including pipes which, if left uncovered, could trap injure or kill individual hedgehogs moving through the site. These effects could increase hedgehog mortality within the sites, leading to reduced breeding success and recruitment into the local population. Provided the mitigation measures detailed within the CEMP are followed during the construction phase, it is considered that the works would have a negligible impact on a receptor of County value, resulting in a neutral effect (not significant).

Operation

Non-Statutory Designated Sites and Veteran Tree

Non-Statutory Designated sites

8.7.29 A total of eight LWSs are located within the search area. The LWSs are separated from the Scheme by a large arable field and a main road. Given the geographical separation of farmland, urban and road between the sites and the roundabout and

the localised development footprint, an adverse impact on the scientific interest of the LWSs is not anticipated.

Veteran Tree

8.7.30 Nitrogen deposition is not believed to have a direct, major effect on tree growth in the UK, but its indirect effects can be many and varied (APIS, n.d.). Predicted annual mean NO_x concentration and nitrogen deposition rates attributable to the Scheme operation are presented in Table 8-10 for the veteran tree. Further details can be found in Chapter 5: Air Quality. The location of the veteran tree is presented in Figure 8-3 in Volume 2C.

8.7.31 With the Scheme in place, the change in Nitrogen deposition between the Do Minimum without the Scheme, and the Do Something with the Scheme in place, it is considered that there is a change in nitrogen deposition of -0.1 (kgN/ha/yr). Therefore, the impact of changes in air quality on the veteran tree is considered to be not significant because 'the change in nitrogen deposition associated with the proposed Scheme will not lead to the loss of one species' as noted in DMRB LA 105. Therefore, this results in no change to a receptor of UK or national value, resulting in a neutral effect (not significant).

Table 8-10: Predicted NO_x concentrations and nitrogen deposition rates at designated habitat transects.

Designated Habitat	Distance from road (m)	X	Y	Site Critical Load (kg N/ha/yr)	LTT DM Total NO_x concentration ($\mu g/m^3$)	LTT DS Total NO_x concentration ($\mu g/m^3$)	Change in LLT Total NO_x concentration ($\mu g/m^3$)	LTT DM Total Nitrogen Deposition (kg N/ha/yr)	LTT DS Total Nitrogen Deposition (kg N/ha/yr)	Change in LTT DS Total Nitrogen Deposition (kg N/ha/yr)
Veteran Tree	99	467176	346064	10	20.8	20.3	-0.5	25.3	25.2	-0.1

Note: Nitrogen deposition exceeded the critical load in the DM and DS Scenarios at all modelled receptors. Annual mean NO_x concentrations were below the objective at all modelled receptors.

Species

Bats

8.7.32 The potential operational impacts upon bats relate to direct mortality and reduction of habitat quality due to artificial light.

8.7.33 The severance of flight lines has the potential to increase levels of bat mortality through accidental collision with vehicles. Direct collision resulting in mortality of bats occurs in areas where bats would attempt to cross the highway when following existing or new linear features (hedgerows, tree lines, woodland edge, linear riparian habitat and other features). Mitigation measures include the replacement and further enhancement of linear features that may be used by foraging and commuting bats, additionally the Scheme does not result in the severance of any new habitat but is restricted to widening along the existing south-west side of the roundabout, reducing the impacts to commuting and foraging bats as a result of direct mortality. Therefore, taking into account the mitigation proposed, it is considered that the Scheme operation will constitute a negligible impact on a receptor of up to County value, resulting in a neutral effect (not significant).

8.7.34 Artificial lighting has the potential to impact upon bats, causing them to avoid otherwise suitable areas of habitat.

8.7.35 The operational lighting scheme, presented in Figure 8-2 in Volume 2C has been designed to the ‘5 second rule’ which forms part of the Institution of Lighting Professionals document PLG02 (ILP, 2013) and DMRB TD 501 Road lighting design (DMRB, 2020). This lighting extent proposed is greater than the current lighting in place for Lowdham Roundabout, therefore the light levels will extend further along the A6097 with the Scheme. The increase in lighting levels causes amenity grassland, neutral grassland, species-poor hedgerow with trees and some residential gardens to be lit >1 lux. It is considered that these habitats provide some low quality, isolated habitat that may be utilised by foraging and commuting bats, however, the surrounding habitat for habitat is sub-optimal and may act as a barrier to flight lines. It is considered that due to the small area and habitat types that are likely to be impacted by the lighting for the Scheme, and as the surrounding area is of sub-optimal bat habitat; the increase in lighting levels will constitute a negligible impact on a receptor of up to County value, resulting in a neutral effect (not significant).

8.7.36 Traffic noise can affect bat activity at least 20 m away from the noise source (Finch, Schofield and Mathews, 2020). Noise modelling data was obtained for the Scheme both during the daytime and night-time, detailed in Figures 8-3 and 8-4 in Volume 2C to determine the changes in noise levels during the operational phase. A total of 756 human receptors were necessary to be assessed by following the DMRB LA 111 methodology which covered the surrounding areas. These points were also considered suitable to determine the impacts to sensitive species as it gives the overall wider impact regarding changes in noise levels.

8.7.37 The noise modelling determined the majority of receptors have an overall negligible beneficial impact with the introduction of the Scheme due to a reduction in noise levels by up 2.9 dB, and 20 receptors where a negligible adverse impact is expected, due to an increase in up to 0.9 dB. Studies have been undertaken regarding traffic noise and how it effects bats in the surrounding habitat. Finch, Schofield and Mathews (2020) conducted the first controlled field experiment to test the impacts of traffic noise of free-living bat assemblages. The results of the experiment concluded that the playback of traffic noise decreased overall bat activity. Therefore, it is considered that due to the presence of the road already in place, the surrounding habitat, at least 20 m from the highway boundary, is determined as sub-optimal due to the current baseline traffic noise. Combined with

the increase being less than 3 dB, which is perceived to have negligible effects (Barber, Crooks, Fristrup, 2009), it is considered the operational noise levels will constitute a negligible impact on a receptor of up to County value, resulting in a neutral effect (not significant).

Birds

8.7.38 The operation of the Scheme has the potential to affect birds through direct mortality and habitat degradation, behavioural patterns, stress response and fitness levels, as a result of increased noise and lighting levels.

8.7.39 Certain birds, for example thrush species and game birds, are at a higher risk of collision as they fly at a low height. Collisions occur where hedgerows and other woodland habitat directly adjoins the carriageway. The Scheme incorporates a footpath directly adjacent to the carriageway, offsetting any suitable habitat directly adjoining the carriageway, which will reduce the risk of direct mortality.

8.7.40 The artificial lighting Scheme has been designed to minimise light-spill onto adjacent habitats and is largely concentrated to the carriageway boundary which is considered to minimise any effects on birds.

8.7.41 Noise modelling data was obtained for the Scheme to determine the changes in noise levels during the Operational phase. A total of 756 human receptors were necessary to be assessed by following the DMRB LA 111 methodology which covered the surrounding areas. These points were also considered suitable to determine the impacts to sensitive species as it gives the overall wider impact regarding changes in noise levels. 20 of these receptors had an increase in noise level of between 0.1-0.9 dB from the existing baseline, with the remaining 736 receptors resulting in either no change, or a decrease in noise levels up to 42.9 dB. As the increase in overall noise levels does not exceed 3 dB, it is considered that the increase in noise level will constitute a negligible impact on a receptor of up to County value, resulting in a neutral effect (not significant).

Hedgehog

8.7.42 Britain's hedgehog numbers are in severe decline, with a possible reason for this being increased deaths caused by road collisions (Mammal Society, 2020). The speed at which a vehicle is travelling has the potential to impact the number of road traffic accidents. According to the road traffic data obtained for the Scheme, for the opening year (2023) and for 2037 there are limited changes in speed bands between the Do Minimum and the Do Something. Additionally, changes to speed limited are proposed with the speed limited reduced from 40mph to 30mph on all approach to the roundabout. Therefore, it is considered that the introduction of the Scheme will constitute a minor beneficial impact on a receptor of County value, resulting in a slight beneficial (not significant) effect.

8.8 Additional Mitigation

Construction Phase

8.8.1 Providing the design and mitigation measures outlined in Section 8.6 are undertaken, significance of effect in the short-term ranges from neutral to slight adverse and in the long-term (once habitats have established) from neutral to slight adverse. Therefore, no further additional mitigation measures have been identified.

Operation Phase

8.8.2 No additional mitigation measures are considered to be required for the operational phase of the Scheme as no significant effects are predicted.

8.9 Residual Effects

8.9.1 The residual effects of the Scheme are considered to be ‘not significant’ for biodiversity for both the construction and operational phases as noted in Table 8-11.

Table 8-11 Residual Effects

Description of Effect	Sensitivity of Receptor	Nature of Effect/ Geographic Scale	Magnitude of Impact	Initial Classification of Effect (with embedded mitigation)	Additional Mitigation	Residual Effect Significance
Construction						
Air quality impact to veteran tree	UK or National	Increase in dust and reduction in air quality	Negligible	Neutral effect (not significant)	No additional mitigation required	Neutral effect (not significant)
Loss of unimproved neutral grassland	County	Temporary loss of 0.25ha of unimproved neutral grassland, with 0.386ha of grassland to be reinstated / created post construction	Moderate adverse	Slight adverse (not significant)	No additional mitigation required	Slight adverse (not significant)
Loss of amenity grassland	Local	Permanent loss of 0.45ha of amenity grassland	Negligible	Neutral effect (not significant)	No additional mitigation required	Neutral effect (not significant)
Loss of arable land	County	Permanent loss of 0.38ha of arable land, with the creation of habitat mosaic post construction	Minor adverse	Neutral effect (not significant)	No additional mitigation required	Neutral effect (not significant)
Loss of seasonally wet ditch	County	Loss of 16m of wet ditch	Moderate adverse	Slight adverse (not significant)	No additional mitigation required	Slight adverse (not significant)
Loss of trees scattered trees	Local	Loss of 2 trees, with the replacement and creation of a further 24 trees	Minor adverse	Neutral effect (not significant)	No additional mitigation required	Neutral effect (not significant)
Loss of hedgerow	Local	Loss of 160m of species-poor hedgerow, with the replacement and creation of a further 330m of species rich hedgerow.	Moderate adverse	Slight adverse (not significant)	No additional mitigation required	Slight adverse (not significant)
Loss of suitable bat habitat	Up to County	Loss of suitable foraging / dispersal habitat	Negligible	Minor adverse	Neutral effect (not significant)	No additional mitigation required

Description of Effect	Sensitivity of Receptor	Nature of Effect/ Geographic Scale	Magnitude of Impact	Initial Classification of Effect (with embedded mitigation)	Additional Mitigation	Residual Effect Significance
Lighting and noise impact on bats	Up to County	Destruction / disturbance to bat roosts and / or dispersal corridors	Negligible	Neutral effect (not significant)	No additional mitigation required	Neutral effect (not significant)
Loss of suitable bird nesting habitat	Up to County	Destruction / disturbance to nesting birds	Negligible	Neutral effect (not significant)	No additional mitigation required	Neutral effect (not significant)
Noise impacts on birds	Up to County	Destruction / disturbance to nesting birds	Negligible	Neutral effect (not significant)	No additional mitigation required	Neutral effect (not significant)
Loss of suitable hedgehog habitat	County	Injury / mortality during habitat clearance	Negligible	Neutral effect (not significant)	No additional mitigation required	Neutral effect (not significant)
Effect of construction activities on hedgehog and brown hare	County	Injury / mortality during construction activities	Negligible	Neutral effect (not significant)	No additional mitigation required	Neutral effect (not significant)
Operation						
Veteran Tree	UK or National	Increase in nitrogen deposition	No change	Neutral effect (not significant)	No additional mitigation required	Neutral effect (not significant)
Increase levels of bat mortality / injury	Up to County	Injury / mortality during operation	Negligible	Neutral effect (not significant)	No additional mitigation required	Neutral effect (not significant)
Changes in artificial lighting levels (bats)	Up to County	Habitat degradation / behavioural patterns	Negligible	Neutral effect (not significant)	No additional mitigation required	Neutral effect (not significant)

Description of Effect	Sensitivity of Receptor	Nature of Effect/ Geographic Scale	Magnitude of Impact	Initial Classification of Effect (with embedded mitigation)	Additional Mitigation	Residual Effect Significance
Changes in noise levels (bats)	Up to County	Habitat degradation / behavioural patterns	Negligible	Neutral effect (not significant)	No additional mitigation required	Neutral effect (not significant)
Increase levels of bird mortality / injury	Up to County	Injury / mortality during operation	Negligible	Neutral effect (not significant)	No additional mitigation required	Neutral effect (not significant)
Changes to artificial lighting levels (birds)	Up to County	Habitat degradation / behavioural patterns / stress response / fitness	Negligible	Neutral effect (not significant)	No additional mitigation required	Neutral effect (not significant)
Changes in noise levels (birds)	Up to County	Habitat degradation / behavioural patterns / stress response / fitness	Negligible	Neutral effect (not significant)	No additional mitigation required	Neutral effect (not significant)
Hedgehog	County	Mortality / injury due to road collisions	Minor beneficial	Slight beneficial	No additional mitigation required	Slight beneficial (not significant)

9. GEOLOGY AND SOILS

9.1 Introduction

9.1.1 This chapter discusses the potential geology and soils effects of the proposed Scheme and the likely significance of such impacts during the construction and operational phases.

9.1.2 This chapter should be read in conjunction with Figure 9-1 within Volume 2C, and Appendix 9-1 of Volume 3C. This assessment has followed the methodology within DMRB LA 109 Geology and Soils Revision 0 (Highways England, 2019).

9.2 Legislation and Policy

9.2.1 Information relating to relevant geology and soils legislation and policy can be viewed in Chapter 9 of Volume 1.

9.3 Consultation

9.3.1 The following consultation responses are considered to be relevant to the geology and soils assessment:

Table 9-1 Summary of Relevant Consultation Responses

Consultee	Comments	Where Addressed
Natural England	Regionally and Locally Important Sites The ES should thoroughly assess the impact of the proposals on non-statutory sites, for example Local Wildlife Sites, Local Nature Reserves (LNR) and Regionally Important Geological and Geomorphological Sites (RIGS). Natural England does not hold comprehensive information on these sites. We therefore advise that the appropriate local biological record centres, nature conservation organisations, Local Planning Authority and local RIGS group should be contacted with respect to this matter.	Consultation with Nottinghamshire Biological and Geological Records Centre (Table 9-2). Section 9.5– Baseline conditions.
	Land use and soils Impacts from the development should be considered in light of the Government's policy for the protection of the best and most versatile (BMV) agricultural land as set out in paragraph 170 and 171 of the NPPF. We also recommend that soils should be considered under a more general heading of sustainable use of land and the valuing of the ecosystem services they provide as a natural resource, also in line with paragraph 170 of the NPPF. Soil is a finite resource that fulfils many important functions and services (ecosystem services) for society; for instance as a growing medium for food, timber and other crops, as a store for carbon and water, as a reservoir of biodiversity and as a buffer against pollution. It is therefore important that the soil resources are protected and used sustainably. The Natural Environment White Paper (NEWP) 'The Natural Choice: securing the value of nature' (Defra, June 2011), emphasises the importance of natural resource protection, including the conservation and sustainable management of soils and the protection of BMV agricultural land.	Soil and agricultural land classification survey. Section 9.9– Additional Mitigation.

Consultee	Comments	Where Addressed
	Development of buildings and infrastructure prevents alternative uses for those soils that are permanently covered, and also often results in degradation of soils around the development as result of construction activities. This affects their functionality as wildlife habitat, and reduces their ability to support landscape works and green infrastructure. Sealing and compaction can also contribute to increased surface run-off, ponding of water and localised erosion, flooding and pollution. Defra published a Construction Code of Practice for the sustainable use of soils on construction sites (2009). The purpose of the Code of Practice is to provide a practical guide to assist anyone involved in the construction industry to protect the soil resources with which they work. As identified in the NPPF new sites or extensions to new sites for Peat extraction should not be granted permission by Local Planning Authorities or proposed in development plans. General advice on the agricultural aspects of site working and reclamation can be found in the Defra Guidance for successful reclamation of mineral and waste sites.	

9.4 Assessment Methodology

Baseline Conditions

9.4.1 To determine the baseline conditions, a Phase 1 geo-environmental desk study was prepared for the site by Via between November 2020 and October 2021, taking into account changes to the assessment boundary over that period of time. The desk study gathered information from historical mapping and environmental data searches provided in a site-specific Envirocheck report. A site walkover survey was also carried out for the site to identify any potential sources of contamination and potential receptors. The information obtained in the desk study was used to develop a preliminary conceptual site model (CSM) for the site. The desk study report is included in Appendix 9-1 of Volume 3C.

9.4.2 The report is referenced as follows:

- Via East Midlands Ltd (2021). Lowdham Roundabout, Lowdham, Nottinghamshire. Phase 1 – Geo-Environmental Desk Study.

9.4.3 A soil resources and agricultural land quality survey has been carried out by Land Research Associates Ltd for the site (1st October and 1st November 2021). The results of the survey have been used to determine the agricultural land classification (ALC) for the site. The final report was not available at the time of writing; however, the initial findings of the ALC survey have been used to inform the geology and soils assessment.

9.4.4 To further inform the baseline conditions, additional consultation has been carried out with the following stakeholders, agencies and on-line resources:

Table 9-2: External Sources of Information

Stakeholder / Agency	Details
British Geological Survey (BGS)	GeoIndex Onshore (BGS, 2021a) – information on 1:50,000 geology, faults and artificial ground.

Stakeholder / Agency	Details
	1:50,000 geological map series (BGS, 1996). 113 Ollerton. Solid and Drift (British Geological Survey, 1996).
Cranfield Soil and Agrifood Institute (2021)	Soilscapes – information on soil types across England and Wales.
Defra (Defra, 2021)	Multi-Agencies Geographic Information for Countryside (MAGIC) – information on local geological sites.
Environment Agency	Information requested on groundwater and surface water abstractions, pollution incidents within the last five years and waste sites. Response received: 25th January 2021. Information on historic landfill sites (Environment Agency, 2021b. Information on authorised landfill site boundaries, (Environment Agency, 2021d).
Natural England	Information requested on sensitive geological sites within the study area. Response received: 2nd February 2021.
NSDC	Information requested on private water supply abstractions. Response received: 26th October 2020.
Nottinghamshire Biological and Geological Records Centre (NBGRC)	Information requested on sensitive geological sites within the study area. Response received: 19th January 2021.

9.4.5 An intrusive ground investigation will be carried out prior to construction. The investigation will include contamination testing and environmental risk assessments for human health, controlled waters and off-site receptors. The results of the investigation will be used to develop appropriate mitigation strategies, including measures to deal with contaminated soils or groundwater that may be encountered during construction.

9.4.6 Based on the site history and Scheme, the intrusive geo-environmental ground investigation is not considered to be a pre-requisite for undertaking the geology and soils assessment.

Study Area

9.4.7 For the purposes of the geology and soils assessment, the study area includes the main extents of the Scheme construction, as defined by the geology and soils assessment boundary (“the site”) and a buffer of 250 m from the assessment boundary. The site excludes areas of the Scheme that are limited to proposed street lighting or signage installation on existing highway land. Any baseline information related to soil geochemistry has been limited to the site area only.

9.4.8 In the case of controlled waters receptors, the study area is extended to include relevant features within 1 km of the assessment boundary. This includes any significant groundwater Source Protection Zones (SPZ), water abstractions, discharge consents, surface water receptors and pollution incidents to controlled waters. It is noted that surface water receptors could potentially be impacted by the Scheme over greater distances than 1 km downstream. This has been taken into account in the assessment, where relevant.

9.4.9 The study area is shown in Figure 9-1 of Volume 2C.

Methodology for Determining Construction Effects

9.4.10 The construction effects are determined by considering how the construction works could affect the environmental receptors identified in the baseline assessment, compared with the existing baseline conditions. The effects are generally considered to be short-term / temporary during the construction phase. However, the assessment includes permanent effects related to loss of or damage to soil resources and to changes in ground contamination conditions during the construction of the Scheme.

9.4.11 Potential geology and soils effects related to the construction of a road scheme can be both adverse and beneficial.

9.4.12 Examples of potential adverse effects are:

- increased mobilisation of contaminants during construction as dust, which could be inhaled or ingested by human receptors or deposited onto surrounding land;
- increased mobilisation of contaminants through leaching of contaminated materials exposed or disturbed during construction, which could impact groundwater and surface water receptors;
- mobilisation of ground gas or vapours during construction, which could impact off-site receptors;
- soil or groundwater contamination from hazardous materials or substances used during construction (e.g. fuel spills, air borne contaminants and spray);
- accidental release of contaminated materials onto surrounding transport routes during transport of contaminated materials from a construction site;
- loss of best and most versatile (BMV) agricultural land or important soil resources;
- damage to BMV agricultural land or important soil resources;
- loss of important geological features, or permanently reduced access; and
- damage to important geological features.

9.4.13 Examples of potential beneficial effects are:

- removal of older road surfacing materials, which may contain contaminants, such as coal tar.
- removal or stabilisation of contaminated soils and other materials in the ground during the construction works.
- removal or remediation of contaminated groundwater during the construction works.

Methodology for Determining Operational Effects

9.4.14 The operational effects are determined by considering how the future use of the site, following completion of the Project, could affect the environmental receptors identified in the baseline, compared with the existing baseline conditions. The effects are generally considered to be long-term / permanent.

9.4.15 The potential geology and soils effects during operation of a road scheme can be both adverse and beneficial.

9.4.16 Examples of potential adverse effects are:

- Increased release of soil contaminants into the environment due to inappropriate placement of contaminated materials, for example, within new embankments. This could have an impact on human receptors, through inhalation, ingestion or dermal contact.
- Increased leaching of soil contaminants into the environment, due to inappropriate placement of contaminated materials. This could have an impact on controlled waters receptors, through vertical and lateral migration in groundwater.
- Release of highways related contaminants into the environment, for example in spray or spills. This could occur as a result of general traffic movements over time, routine road maintenance activities and road traffic accidents or other incidents.
- Increased soil erosion impacts, for example within cuttings and embankments.

9.4.17 Examples of potential beneficial effects are:

- Reduced future risks from soil and groundwater contaminants due to ground improvements. For example, removal or treatment of contaminated soils and groundwater, or appropriate placement of potentially contaminated materials in low risk areas.
- Reduced future risks from highways related contaminants due to improved design and materials. For example, improved drainage, improved hardstanding materials and better traffic management and flow.
- Improved access to designated sites or potential to uncover new features of interest. For example, new geological exposures in road cuttings.
- Mitigation of existing adverse soil erosion effects through improved drainage.

Significance Criteria

9.4.18 Qualitative environmental assessments have been carried out to determine the significance of potential geology and soils effects on potential environmental receptors. The general methodology, based on DMRB LA 104, is described in Chapter 4 of Volume 1.

9.4.19 The significance of the effects (described as adverse, neutral or beneficial) have been determined using the significance matrix taken from DMRB LA 104, which has been reproduced in ES Volume 1 Chapter 4: Environmental Assessment Methodology. This is based on the environmental value (sensitivity) versus the magnitude of impact (degree of change).

9.4.20 The criteria used to determine the receptor sensitivity and magnitude of impact for geology and soils are presented in Table 9-3 and Table 9-4, respectively.

9.4.21 Very large, large and moderate effects are considered to be significant, while slight and neutral effects are considered to be manageable and not significant.

9.4.22 In some cases the significance falls between two levels, e.g. a minor impact on a high sensitivity receptor gives a “slight or moderate” effect. In these cases, one level of significance has been selected, with justification for that decision included in the assessment.

Receptor Sensitivity

9.4.23 The receptor sensitivity has been assessed using the criteria in Table 9-3. This is based on Table 3.11 of DMRB LA 109 for geology, soils and human health receptors and Table 3.70 of DMRB LA 113 for surface water and groundwater receptors.

Table 9-3 Environmental Value (sensitivity) and Descriptions (based on DMRB LA 109 and LA 113)

Receptor value (sensitivity)	Description	Typical examples
Very high	Geology	Very rare and of international importance with no potential for replacement (e.g. UNESCO World Heritage Sites, UNESCO Global Geoparks, SSSIs and GCR sites where citations indicate features of international importance). Geology meeting international designation citation criteria which is not designated as such.
	Soils	Soils directly supporting an EU designated site (e.g. SAC, SPA, Ramsar). Agricultural land classification (ALC) grade 1 & 2 or Land Capability for Agricultural Classification (LCAc) grade 1 & 2.
	Contamination – human health	Very high sensitivity land use such as residential or allotments.
	Contamination – surface water	Watercourse having a WFD classification shown in a RBMP and Q95[3] ≥1.0 m^3/s. Site protected under EC or UK legislation (SAC, SPA, SSSI, Ramsar site, salmonid water). Species protected by EC legislation.
	Contamination – groundwater	Principal Aquifer providing a regionally important resource and / or supporting a site protected under EC and UK legislation. Groundwater that locally supports GWDTE. SPZ 1.
High	Geology	Rare and national importance with little potential for replacement (e.g. geological SSSI, ASSI, NNR). Geology meeting national designation citation criteria which is not designated as such.
	Soils	Soils directly supporting a UK designated site (e.g. SSSI). ALC grade 3a or LCAc grade 3.1.
	Contamination – human health	High sensitivity land use such as public open space.
	Contamination – surface water	Watercourse having a WFD classification shown in a RBMP and Q95 <1.0 m^3/s. Species protected under EC or UK legislation.
	Contamination – groundwater	Principal Aquifer providing locally important resource or supporting a river ecosystem. Groundwater that supports a GWDTE SPZ 2.
Medium	Geology	Geology of regional importance with limited potential for replacement (e.g. RIGS). Geology meeting regional designation citation criteria which is not designated as such.
	Soils	Soils supporting non-statutory designated sites (e.g. LNRs, LGSs, SNCIs).

[3] Q95: The flow in cubic metres per second which was equalled or exceeded for 95% of the flow record. The Q95 flow is a significant low flow parameter particularly relevant in the assessment of river water quality consent conditions.

Receptor value (sensitivity)	Description	Typical examples
		ALC grade 3b or LCAc grade 3.2.
	Contamination – human health	Medium sensitivity land use such as commercial or industrial.
	Contamination – surface water	Watercourses not having a WFD classification shown in a RBMP and Q95 >0.001 m^3/s.
	Contamination – groundwater	Aquifer providing water for agricultural or industrial use with limited connection to surface water. SPZ 3.
Low	Geology	Geology of local importance / interest with potential for replacement (e.g. non-designated geological exposures, former quarries / mining sites).
	Soils	ALC grade 4 & 5 or LCAc grade 4.1 to 7. Soils supporting non-designated notable or priority habitats.
	Contamination – human health	Low sensitivity land use such as highways and rail.
	Contamination – surface water	Watercourses not having a WFD classification shown in a RBMP and Q95 ≤0.001 m^3/s.
	Contamination – groundwater	Unproductive strata.
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 – human health	Undeveloped surplus land / no sensitive land use proposed.
	Contamination – surface water	N/A
	Contamination – groundwater	N/A

9.4.24 DMRB LA 109 also notes that soils not categorised as best and most versatile (land in grades 1, 2 and 3a of the ALC) or prime land (land in grades 1, 2 and 3.1 of the LCAc) can be allocated in a higher sensitivity category where particular agricultural practices contribute to the quality and character of the environment or local economy (e.g. in upland areas where lower quality agricultural land is integral to agricultural practices).

Magnitude of Change

9.4.25 The magnitude of change on the receptors has been determined using the criteria in Table 9-4. This is based on Table 3.12 and Table E/2.1 of DMRB LA 109 for geology, soils and human health receptors. The relevant sensitivity criteria in Table 3.71 of DMRB LA 113 have been used for surface water and groundwater receptors.

Table 9-4 Magnitude of Impact (based on DMRB LA 109 and LA 113)

Magnitude of impact (change)	Description	Typical examples
Major	Geology	Loss of geological feature / designation and / or quality and integrity. Severe damage to key characteristics, features or elements.
	Soils	Physical removal or permanent sealing of >20 ha of agricultural land.
	Contamination – human health	Significant contamination identified. Contamination levels significantly exceed background levels and relevant screening criteria (e.g. category 4 screening levels (CL:AIRE, 2014)) with potential for significant harm to human health. Contamination heavily restricts future use of land.
	Contamination – surface water	Failure of both acute-soluble and chronic-sediment related pollutants in HEWRAT and compliance failure with EQS values. Calculated risk of pollution from a spillage ≥2% annually (spillage assessment). Loss or extensive change to a fishery. Loss of regionally important public water supply. Loss or extensive change to a designated nature conservation site. Reduction in water body WFD classification.
	Contamination – groundwater	Loss or, or extensive change to, an aquifer. Loss of regionally important water supply. Potential high risk of pollution to groundwater from routine runoff – risk score >250 (Groundwater quality and runoff assessment). Calculated risk of pollution from spillages ≥2 % annually (Spillage assessment). Loss of, or extensive change to GWDTE or baseflow contribution to protected surface water bodies. Reduction in water body WFD classification.
Moderate	Geology	Partial loss of geological feature / designation, potentially adversely affecting the integrity. Partial loss of / damage to key characteristics, features or elements.
	Soils	Physical removal or permanent sealing of 1 ha – 20 ha of agricultural land. 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 – human health	Contaminant concentrations exceed background levels and are in line with limits of relevant screening criteria (e.g. category 4 screening levels (CL:AIRE, 2014)). Significant contamination can be present. Control / remediation measures are required to reduce risks to human health / make land suitable for intended use.

Magnitude of impact (change)	Description	Typical examples
	Contamination – surface water	Failure of both acute-soluble and chronic-sediment related pollutants in HEWRAT but compliance with EQS values. Calculated risk of pollution from spillages ≥1 % annually and <2 % annually. Partial loss in productivity of a fishery. Degradation of regionally important public water supply or loss of major commercial / industrial / agricultural supplies. Contribution to reduction in water body WFD classification.
	Contamination – groundwater	Partial loss or change to an aquifer. Degradation of regionally important public water supply or loss of significant commercial / industrial / agricultural supplies. Potential medium risk of pollution to groundwater from routine runoff – risk score 150-250. Calculated risk of pollutant from spillages ≥1 % annually and <2 % annually. Partial loss of the integrity of GWDTE. Contribution to reduction in water body WFD classification.
Minor	Geology	Minor measurable change in geological feature / designation attributes, quality or vulnerability. Minor loss of, or alteration to, one (maybe more) key characteristics, features or elements.
	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 – human health	Contaminant concentrations are below relevant screening criteria (e.g. category 4 screening levels (CL:AIRE, 2014)). Significant contamination is unlikely with a low risk to human health. Best practice measures can be required to minimise risks to human health.
	Contamination – surface water	Failure of either acute soluble or chronic sediment related pollutants in HEWRAT. Calculated risk of pollution from spillages ≥0.5 % annually and <1 % annually. Minor effects on water supplies.
	Contamination – groundwater	Potential low risk of pollution to groundwater from routine runoff – risk score <150. Calculated risk of pollution from spillages ≥0.5 % annually and <1 % annually. Minor effects on an aquifer, GWDTEs, abstractions.
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	Physical removal or permanent sealing of <1 ha of agricultural land.

Magnitude of impact (change)	Description	Typical examples
		No discernible loss / reduction of soil function(s) that restrict current or approved future use.
	Contamination – human health	Contaminant concentrations substantially below levels outlined in relevant screening criteria (e.g. category 4 screening levels (CL:AIRE, 2014)). No requirement for control measures to reduce risks to human health / make land suitable for intended use.
	Contamination – surface water	No risk identified by HEWRAT (pass both acute-soluble and chronic-sediment related pollutants). Risk of pollution from spillages <0.5 %.
	Contamination – groundwater	No measurable impact upon an aquifer and / or groundwater receptors and risk of pollution from spillages <0.5 %.
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	Reported contaminant concentrations below background levels.
	Contamination – surface water	No loss or alteration of characteristics, features or elements; no observable impact in either direction.
	Contamination – groundwater	No loss or alteration of characteristics, features or elements; no observable impact in either direction.

Assumptions and Limitations

9.4.26 The geology and soils assessment is based on information obtained from a geo-environmental desk study, using the sources described in Section 8.5 above. The assessment is based on the information available at the time of reporting and is based on the Scheme design as described in Chapter 2: The Scheme, including the likely extents of land take required for its construction and operation.

9.4.27 As part of the assessment, it is assumed that the roundabout and surrounding roads will be partially in use during construction of the Scheme. Therefore, road-users are included as receptors during the construction phase.

9.4.28 It is assumed that the Scheme will not include the development of new land uses that could result in additional significant contamination sources or receptors, with the exception of a proposed balancing pond or ponds to the west of the junction.

9.4.29 It is assumed that all areas of temporary land use during the construction phase will be returned to the current land use on completion of the Project.

9.4.30 Re-use or disposal of materials arising from construction will be managed in accordance with the Definition of Waste: Development Industry Code of Practice (CL:AIRE, 2011) or appropriate waste management regulations, as applicable.

9.4.31 In accordance with DMRB LA 109, potential effects related to ground stability do not form part of the geology and soils assessment. It is noted that the Envirocheck report (see Appendix 9-1 of Volume 3C) identified a moderate risk of natural ground

stability hazards from compressible deposits (alluvium) underlying the site and there may be potential risks from areas of deep made ground, if present. The site is also located within an area affected by deep coal mining. However, ground stability risks are expected to be low. The results of the Phase 2 ground investigation will be used by the design team to verify the design.

9.4.32 In accordance with DMRB LA 109, potential effects related to impacts on future mineral resources do not form part of the geology and soils assessment. However, as the Scheme will be located in the area of the existing road junction, it is not expected to have any significant impacts on mineral resources.

9.5 Baseline Conditions

9.5.1 Baseline conditions have been identified for the study area to assess the potential geology and soils effects of the Scheme on the receptors identified in Table 9-3.

Topography

9.5.2 The topographic baseline has been determined using the results of a topographic survey of the proposed Scheme permanent works and OS topographic mapping included within the Envirocheck report. These documents are included within the desk study (Appendix 9-1 of Volume 3C).

9.5.3 The existing roundabout is located at an elevation of approximately 20.50 m AOD on the highway, increasing to 21.27 m AOD at the highest area of the central island. The following changes in elevation were recorded within the assessment boundary, moving away from the roundabout:

- To the north-west, the A6097 / Epperstone Bypass rises to approximately 21.20 m AOD at the assessment boundary. The road falls away from the centreline to the verges, with ditches on either side of the carriageway.
- To the north-east, Southwell Road rises gradually to approximately 21.30 m AOD at the assessment boundary. The A612 / Nottingham Road falls from approximately 20.45 m AOD at the intersection with Southwell Road to 20.40 m AOD at the assessment boundary.
- To the south-east, the A6097 / Epperstone Bypass rises slightly to approximately 20.80 m AOD at the assessment boundary. The road falls away from the centreline to the verges, with a ditch on the south-western side of the carriageway.
- To the south-west, the A612 / Nottingham Road rises gradually to approximately 20.90 m AOD.
- To the west, the roundabout is bordered by a ditch, beyond which, elevations of approximately 19.80 m AOD were recorded at the edge of the field, with an increase in gradient to the south-west.

9.5.4 Within the study area, the surrounding areas to the west and north of the site increase in elevation, rising up to approximately 40 m AOD at the edge of the study area, 250 m west of the assessment boundary. The roadside verge to the north of the roundabout is bordered by a 1 m high embankment, which is off-site. The land to the east of the site is relatively flat lying.

9.5.5 In the wider surrounding area, within 1 km of the assessment boundary, the ground levels continue to increase to the west of the site. To the north, the ground level drops back down to approximately 20 m AOD, from a hilltop east and north of Lowdham. To the east, the ground level does not change significantly within 1 km of the site; however, there is a gentle downward gradient to the south-east.

9.5.6 The topographic data indicates a general fall in elevation towards the existing roundabout from the field to the west and from Lowdham to the north.

Published Geology

9.5.7 A summary of the geological setting of the site, based on BGS mapping sources (Section 9.4) is presented in Table 9-5.

Table 9-5 Summary of Published Geology

Geological Feature	Description
Artificial Deposits	No deposits of artificial ground are shown on the geological mapping sources. However, due to the development history of the Scheme, shallow deposits of made ground are expected to be present across much of the study area.
Superficial deposits	The published BGS geological mapping identifies alluvium across most of the site area. This is described as clay, silt, sand and gravel. Head deposits are located in the western and eastern parts of the study area and underly the north-western corner of the site. These deposits are described as clay, silt, sand and gravel. Deposits of Holme Pierrepont Sand and Gravel Member are locally present in the south-eastern part of the study area. These deposits comprise sand and gravel.
Bedrock Geology	The published BGS geological mapping identifies the bedrock geology within most of the study area as the Sidmouth Mudstone Formation, Radcliffe Member. This is described as finely interlaminated mudstone, siltstone and very fine-grained sandstone. The Sidmouth Mudstone Formation, Gunthorpe Member underlies the temporary work areas in the western part of the site and the study area lying to the west of the Scheme. This is described as red-brown mudstone with subordinate greenish grey dolomitic siltstone and fine-grained sandstone. Gypsum veins and nodules are common.
Faults	No faults are mapped within the study area.

Geological Features

9.5.8 No designated regionally important geological sites (RIGS) or local geological sites (LGS) have been identified within the study area. This is based on the MAGIC application and information from the Nottinghamshire Biological and Geological Records Centre.

Hydrogeology

9.5.9 The key hydrogeological features of the study area, which are considered relevant to the geology and soils assessment, are summarised in Table 9-6.

Table 9-6 Summary of Hydrogeological Baseline

Hydrogeological Feature	Description
Aquifers	The alluvium is classified as a Secondary A Aquifer and the head deposits are classified as a Secondary Aquifer (undifferentiated).

Hydrogeological Feature	Description
	The Radcliffe Member and Gunthorpe Member are classified as Secondary B Aquifers. Based on the topography of the study area, the main direction of groundwater flow is likely to be to the south-east and / or east, towards the River Trent.
Groundwater vulnerability	Groundwater vulnerability is classed as high in relation to the superficial and bedrock geology. High vulnerability is defined as 'areas able to easily transmit pollution to groundwater. They are characterised by high-leaching soils and the absence of low-permeability superficial deposits'.
Groundwater Source Protection Zones (SPZ) and Drinking Water Groundwater Safeguard Zones (SgZ)	Source protection zones are defined around large and public potable groundwater abstraction sites. The Scheme is not located within or near to a groundwater SPZ. A SPZ 3 (total catchment area) is located approximately 900 m north of the assessment boundary. This is for a public water supply abstraction located approximately 2 km to the north-west of the site. The study area is not located within a Drinking Water SgZ for groundwater. However, a Drinking Water SgZ is located 1.27 km north-west of the site.
Groundwater abstractions	Information from the Environment Agency indicates that there are no current licenced groundwater abstractions within 1 km of the assessment boundary. One Environment Agency licenced groundwater abstraction has been identified in the Envirocheck report within 1 km of the assessment boundary. This relates to spray irrigation for a cricket club and is located approximately 870 m east of the Scheme. It is possible that this abstraction is no longer active, as it is not included within the Environment Agency dataset. However, no end date has been supplied for the licence. No private water supply boreholes have been identified by NSDC within 1 km of the assessment boundary. Two boreholes are located approximately 1.4 km and 1.8 km to west of the existing roundabout. Based on the distance and likely up-gradient position of these boreholes, it is considered unlikely that they are at risk from the site.
Discharge consents to groundwater	Information on discharge consents is based on the Envirocheck report only. Four discharge consents to groundwater have been identified within 1 km of the assessment boundary. These relate to sewage effluent discharges to groundwater. The closest discharge consent record is approximately 115 m north-east of the assessment boundary.
Groundwater levels	Groundwater levels at the site are not known. However, the site is in an area with potential for groundwater flooding to occur at surface. Therefore, groundwater is likely to be present at shallow depth.
Permeability	Based on the anticipated geology at the site, the soils are expected to have variable permeability. Infiltration of surface water is likely to be restricted due to the likely presence of cohesive clay layers within the superficial deposits and mudstone / siltstone bedrock.

9.5.10 The baseline information indicates that the groundwater receptors within the study area have a medium environmental sensitivity.

9.5.11 Further details on the hydrogeological conditions at the location of the Scheme are presented in Chapter 11: Road Drainage and the Water Environment.

Hydrology

9.5.12 The key hydrological features of the study area, which are considered relevant to the geology and soils assessment, are summarised in Table 9-7.

Table 9-7 Summary of Hydrological Baseline

Hydrological Feature	Description
Surface water features	There are two surface water features in the southern area of the site. These comprise a short ditch, which follows the south-western edge of the A6097 / Epperstone Bypass and a stream which flows to the north-east along the south-eastern edge of the A612 / Nottingham Road before changing direction and flowing to the south-east along the north-eastern boundary of the adjacent field. This stream connects with other land drains to the south of the site and is a tributary of the Cocker Beck. The topographic survey for the site also identified roadside drains in the northern area of the site along the A6097 / Epperstone Bypass. Highway surface water drainage from within the site area and the wider study area to the north-west and south-west is expected to runoff into the ditches and stream on-site. During a site walkover visit in December 2020, an oily sheen indicative of hydrocarbon contamination was noted on the surface of water standing in the drainage ditch in the southern site area. A river, identified as the Cocker Beck, is located to the north and east of the site and is approximately 80 m from the site at the closest point. The Cocker Beck flows south to the River Trent, which is approximately 2 km south of the assessment boundary. Cocker Beck has a Q95 of 0.012 m^3/s. A HEWRAT assessment has been carried out for the Cocker Beck (see Chapter 11: Road Drainage and the Water Environment). Dover Beck is located approximately 1 km to the north-east of the site, flowing south-east to the River Trent, and several land drains are located on agricultural land lying between the Cocker Beck and Dover Beck. There are several pond features within 1 km of the site. The closest pond is approximately 300 m to the south-west of the assessment boundary.
Surface water quality	Cocker Beck recorded a GQA Grade C (fairly good) for river quality in 2000 at a monitoring point to the north-west of the site. The Cocker Beck (tributary of River Trent) had a ‘moderate’ ecological status in 2019. The 2027 objective is for ecology is ‘good’.
Drinking Water Surface Water Safeguard Zones (SgZ)	No Drinking Water SgZ for surface water are located within 2 km of the site.
Surface water abstractions	Information from the Environment Agency and the Envirocheck report indicates that there is one surface water abstraction within 1 km of the assessment boundary. The Envirocheck report includes four records for the abstraction, which are located approximately 700 m south of the assessment boundary and is used for spray irrigation (general agriculture).
Discharge consents to surface water	Six surface water discharge consents have been identified in the Envirocheck report within 1 km of the assessment boundary. The closest is located approximately 45 m north-east of the site and relates to discharge of surface water from a storm tank. The status is listed as surrendered. The remaining discharge consents relate to discharge of surface water, final effluent from sewage treatment works and sewage discharges (final / treated effluent) from a domestic property.

Hydrological Feature	Description
Pollution incidents to controlled waters (up to 1999)	Ten incidents have been identified within 1 km of the site in the Envirocheck report, between 1996 and 1999. All were Category 3 (minor) incidents.
Substantiated pollution incidents register (from 1999)	The Environment Agency has provided information on substantiated pollution incidents in the last five years. One incident was located within 1 km of the assessment boundary and occurred in 2017. The incident was approximately 570 m east of the assessment boundary and was caused by sewage materials from an underground storage tank failure (domestic and residential). This was a Category 3 (minor) incident to water. No substantiated pollution incidents between 1999 and 2014 were identified in the Envirocheck report within 1 km of the site.
Surface water flooding	The indicative floodplain map for the area, presented in the Envirocheck report, shows that the site lies within a flood zone 2 and flood zone 3 area. The site is generally at medium (100-year return) with localised high risk (30-year return) of surface water flooding, indicated in the north-west and to the north of the site.

9.5.13 The baseline information indicates that the surface watercourses on-site have a high environmental sensitivity, as they include a tributary of the Cocker Beck.

9.5.14 As the Cocker Beck has a WFD status and a Q95 of 0.012 m^3/s, the environmental sensitivity of this watercourse is high.

9.5.15 Dover Beck is unlikely to be directly down-gradient of the site and is at least 1 km in distance from the site. This watercourse is therefore not considered to be a significant potential receptor for the geology and soils assessment.

9.5.16 Local ponds and drainage ditches outside the assessment boundary have also been excluded as potential receptors from the geology and soils assessment. These features are considered to be very low risk, compared with the on-site drainage features.

9.5.17 Further details on the hydrological baseline conditions at the location of the Scheme are presented in Chapter 11: Road Drainage and the Water Environment.

Historical and Current Land Uses

9.5.18 The baseline conditions related to historical and current land uses and their potential land contamination effects are summarised in Table 9-8 below.

Table 9-8 Historical and Current Land Uses

Identified Land Use	Description
Highways	The site was historically developed as a road prior to 1883, which ran through the site approximately north-east to south-west. Additional roads were constructed in the 1930s, forming the north-western and south-eastern branches of the existing junction. The existing Lowdham roundabout is located in the central part of the study area. The roundabout was constructed approximately in the late 1950s – early 1960s. The centre of the roundabout is grass-covered, with curb stone edging. Four roads branch out from the roundabout, comprising the A6097 / Epperstone Bypass to the north-west and south-east and the A612 / Nottingham Road to the north-east and south-west. Southwell Road is also located within the study area, branching from Nottingham Road to the north-east of the roundabout.

Identified Land Use	Description
	A central grass covered reservation is located on the northern section of Epperstone Bypass and an asphalt covered paved section on the southern section. Grass verges are located around the outer perimeter of the roundabout. Manhole covers for buried services were observed sporadically during a walkover survey carried out in December 2020.
Agriculture	Agricultural land is located immediately west of the existing roundabout. The assessment boundary includes a portion of the agricultural field adjacent to the roundabout, comprising approximately 1.01 ha. Agricultural fields and farm buildings (Brakes Farm) are located to the south-west of the roundabout. The assessment boundary includes a portion of a field on the south-eastern side of Nottingham Road, comprising approximately 0.36 ha. The entrance to the field is surfaced with concrete hardstanding onto a rectangular hardcore-surfaced compound area, with a farm track beyond. During a site visit in October 2021, this entrance was found to be secured with temporary fencing and padlocks. It is understood that a steel portal frame building is being constructed within the field, to the rear of the farm buildings.
Residential	Four residential dwellings are located immediately south of the roundabout. The houses are not within the assessment boundary. Residential dwellings are also located to the south-west of the roundabout.
Public open space	To the north of the roundabout, there is an area of grass and trees, beyond which is a cricket club / sports field. This land is also outside the assessment boundary.
Railway	A railway line is located approximately 300 m south-east of the existing roundabout, running north-east to south-west. Lowdham Railway Station is also located within the study area, adjacent to the railway line.
Mining and quarrying	Historical land uses within the study area include a tan yard to the north-east and a brickyard to the north (both pre-1900). A brick works was also located to the south-west of the site (pre-1950). The site is located within a coal mining affected area. However, a Coal Mining Report obtained as part of the Phase 1 desk study did not identify any significant risks related to coal mining at the site.
Industrial land uses	A current garage is located 170 m north of the site. The garage has a small petrol station facility within the property. A depot and chimney were located to the east of the site, approximately from the 1960s. This area had been redeveloped for residential use by 1991.
Waste sites and infilled land	No registered or historical landfill or waste transfer sites have been identified within the study area. One area of potentially infilled land (water) is recorded approximately 60 m north-east of the site. Two areas of potentially infilled land (non-water) are recorded approximately 140 m to the south-west and 190 m to the north-east of the assessment boundary. These features are related to the former brickyard / brick works.
Designated sites	No designated sites are indicated within the study area. The site is not located within a SSSI impact risk zone. The site is located within a nitrate vulnerable zone (NVZ) and an area of adopted greenbelt.

9.5.19 The baseline information in Table 9-8 identifies the following potential sources of contamination at the site:

- made ground associated with the existing highway construction and surrounding developments;
- hardstanding materials containing coal tar and other potential contaminants;
- spills and leaks of fuels / oils from vehicles utilising the roads on-site;
- spills and leaks from the petrol station to the north of the site;
- agricultural land uses (e.g. fertilisers, pesticides, herbicides, leaks and spills); and
- potentially infilled land to the south-west and north-east.

9.5.20 The railway line to the south-east is considered to present a very low risk of contamination to the site, based on the distance and likely down-gradient location.

9.5.21 Based on the Scheme design (see Chapter 2: The Scheme) and baseline information in Table 9-8, the following potential human health receptors have been identified at the site:

- current and future users of the site, surrounding roads and farm businesses;
- current and future residents in the surrounding area;
- current and future users of the adjacent sports ground; and
- current and future consumers of agricultural products (e.g. crops, meat products).

Soil Resources and Agricultural Land Classification

9.5.22 The baseline conditions related to agricultural land classification (ALC) and soil resources are summarised in Table 9-9.

Table 9-9 Soil Resources and ALC

Resource	Description
Soil Types	The soils within the study area are described as loamy and clayey floodplain soils with naturally high groundwater. These soils have moderate fertility and medium carbon content. Close proximity to rivers can lead to pollution risks from floodwater scouring and from drainage water after spreading of fertiliser or slurry.
Agricultural soils	The assessment boundary includes two areas of agricultural land, comprising an area of approximately 1.01 ha immediately west of the existing roundabout and an area of approximately 0.36 ha to the south-west of the existing roundabout. Approximately 0.88 ha of this land is required for the temporary works during construction, with approximately 0.43 ha to be included within the permanent works to the west of the roundabout (for an attenuation pond) and approximately 0.065 ha to be included within the permanent works to the southw-est of the roundabout (for an access road). The initial findings of the ALC survey carried out at the site indicate that the areas of agricultural land on-site are largely Grade 2 and Grade 3a, which is considered to be best and most versatile (BMV) land, with small areas of Grade 3b.

9.5.23 Based on the desk study information and initial survey findings, the environmental sensitivity of the soil resources is assessed to be very high.

Future Baseline

9.5.24 The future baseline is expected to be very similar to the existing conditions as there will be limited changes in land use.

9.6 Design, Mitigation and Enhancement Measures

9.6.1 The geology and soils assessment is based on the absence of any specific / additional mitigation measures for geology and soils effects. However, general design, mitigation and enhancement measures, outlined in Chapter 2 – The Scheme, are included within the assessment. The relevant mitigation measures for geology and soils are summarised in Table 9-10.

Table 9-10 Mitigation Measures

Receptor	Mitigation	Design / Implementation
Geology	None required.	N/A
Soil resources	Mitigation measures will include the following: Prior to commencing construction works, re-usable topsoil and / or subsoil from areas of permanent loss will be stripped and stockpiled separately. A soil resources plan will be developed to identify re-use options for the material, where possible. Construction traffic will use designated traffic routes within the work sites to prevent unnecessary compaction and degradation of soil resources. Soil stockpiles will be not be stored close to potentially contaminative materials (e.g. fuel storage containers) and will not be mixed with construction waste or potentially contaminated materials.	The mitigation measures will be determined within a soil resources plan. The plan will be based on the findings of the soil resources and agricultural land quality survey and will be implemented by the appointed contractor. An earthworks strategy (or equivalent document) will be produced by the designer. This will be implemented by the contractor. ASWMP will be required for the Scheme. As part of the SWMP, a Materials Management Plan (MMP) will be prepared, to reduce the volume of material requiring waste disposal, including re-usable soil resources. The works will be carried out in accordance with the Defra “Code of Practice for the Sustainable Use of Soils on Construction Sites” (Defra, 2009), BS 3882:2015 “Specification for Topsoil and Requirements for Use” (BSI, 2013a), BS 8601:2013 “Specification for Subsoil and Requirements for Use” (BSI, 2013b) and the CL:AIRE guidance “The Definition of Waste: Development Industry Code of Practice” (2011).
Human health	Mitigation measures will include the following: Identification and assessment of unexpected areas of contamination. Removal of contamination hotspots, if identified. Dust control measures, to mitigate inhalation risks (e.g. damping down). Excavated materials will be stockpiled separately based on soil type, to prevent mixing of contaminated materials with uncontaminated materials. Spill control measures will be used, such as dedicated areas for fuel storage and refuelling, bunded tanks, impermeable bases / trays.	Prior to commencing construction works on site, a CEMP and SWMP / MMP will be prepared by the appointed contractor. This will be implemented by the contractor on-site. A contamination watching brief will be prepared and implemented by the contractor. This will identify the procedures required to ensure that any potential contamination encountered is identified, assessed and, if necessary, remediated.

Receptor	Mitigation	Design / Implementation
	Emergency spill response procedures and reporting will be in place throughout the construction phase of the project.	
Controlled waters	Mitigation measures will include the following: Spill control measures will be used, such as dedicated areas for fuel storage and refuelling, bunded tanks, impermeable bases / trays. Emergency spill response procedures and reporting will be in place throughout the construction phase of the project. The on-site watercourses will be protected from surface water runoff related to the construction works and temporary storage area. This could require, for example, an exclusion zone between the storage area and the watercourses, dedicated areas to store hazardous materials further away from the watercourses and barriers to prevent uncontrolled runoff.	Prior to commencing construction works on site, a CEMP will be prepared by the appointed contractor. This will be implemented by the contractor on-site. A drainage strategy will be prepared to inform the Scheme design. This will consider the potential risks to controlled waters associated with the proposed surface water drainage and identify any additional mitigation measures required to protect controlled waters. The drainage will be designed to have a neutral to beneficial effect compared with the existing baseline conditions.

9.7 Assessment of Likely Significant Effects

Construction

9.7.1 The possible geology and soils effects identified for the Scheme are described in Table 9-11.

Table 9-11 Geology and Soils Effects – Construction

Receptor Type	Type of Effect	Description
Soils	Adverse	Permanent loss of approximately 0.50 ha of agricultural land, in total.
		Temporary loss of approximately 0.88 ha of agricultural land during construction.
		Potential reduced soil quality (e.g. ALC) in areas of agricultural land used during the temporary works.
Contamination - human health - controlled waters	Adverse	The construction works could expose or disturb existing ground contamination at the site. This could create new pathways for contaminants to migrate to receptors through wind-blown dust, increased leaching of contaminants from soil into groundwater, surface water runoff and changes in the movement of groundwater and ground gas / vapours. The following potential sources of contamination have been identified: Made ground on-site. Hardstanding materials containing coal tar and other potential contaminants. Spills and leaks of fuels / oils from vehicles utilising the roads on-site. Agricultural runoff (e.g. nitrate). Potentially infilled land to the south-west and north-east. Spill and leaks of fuels / oils from the petrol filling stations to the north of the site.

Receptor Type	Type of Effect	Description
		Previous pollution incidents within the study area.
		Land or groundwater contamination could occur during the construction works, for example through leaks and spills of hazardous substances within construction compounds, access routes and work sites. This could potentially lead to short-term pollution incidents during the construction phase, and / or long-term detrimental impacts on the land and water quality of the study area, including the Scheme and restored areas of agricultural land.
		There could be slightly increased risks of contamination if road planings generated from breaking out the existing road surface are re-used within the Scheme. This is due to the potential presence of coal tar in older types of bituminous hardstanding. Road planings would have a much higher surface area exposed to the environment, compared with the intact hardstanding.
	Beneficial	Potentially contaminated soils or materials might be removed as part of the ground works operation, for example due to unsuitable geotechnical properties.
		Any imported materials used in the Scheme will be required to pass chemical compliance criteria and, as such, could be lower risk than existing fill materials.
		Contamination risks are likely to be reduced compared with the existing baseline if old surfacing containing coal tar is removed from the site entirely.

9.7.2 An assessment of the likely significance of the above effects during the construction of the Scheme is presented in Table 9-12. The magnitude of impact and significance are based on the possible effects in the absence of any specific mitigation measures for geology and soils effects.

Table 9-12 Significance of Geology and Soils Effects – Construction

Geology and Soils Receptor	Description of Sources / Cause of Impact	Description of Impacts	Receptor Value (Sensitivity)	Magnitude of Impact	Significance of Effects	Significant Effect? (Yes / No)
Geology	None identified.	None identified.	Negligible	No change	No change	No
Soils	Use of agricultural land for temporary compounds, storage and access during construction of the Scheme.	Permanent damage to agricultural land during construction works.	Very High	Negligible (adverse)	Moderate adverse (due to potential localised impacts around road boundaries)	Yes
		Temporary loss of approximately 0.88 ha of agricultural land, compared with the existing baseline.	Very high	Negligible (adverse)	Slight adverse	No
	Use of agricultural land within the permanent works for the Scheme.	Permanent loss of approximately 0.5 ha of agricultural land, compared with the existing baseline.	Very High	Negligible (adverse)	Slight adverse	No
Contamination – human health	Soil and groundwater contamination (see Table 9-11).	Impacts on nearby residents from ingestion of contaminated particulates, dermal contact with soils and / or inhalation of contaminated dust / particles.	Very high	Negligible (adverse)	Slight (due to short duration and low potential for contamination).	No
		Impacts on future consumers of agricultural produce (e.g. crops or meat products) due to contamination of agricultural land during construction (e.g. areas used for storage and compounds).	Very high	Negligible (adverse)	Slight adverse (due to potential for permanent contamination impact from construction works).	No
		Impacts on users of adjacent sports ground from ingestion of contaminated particulates, dermal contact with soils	High	Negligible (adverse)	Slight adverse (due to short duration and low	No

Geology and Soils Receptor	Description of Sources / Cause of Impact	Description of Impacts	Receptor Value (Sensitivity)	Magnitude of Impact	Significance of Effects	Significant Effect? (Yes / No)
		and / or inhalation of contaminated dust / particles.			potential for contamination).	
		Impacts on users of surrounding businesses from ingestion of contaminated particulates, dermal contact with soils and / or inhalation of contaminated dust / particles during construction.	Medium	Negligible (adverse)	Slight adverse (due to short duration and low potential for contamination).	No
		Impacts on road users from ingestion of contaminated particulates, dermal contact with soils and / or inhalation of contaminated dust / particles.	Low	Negligible (adverse)	Slight adverse	No
		Impacts on adjacent residents from inhalation of ground gas or vapours in indoor air that may have migrated from the site.	Very high	Negligible (adverse)	Slight adverse (due to short duration and low potential for ground gas)	No
		Impacts on users of surrounding businesses from inhalation of ground gas or vapours in indoor air that may have migrated from the site.	Medium	Negligible (adverse)	Slight adverse	No
Contamination – surface water	Soil and groundwater contamination (see Table 9-11).	Impacts on on-site watercourses from surface water run-off and / or migration of contaminated groundwater.	High	Minor (adverse)	Slight adverse (due to roadside location of the watercourses)	No
		Impacts on the Cocker Beck from surface water run-off and / or migration of contaminated groundwater.	High	Minor (adverse)	Slight adverse (due to distance from the site)	No

Geology and Soils Receptor	Description of Sources / Cause of Impact	Description of Impacts	Receptor Value (Sensitivity)	Magnitude of Impact	Significance of Effects	Significant Effect? (Yes / No)
Contamination – groundwater	Soil and groundwater contamination (see Table 9-11).	Impacts on Secondary A Aquifer from leaching of contaminated soils, surface water run-off and / or migration of contaminated groundwater.	Medium	Minor (adverse)	Slight adverse	No
		Impacts on Secondary Aquifer (undifferentiated) from leaching of contaminated soils, surface water run-off and / or migration of contaminated groundwater.	Medium	Minor (adverse)	Slight adverse	No
		Impacts on Secondary B Aquifers from leaching of contaminated soils, surface water run-off and / or migration of contaminated groundwater.	Medium	Minor (adverse)	Slight adverse	No

Operation

9.7.3 The possible geology and soils effects identified for the Scheme are described in Table 9-13.

Table 9-13 Geology and Soils Effects – Operation

Receptor Type	Type of Effect	Description
Contamination - human health - controlled waters	Adverse	The operation of the Scheme could potentially result in increased pathways for existing ground contamination from the identified potential sources (see Table 9-11) to migrate to receptors. For example: increased infiltration of groundwater through areas of contaminated ground; and migration of ground gas or contaminated groundwater through new service conduits or buried structures.
		Future contamination impacts from the road junction could be slightly higher than the current conditions (e.g. spills and leaks from vehicles on the road). This is due to the predicted increase in traffic and the increased risk of traffic collisions associated with the Scheme.
	Beneficial	Improvements in road surfacing, drainage and buried services could reduce the potential for contaminated surface water runoff to migrate to the receptors during operation.
		Improvements in road surfacing, drainage and buried services could also reduce the potential infiltration of groundwater through areas of contaminated ground during operation.

9.7.4 An assessment of likely significant effects during the operation of the Scheme is presented in Table 9-14. The magnitude of impact and significance are based on the possible effects in the absence of any specific mitigation measures for geology and soils effects.

Table 9-14 Significance of Geology and Soils Effects – Operation

Geology and Soils Receptor	Description of Sources / Cause of Impact	Description of Impacts	Receptor Value (Sensitivity)	Magnitude of Impact (Degree of Change)	Significance of Effects	Significant Effect? (Yes / No)
Geology	None identified.	None identified.	Negligible	No change	Neutral	No
Soils	None identified.	None identified.	High	No change	Neutral	No
Contamination – human health	Soil and groundwater contamination related to historical sources, construction works, and future uses of the site (see Table 9-13).	Impacts on future road users from ingestion of contaminated particulates, dermal contact with soils and / or inhalation of contaminated dust / particles.	Low	No change	Neutral	No
		Impacts on nearby residents from ingestion of contaminated particulates, dermal contact with soils and / or inhalation of contaminated dust / particles.	Very high	No change	Neutral	No
		Impacts on visitors to adjacent sports field from ingestion of contaminated particulates, dermal contact with soils and / or inhalation of contaminated dust / particles.	High	No change	Neutral	No
		Impacts on future consumers of agricultural produce (e.g. contaminated crops or meat products) due to contamination of agricultural land.	Very high	Negligible (adverse)	Slight adverse	No
		Impacts on users of surrounding businesses from ingestion of contaminated particulates, dermal contact with soils and / or inhalation of contaminated dust / particles.	Low	No change	Neutral	No

Geology and Soils Receptor	Description of Sources / Cause of Impact	Description of Impacts	Receptor Value (Sensitivity)	Magnitude of Impact (Degree of Change)	Significance of Effects	Significant Effect? (Yes / No)
		Impacts on future road users from inhalation of ground gas or vapours.	Low	No change	Neutral	No
		Impacts on adjacent residents from inhalation of ground gas or vapours migrating from the Scheme.	Very high	Negligible (adverse)	Slight adverse	No
		Impacts on users of surrounding businesses from inhalation of ground gas or vapours that have migrated from the Scheme.	Medium	Negligible (adverse)	Neutral (due to low potential for ground gas sources)	No
Contamination – surface water	Soil and groundwater contamination related to historical sources, construction works, and future uses of the site (see Table 9-13).	Impacts on existing on-site watercourses from surface water run-off and / or migration of contaminated groundwater.	High	Minor (adverse)	Slight adverse (due to limited changes to the site from existing)	No
		Impacts on future balancing pond(s) from surface water run-off and / or migration of contaminated groundwater.	Low	Minor (adverse)	Slight adverse (due to new receptor)	No
		Impacts on the Cocker Beck from surface water run-off and / or migration of contaminated groundwater.	High	Negligible (adverse)	Slight adverse	No
Contamination – groundwater	Soil and groundwater contamination related to historical sources, construction works, and future uses of the site (see Table 9-13).	Impacts on Secondary A Aquifer from leaching of contaminated soils, surface water run-off and / or migration of contaminated groundwater.	Medium	Negligible (adverse)	Slight adverse (due to the Secondary A status and location directly below the site)	No

Geology and Soils Receptor	Description of Sources / Cause of Impact	Description of Impacts	Receptor Value (Sensitivity)	Magnitude of Impact (Degree of Change)	Significance of Effects	Significant Effect? (Yes / No)
		Impacts on Secondary Aquifer (undifferentiated) from leaching of contaminated soils, surface water run-off and / or migration of contaminated groundwater.	Medium	Negligible (adverse)	Neutral (due to location outside the site boundary)	No
		Impacts on Secondary B Aquifers from leaching of contaminated soils, surface water run-off and / or migration of contaminated groundwater.	Medium	Negligible (adverse)	Neutral (due to overlying alluvium across the site)	No

9.8 Additional Mitigation

9.8.1 Additional mitigation measures to address the likely significant geology and soils effects are presented in Table 9-15.

Table 9-15 Additional Mitigation Measures

Receptor	Additional Mitigation	Design / Implementation
Geology	None required.	N/A
Soil resources	Prior to commencing construction works, agricultural topsoil and, if required, subsoil will be excavated from the temporary work areas and will be stockpiled for use in restoration of the land on completion of the temporary works. Topsoil and subsoil will not be mixed together.	The mitigation measures will be determined within the soil resources plan.
Human health	Additional mitigation may be required if significant contamination is identified that presents a risk to one or more receptors.	A Phase 2 geo-environmental ground investigation will be carried out at the site in advance of any development works. Environmental risk assessments will be carried out to identify any additional mitigation measures required prior to construction. In the event that any unexpected contamination is identified, a remediation strategy will be prepared by a geo-environmental specialist. This will be implemented on site by the contractor, or a suitably qualified contaminated land consultant.
Controlled waters	Aquifer protection measures will be used if deeper excavations are required, subject to risk assessment. This could include, for example, measures to ensure that potentially contaminated materials are not smeared or mixed into the natural aquifer at depth and measures to prevent increased migration pathways forming between the ground surface and the underlying groundwater.	A Phase 2 geo-environmental ground investigation will be carried out at the site in advance of any development works. Environmental risk assessments will be carried out to identify any additional mitigation measures required prior to construction.

9.9 Residual Effects

9.9.1 An assessment of the geology and soils effects following implementation of additional mitigation measures is presented in Table 9-16.

9.9.2 The assessment concludes that all geology and soils effects will be reduced to slight adverse or neutral following implementation of mitigation measures and will not be significant.

9.9.3 The cumulative effects associated with permanent loss of agricultural land across the whole Project are discussed in Volume 1, Chapter 9.

Table 9-16: Residual Effects

Description of Effect	Sensitivity of Receptor	Nature of Effect/ Geographic Scale	Magnitude of Impact	Initial Classification of Effect (with embedded mitigation)	Additional Mitigation	Residual Effect Significance
Permanent damage to agricultural land during construction works.	Very high	Loss or damage to soil resources within the assessment boundary.	Minor (adverse)	Moderate adverse	See Table 9-15 for additional mitigation.	Slight adverse
Temporary loss of approximately 0.88 ha of agricultural land, compared with the existing baseline, during construction works.	Very high	Loss of agricultural land within the assessment boundary.	Negligible (adverse)	Slight adverse	No additional mitigation proposed.	Slight adverse
Permanent loss of approximately 0.50 ha of agricultural land, compared with the existing baseline.	Very high	Loss or damage to agricultural land within the assessment boundary.	Negligible (adverse)	Slight adverse	No additional mitigation proposed due to no discernible loss.	Slight adverse
Construction impacts on nearby residents from ingestion of contaminated particulates, dermal contact with soils and / or inhalation of contaminated dust / particles.	Very high	Contamination impacts on human health receptors within the study area.	Negligible (adverse)	Slight adverse	No additional mitigation proposed.	Slight adverse
Construction impacts on future consumers of agricultural produce (e.g. crops or meat products) due to contamination of agricultural land (e.g. areas used for storage and compounds).	Very high	Human health impacts from consumption of contaminated crops / meat.	Negligible (adverse)	Slight adverse	See Table 9-15 for additional mitigation.	Neutral
Construction impacts on users of the adjacent sports ground from ingestion of contaminated particulates, dermal contact with soils and / or inhalation of contaminated dust / particles.	High	Contamination impacts on human health receptors within the study area.	Negligible (adverse)	Slight adverse	No additional mitigation proposed.	Slight adverse
Construction impacts on users of surrounding businesses from ingestion of contaminated particulates, dermal contact	Medium	Contamination impacts on human health receptors within the study area.	Negligible (adverse)	Slight adverse	No additional mitigation proposed.	Slight adverse

Description of Effect	Sensitivity of Receptor	Nature of Effect/ Geographic Scale	Magnitude of Impact	Initial Classification of Effect (with embedded mitigation)	Additional Mitigation	Residual Effect Significance
with soils and / or inhalation of contaminated dust / particles.						
Construction impacts on road users from ingestion of contaminated particulates, dermal contact with soils and / or inhalation of contaminated dust / particles.	Low	Contamination impacts on human health receptors within the study area.	Negligible (adverse)	Slight adverse	No additional mitigation proposed.	Slight adverse
Construction impacts on adjacent residents from inhalation of ground gas or vapours in indoor air that may have migrated from the site.	Very high	Contamination impacts on human health receptors within the study area.	Negligible (adverse)	Slight adverse	No additional mitigation proposed.	Slight adverse
Construction impacts on users of surrounding businesses from inhalation of ground gas or vapours in indoor air that may have migrated from the site.	Medium	Contamination impacts on human health receptors within the study area.	Negligible (adverse)	Slight adverse	See Table 9-15 for additional mitigation.	Neutral
Construction impacts on on-site watercourses from surface water run-off and / or migration of contaminated groundwater.	High	Contamination impacts on surface water receptors within the site boundary.	Moderate (adverse)	Moderate adverse	See Table 9-15 for additional mitigation.	Neutral
Construction impacts on the Cocker Beck from surface water run-off and / or migration of contaminated groundwater.	High	Contamination impacts on surface water receptors within the study area.	Minor (adverse)	Slight adverse	See Table 9-15 for additional mitigation.	Neutral
Construction impacts on Secondary A Aquifer from leaching of contaminated soils, surface water run-off and / or migration of contaminated groundwater.	Medium	Contamination impacts on groundwater receptor within the study area.	Minor (adverse)	Slight adverse	See Table 9-15 for additional mitigation.	Neutral
Construction impacts on Secondary Aquifer (undifferentiated) from leaching of contaminated soils, surface water run-off and / or migration of contaminated groundwater.	Medium	Contamination impacts on groundwater receptor within the study area.	Minor (adverse)	Slight adverse	See Table 9-15 for additional mitigation.	Neutral

Description of Effect	Sensitivity of Receptor	Nature of Effect/ Geographic Scale	Magnitude of Impact	Initial Classification of Effect (with embedded mitigation)	Additional Mitigation	Residual Effect Significance
Construction impacts on Secondary B Aquifers from leaching of contaminated soils, surface water run-off and / or migration of contaminated groundwater.	Medium	Contamination impacts on groundwater receptor within the study area.	Minor (adverse)	Slight adverse	See Table 9-15 for additional mitigation.	Neutral
Impacts on future consumers of agricultural produce (e.g. contaminated crops or meat products) due to contamination of agricultural land during operation.	Very high	Contamination impacts on human health receptors outside the study area.	Negligible	Slight adverse	See Table 9-15 for additional mitigation.	Neutral
Impacts on adjacent residents from inhalation of ground gas or vapours migrating from the Scheme during operation.	Very high	Contamination impacts on human health receptors.	Negligible (adverse)	Slight adverse	See Table 9-15 for additional mitigation.	Neutral
Impacts on existing on-site watercourses from surface water run-off and / or migration of contaminated groundwater during operation.	High	Contamination impacts on surface water receptors within the site boundary.	Minor (adverse)	Slight adverse	See Table 9-15 for additional mitigation.	Neutral
Impacts on future balancing pond(s) from surface water run-off and / or migration of contaminated groundwater during operation.	Low	Contamination impacts on surface water receptor within the site boundary.	Minor (adverse)	Slight adverse	See Table 9-15 for additional mitigation.	Slight adverse
Impacts on the Cocker Beck from surface water run-off and / or migration of contaminated groundwater during operation.	High	Contamination impacts on surface water receptors within the study area.	Negligible (adverse)	Slight adverse	See Table 9-15 for additional mitigation.	Slight adverse
Impacts on Secondary A Aquifer from leaching of contaminated soils, surface water run-off and / or migration of contaminated groundwater during operation.	Medium	Contamination impacts on groundwater receptor within the study area.	Negligible (adverse)	Slight adverse	See Table 9-15 for additional mitigation.	Neutral

Description of Effect	Sensitivity of Receptor	Nature of Effect/ Geographic Scale	Magnitude of Impact	Initial Classification of Effect (with embedded mitigation)	Additional Mitigation	Residual Effect Significance
Impacts on Secondary Aquifer (undifferentiated) from leaching of contaminated soils, surface water run-off and / or migration of contaminated groundwater during operation.	Medium	Contamination impacts on groundwater receptor within the study area.	Negligible (adverse)	Slight adverse	See Table 9-15 for additional mitigation.	Neutral
Impacts on Secondary B Aquifers from leaching of contaminated soils, surface water run-off and / or migration of contaminated groundwater during operation.	Medium	Contamination impacts on groundwater receptor within the study area.	Negligible (adverse)	Slight adverse	See Table 9-15 for additional mitigation.	Neutral

10. NOISE AND VIBRATION

10.1 Introduction

10.1.1 This chapter considers the noise and vibration impacts of the construction and operation of the proposed Scheme by using the assessment methodology described in the DMRB LA 111 Noise and Vibration Version 2 (Highways England, 2020g).

10.1.2 This chapter should be read in conjunction with Figures 10-1 to 10-3 within Volume 2C and Appendix 10-1 in Volume 3C.

10.2 Legislation and Policy

10.2.1 Information relating to relevant noise and vibration legislation and policy can be viewed in Volume 1, Chapter 10.

10.3 Consultation

10.3.1 During the consultation on the Scoping Report, the proposed methodologies were set out and the statutory consultees were invited to comment on the proposals.

10.3.2 No specific comments were received in relation to the noise assessment methodology within the formal Scoping Opinions or the consultee responses.

10.3.3 A comment was received from the NCC Ecologist regarding the potential noise impacts on sensitive ecological receptors. Figure 10-2 of Volume 2C shows the noise contour changes across the study area and any impacts on ecological receptors is assessed in Chapter 8: Biodiversity, of this Environmental Statement.

10.4 Assessment Methodology

General Approach

10.4.1 The noise and vibration assessment includes the following elements:

- quantitative/qualitative assessment of construction noise and vibration impacts; and
- quantitative assessment of operational traffic noise impacts.

10.4.2 Construction traffic noise was scoped out as traffic changes during construction are expected to be minimal, and use the Major Road Network, resulting in minimal increases in the proportion of Heavy Goods Vehicles (HGV) within the traffic flows. Where short-term diversions are required, these are expected to be diverted to the Strategic Road Network (SRN), which would be likely to result in minor changes to traffic flows on these roads during construction.

10.4.3 Operational impacts resulting from vibration are scoped out of further assessment in accordance with DMRB.

10.4.4 Key methodology documents of relevance to the noise and vibration assessment are as follows:

- DMRB LA 111 Noise and Vibration;
- Calculation of Road Traffic Noise (CRTN);

- BS 5228-1&2:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites (BSI, 2009); and
- BS 7385-2: 1993 Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from ground borne vibration (British Standards Institute, 1993).

10.4.5 DMRB LA 111 describes a standard methodology for the assessment of noise and vibration impacts during the construction and operational phases of road projects.

10.4.6 The CRTN is the standard method applied in the UK to assess noise from road traffic. The document defines calculation methods for assessing road traffic noise based on the following five parameters: traffic flows, percentage of heavy vehicles, the traffic speed, the gradient of the road, and the road surfaces.

10.4.7 BS 5228-1&2 gives recommendations for basic methods of noise and vibration control relating to construction and open sites where work activities/operations generate significant noise and vibration levels. These are the standards more typically used to assess noise and vibration arising from construction activities.

Baseline Conditions

10.4.8 Baseline conditions in the vicinity of the Scheme are detailed in Section 10.5, which provides details of potentially sensitive receptors within the study area which have been determined from the OS address base dataset and OS mapping.

10.4.9 Sensitive receptors are illustrated in Figure 10-1 in Volume 2C. The vast majority of potentially sensitive receptors in the vicinity of the Scheme are residential properties. Non-residential potentially sensitive receptors can include educational buildings, medical buildings and facilities (such as places of worship).

10.4.10 The Institute of Acoustics (IOA) and the Association of Noise Consultants (ANC) published a document called “Joint Guidance on the Impact of COVID-19 on the Practicality and Reliability of Baseline Sound Level Surveying and the Provision of Sound & Noise Impact Assessments – Version 6 (Institute of Acoustics, 2021) to help their members to adjust their baseline assessments in light of the COVID pandemic.

10.4.11 The COVID pandemic has resulted in variation in journey patterns compared to pre-COVID travel patterns. Therefore, traditional baseline noise measurements have not been used to validate the noise model due to potential unreliability and inaccuracy of the data.

10.4.12 Current guidance states that for transport schemes, there may still need to be some reliance on predicted sound levels to describe the baseline conditions, with a corresponding need to obtain flow/ activity data. There are now many sources of noise/transport data available, and a link is provided to the most recent noise mapping carried out in England which includes the roads around Lowdham roundabout. The noise modelling undertaken for this Scheme was compared and validated against the noise levels in the Defra strategic noise maps (Extrium, 2018), produced in accordance with the requirements of the Environmental Noise (England) Regulations 2006 (as amended) (HMSO, 2006b) for the baseline year traffic data of 2018.

10.4.13 The 18-hour Average Annual Weekday Traffic ($AAWT_{18hr}$) flows for the baseline year of 2018 were used to create the baseline noise scenario (data provided from the traffic modelling as described in Chapter 4: Environmental Assessment Methodology) by using the CRTN method, and then compared with Defra’s strategic noise maps at two different validation locations for the following road traffic noise indicators: L_{den}, L_{night}, and $LA_{eq,16hr}$. The results of the validation exercise are

presented in Section 10.5

10.4.14 The future Do Minimum (without Scheme) conditions have been determined for the opening (2023) and future (2037) years, at all identified sensitive receptors based on predicted traffic noise levels in the absence of the Scheme. Details of the traffic noise prediction methodology for Do Something (with Scheme) scenarios are provided in the Operational section below.

10.4.15 A comparison has been made of the forecast Do Minimum Opening Year (DMOY) and Do Minimum Future Year (DMFY) to determine the change in the baseline condition. The DMOY vs DMFY will be modelled using traffic data factored to opening and future years.

Study Area

10.4.16 The study area for the construction phase noise and vibration impacts focuses on quantifying the potential impacts at the closest existing identified sensitive receptors to the various works, with some additional receptors selected to represent the impacts further away from the works. The selected receptors are collectively representative of all identified potentially sensitive receptors in the study area. By focussing on a selection of the closest identified potentially sensitive receptors the reported impacts at these receptors will, therefore, be typical of the worst affected receptors and all potentially significant effects will be identified. The receptors selected further away from the works will demonstrate how the impact will reduce further away from the works.

10.4.17 As detailed in DMRB LA 111 noise impacts from construction activities are assessed up to a maximum distance of approximately 300 m from the works, and vibration impacts up to a maximum distance of approximately 100 m from the works, as this is normally sufficient to encompass Noise Sensitive Receptors (NSRs). A total of 365 NSRs were identified within the 300 m study area and 52 were identified within the 100 m study area.

10.4.18 For the operational phase, the study area comprises an area 600 m from the roads physically changed by the Scheme. A total of 761 NSRs were identified within the 600 m study area.

10.4.19 The baseline assessment will identify any Noise Important Areas (NIA) located within the study as shown in the Defra Strategic Noise maps.

10.4.20 The construction and operational study areas and location of the NSRs are illustrated in Figure 10-1 of Volume 2C.

Methodology for Determining Construction Effects

Construction Noise

10.4.21 BS 5228-1 gives recommendations for basic methods of noise control relating to construction and open sites where work activities/ operations have the potential generate significant noise levels.

10.4.22 BS 5228-1 is the standard typically used to assess noise arising from construction activities. The methodology for predicting noise arising from construction activities described in BS 5228-1 has been used to predict noise levels arising from the proposed works at the nearest sensitive receptors.

10.4.23 Precise information on the construction works is not available at this stage and will be confirmed during the detailed design stage. Therefore, the estimated construction noise levels reported herein are based on a range of typical construction activities utilising the number and type of plant likely to be required for

each construction activity. Noise levels have then been predicted for each activity for a range of distances from the works boundary.

10.4.24 Annex C presented in BS 52228-1 provides the sound level data from a range of site equipment and activities. Values of the sound power levels for a particular type and size of machine and the equivalent continuous sound pressure levels for the site activities given in Tables C.1 to C.12 of BS 5228-1 has been used in the prediction of the activity noise levels.

10.4.25 Noise levels generated by construction activities are deemed to be significant if the total noise (pre-construction ambient plus construction noise) exceeds the pre-construction ambient noise by 5 dB or more, subject to lower cut-off values of 65 dB, 55 dB and 45 dB LA_{eq}, from construction noise alone, for the daytime, evening and night-time periods, respectively.

10.4.26 DMRB adopts the ABC method in BS 5228-1 for identifying the threshold of potentially significant construction noise effects. This approach is based on setting the threshold for the onset of potentially significant adverse effects (i.e. the significant observation adverse effect level (SOAEL)) depending on the existing ambient noise level. The lowest observed adverse effect level (LOAEL) is the existing ambient noise level. Table 10-1 below is adopted from Table E.1 in BS5228-1, which sets out the construction noise SOAEL and LOAEL proposed for this assessment.

Table 10-1 Example threshold of SOAEL and LOAEL at dwellings

Time of Day	SOAEL LAeq,T (dB) Façade			LOAEL LAeq,T (dB) Façade
	Category A[1]	Category B[2]	Category C[3]	
Daytime (07:00 – 19:00) and Saturdays (07:00 – 13:00)	65	70	75	Existing ambient noise level
Evenings (19:00 – 23:00 weekdays) (13:00 – 23:00 Saturdays) (07:00 – 23:00 Sundays)	55	60	65	Existing ambient noise level
Night-time (23:00 – 07:00)	45	50	55	Existing ambient noise level

[1]**Category A:** threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are less than these values.

[2]**Category B:** threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are the same as the category A values.

[3]**Category C:** threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are higher than the category A values.

NOTE: if the ambient noise level exceeds the Category C threshold values then the SOAEL and LOAEL are defined as equal to the existing ambient.

10.4.27 To determine the SOAEL and LOAEL, ambient noise levels at the relevant façade of each of the selected receptors have been predicted based on the 2018 Baseline traffic data.

Construction Vibration

10.4.28 Construction generated vibration has been assessed in accordance with guidance

in BS 5228-2. The main construction activities that can result in significant levels of vibration are percussive piling, earth compaction works, or other works requiring the use of a vibratory roller. Vibration levels have been estimated in accordance with the relevant methodologies in BS 5228-2. Table 10-2 details Peak Particle Velocity (PPV) vibration levels and provides a semantic scale for the description of construction vibration effects on human receptors, based on guidance contained in BS 5228-2.

Table 10-2 Construction vibration criteria for human receptors (annoyance).

PPV (in mms^{-1})	Description
10 mms^{-1}	Vibration is likely to be intolerable for any more than a very brief exposure to this level.
1.0 mms^{-1}	It is likely that vibration of this level in residential environments will cause complaint but can be tolerated if prior warning and explanation has been given to residents.
0.3 mms^{-1}	Vibration might be just perceptible in residential environments.
0.14 mms^{-1}	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.

10.4.29 In addition to human annoyance, building structures may be damaged by high levels of vibration. The levels of vibration that may cause building damage are far in excess of those that may cause annoyance. Consequently, if vibration levels within buildings are controlled to those relating to annoyance (i.e. 1.0 mms^{-1}), then it is highly unlikely that buildings would be damaged by construction vibration.

Construction Significance of Effect

10.4.30 The magnitude of the impact (from construction noise and vibration levels) is considered on a scale from negligible to major, as detailed in Table 10-3, adopted from DMRB LA 111.

Table 10-3 Magnitude of the impacts from construction noise and vibration

Magnitude of the Impact	Construction noise level	Construction vibration level
Major	Above or equal to the SOAEL + 5 dB	Above or equal to 10 mms-1 PPV
Moderate	Above or equal to the SOAEL and below +5 dB	Above or equal to the SOAEL (1.0 mms-1) and below 10 mms-1 PPV
Minor	Above or equal to the LOAEL and below the SOAEL	Above or equal to the LOAEL (0.3 mms-1) and below the SOAEL (1.0 mms-1)
Negligible	Below LOAEL	Below LOAEL (0.3 mms-1)

10.4.31 DMRB states that construction noise, or construction vibration shall constitute a significant effect where a major or moderate magnitude of impact would occur for a duration of:

- 10 or more working days (or evenings/weekends or nights) in any 15 consecutive days; or

- more than 40 days (or evenings/weekends or nights) in any 6 consecutive months.

Methodology for Determining Operational Effects

10.4.32 Noise from road traffic is generated by the vehicle engines and the interaction of tyres with the road surface. The traffic noise level at a receptor, such as an observer at the roadside or residents within a property, is influenced by a number of factors including traffic flow, speed, composition (percentage of HGV), road gradient, the type of road surface, the distance from the road and the presence of any obstructions between the road and the receptor.

10.4.33 The index adopted by the UK Government in CRTN to assess traffic noise is $LA_{10,18h}$. This value is determined by taking the highest 10% of noise readings in each of the 18 one-hour periods between 06:00 and 00:00, and then calculating the arithmetic mean.

10.4.34 CRTN provides the standard methodology for predicting the $LA_{10,18h}$ road traffic noise level. Noise levels are predicted at a point measured 1 m horizontally from the external façade of buildings. DMRB LA 111 also request the use of the indicator L_{night}.

10.4.35 The prediction of the $LA_{10,18hr}$ and L_{night} at the noise sensitive-receptors locations will be assessed by using the noise modelling software NoiseMap® Five (Noisemap LTD, 2008), through the creation of digital terrain models (DTM) of the different scenarios for the study area.

10.4.36 The following traffic scenarios have been modelled and assessed:

- Do Minimum (without the Scheme) in the opening year (DMOY);
- Do Something (with the Scheme) in the opening year (DSOY);
- Do Minimum in the future assessment year (DMFY); and
- Do Something in the future assessment year (DSFY).

10.4.37 The SOAEL and the LOAEL for road traffic noise used in this assessment are detailed in Table 10-4, as defined in DMRB LA 111.

Table 10-4 Noise SOAEL and LOAEL for all receptors

Time of Day	SOAEL	LOAEL
06:00 – 00:00	68 dB $LA_{10,18h}$ (façade)	55 dB $LA_{10,18h}$ (façade)
23:00 – 07:00	55 dB $L_{night,outside}$ (free-field)	40 dB $L_{night,outside}$ (free-field)

10.4.38 The operational road traffic noise SOAELs and LOAELs have been applied successfully for numerous road schemes in recent years, including schemes which have successfully been determined through the Planning Act 2008 procedures.

10.4.39 No special circumstances have been identified for the Scheme which suggest an alternative SOAEL or LOAEL should be adopted.

Operational Significance of Effect

10.4.40 An initial identification of significant effects (in terms of EIA) is carried out based on the magnitude of change in traffic noise levels due to the Scheme. DMRB provides two classifications for the magnitude of the traffic noise impact of a proposed road scheme, as shown in Table 10-5. These relate to both short-term changes and long-term changes in traffic noise levels. The short-term classification detailed in Table 10-5 is the main driver of the initial identification of significant effects.

Table 10-5 Magnitude of Change in traffic noise (short and long-term).

Short-Term Change		Long-term Change	
Noise level change (rounded to 0.1 dB) $LA_{10,18h}$ dB	Magnitude of the Impact	Noise level change (rounded to 0.1 dB) $LA_{10,18h}$ dB	Magnitude of the Impact
0	No change	0	No change
Less than 1.0	Negligible	Less than 3.0	Negligible
1.0 – 2.9	Minor	3.0 – 4.9	Minor
3.0 – 4.9	Moderate	5.0 – 9.9	Moderate
5.0+	Major	10.0+	Major

10.4.41 As proposed in DMRB LA 111, an initial identification of significant environmental impact assessment effects has been carried out based on the magnitude of change in traffic noise levels due to the Scheme in the short-term in the opening year as shown in Table 10-6.

Table 10-6: Initial assessment of operational noise significance

Significance	Short-term magnitude of change
Significant	Major
Significant	Moderate
Not Significant	Minor
Not Significant	Negligible

10.4.42 Negligible changes in the short-term would not cause changes to behaviour or response to noise, and as such, would not give rise to significant effects. For minor, moderate, and major changes DMRB LA 111 outlines a range of additional factors which will be considered in identifying significant effects.

- Where the magnitude of change in the short-term lies relative to the boundaries between the bands outlined in Table 10-5. In some circumstances a change within 1 dB of the top of the minor range may be appropriate to be considered a likely significant effect. Conversely a change within 1 dB of the bottom of the moderate range, may in some circumstances be more appropriate to be considered as not likely to be a significant effect.
- The magnitude of change in the long-term is different to that in the short-term: If the short-term change is minor (not significant), but the long-term change is moderate (significant) it may be more appropriate to be considered as a likely significant effect. Conversely, a smaller magnitude of change in the long-term compared to the short-term may indicate that it is more appropriate to be considered as not likely to be a significant effect.

- The absolute noise levels relative to the SOAEL. If the Do Something traffic noise levels are high i.e. above the SOAEL, a traffic noise change in the short-term opening year of 1.0 dB or more may be more appropriate to be considered as a likely significant effect.
- The location of noise sensitive parts of a receptor: A receptor may contain areas which are more or less sensitive than others e.g. office spaces or kitchens in a school would be considered less sensitive than classrooms.
- The acoustic context, if the Scheme changes the acoustic character of an area: If a scheme introduces road noise into an area where road noise is not currently a major source, it may be appropriate to conclude a minor short-term change is a likely significant effect.
- The likely perception of a traffic noise change: If the Scheme results in obvious changes to the landscape or setting of a receptor it is likely the traffic noise level changes would be more acutely perceived, and it may be more appropriate to conclude a minor short-term change is a likely significant effect. Conversely if the Scheme is not visible it can be more appropriate to conclude a moderate change is not a likely significant.

10.4.43 With regard to significant policy effects, the traffic noise SOAEL and LOAEL has been used to consider how the Scheme complies with the policy aims detailed in the NPPF, within the context of government policy on sustainable development, namely to:

- avoid noise from giving rise to significant adverse effects on health and quality of life resulting from noise from new development i.e. reduce traffic noise levels at receptors to below the SOAEL; and
- mitigate and reduce to a minimum, other adverse effects on health and quality of life resulting from noise from new development i.e. reduce traffic noise levels at receptors which are between the LOAEL and the SOAEL.

Noise Insulation Regulations

10.4.44 A preliminary indication of any properties likely to qualify under the Noise Insulation Regulations is provided in the assessment. A full assessment would be completed once the detailed design of the Scheme is finalised and in accordance with the timescales set out in the Regulations.

Assumptions and Limitations

10.4.45 The following assumptions or limitations are relevant to this noise and vibration impact assessment:

- The main limitation is the reliance on the Defra noise maps (Extrium, 2018) to undertake validation of the noise model as it has not been possible to undertake reliable site-based noise measurements due to the ongoing effects of the COVID-19 pandemic on journey patterns. The validation has been undertaken in accordance the Joint Guidance on the Impact of COVID-19 on the Practicality and Reliability of Baseline Sound Level Surveying and the Provision of Sound & Noise Impact Assessments provided by the IOA and ANC as described earlier in this section.
- Ordnance Survey (OS) Address Base Plus data detailing building usage and OS Building Height Attribute data have been used as provided in 2020. However, the heights of residential buildings have been standardised as a 6 m height. All the noise models developed were created by assuming a calculation height of 4 m.

- The construction assessment is based on the construction information that is currently available as described in Chapter 2: The Scheme and noted herein. As with all construction assessments, the exact details of the construction activities would not be fully understood before the detailed design stage of a scheme when the exact construction methods and programme will be determined. Whilst the precise details may be subject to change, the overall picture of significant construction effects is unlikely to be materially worse, and therefore the conclusions of the assessment would not be affected. Given the robust approach adopted in the ES the number of significant effects may well be less than those reported in the ES.

10.5 Baseline Conditions

10.5.1 The existing roundabout is adjacent to Lowdham Village. There are several sensitive receptors which are immediately adjacent to the junction fronting onto the A612 eastbound and westbound of the roundabout.

10.5.2 The greatest concentration of receptors within the study area is to the east/ south-east in Lowdham Village. As well as residential receptors other identified receptors include Lowdham Medical Centre, Alphabet House Day Nursery Lowdham, Daisies Day Nursery, Lowdham Village Hall, and Victoria Cottage Residential Care Home.

10.5.3 The existing noise climate at the nearest properties is likely to be dominated by traffic noise, with those located further east/ south-east on the edge of Lowdham Village dominated by distant road traffic, railway noise from the nearby railway line which passes through the village and occasional activities associated with agriculture.

10.5.4 Heritage assets within the study area are considered in Chapter 6: Cultural Heritage.

10.5.5 Two NIAs were identified through the Extrium, England Noise and Air Quality Viewer (Extrium, 2018) within 600 m of the Lowdham Roundabout Scheme: the first (ID 11650) is the southern arm of the A6097 in a southerly direction for approximately 1.5 km and the second (ID 11649) is a small section on the north bound dual carriageway of the northern arm of the A6097 starting approximately 450 m north of the roundabout for a distance of around100 m. Both of these NIAs are the responsibility of NCC.

10.5.6 The validation point locations and comparison with the Strategic Noise Maps (Extrium, 2018) are described in Table 10-7.

Table 10-7: Baseline Assessment (Comparison between Defra data and the Scheme noise model developed).

Validation Point Location	**$LA_{eq,16hr}$ (dB(A))**		**L_{den} (dB(A))**		**L_{night} (dB(A))**	
	Defra Noise Levels Range	**Noise Level from the Baseline Model**	**Defra Noise** Levels Range	**Noise Level from the** Baseline Model	**Defra Noise Levels Range**	**Noise Level from the Baseline Model**
10 The Orchards, NG14 7DP	65 - 69.9	66.0	65 - 69.9	66.8	55 - 59.9	57.8
25 Plough Lane, NG14 7AT	60 - 64.9	62.6	60 - 64.9	64.1	55 - 59.9	54.7

10.5.7 The results obtained from the Scheme developed noise model for Lowdham show noise levels at the validation points are within the Defra Noise Level range for $L_{Aeq,16hr}$ and L_{den}. For night-time noise (L_{night}) the noise modelling results are either within the Defra noise level range or within less than 1 dB. As such, the Scheme developed noise model is considered representative and valid for use in this assessment.

10.5.8 A comparison of the baseline traffic noise level changes without the Scheme for the opening and forecast years has been made in the Table 10-8.

Table 10-8: Long-term change in predicted Do Minimum traffic noise levels (DM 2023 to DM 2037)

Scenario/Comparison: DMOY VS DMFY (No-Change)

Change in Noise Level, dB(A)		Magnitude of Impact	Number of dwellings ($LA_{10,18hr}$)	Number of other Sensitive Receptors ($LA_{10,18hr}$)	Number of dwellings (L_{night})	Number of other Sensitive Receptors (L_{night})
Increase in noise level dB $LA_{10,18hr}/L_{night}$ (adverse)	0.1 - 2.9	Negligible	755	5	755	5
	3.0 - 4.9	Minor	0		0	
	5 - 9.9	Moderate	0		0	
	> 10	Major	0		0	
No Change	0	No Change	0		0	
Decrease in noise level dB $LA_{10,18hr}/L_{night}$ (beneficial)	0.1 - 2.9	Negligible	0		0	
	3.0 - 4.9	Minor	0		0	
	5 - 9.9	Moderate	0		0	
	> 10	Major	0		0	

10.5.9 The results demonstrate that at all NSRs a negligible adverse increase in noise levels will occur due to the general growth of traffic over time.

10.6 Design, Mitigation and Enhancement Measures

10.6.1 Changes to speed limits are proposed with the speed limit reduced from 40 mph to 30 mph at the roundabout. The 30 mph speed limit would extend approximately 140 m from the junction on the north-western leg of the A6097 and approximately 100 m from the junction on the south-western leg of the A612. There are no proposed changes to the other approaches to the roundabout. Lower speed limits can reduce noise caused by tyre/ road surface interaction which dominates at higher speeds.

10.6.2 The realignment and widening of the eastbound A612 approach to the roundabout will result in an increased distance (offset) of traffic flows for some receptors located on the southern side of the A612. Increased distance of traffic flows from receptors will lead to a corresponding decrease in noise levels, even for relatively small changes for those NSRs located closest to the existing road.

10.6.3 No other embedded mitigation or enhancement measures have been identified.

10.7 Assessment of Likely Significant Effects

Construction

Construction Noise

10.7.1 At this stage, precise information on the construction works is not available. To provide an indication of the likely construction noise levels for various road construction activities, noise predictions were made at various distances from these activities based on a representative distance between construction activities and NSRs. Table 10-9 provides a summary of the predicted $LA_{eq,1hr}$ at various distances from the different typical road construction activities at all dwellings with a direct line of sight to the construction activities. Each activity consists of a range of typical construction plant associated with that particular activity and is assumed to be operating at the nearest works boundary.

Table 10-9: Summary of construction noise level predictions for different construction activities

	Predicted construction noise levels at different distances ($LAeq_{,1hr}$ dB(A))								
Construction Activity	10 m	25 m	50 m	75 m	100 m	150 m	200 m	250 m	300 m
Site Clearance	83.0	75.1	67.5	63.1	60.0	55.6	52.5	50.1	48.1
Earthworks	82.8	74.9	67.3	62.9	59.8	55.4	52.3	49.9	47.9
Drainage/Ducting	80.1	72.2	64.6	60.2	57.1	52.7	49.6	47.2	45.2
Road Formation/Surfacing	83.5	75.6	68.0	63.6	60.5	56.1	53.0	50.6	48.6
Signs and Lighting	80.3	72.4	64.8	60.4	57.3	53.9	49.8	47.4	45.4
Landscaping	81.4	73.5	65.9	61.5	58.4	54.0	50.9	48.5	46.5
Number of NSRs (based on the nearest works boundary)	**9**	**8**	**11**	**8**	**17**	**47**	**83**	**95**	**87**

10.7.2 The results of the assessment predict potential major impacts from construction noise activity at up to 27 NSRs during the daytime all located within 50 m of the nearest part of the assessment boundary. The full list of properties identified as having a potential major adverse impact is provided in Appendix 10-1 of Volume 3C.

10.7.3 The receptors identified as having a potential Major Adverse impact are located on Nottingham Road, Victoria Avenue and Station Road.

10.7.4 On Nottingham Road, the receptors within 50 m of the works boundary and therefore identified as having a potential Major Adverse impacts are all the odd numbered properties on the north-eastern arm and south-western arm (No.s 1-21) and even number properties on the south-western arm (No.s 2-16). Even number properties further south-west are anticipated to experience a decreasing impact with distance from the roundabout.

10.7.5 On Victoria Avenue, the receptors within 50 m of the works boundary and therefore identified as having potential Major Adverse impacts are those located furthest west (No.s 3-8) with the exception of No.7 due to having a higher existing ambient noise

level due to its proximity to the A6097.

10.7.6 On Station Road No.s 2 and 4 have been identified as having potential Major Adverse impacts

10.7.7 For NSRs located at distances between 50 m and 75 m, the magnitude of the impacts resulting from the construction works is expected to range between minor to moderate dependent on the distance and existing ambient noise levels at the NSR.

10.7.8 At distances over 75 m the magnitude of impact at NSRs is expected to range between negligible to minor dependent on the distance and existing ambient noise levels at the NSR.

10.7.9 The assessment assumes works are taking place in the closest proximity to the NSR – i.e. at the nearest works boundary. In reality the majority of the construction works will occur at a distance greater than the nearest works boundary. For example, for properties identified being less than10 m from the works boundary, the typical average distance for construction activities is likely to be greater than 50 m. At 50 m the magnitude of noise impact for those receptors located adjacent to the works boundary is predicted to range from minor to moderate, due to high pre-existing ambient noise levels rather than a major impact.

10.7.10 DMRB states that construction noise, shall constitute a significant effect where a major or moderate magnitude of impact would occur for a duration of:

- 10 or more working days (or evenings/weekends or nights) in any 15 consecutive days; or
- more than 40 days (or evenings/weekends or nights) in any 6 consecutive months.

10.7.11 At this stage there is insufficient information on the construction activities and programme to discount the possibility that the timescales outlined would be exceeded. Therefore, it is conceivable that a significant adverse effect due to construction noise may occur at up to 35 NSRs (those identified as having either a moderate or major magnitude of impact).

10.7.12 Should evening working be required, there is potential for major impacts to extend to NSRs located up to 100 m from the works boundary and moderate impacts up to around 150 m from the works boundary, depending on the pre-existing ambient noise levels at the NSR.

10.7.13 Should night-time working be required, there is potential for major impacts to extend to NSRs located up to 200 m from the works boundary and moderate impacts up to around 300 m from the works boundary, depending on the pre-existing ambient noise levels at the NSR and precise location of work activities. Though, it is likely at these distances, many would experience much lower levels of noise due to intervening screening effects.

10.7.14 Consideration will therefore need to be given to additional controls to mitigate noise as low as practicably possible through the employment of Best Practicable Means (BPM) techniques by the contractor. This is discussed further in Section 10.8.

Construction Vibration

10.7.15 The potential for temporary construction vibration impacts is dependent on the need for construction activities which are a potentially significant source of vibration, such as earthworks and road construction (pavement) works using vibratory rollers. No piling operations are anticipated to be required.

10.7.16 Vibration levels during works using vibratory rollers have been estimated in accordance with the procedures set out in BS 5228-2 Table E.1.

10.7.17 The effects of vibration can vary according to a number of factors including: the magnitude of the vibration source, the particular ground conditions between the source and receiver, the foundation-to-footing interaction and the large range of structures that exist in terms of design (e.g. dimensions, materials, type and quality of construction, and footing conditions). The intensity, duration, frequency, and number of occurrences of a vibration all play an important role in both the annoyance levels caused and the strains induced in structures.

10.7.18 The typical sources of ground vibration include hydraulic breakers and vibratory rollers during the road construction phases.

10.7.19 For human receptors the LOAEL for vibration annoyance is defined as a PPV of 0.3 mms^{-1}, this being the point at which construction vibration is likely to become perceptible. The SOAEL is defined as a PPV of 1.0 mms^{-1}, this being the level at which construction vibration can be tolerated with prior warning.

10.7.20 The estimated PPV due to the steady state operation of vibratory plant is estimated to exceed the SOAEL for vibration annoyance within approximately 50 m of works using a large (approximately 13 tonnes) roller, and approximately 20 m for the medium sized twin drum roller and medium sized towed roller (approximately 3.5 tonnes).

10.7.21 A total of 16 receptors are located within 20 m of the works boundary, with a further 11 receptor located between 20-50 m from the works boundary, where using a large vibratory roller and a medium sized towed roller has the potential to generate vibration levels in excess of SOAEL for periods during the works.

10.7.22 The magnitude of the impact is considered moderate adverse at all 27 receptors in accordance with the Magnitude of the Impacts for Construction Vibration in Table 10-3. Even when working at the closest works boundary, vibration levels are not expected to exceed the threshold for Major adverse impact of 10 mms^{-1}

10.7.23 The remaining receptors inside the construction vibration study area are located at distances greater than 50 m from the nearest works boundary where only negligible to minor adverse effects are expected to occur.

10.7.24 With regards to structural damages, the PPV due to vibratory rollers would be well below the threshold for cosmetic damage of 15 mm^{-1} according to Table B.2 of BS5228-2. The associated magnitude of the impacts is considered to be negligible to minor adverse.

Operation

10.7.25 Detailed predictions have been carried out for a total of 761 receptors identified within the study area (which includes five other NSRs – Lowdham Medical Centre, Alphabet House Day Nursery Lowdham, Daisies Day Nursery, Lowdham Village Hall, and Victoria Cottage Residential Care Home).

10.7.26 The noise contours ($LA_{10,18hr}$ and L_{night}) for all the required scenarios (DMOY, DSOY, DMFY, and DSFY) were produced based on free-field traffic noise levels at first floor level (4.0 m above ground) using a 10 m x 10 m grid.

Short-term

10.7.27 The assessment details the short-term and long-term impacts of the Scheme. For short-term impacts, a comparison is made between the DMOY and the DSOY (Table 10-10).

Table 10-10: Short-term traffic noise levels changes with the Scheme (DMOY VS DSOY).

Scenario/Comparison: DMOY VS DSOY (Short-Term)

Change in Noise Level, dB(A)		Magnitude of Impact	Number of dwellings ($LA_{10,18hr}$)	Number of other Sensitive Receptors ($LA_{10,18hr}$)	Number of dwellings (L_{night})	Number of other Sensitive Receptors (L_{night})
Increase in noise level dB $LA_{10,18hr}/L_{night}$ (adverse)	0.1 - 0.9	Negligible	67	0	62	0
	1.0 - 2.9	Minor	0	0	0	0
	3.0 - 4.9	Moderate	0	0	0	0
	> 5	Major	0	0	0	0
No Change	0	No Change	264	0	292	0
Decrease in noise level dB $LA_{10,18hr}/L_{night}$ (beneficial)	0.1 - 0.9	Negligible	396	5	374	5
	1.0 - 2.9	Minor	29	0	28	0
	3.0 - 4.9	Moderate	0	0	0	0
	> 5	Major	0	0	0	0

10.7.28 During the daytime in the opening year of 2023, 52.7 % of NSRs within the 600 m study area are predicted to experience a negligible beneficial impact (0.1 - 0.9 dB decrease) in traffic noise levels due to the Scheme. 3.8 % of receptors are predicted to experience a minor beneficial impact (1.0 – 2.9 dB decrease). 8.8 % are predicted to experience a negligible adverse impact (0.1 - 0.9 dB increase) while the remaining 34.7 % of receptors are predicted to experience no change in traffic noise levels.

10.7.29 During the night-time in the opening year of 2023, 49.8 % of receptors within the 600 m calculation area are predicted to experience a negligible beneficial impact (0.1 - 0.9 dB decrease) due to traffic noise from the implementation of the Scheme, 3.7 % of receptors a minor beneficial impact (1.0 – 2.9 dB decrease). 8.1 % are predicted to experience a negligible adverse impact (0.1 - 0.9 dB increase), while the remaining 38.4 % of receptors are predicted to experience no change in traffic noise levels.

10.7.30 In the short-term, the overall trend is for either no change or a negligible to minor beneficial impact due to the introduction of Scheme. This is likely to be primarily due to increased offsets of running lanes from the nearest receptors and lower speeds.

10.7.31 Noise contours illustrating the predicted short-term (DMOY to DSOY) noise level change within the 600 m study area are presented in Figure 10-2 of Volume 2C.

Long-term

10.7.32 For long-term impacts as a result of the Scheme, a comparison is made between the DMOY and DSFY (Table 10-11).

Table 10-11: Long-term traffic noise levels changes with the Scheme (DMOY VS DSFY).

Scenario/Comparison: DMOY VS DSFY (Long-Term)

Change in Noise Level, dB(A)		Magnitude of Impact	Number of dwellings ($LA_{10,18hr}$)	Number of other Sensitive Receptors ($LA_{10,18hr}$)	Number of dwellings (L_{night})	Number of other Sensitive Receptors (L_{night})
Increase in noise level dB $LA_{10,18hr}/L_{night}$ (adverse)	0.1 - 2.9	Negligible	648	5	641	5
	3.0 - 4.9	Minor	0		0	
	5.0 - 9.9	Moderate	0		0	
	> 10	Major	0		0	
No Change	0	No Change	28		40	
Decrease in noise level dB $LA_{10,18hr}/L_{night}$ (beneficial)	0.1 - 2.9	Negligible	80		75	
	3.0 - 4.9	Minor	0		0	
	5.0 - 9.9	Moderate	0		0	
	> 10	Major	0		0	

10.7.33 During the daytime in the DMOY vs DSFY, 85.8% of receptors within the 600 m study area are anticipated to experience a negligible adverse impact (0.1 - 2.9 dB increase) in traffic noise levels. A further 10.5% are anticipated to experience a negligible beneficial impact (0.1 - 2.9 dB decrease) while the remaining 3.7% of receptors are anticipated to experience no change in traffic noise levels.

10.7.34 During the night-time (DMOY vs DSFY) similar results are obtained when compared to daytime. 84.9% of receptors within the 600 m study area are anticipated to experience a negligible adverse impact (0.1 - 2.9 dB increase) in traffic noise levels. A further 9.9% are anticipated to experience a negligible beneficial impact (0.1 - 2.9 dB decrease) in traffic noise levels, while the remaining 5.3% of receptors are anticipated to experience no change in traffic noise levels.

10.7.35 It should be noted that the negligible adverse impacts in the long-term will be mainly attributable to traffic growth over this period as illustrated in Table 10-8 of the Baseline assessment.

10.7.36 As no receptors are expected to experience any adverse impact greater than a negligible adverse impact in both the short and long-term, it can be concluded that there will be no significant adverse effects during the daytime or night-time due to operational noise as a result of the implementation of the Scheme.

10.7.37 Any beneficial impacts are either negligible or minor and are therefore also not significant.

Operational traffic noise – above SOAEL

10.7.38 Details of the number of residential receptors in the 600 m study area which are predicted to have one or more facades exposed to noise levels above the daytime or night-time SOAEL (68 dB(A) $LA_{10,18hr}$ or 55 dB(A) L_{night}) respectively in any of the four assessment scenarios are provided below in Table 10-12.

Table 10-12: Number of residential buildings above the SOAEL

Scenario	Day ($LA_{10,18hr}$)	Night (L_{night})
DMOY	13	41
DSOY	13	36
DMFY	18	60
DSFY	15	43

10.7.39 For daytime traffic noise, the Scheme is predicted to result in no change to the number of receptors with one or more façades experiencing traffic noise levels above SOAEL in the short-term, with an overall reduction (from 18no. to 15no.) above SOAEL (68dB $LA_{10,18hr}$) in the long-term.

10.7.40 Of the 13 receptors which experience daytime traffic noise levels above the SOAEL in the short-term, 10 are located inside the NIA 11650, one is a NSR near NIA 11649, and the remaining two are located on Nottingham Road and Southwell Road.

10.7.41 For night-time traffic noise the Scheme is predicted to result in an overall reduction (from 41no. to 36no.) receptors with one or more façades experiencing traffic noise levels above SOAEL (55dB L_{night}) in the short-term, and a reduction (from 60no. to 43no.) in receptors with one or more façades experiencing traffic noise levels above SOAEL (55dB L_{night}) in the long-term.

10.7.42 Of the 34 residential dwellings which will continue to experience levels of traffic noise levels above SOAEL during the night-time, 20 are located inside NIA 11650, two are located near NIA 11649, nine are located near Southwell Road, and the remaining three are located near Nottingham Road.

10.7.43 In the long-term, it is anticipated that the implementation of the Scheme will reduce the number of dwellings experiencing noise levels above SOAEL during the daytime by three, with a reduction of 17 residential dwellings experiencing noise levels above SOAEL during the night-time.

10.7.44 This demonstrates compliance with the NPPF which aims to ensure that development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment.

10.7.45 This also demonstrated that the Scheme also complies with the aims of the Noise Policy Statement for England (NPSE) which introduced LOAEL and SOAEL and sets out the Government's policy on noise and long-term vision of sustainable development to achieve the following:

- avoid significant adverse impacts on health and quality of life;
- mitigate and minimise adverse impacts on health and quality of life; and
- where possible, contribute to the improvement of health and quality of life.

Noise Important Areas

10.7.46 In the short-term, ten receptors which experience daytime traffic noise levels above

the SOAEL are located within NIA 11650 and one is located near NIA 11649. The assessment indicates no change or a negligible beneficial impact in noise levels at these receptors in the short-term (DMOY vs DSOY). However, they will continue to be above SOAEL.

10.7.47 Similar results were obtained for night-time traffic noise levels above the SOAEL in the short-term. The same number of the receptors inside the NIAs will continue to experience traffic noise levels above SOAEL (20 receptors located in NIA 11650 and two located near NIA 11649). The results of the assessment indicate no-change to a negligible beneficial impact to these receptors as a result of the introduction of the Scheme.

10.7.48 In the long-term (DMOY Vs DSFY) all receptors in the NIAs within the study area will experience a negligible adverse impact during both the daytime and night-time. However, this is due to traffic growth over the period rather than the direct implementation of the Scheme.

10.7.49 Overall, the Scheme will result in no significant adverse impacts on any receptors within any of the identified NIAs within the study area in the short and long-term during both the daytime and night-time.

Noise Insulation Regulations

10.7.50 An initial assessment indicates that there are no receptors which would be eligible for noise insulation, as the assessment indicates that the proposed Scheme would not generate a “Relevant Noise” which is at least 1 dB greater than the “Prevailing Noise Level” and exceeds the “Specified Noise Level” as defined in the Regulations.

10.8 Additional Mitigation

10.8.1 Full details of the proposed construction plant, timescales and hours of operation were not available at the time of the assessment; however, it is anticipated that the contractor will employ standard Best Practicable Means (BPM) controls to manage noise and vibration levels during the construction phase and such measures would be detailed in the CEMP. It is expected that measures would include but not be limited to:

- liaison with local receptors throughout the various phases of works and to notify them in advance of any particularly noisy activities;
- selection of quiet and low vibration equipment and methodologies;
- review of construction programme and methodology to consider low noise and low vibration methods (including non-vibratory compaction plant where required);
- optimal location of equipment on site to minimise noise disturbance;
- the provision of acoustic enclosures around static plant, where necessary;
- use of less intrusive alarms, such as broadband vehicle reversing warnings;
- no start-up or shut down of large vibratory rollers (approximately 13 tonnes) within 50 m of receptors and medium vibratory rollers (approximately 3.5 tonnes) within 15 m of receptors;
- undertake milling of pavement surfaces where possible which produces lower levels of non-damaging vibration compared to other breaking out methods; and
- where mechanical excavators and associated equipment is used to break up pavement surfaces ensure good practices are adopted and non-approved

practices such as pounding large tarmac sections with excavator buckets and dropping from height to break into smaller pieces are prohibited on site.

10.8.2 There is also the potential for additional attenuation of noise from construction activities using localised temporary noise screening. This has not been included in the assessment of construction noise in order to represent a worst-case scenario. BS 5228 (Ref 11.16) advises that such screening can provide a reduction in noise levels of 5 dB when the top of the plant is just visible over the noise screening, and 10 dB when the plant is completely screened from a receptor. The effectiveness of a noise barrier depends upon its length, effective height, position relative to the noise source and to the receptors, and the material from which it is constructed. Therefore, the potential attenuation provided by any such additional localised screening cannot be quantified at this stage. Proposals for the use of localised temporary noise screening would be developed at the detailed design stage and implemented during the works.

10.8.3 In accordance with the aims of the NPSE and ProPG, the Scheme could avoid significant adverse impacts through the inclusion of a range of noise mitigation measures and coupled with effective operational management and control of noise, will minimise any adverse impact on health and quality of life for its neighbours.

10.9 Residual Effects

10.9.1 The residual effects taking into account further mitigation (where feasible) is outlined in Table 10-13. At this stage any noise/vibration reduction benefits of the measures outlined in Section 10.8 or the feasibility thereof, cannot be accurately quantified and so no change to the significance of effect has been accounted for at this stage to ensure that a 'worst-case scenario' has been presented.

10.9.2 Given the robust approach adopted in the construction noise and vibration assessments in the ES, the number of significant effects may well be less than those reported.

Table 10-13: Summary of Residual Effects

Description of Effect	Sensitivity of Receptor	Nature of Effect/ Geographic Scale	Magnitude of Impact	Initial Classification of Effect (with embedded mitigation)	Additional Mitigation	Residual Effect Significance
Construction Noise	High	Temporary 35no. receptors	Up to Major	Significant Adverse	BPM & Temporary screening where feasible	Significant Adverse
Construction Vibration	High	Temporary 28no. receptors	Up to Major	Significant Adverse	BPM	Significant Adverse
Construction Noise	High	Temporary 330no. receptors	Negligible - Minor	Not Significant	-	Not Significant
Construction Vibration	High	Temporary 26no. receptors	Negligible - Minor	Not Significant	-	Not Significant
Operational Traffic	High	Long-term Local across study area (761 NSRs)	Negligible Adverse to Negligible Beneficial	Not Significant	-	Not Significant

11. ROAD DRAINAGE AND THE WATER ENVIRONMENT

11.1 Introduction

11.1.1 This chapter presents the assessment of the likely significant effects of the Scheme on road drainage and water environment. The water environment assessment considers water quality, groundwater, flood risk and drainage.

11.1.2 Hydromorphological impacts were scoped out as there are no direct works to watercourses with this Scheme.

11.1.3 A qualitative assessment of groundwater level and flow only has been undertaken at this stage since no cuttings or significant excavations are included within the design.

11.1.4 The assessment has followed the approach within DMRB LA 113 Road Drainage and the Water Environment (Highways England, 2020h). This chapter cross-refers to Chapter 9: Geology and Soils and Chapter 8: Biodiversity where appropriate.

11.1.5 This chapter should be read in conjunction with Figures 11-1 to 11-3 in Volume 2C and Appendices 11-1 and 11-2 in Volume 3C. The FRA can be found in Appendix 4-3 of Volume 3.

11.2 Legislation and Policy

11.2.1 Relevant water environment legislation and policy can be viewed in Chapter 11: Road Drainage and the Water Environment in Volume 1.

11.3 Consultation

11.3.1 The project team have been engaging with the Environment Agency since early in the development of the Project, specifically in relation to the Lowdham Roundabout Scheme, flood risk and proposals the Environment Agency are planning to bring forward in the area. Data was obtained from the Environment Agency as noted in the FRA (Appendix 4-3 of Volume 3).

11.3.2 Table 11-1 notes the responses from the Scoping Opinion relating to the water environment at Ollerton Roundabout.

Table 11-1: Scoping Opinions

Consultee	Comment	Response
NCC (Scoping Opinion)	The NCC letter draws attention to the Environment Agency point as shown above. Attention is drawn to the County Council's adopted Guidance Note on the Validation Requirement for Planning Applications which sets out the national and local information requirements for planning applications.	The FRA is included in Appendix 4-3 of Volume 3. This includes the drainage strategy document.
Environment Agency	The Environment Agency draws attention to matters to be considered in the FRA. A detailed FRA will be required which needs to contain a plan identifying rivers and water bodies, a topographical survey of the existing and proposed site levels, information about historical flood risk, and the flood risk from all sources. Furthermore the FRA should also assess, as a minimum the potential impacts of both temporary and permanent works, storage of any excavated material, with any temporary placement to ensure it does not impede flood water, potential impacts of climate change, impacts of ongoing of future Environment Agency flood risk management scheme such as the Lowdham Recovery Works project, breach/overtopping, impact of ground level raising, whether compensation is required, any impact on Environment Agency assets, any impact on flood flow route, requirements for mitigation, surface water runoff rates before and post development and how surface water runoff will be discharged. The Environment Agency recently updated the allowances for peak river flow and FRA climate change allowances following research completed in 2020.	The FRA is included in Appendix 4-3 of Volume 3. This includes the drainage strategy document.

11.4 Assessment Methodology

Baseline Conditions

11.4.1 Establishment of the baseline conditions has involved reference to existing data sources, consultation with statutory bodies and other organisation, and field surveys. These sources are described in more detail in the following sections.

11.4.2 A desk study has been undertaken to establish baseline information, this included a review of the following data sources:

- existing scheme information, topographical data, site reports and consultations;
- VIA East Midlands (2022) A614 / A6097 Major Road Network Improvements Flood Risk Assessment (see Appendix 4-3 of Volume 3);
- Environment Agency data requests, received January 2021 (Environment Agency Reference EMD-191101) (Environment Agency, 2021a);
- online Ordnance Survey (OS, 2021) and aerial maps (Bing, 2021);
- Met Office (2021) website;
- British Geological Survey Geoindex website (BGS, 2021b);
- Cranfield University's 'Soilscapes' website (Cranfield University, 2021);
- Environment Agency Catchment Data Explorer website (Environment Agency, 2021c);
- Environment Agency Flood Map for Planning website (Environment Agency, 2021e);
- Environment Agency Water Quality Archive (Environment Agency, 2021f);
- Environment Agency Areas Susceptible to Groundwater Flooding website (AStGwF) (GOV.UK, 2021a);
- Highways England Drainage Data Management System (HADDMS) (Highways England, 2021a);
- Humber River Basin District RBMP (Defra, 2016);
- Nottinghamshire County Council Preliminary Flood Risk Assessment (PFRA) (NCC, 2011);
- Greater Nottingham Strategic Flood Risk Assessment Addendum (SFRA) (AECOM, 2017); and
- details of private water supplies were supplied by NSDC Environmental Health Department.

Field Surveys

11.4.3 A field survey was undertaken on 1st July 2021 by a surface water quality specialist and hydromorphologist in warm dry summer conditions following several days without rain. Thus, the watercourses were at low flow conditions and it was possible to see bedforms and features. The aim of the site walkover was to identify water receptors in the study area and to assess them in terms of their character, hydromorphology, and their connectivity to the Scheme in the context of the surrounding topography and receptors (e.g. nearby sites of ecological importance).

11.4.4 No water quality monitoring has been undertaken. There has been no aquatic ecology surveys undertaken. The ecological desk study undertaken by Bakers

(Appendix 4-5 of Volume 3) recorded no amphibian records due to lack of standing water.

Study Area

11.4.5 For the purposes of the water resource (flow and quality) assessment, a study area of approximately 1 km around the Scheme boundary has been considered, in order to identify surface and groundwater bodies that could reasonably be affected by direct impacts associated with the Scheme (i.e. there is a pathway between the Scheme and the waterbody).

11.4.6 Consideration has also been given to any attributes of surface water or groundwater bodies or water dependent ecological sites outside this study area, as pollutants can propagate downstream. Professional judgment has been applied to identify the extent to which such features are included.

11.4.7 The flood risk study area comprises the Environment Agency flood zones along the watercourses that may be affected by the Scheme. The Environment Agency designates flood risk zones on the basis of the annual probability of a flood event to occur as follows:

- Zone 1 is less than 0.1% annual probability of flood risk (i.e. a very low risk of flooding);
- Zone 2 between 0.1 - 1% annual probability of flood risk (i.e. a low risk of flooding); and
- Zone 3 is more than 1% annual probability of flood risk (i.e. a medium risk of flooding).

11.4.8 For hydraulic modelling purposes for the Flood Risk Assessment a distance of approximately 2.6 km upstream and 2.8 km downstream has been used.

Methodology for Determining Construction and Operational Effects

Assessment of routine road runoff and accidental spillages

11.4.9 An assessment of the potential impacts of routine runoff on surface waters has been undertaken following the Highways England Water Risk Assessment Tool (HEWRAT version 2.0.4, 2020) (Highways England, 2020j) methodology as described within DMRB LA 113, and available for download from the HADDMS website.

11.4.10 HEWRAT was developed for this purpose and the methodology behind it has been derived from a collaborative research programme undertaken by Highways England (now National Highways) and the Environment Agency, which investigated the effects of routine road runoff on receiving waters and their ecology. The assessment helps to determine the risk of routine runoff pollution, and spillage risk to the receiving water body and what treatment measures are required to mitigate this risk. The HEWRAT quantitative assessment is included within Section 11.7 of this ES.

11.4.11 Appendix D of DMRB LA 113 has been used to assess the risk of pollution of a watercourse from a serious road traffic accident. This method is contained within the HEWRAT tool. This method combines various risk factors, including the volume of traffic flows in a 24-hour period, the percentage of heavy goods vehicles, and the risk attributed to different types of road, to determine the probability of an accident resulting in a serious pollution incident. The acceptable standard is measured as a return period with 1 in 100 years (i.e. the probability of an event occurring in any given year is 1%), as the minimum threshold for non-sensitive water environments. This increases to 1 in 200 years for sensitive receptors (for example SSSIs). The

assessment is presented within Section 11.7 of this ES.

Evaluation of receptor importance

11.4.12 The importance of potentially affected water environment features has been established using a four-point scale (low, medium, high, very high) developed on the basis of Table 3.70 within DMRB LA 113. This four-point scale is presented in Table 11-2. Note that the criteria presented in DMRB LA 113 do not include navigation. Bespoke criteria for navigation have been included in Table 11-2 based on professional judgement.

11.4.13 For the purpose of this assessment, receptor 'importance' has been identified rather than receptor 'value'. This is because when considering the water environment, the availability of dilution means that there can be a difference in the sensitivity and importance of a water body. For example, a small drainage ditch of low conservation value and biodiversity with limited other socio-economic attributes can be very sensitive to impacts, whereas an important regional scale watercourse, that could have conservation interest of international and national significance and support a wider range of important socio-economic uses, is often less sensitive by virtue of its ability to assimilate discharges and physical effects. Irrespective of importance, all controlled waters in England are protected by law from being polluted.

11.4.14 Within Table 11-2, receptor importance is also included for flood risk. The FRA has been prepared for the Scheme in accordance with NPPF requirements.

Future Maintenance

11.4.15 Consideration was given to the activities associated with the likely future maintenance and management of the Scheme and whether these have the potential to result in significant effects on the water environment. Following a review of the likely maintenance activities (not including road safety in adverse weather conditions), it was concluded that there will be limited potential of such effects to occur, and that these activities are comparable with standard maintenance operations already being undertaken elsewhere on the road network. Accordingly, the effects associated with this phase of the Scheme are scoped out of the assessment and are not considered further.

Table 11-2: Criteria to determine receptor importance

Importance[1]	Type of Receptor				
	Groundwater	Surface water	Hydromorphology[2]	Flood Risk[3]	Navigation
Very High	Principal Aquifer providing a regionally important resource and/or supporting a site protected under UK legislation Ecology and Nature Conservation Groundwater locally supports GWDTE* SPZ 1	Watercourse having a WFD classification shown in a RBMP and Q95 > 1.0 m3/s. Site protected/designated under UK legislation Ecology and Nature Conservation.	Unmodified, near to or pristine conditions, with well-developed and diverse geomorphic forms and processes characteristic of river type	Essential infrastructure or highly vulnerable development.	Corridor is a navigation route of principal importance (e.g. used daily by a large number and a wide range of vessels and purposes)
High	Principal Aquifer providing locally important resource or supporting river ecosystem. Groundwater supports a GWDTE SPZ 2	Watercourse having a WFD classification shown in a RBMP and Q95 m3/s <1.0 m3/s. Species protected under EC or UK legislation Ecology and Nature Conservation.	Conforms closely to natural, unaltered state and would often exhibit well-developed and diverse geomorphic forms and processes characteristic of river type, with abundant bank side vegetation. Deviates from natural conditions due to direct and/or indirect channel, floodplain, and/or catchment development pressures	More vulnerable development	Corridor is a navigation route of high importance (e.g. used frequently by a large number of vessels)
Medium	Aquifer providing water for agricultural or industrial use with limited connection to surface water. SPZ 3	WFD not having a WFD classification shown in a RBMP and Q95 >0.001 m^3/s.	Shows signs of previous alteration and/or minor flow regulation but still retains some natural features or may be recovering towards conditions indicative of the higher category	Less vulnerable development	Corridor is a navigation route of medium importance (e.g. intermittently used by a small number of craft)

Importance[1]	Type of Receptor				
	Groundwater	Surface water	Hydromorphology[2]	Flood Risk[3]	Navigation
Low	Unproductive strata	Watercourses not having a WFD classification shown in a RBMP and Q95 $\leq$0.001 m^3/s.	Substantially modified by past land use, previous engineering works or flow regulation and likely to possess an artificial cross-section (for example trapezoidal) and would probably be deficient in bedforms and bankside vegetation. Could be realigned or channelised with hard bank protection, or culverted and enclosed. May be significantly impounded or abstracted for water resources use. Could be impacted by navigation, with associated high degree of flow regulation and bank protection, and probable strategic need for maintenance dredging. Artificial and minor drains and ditches would fall into this category.	Water compatible development	Corridor is rarely used for navigation or is non-navigable

1 Professional judgement is applied when assigning an importance category to all water features. All controlled waters are protected from pollution under the Environmental Permitting (England and Wales) Regulations 2016 (HM Government, 2016) and the Water Resources Act 1991 (as amended) (HM Government, 1991), and future WFD targets also need to be considered.

2 Based on the water body 'Reach Conservation Status' presently being adopted for HS2 and developed from the Environment Agency conservation status guidance (Environment Agency, 1998a, 1998b). DMRB LA 113 (Highways England, 2020h) provides advice on hydromorphological assessment but does not provide criteria for determining hydromorphological receptor importance.

3 Vulnerable development, less vulnerable development and water compatible development are defined in the NPPF.

* GWDTE: Groundwater Dependent Terrestrial Ecosystems

Magnitude of impact

11.4.16 The magnitude of impact on the water environment has been established using the criteria outlined in Table 3.71 of LA 113. These impacts take into consideration the extent that the Scheme would directly or indirectly affect the identified water receptors. The identification of impacts takes account of all embedded and essential mitigation measures described in Section 11.6 of this chapter and Chapter 2: The Scheme in this document.

Table 11-3: Criteria to determine magnitude of impact

Magnitude of Impact	Criteria	Description
Major Adverse	Results in a loss of attribute and/or quality and integrity of the attribute.	Surface water: ▪ Failure of both acute-soluble and chronic sediment related pollutants in HEWRAT and compliance failure with Environment Quality Standard (EQS) values. ▪ Calculated risk of pollution from a spillage >2% annually (spillage assessment). ▪ Loss or extensive change to a fishery. ▪ Loss of regionally important public water supply. ▪ Loss or extensive change to a designated nature conservation site. ▪ Reduction in water body WFD classification. Groundwater: ▪ Loss of, or extensive change to, an aquifer. ▪ Loss of regionally important water supply. ▪ Potential high risk of pollution to groundwater from routine runoff – risk score >250 (Groundwater quality and runoff assessment). ▪ Calculated risk of pollution from spillages >2% annually (Spillage assessment). ▪ Loss of, or extensive change to GWDTE or baseflow contribution to protected surface water bodies. ▪ Reduction in water body WFD classification. ▪ Loss or significant damage to major structures through subsidence or similar effects. Flood Risk: ▪ Increase in peak flood level >100 mm.
Moderate Adverse	Results in effect on integrity of attribute, or loss of part of attribute	Surface Water: ▪ Failure of both acute-soluble and chronic sediment-bound pollutants in HEWRAT but compliance with EQS values. ▪ Calculated risk of pollution from spillages >1% annually and <2% annually. ▪ Partial loss in productivity of a fishery. ▪ Degradation of regionally important public water supply or loss of major commercial/industrial/agricultural supplies. ▪ Contribution to reduction in water body WFD classification.

Magnitude of Impact	Criteria	Description
		Groundwater: ▪ Partial loss or change to an aquifer. ▪ Degradation or regionally important public water supply or loss of significant commercial/industrial/agricultural supplies. ▪ Potential medium risk of pollution to groundwater from routine runoff – risk score 150-250. ▪ Calculated risk of pollution from spillages >1% annually and <2% annually. ▪ Partial loss of the integrity of GWDTE. ▪ Contribution to reduction in water body WFD classification. ▪ Damage to major structures through subsidence or similar effects or loss of minor structures. Flood Risk: ▪ Increase in peak flood level > 50mm.
Minor Adverse	Results in some measurable change in attribute's quality or vulnerability.	Surface Water: ▪ Failure of either acute soluble or chronic sediment related pollutants in HEWRAT. ▪ Calculated risk of pollution from spillages >0.5% annually and <1% annually. ▪ Minor effects on water supplies. Groundwater: ▪ Potential low risk of pollution to groundwater from routine runoff – risk score <150 ▪ Calculated risk of pollution from spillages >0.5% annually and <1% annually ▪ Minor effects on an aquifer, GWDTEs, abstractions and structures. Flood Risk: ▪ Increase in peak flood level >10mm.
Negligible	Results in effect on attribute, but of insufficient magnitude to affect the use or integrity.	Surface Water: ▪ No risk identified by HEWRAT (pass both acute-soluble and chronic-sediment related pollutants). ▪ Risk of pollution from spillages <0.5%. Groundwater: ▪ No measurable impact upon an aquifer and/or groundwater receptors and risk of pollution from spillages <0.5%. Flood Risk: ▪ Negligible change in peak flood level <+/- 10mm.
Minor beneficial	Results in some beneficial effect on attribute or a reduced risk of negative impact occurring.	Surface Water: ▪ HEWRAT assessment of either acute soluble or chronic-sediment related pollutants becomes pass from an existing site where the baseline was a Fail condition. ▪ Calculated reduction in existing spillage risk by 50% or more (when existing spillage risk is <1% annually). Groundwater: ▪ Calculated reduction in existing spillage risk by 50% or more to an aquifer (when existing spillage risk <1% annually).

Magnitude of Impact	Criteria	Description
		▪ Reduction or groundwater hazards to existing structures. ▪ Reductions in waterlogging and groundwater flooding. Flood Risk: ▪ Creation of flood storage and decrease in peak flood level (>10mm).
Moderate beneficial	Results in moderate improvement of attribute quality	Surface Water: ▪ HEWRAT assessment of both acute-soluble and chronic-sediment related pollutants becomes pass from an existing site where the baseline was a fail condition. ▪ Calculated reduction in existing spillage by 50% or more (when existing spillage risk >1% annually). ▪ Contribution to improvement in water body WFD classification. Groundwater: ▪ Calculated reduction in existing spillage risk by 50% or more (when existing spillage risk is >1% annually). ▪ Contribution in improvement in water body WFD classification. ▪ Improvement in water body catchment abstraction management strategy (CAMS) (or equivalent) classification. ▪ Support to significant improvements in damaged GWDTE. Flood Risk: ▪ Creation of flood storage and decrease in peak flood level (>50mm).
Major beneficial	Results in major improvement of attribute quality	Surface Water: ▪ Removal of existing polluting discharge or removing the likelihood of polluting discharges occurring to a watercourse. ▪ Improvement in water body WFD classification. Groundwater: ▪ Removal of existing polluting discharge to an aquifer or removing the likelihood of polluting discharges occurring. ▪ Increased recharge to an aquifer. ▪ Improvement in water body WFD classification. Flood Risk: ▪ Creation of flood storage and decrease in peak flood level (>100mm).
No change		No loss or alteration of characteristics, features, or elements; no observable impact in either direction.

Significance Criteria

11.4.17 The approach to deriving the effects significance from receptor value and magnitude of impacts is based on the significance matrix set out in the DMRB LA 104 and reproduced in Table 4-3 in Chapter 4: Assessment Methodology in Volume 1. The matrix combines receptor importance with magnitude of impact. Where the significance of effect is represented by two descriptors (for example large/very large), professional judgement based on knowledge and experience of similar schemes has been used to determine which of the significance descriptors applies

to the effect being assessed.

11.4.18 The matrix has been used to guide the identification and assessment of effects on water resources; however, where professional judgement has resulted in a deviation from the thresholds contained in the matrix, these are explained within the relevant sections of the chapter and are supported by appropriate evidence and explanation. The negligible environmental value (sensitivity) is not included as the importance of receptors for the water environment does not include receptors of negligible importance.

11.4.19 Effects that are anticipated to be moderate, large or very large are considered to be significant.

Assumptions and Limitations

11.4.20 The assessment has been based on the current drainage design drawings (see Appendix 2-2 of Volume 3). This has been designed to manage surface water runoff that drains to tributaries within the Cocker Beck catchment, and the Cocker Beck itself. There will be no new outfalls constructed into the receiving water course/ditch to the south-east of Lowdham roundabout, and no new outfalls or crossings constructed on the Cocker Beck.

11.4.21 The sizing of the culvert for the roadside ditch on the south side of the A612 would be sized to ensure no worsening of surface water flooding potential.

11.4.22 Baseline conditions have been completed using data held and maintained by third parties, and is assumed to be accurate, up to date and appropriate for use.

11.4.23 The assessment has been undertaken using available data and Scheme design details as available in November 2021.

11.5 Baseline Conditions

Topography, Rainfall and Land Use

11.5.1 The area of Lowdham Roundabout is characterised by a relatively flat area of land at approximately 20 m aOD. Land to the east and south is flat lying, with the ground sloping upwards to the west (up to 65 m aOD within 1 km) and to the north (50 m aOD at Marker Hill situated north of Lowdham).

11.5.2 The land use in the area is characterised by the residential area of Lowdham located to the north of the A6097 and to the north and east of the junction. Lying south and west of the junction, the area is agricultural with some residential houses along the A612 towards the south-west from the junction. The area is located within the floodplain of the Cocker Beck. A railway line is located 300 m to the south-east, which is parallel to the A612 and is orientated in a north-east to south-western direction.

11.5.3 Based on the Meteorological Office website (Met Office, 2021), the nearest weather station is located at Watnall 16 km to the west of the Scheme. Using the data from this weather station it is estimated that the study area experiences an average of 710 mm of rainfall per year, with it raining more than 1 mm on 124 days per year, which is average for the UK. The wettest months of the year are October to December with over 65 mm rain per month.

Surface Water Features

11.5.4 The Scheme lies within the Water Framework Directive (WFD) (HMSO, 2015) water body catchment for the “*Cocker Beck (trib of Trent)*” (GB104028053290), which is

part of the Nottinghamshire South A operational catchment of the Humber River Basin Management Plan. The classifications can be found in Table 11-4.

11.5.5 A main river, the Cocker Beck, is located 160 m east of the existing junction. This flows to the south-east towards the River Trent approximately 2.5 km downstream.

11.5.6 According to the Environment Agency's Catchment Data Explorer (Environment Agency, 2021c) website, it is currently at Moderate Ecological Status (2019), with a target status of good by 2027. Reasons for not achieving good status are stated as physical modification, private sewage treatment point sources, and diffuse pollution sources from livestock management. This has led to failures for mercury and its compounds, polybrominated diphenyl ethers (PDBE) and benzo (g-h-i) perylene. Within the physico-chemical elements, all are noted as High, with the exception of phosphate which is Moderate.

11.5.7 Bordering to the east of the Cocker Beck catchment area within the study area is the waterbody catchment for *"Dover Beck Catchment (trib of Trent)*" (Environment Agency Catchment Data Explorer website, accessed October 2021) (GB104028053370), which is part of the Nottinghamshire South A operational catchment of the Humber River Basin Management Plan. The classifications can be found in Table 11-4.

11.5.8 According to the Environment Agency's Catchment Data Explorer website the "*Devon Beck Catchment (trib of Trent)*" is currently at Moderate Ecological Status (2019, with a target status of Moderate by 2015, which it has met). Reasons for not achieving Good status are stated as water industry sewage discharges and groundwater abstractions, agriculture and rural land management with poor livestock and nutrient management, and urban and transport road drainage. This has led to bed status for phosphate levels and failures for mercury (and its compounds) and PBDE.

Table 11-4: WFD Classifications for study area waterbody.

Parameter	Cocker Beck (trib of Trent)	Dover Beck (trib of Trent)
Designation	River	River
WFD Catchment	Cocker Beck (trib of Trent)	Dover Beck (trib of Trent)
ID	GB104028053290	GB104028053370)
Hydromorphological Designation	Heavily modified	Not designated artificial or heavily modified
Area	1,575.84 ha	6,753.32 ha
Length	11.267 km	23.992 km
Overall Status (2019)	Moderate	Moderate
Ecological Status	Moderate	Moderate
Chemical Status	Fail	Fail
Overall Waterbody Objective	Good by 2027	Moderate by 2015

11.5.9 The Scheme is not located within the catchment area of Dover Beck, and there is no pathway from the area of the Scheme to the catchment of Dover Beck. Therefore, Dover Beck has been scoped out of further assessment.

11.5.10 In the area to the south of the roundabout the Ordnance Survey mapping shows

straightened drains flowing south and then west on the northern side of the railway line. After being culverted under the railway line this minor watercourse flows south-west to enter the Cocker Beck (trib of Trent) 2 km south of the Scheme, west of Gunthorpe. The catchment area of this watercourse includes the western and southern areas of the assessment boundary.

11.5.11 No further waterbodies with hydraulic connectivity were identified from a review of OS mapping or the site survey, although there may be minor drainage ditches that remain unknown. These have been assessed generically.

11.5.12 During a review of baseline information, no known socio-economic uses of the Cocker Beck were noted. There are fishing lakes to the east within the Dover Beck catchment which are outside of the study area.

11.5.13 From the Environment Agency Water Quality Archive website, there is a data point 2.6 km downstream of the Lowdham roundabout which has recent monthly monitoring data from May to August 2021. The data from the monitoring location at the Cocker Beck at Gunthorpe is summarised below in Table 11-5.

Table 11-5 Summary of Water Quality Data from Coker beck at Gunthorpe (May – August 2021)

Determinand	Unit	May	June	July	August	Average
pH		8.05	8.15	8.18	8.14	8.13
Temperature of Water	°C	7.9	13.2	14.3	16.1	12.875
Ammoniacal Nitrogen as N	mg/l	0.066	0.031	< 0.03	0.04	0.045667
Nitrogen, Total Oxidised as N	mg/l	7.6	5	8	4.9	6.375
Nitrate as N	mg/l	7.54	4.93	7.94	4.87	6.32
Nitrite as N	mg/l	0.057	0.066	0.06	0.035	0.0545
Ammonia un-ionised as N	mg/l	0.00103	0.00071	< 0.00075	0.00114	0.00096
Alkalinity to pH 4.5 as $CaCO_3$	mg/l	280	240	310	320	287.5
Orthophosphate, reactive as P	mg/l	0.276	0.069	0.14	0.16	0.16125
Oxygen, Dissolved, % Saturation	%	95.6	87.9	97.4	93.2	93.525
Oxygen, Dissolved as O_2	mg/l	11.3	9.2	9.95	9.16	9.9025

11.5.14 However, in order to carry out the Highways England Water Risk Assessment Tool calculations, data is also required on copper, zinc, dissolved organic carbon, water hardness, and calcium concentrations. Data on these parameters was obtained from a site ‘Cocker Beck at Trent Confluence’. Data was collected from 123 samples between 2004 to 2017. An average of the concentrations of these parameters for 2015-2016 is included below:

- pH Average: 7.9 ;
- Dissolved Organic Carbon Average: 4.65 mg/l;
- Dissolved Calcium Average: 166 mg/l;
- Dissolved Copper: 2.38 µg/l;
- Zinc: 5.45 µg/l; and

- Hardness: 507 mg/l.

11.5.15 There are no river flow gauges on the Cocker Beck on the National River Flow Archive website (accessed January 2021). LowFlows Software (UK Centre for Ecology and Hydrology, 2021b) has been used to obtain an estimate of the Cocker Beck at a point further downstream where a watercourse which drains the south of Lowdham roundabout flows into the Cocker Beck. This is located 2 km south of the Scheme, and west of Gunthorpe. This gives a Q95 of 0.012 m^3/s (or 12 l/s).

11.5.16 There are several ponds located within the study area, as detailed in Table 11-6Table 11-6.

Table 11-6: Ponds within 1 km of Lowdham Roundabout

Pond number and location	Grid reference
1: Isolated field pond, south-west of the Scheme, approximately 300 m south-west of Brakes Farm	X: 466794 Y: 345606
2: Isolated field pond, south-west of the Scheme, approximately 300 m south-west of Brakes Farm	X: 466439 Y: 346452
3: Ponds around 'Castle Mound', 850 m north-west of the Junction	X: 466441 Y: 346738
4: Ponds around 'Castle Mound', 850 m north-west of the Junction	X: 466462 Y: 346765
5: Isolation field pond 900 m south-east of the Junction.	X: 467745 Y: 345433

Water Resources

11.5.17 The location of surface water, and groundwater abstractions, details of pollution incidents, and discharge consents were obtained from the Environment Agency. Details of Private Water Supply (PWS) abstractions were requested from NSDC, and no PWS abstractions are located within 2 km of the site.

11.5.18 The area is located within Nitrate Vulnerable Zone S326 (Cocker Beck catchment (tributary of the River Trent).

11.5.19 There are no Drinking Water Protected Areas and no Drinking Water Safeguard Zones (surface water or groundwater) in the study area.

11.5.20 There is a surface water abstraction licence (03/28/64/0309/R01) on the Dover Beck at Epperstone, which is 1.75 km north of the Scheme. It is a single point abstraction, used for private non-industrial purposes for make up or top up water. This abstraction is shown in Figure 11-1 in Volume 2C, but as it is outside of the 1 km study area it is not considered further.

11.5.21 There are no discharge consents within the study area.

Hydromorphology

11.5.22 Under the WFD, the "Cocker Beck Catchment (tributary of the River Trent)" (GB104028053290) is described as a heavily modified watercourse, at Moderate Ecological status with the hydromorphological supporting elements as 'Supporting Good' potential.

11.5.23 The field survey was undertaken to scope the potential watercourses affected, in order to inform designs of any outfall and watercourse crossings / alterations to existing structures, and to identify potential opportunities for mitigation or enhancements. The watercourses in close proximity to the site were identified as

the Cocker Beck and a minor watercourse to the south of the roundabout and a tributary of the Cocker Beck. It was not possible to survey the unnamed tributary of the Cocker Beck due to land access restrictions at the time of survey. These watercourses are described further in Appendix 11-1 of Volume 3C.

11.5.24 The works would not physically impact the Cocker Beck through crossing or realignment. Discharge to this watercourse is not proposed. On this basis the Scheme is not considered likely to significantly impact the hydromorphology of the Cocker Beck and as such this was scoped out of additional assessment.

11.5.25 No works are proposed on or within close proximity to the unnamed tributary of the Cocker Beck and it will not receive surface water runoff from the Scheme. On this basis the unnamed tributary of the Cocker Beck has been scoped out of further assessment.

A6097 drainage ditch

11.5.26 A drainage ditch is located parallel to the western boundary of the A6097. This ditch is separate to the highway drainage channels and standing water was observed in the channel at the time of survey. During the survey it appeared that there were no connections to anything at the upstream extent. There was no southern downstream connection observed during the site visit and it appeared to be standing water.

A612 drainage ditch

11.5.27 A drainage ditch runs parallel to the southern side of the A612 before turning at right angles and flowing through a 525 mm diameter. PVC pipe in a south-easterly direction along the field boundary away from the Scheme. This is an artificial drainage ditch which takes flow from the highway. It is not connected at the upstream extent and is likely to be dry for large periods of the year. Although not verified on site due to lack of access, it is believed that this drain discharges into the unnamed tributary of the Cocker Beck approximately 1 km south-west of the proposed Scheme.

Nature Conservation and Aquatic Ecology

11.5.28 No records for protected aquatic species were returned from the Nottinghamshire Biological and Geological Records Centre (NBGRC). Further information is contained within Chapter 8: Biodiversity.

Geology, Hydrogeology and Soils

11.5.29 Groundwater is a protected resource and its vulnerability to pollution is classified depending on the geology of the area (which determines the aquifer status) and the leaching potential of overlying soils (which determines how easily pollution from above ground sources may filter through to the aquifer).

11.5.30 The current groundwater levels across the Scheme are unknown, however, regionally it is likely to be providing baseflow to both local watercourses.

11.5.31 From the geology and soils baseline (Chapter 9: Geology and Soils), Lowdham Roundabout is underlain by alluvium (clay, silt, sand and gravel), with Head deposits bordering the alluvial zones. The superficial deposits are overlying the Sidmouth Mudstone Formation, Radcliffe Member. This is described as finely interlaminated mudstone, siltstone and very fine-grained sandstone.

11.5.32 Whilst no made ground is shown on the geological mapping it is expected that made ground would be present across much of the study area due to the development history of the junction area.

11.5.33 The bedrock geology is classified as a Secondary B Aquifer, with the areas of superficial alluvium being designated as a Secondary A Aquifer, and the Head deposits being designated as a Secondary B Aquifer. The study area contains areas of medium to high groundwater vulnerability.

11.5.34 The Scheme and study area lie within the WFD groundwater body “Trent Lower Erewash – Secondary Combined” (GB40402G990300). This has an overall status of Good (2019). The status is Good for quantitative and chemical aspects. The objective is for Good by 2027 which it has met.

11.5.35 The majority of study area is not within a catchment area for a groundwater SPZ for any large abstraction sources. There is a small area in the very north of the 1 km study area which is contained within a Zone 3 (total catchment area) SPZ. This is for a public water supply abstraction located approximately 2 km to the north-west of the Scheme. This area coincides with a Drinking Water Safeguard Zone for Groundwater.

11.5.36 From the Soilscapes website, the study area consists of a four main soil textures; ‘slightly acid loamy and clayey soils with impeded drainage’, ‘freely draining floodplain soils’, ‘freely draining slightly acid loamy soils’, and ‘loamy and clayey floodplain soils with naturally high groundwater’.

11.5.37 There are records of four boreholes in the study area. The closest is located 175 m to the south, west of a tributary to the Cocker Beck drain flowing south. SK64NE1 was drilled to 5.48 m below ground level (bgl) for the Southwell Rural District Council (RDC) Lowdham Sewerage Scheme at National Grid Reference 467070 345920. The borehole logs are hand drawn with no depth information provided. The closest borehole to the Scheme shows soil over red sandy clay, over red clay and stones.

11.5.38 No ground investigation has been undertaken for the Scheme at the time of writing.

Road Drainage

11.5.39 Surface water runoff generated on the A6097 is drained via gullies and kerb outlets into ditches on either side of the road. During the site visit, it was observed that many of the existing ditches were overgrown, silted up and covered with litter. There is a pipe flowing into the Cocker Beck which is connected to a gully on the cricket pitch to allow standing water from the floodplain back into the channel. Gullies and kerb outlets also directed water into ditches on Nottingham Road and Southwell Road but again these were poorly maintained. It was also observed that quite a few trees were to be removed from the cricket pitch as part of the proposed development, this may increase surface water runoff in the event of heavy rainfall.

Water Dependent Ecological Areas and Relevant Protected Species

11.5.40 The local designated ecological sites within the study area are noted in Chapter 8: Biodiversity and are summarised in Table 11-7 below:

Table 11-7: Water Dependent ecological features

Name / Status	Location / distance	Feature of interest
Lowdham Pasture / LWS	750 m to the north-east	Botanical – species-rich sloping pasture
Caythorpe Grassland / LWS	750 m to the east	Botanical – ridge and furrow, species-rich

11.5.41 The reasons for designation do not appear to have water dependent habitats. These sites are scoped out of further assessment based on extent of Scheme

design and the designations not being water based, e.g. not marshes or wet woodland habitats.

11.5.42 The desk study results from Chapter 8: Biodiversity include records of the common frog *Rana temoraria*. There are no records of protected aquatic invertebrates within the study area.

Flood Risk

Fluvial flood risk

11.5.43 The Lowdham Roundabout is located within Flood Zone 2 and Flood Zone 3 on the Flood Map for Planning (GOV.UK, 2021b). This information is included in Figure 11-2 in Volume 2C. Land and property in Flood Zone 3 is considered to have a high probability of flooding from rivers or the sea and land or property in Flood Zone 2 is considered to have a medium probability of flooding from rivers or the sea. At Lowdham, the source of this flood risk is the Cocker Beck which flows north-south through the village with areas of flood risk on both sides of the watercourse. The Cocker Beck is a tributary of the River Trent and downstream of the roundabout has a confluence with the River Trent at Gunthorpe, near East Bridgford. At Gunthorpe, there is a wide expanse of floodplain associated with the River Trent and Environment Agency flood defences.

11.5.44 The Environment Agency Flood Map (GOV.UK, 2021b) shows the presence of some flood defences along the right and left banks of the Cocker Beck as it flows through Lowdham. Importantly, these defences *are not* taken into account in the Flood Zone mapping. An updated ‘baseline’ model from the Environment Agency was obtained for the FRA which includes the existing defences near the roundabout. This consists of a defence spanning part of Cocker Beck and around the cricket pitch to the north of the roundabout.

11.5.45 Fluvial flood modelling has been undertaken including the existing defences near the roundabout for the 1% Annual Exceedance Probability (AEP) event, including an allowance of 39% for climate change. The more detailed flood risk modelling, including representation of these defences shows a lower level of risk to the Lowdham roundabout than indicated by the Environment Agency Flood Zones. This is shown in Appendix 4-3 of Volume 3, and is reproduced as Plate 11-1 .

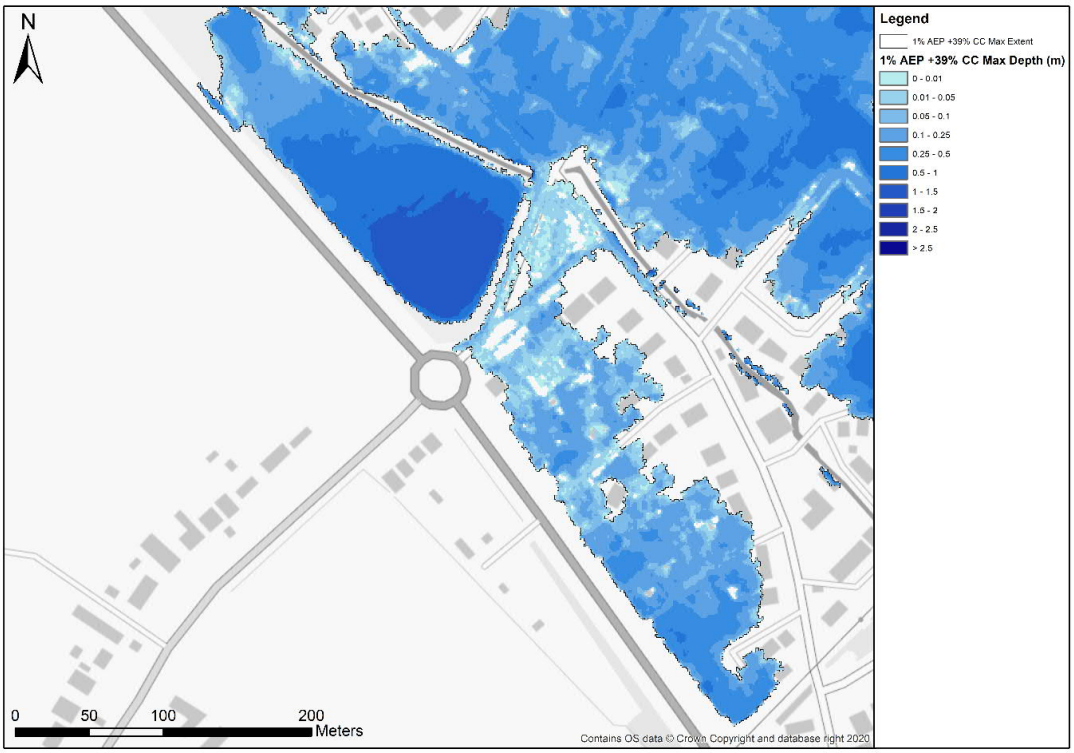

Plate 11-1 Baseline results of Maximum Flood Depths from the updated model for a 1% AEP event, including + 39% climate change allowance

11.5.46 The FRA shows that the updated baseline modelled flooding is confined to the north and east of the roundabout, as shown in Plate 11-1. This confinement of flooding to the field north of the roundabout is due to existing defences located at the right bank of the Cocker Beck and surrounding the cricket pitch. The baseline modelling does not show inundation of the roundabout or of the main approach roads from the north, west and south. Flooding to the east of the roundabout is present due to flow exceeding the Cocker Beck north of the cricket pitch field and following flow routes toward a residential area east of the A6097.

Historical flooding

11.5.47 Lowdham has flooded significantly in 2007, 2012, 2013 and most recently in 2020 where up to 95 houses were flooded. The 2007 floods in Lowdham were relatively localised and of short duration, yet the flooding affected around 300 homes and some residents had to be evacuated to emergency shelters. According to a report undertaken into the events that led up to the 2013 flooding event, the floods were likely exacerbated by poor maintenance, of channels and drainage systems, as observed on the site visit, which are designed to withstand large volumes of water from extreme rainfall events. The village of Lowdham is currently the focus of an Environment Agency project focussed on managing flood storage options upstream of Lowdham.

Surface water flood risk

11.5.48 The GOV.UK Flood Risk from Surface Water map (accessed January 2021) indicates that the risk of surface water flooding at Lowdham Roundabout is generally classed as ‘Medium’ to ‘Low’.

11.5.49 A ‘Low’ risk means that each year the area has a chance of flooding from surface water of between 0.1% and 1%. A ‘Medium’ risk means that each year this area has a chance of flooding of between 1% and 3.3%. The map explains that flooding from surface water is difficult to predict as rainfall location and volume are difficult to forecast. In addition, local features can greatly affect the chance and severity of

flooding. The area of the junction is characterised by a relatively flat area of land at approximately 20 m aOD.

11.5.50 The Environment Agency long-term flood risk map does not indicate the probability of flooding from surface water sewers. However, as the map indicates the risk of flooding from surface water to be low or very low, it can also be inferred that that risk of flooding from surface water sewers is likely to be low. Furthermore, the current maintaining agent has not reported any known history of sewer flooding to the Schemes.

Flooding from artificial water bodies

11.5.51 The Environment Agency Risk of Flooding from Reservoir map indicates that the Scheme is not within an area at risk of flooding from reservoirs and there are no other artificial sources of flooding in the vicinity.

11.5.52 There is a series of fishing lakes approximately 1.5 km to the east, and also to the south, of Lowdham, near the River Trent, away from the Scheme location. The Scheme location is distant from these waterbodies and they would not pose a flood risk to the Scheme.

Flooding from groundwater

11.5.53 The BGS 1:50,000 Groundwater Flood Susceptibility Map (accessed November 2021) shows consolidated bedrock aquifers (chalk, sandstone etc.) and superficial deposits. The mapping does not take account of the chance of flooding from groundwater rebound[4]. It shows the proportion of each 1 km grid square where geological and hydrogeological conditions indicate that groundwater might emerge.

11.5.54 The Scheme is located in a 1 km grid square with a >= 50% to <75% susceptibility to groundwater flooding. The risk of flooding from ground water at Lowdham is Medium.

Tidal flooding

11.5.55 Due to the location of the study area there is considered to be no risk of flooding from tidal sources.

Flooding from drains and sewers

11.5.56 The risk of flooding from drains and sewers is considered to be Low

Future Baseline Conditions

11.5.57 There are no other developments to consider for the future baseline within the area of the Scheme.

Opening year baseline (2025)

11.5.58 The surface WFD waterbodies have currently met their current target objectives, and are unlikely to be improved before 2025. Therefore, their importance is expected to stay the same in the opening year baseline. The baseline within the opening year for groundwater is expected to be largely the same as the current baseline.

11.5.59 Climate change is predicted to alter the future fluvial flood risk and thus it is important that it is taken into account by FRA. Climate change resilience has been accounted for within the proposed drainage strategy with a 40% climate change allowance.

Design year baseline (2037)

11.5.60 The design year is 15 years after the traffic base year of 2023. The surface WFD waterbodies have currently met their current target objectives for 2024. It is possible

[4] Groundwater rebound is the recovery of groundwater levels from the switching off of legacy coal mine pumping systems.

that these could be improved by the 2037 design year. However, using the current DMRB LA 113 criteria an improvement of WFD classification would not change the importance of the surface waterbodies. Therefore their importance is expected to stay the same in the design year baseline. The baseline within the design year for groundwater is expected to be largely the same as the current baseline.

11.5.61 Climate change is predicted to alter the future fluvial flood risk and thus it is important that it is taken into account by FRA. Climate change resilience has been accounted for within the proposed drainage strategy with a 40% climate change allowance.

Importance of Receptors

11.5.62 The key local water resources receptors within the study area are summarised in Table 11-8.

Table 11-8 Key local water resource receptors within the study area

Receptor Name	Receptor Type	Importance	Justification
Cocker Beck, and its tributary	Water quality	High	Cocker Beck is a WFD waterbody, classified as being of Moderate potential. A calculation of Q95 flow (using LowFlow software at a point where the tributary and the Cocker Beck meet is 0.012 m^3/s (i.e. <1.0 m^3/s). This is a watercourse affected by sewage treatment, livestock manage and physical modification.
	Hydromorphology	Medium	Cocker Beck is designated as heavily modified and sections have been altered through realignment, straightening, installation of hard banks and culverting under the roads in the area.
	Fluvial Flood risk	Low	Based on the updated baseline modelling including the existing Cocker Beck defences located round the cricket pitch, the area of the roundabout and three of the access roads would not be inundated with a 1% AEP flood, +39% climate change. Areas of Lowdham to the east of the Scheme remain in Flood Zone 2/3.
A6097 ditch	Water quality	Low	Standing water in what appears to be an isolated agricultural drainage ditch. Overflow from this ditch can enter the highway drainage ditch crossing under the roundabout and discharging to a roadside ditch south of the roundabout.
	Hydromorphology	Low	This is an artificial ditch which is heavily modified as a straightened agricultural drainage ditch.
A612 ditch	Water quality	Low	This is a roadside ditch at the head of a catchment, which was dry at the time of the visit. Water from the road drains into this ditch, then the path turns a right angle close to the house to enter a 525 mm PVC pipe going south. It is assumed that this discharges to a Cocker Beck tributary.
	Hydromorphology	Low	This appears to be an artificial ditch which is heavily modified as a straightened roadside

Receptor Name	Receptor Type	Importance	Justification
			drainage ditch, and then and flow would enter a PVC pipe to the south.
Local ponds	Water quality	Medium	Various ponds are situated within the study area.
Trent Lower Erewash – Secondary Combined WFD groundwater body	Groundwater	Medium	The bedrock is a Secondary B Aquifer can provide water to agricultural or industrial use, with potentially more limited connection to surface water. The status is Good WFD for quantitative and quality.

Floodplain Sensitivity for Impact Assessment

11.5.63 Most of the Scheme area for works is within Flood Zone 3 on the Environment Agency mapping. Updated baseline modelling, which includes the existing Cocker Beck flood defences, shows the roundabout and three of the access roads are not at risk for a 1% AEP flood event including 39% climate change. Therefore, the importance of fluvial flooding for the Scheme is considered to be Low.

11.5.64 When considering construction, the key receptor in terms of all forms of flood risk are the construction workers present on site. However, as the area of the Scheme is located in an area not at risk of flooding for a 1% AEP event plus 39% climate change this receptor is not considered further for the assessment.

11.5.65 The criteria in Table 11-2 do not provide examples of importance for other forms of flood risk, and so the importance is based on the existing baseline risk described earlier in this chapter. For this impact assessment, the sensitivity of non-fluvial flood risk is as follows:

- flooding from surface water is considered mainly of Medium importance;
- flooding from groundwater sources is considered to be of Medium importance; and
- flooding from artificial sources and sewers is considered to be of Low importance.

11.6 Design, Mitigation and Enhancement Measures

11.6.1 This section describes how potential environmental impacts have been, or would be avoided, prevented, reduced or offset through design and / or management during the construction phase processes and operational designs. These mitigation measures are embedded within the design and are thus taken into account by the impact assessment in the initial prediction of effects.

Embedded Mitigation

Construction Mitigation

11.6.2 The risk of significant, acute pollution to watercourses is greatest during the construction stages of the project, particularly works within and adjacent to water bodies. Pollution may arise directly from spillages of oil or other polluting chemical substances, or from site runoff containing high levels of suspended solids from hard standing, other sealed surfaces (including compacted earth), and washed off from construction machinery or from the direct disturbance of river bed and banks.

11.6.3 Prior to construction starting on site, a Construction Environmental Management Plan (CEMP) will be prepared by the Principal Contractor. The CEMP would outline the measures necessary to avoid, prevent and reduce adverse effects where possible upon the local surface water and groundwater environment.

11.6.4 The CEMP will need to be reviewed, revised and updated as the project progresses towards construction to ensure all potential impacts and residual effects are considered and addressed as far as practicable, in keeping with available good practice at that point in time. The principles of the mitigation measures set out below are the minimum standards that the Principal Contractor will implement. However, it is acknowledged that for some issues, there are multiple ways in which they may be addressed. In addition, the methods of dealing with pollutant risk will need to be continually reviewed on site and adapted as construction works progress in response to different types of work, weather conditions, and locations of work.

11.6.5 The CEMP will be standard procedure for the Scheme and will describe the principles for the protection of the water environment during construction. It will include a section on control measures to protect the water environment. This will provide greater detail regarding the mitigation to be implemented to protect the water environment from adverse impacts during construction.

Good Practice Guidance

11.6.6 The following relevant GPPs have been released to date on the NetRegs website (Netregs, 2021) and are listed below. While these are not regulatory guidance in England where the UK government website outlines regulatory requirements, it remains a useful resource for best practice.

- GPP 1: Understanding your environmental responsibilities – good environmental practices;
- GPP 2: Above ground oil storage;
- GPP 3: Use and design of oil separators in surface water drainage systems;
- GPP 4: Treatment and disposal of wastewater where there is no connection to the public foul sewer;
- GPP 5: Works and maintenance in or near water;
- GPP 8: Safe storage and disposal of used oils;
- GPP 13: Vehicle washing and cleaning;
- GPP 19: Vehicles: Service and Repair;
- GPP 20: Dewatering underground ducts and chambers;
- GPP 21: Pollution Incident Response Plans;
- GPP22: Dealing with spills; and
- GPP26: Safe storage – drums and intermediate bulk containers.

11.6.7 Where new GPPs are yet to be published, previous Pollution Prevention Guidance (PPGs) still provide useful advice on the management of construction to avoid, minimise and reduce environmental impacts, although they should not be relied upon to provide accurate details of the current legal and regulatory requirements and processes. Construction phase operations would be carried out in accordance with guidance contained within the following PPG:

- PPG6: Working at construction and demolition sites (Gov.uk, 2012);
- PPG7: Safe storage – the safe operation of refuelling facilities (Gov.uk, 2011); and

- PPG18: Managing fire water and major spillages (Gov.uk, 2000).

11.6.8 Additional good practice guidance for mitigation to protect the water environment can be found in the following key CIRIA documents and British Standards Institute documents:

- British Standards Institute (2009) BS6031:2009 Code of Practice for Earth Works (incorporating corrigendum No. 1) (BSI, 2009b).
- British Standards Institute (2013) BS8582 Code of Practice for Surface Water Management of Development Sites (BS1, 2013c).
- C753 (2015) The SuDS Manual (second edition) (CIRIA, 2015a);
- C741 (2015) Environmental good practice on site guide (fourth edition) (CIRIA, 2015);
- C648 (2006) Control of water pollution from linear construction projects, technical guidance (CIRIA, 2006);
- C609 (2004) Sustainable Drainage Systems, hydraulic, structural and water quality advice (CIRIA, 2004); and
- C532 (2001) Control of water pollution from construction sites – Guidance for consultants and contractors (CIRIA, 2001).

Managing Construction Site Runoff

11.6.9 The measures outlined below, which will be included in the CEMP within a section on control measures to protect the water environment, will be required for the management of fine sediments in surface water runoff as a result of the construction activities:

- Reasonably practicable measures will be taken to prevent the deposition of fine sediment or other material in, and the pollution by sediment of, any existing waterbody, arising from construction activities. The measures will accord with the principles set out in industry guidelines including the CIRIA report 'C532: Control of water pollution from construction sites' (CIRIA, 2001). Measures may include use and maintenance of temporary lagoons, tanks, seeding / covering of earth stockpiles, earth bunds, straw bales and sandbag walls, proprietary measures (e.g. lamella clarifiers or contained chemical treatment) and fabric silt fences or silt screens as well as consideration of the type of plant used.
- A temporary drainage system will be developed to prevent runoff contaminated with fine particulates from entering surface water drains without treatment. This will include identifying all land drains and water bodies on the site and ensuring that they are adequately protected using drain covers, sandbags, earth bunds, geotextile silt fences, straw bales, or proprietary treatment (e.g. lamella clarifiers). Discharge to such water bodies (directly or indirectly) will only be made with the permission of the Environment Agency and with the necessary treatment measures implemented.
- Where possible, earthworks will be undertaken during the drier months of the year and will avoid periods of wet weather (if possible) to minimise the risk of generating runoff contaminated with fine particulates. However, it is likely that some working during wet weather periods will be unavoidable, in which case mitigation measures will be implemented to control fine sediment laden runoff.
- To protect waterbodies from fine sediment runoff, topsoil/subsoil will be stored a minimum of 20 m from any water body on flat lying land (and further if the ground is sloping, subject to ono site risk assessment on observational monitoring) and not within the fluvial floodplain. Where this is not possible, and it is to be stockpiled for longer than a two-week period, the material will either be

covered with geotextile mats, seeded to promote vegetation growth. In all situations, runoff from the stockpile will be prevented from draining to a watercourse without prior treatment.

- Appropriately sized runoff storage areas for the settlement of excessive fine particulates in runoff will be provided. It is likely that treated water will then be pumped under a temporary Water Activity Permit from the Environment Agency or to a water treatment works as agreed with the sewerage undertaker.
- Mud deposits will be controlled at entry and exit points to the site using wheel washing facilities and / or road sweepers operating during earthworks activities or other times as considered necessary.
- Equipment and plant are to be washed out and cleaned in designated areas within the site compound where runoff can be isolated for treatment before discharge to surface water drainage under appropriate consent and / or agreement with Environment Agency, or otherwise removed from site for appropriate disposal at a licensed waste facility.
- Debris and other material will be prevented from entering surface water drainage, through maintenance of a clean and tidy site, provision of clearly labelled waste receptacles, grid covers and the presence of site security fencing.
- The CEMP section on the water environment will include details of pre, during and post-construction water quality monitoring. This will be based on a combination of visual observations, frequent in situ testing using water quality probes, and periodic sampling for laboratory analysis

Managing Construction Site Runoff - Spillages

11.6.10 The measures outlined below will be implemented to manage the risk of accidental spillages on site and potential conveyance to nearby waterbodies via surface runoff or land drains. The measures relating to the control of spillages and leaks will be included in the water section of the CEMP and adopted during the construction works:

- Fuel will be stored and used in accordance with the Control of Substances Hazardous to Health Regulations 2002 (HMSO, 2002), and the Control of Pollution (Oil Storage) (England) Regulations 2001 (HMSO, 2001). Special care will be taken with the delivery and use of concrete and cement as it is highly corrosive and alkaline.
- Fuel and other potentially polluting chemicals will either be in self bunded leak proof containers or stored in a secure impermeable and bunded area (minimum capacity of 110% of the capacity of the containers).
- Any plant, machinery or vehicles will be regularly inspected and maintained to ensure they are in good working order and clean for use in a sensitive environment. This maintenance is to take place off site if possible or only at designated areas within the site compound. Only construction equipment and vehicles free of all oil/fuel leaks will be permitted on site. Drip trays will be placed below static mechanical plant.
- All washing down of vehicles and equipment will take place in designated areas and wash water will be prevented from passing untreated into watercourses.
- All refuelling, oiling and greasing will take place above drip trays or on an impermeable surface which provides protection to underground strata and watercourses, and away from drains as far as reasonably practicable. Vehicles will not be left unattended during refuelling.

- As far as reasonably practicable, only biodegradable hydraulic oils will be used in equipment working in or over watercourses.
- All fixed plant used on the site will be self-bunded.
- Mobile plant is to be in good working order, kept clean and fitted with plant 'nappies' at all times.
- A Pollution Prevention Plan will be prepared and included alongside the CEMP. Spill kits and oil absorbent material will be carried by mobile plant and located at high risk locations across the site and regularly topped up. All construction workers will receive spill response training and toolbox talks.
- The site will be secure to prevent any vandalism that could lead to a pollution incident.
- Construction waste / debris are to be prevented from entering any surface water drainage or water body.
- Surface water drains on roads or within the construction compound will be identified and, where there is a risk that fine particulates or spillages could enter them, the drains will be protected (e.g. using covers or sandbags).
- Suitable facilities for concrete wash water (e.g. geotextile wrapped sealed skip, container or earth bunded area) will be adequately contained, prevented from entering any drain, and removed from the site for appropriate disposal at a suitably permitted waste facility.
- Water quality monitoring of potentially impacted watercourses will be undertaken to ensure that pollution events can be detected against baseline conditions and can be dealt with effectively.

11.6.11 In addition, any site welfare facilities will be appropriately managed, and all foul waste disposed of by a licensed contractor to a suitably permitted facility.

Operation Mitigation

11.6.12 The drainage design is presented in Appendix 2-2 of Volume 3. This has been designed to manage surface water runoff that drains to the Cocker Beck, and its tributaries. The area is to be split up into three catchments, with Catchment 3 consisting of two separate surface water networks with separate flow controls and storage.

11.6.13 There are three catchment areas on the drawing with the following impermeable areas:

- Catchment 1 Impermeable Area: 3,721 m^2. This area includes the southbound drainage of the A6097, the eastern part of the roundabout, and Southwell Road off to the east. Routine road drainage from this area is directed south, into the existing drainage system east, and discharges into the Cocker Beck at approximately 100m south of Station Road.
- Catchment 2 Impermeable Area: 2,040 m^2. This area includes the northbound drainage of the A6097, and the western part of the roundabout. North of the roundabout the A6097 discharges into an existing road drainage ditch. Due to the widening of the roundabout egress, this drainage ditch is being relocated to the west of the current position. This will lead to the loss of the agricultural drainage ditch. This ditch enters a 450mm diameter carrier pipe under the roundabout southwards, and discharges into an existing ditch on the west of the A6097 in the area of Victoria Avenue.
- Catchment 3a. The A612 Nottingham Road will have surface water collected by gullies, which will discharge via pipes to an attenuation pond to the northwest of

the roundabout. This will release water via a flow control chamber into a 525 mm carrier drain, draining southwards to outfall into the Cocker Beck beside properties Brookside on A6097 north bound carriageway.

- Catchment 3b. This catchment consists of the westbound A612 and the new access side road for residential property access. This will have the surface water collected by gullies. These will discharge into an attenuation tank under the new side access road. The impermeable area for Catchments 3a and 3b total 2,974m^2. .

11.6.14 Without attenuation increased flows may result in bank erosion, increased sediment loading, greater flooding and increased pollution to the receiving Cocker Beck. The specific treatment approach adopted for each road catchment has been designed to reflect the extent of flow attenuation required.

11.6.15 Drainage from the Scheme will tie into the existing drainage at the site. The design includes the use of three existing outfalls, with no new outfalls to watercourses or WFD watercourse the Cocker Beck. The outfalls to the new ditches will be designed to minimise any adverse impacts on processes within the receiving ditch.

11.6.16 SuDs are the preferred attenuation solution as they provide several functions, including minimising the risk and impact of flooding in addition to potentially providing a degree of treatment for pollutants (e.g. suspended solids, metals and hydrocarbons). SuDS can take the form of filter drains and ditches. Within the proposed design the drainage discharges to existing ditches to the south of the Scheme.

11.6.17 It is anticipated that the new drainage systems proposed for the Scheme will be designed to prevent and or minimise the risk of groundwater contamination from contaminated surface water runoff.

Floodplain Compensation

11.6.18 The FRA concludes that no floodplain compensation is required.

Watercourse Crossings, Realignments, Diversions and Culverts

11.6.19 The design of the Scheme ensures no works will place in parts of the road network which cross the Cocker Beck, or the local drainage ditch linked to the Cocker Beck.

11.6.20 There is a small ditch on the south side of the A612. This is an artificial ditch which is shown to discharge into a 525 mm carrier drain trending south-east. This roadside ditch will be culverted beneath the new residential access road.

Relevant Permits, Consents and Licences

11.6.21 The improvement Scheme does not cross any ordinary watercourses of main rivers.

11.6.22 The proposed works in the area, as they are located within an area at risk of flooding, will require a flood risk activity permit from the Environment Agency under the Environmental Permitting (England and Wales) Regulations 2016 (HMSO, 2016), where exemptions do not apply.

11.7 Assessment of Likely Significant Effects

11.7.1 The prediction of impacts and the assessment of effects (and their significance) during the construction and operation of the Scheme on the water environment within the study area has taken account of the embedded and essential mitigation measures presented in Section 11.7.

11.7.2 Based on the baseline data, as assessed against Table 11-2, the local water resources receptors within the study area have been attributed an importance level. These are tabulated in Table 11-8.

Construction

Surface Water Quality

11.7.3 Where construction works are undertaken in close proximity to, within, over or under water bodies, close to existing land drains providing a pathway to surface watercourses or ponds, or on steeper terrain angled towards a waterbody, there is the potential for direct adverse effects on water quality. This is due to deposition or spillage of soils, sediments, oils, fuels, or other construction chemicals which could be spilt on site. There may also be indirect water quality impacts from works further from water bodies via existing land drains/ sewers.

11.7.4 There is no requirement for works close to or directly within any watercourses for the Scheme. There is work required within highways ditches which are intrinsically linked to road drainage and are not water receptors requiring assessment in their own right. There would be the potential for conveyance of spills and fine sediment during any works to highway drains and the existing drainage system. This could result in indirect impacts to the Cocker Beck which is hydrologically connected via the existing drainage system and the ditch labelled ‘drain’ on OS mapping.

11.7.5 Construction works for the Scheme has the potential to cause reduction in water quality through sediment disturbance from site clearance and excavation, mobilisation of any existing ground contamination, and the risk of chemical spillages from plant, equipment and materials.

11.7.6 During construction all works would be carried out in accordance with the mitigation measures set out in the CEMP (see Section 11.6), and any discharges to surface water of ‘unclean runoff’ would require a Water Activity Permit from the Environment Agency. The conditions attached to any such consent and to limits on oils, suspended solids and other pollutants; would be adhered to.

11.7.7 Implementation of standard mitigation measures as defined within the CEMP would help avoid or reduce any potential adverse effects on surface water quality impacts during construction. Given that there are no surface watercourses within the Scheme boundary aside from highway drains, plus the fact that mitigation measures are in place to prevent runoff laden with fine sediment and chemical spillages, it is considered that the magnitude of impact of construction works on the Cocker Beck which is of High importance would be negligible. This gives a temporary slight adverse effect (not significant) for the Cocker Beck.

Hydromorphology

11.7.8 The modifications proposed to the roadside ditch to the west of the A6097 will have negligible impact on any receiving watercourses as discharge rates and sources of flow will not change. It is considered there would be a slight betterment in terms of the length of wet habitat available. However, this is considered to be negligible overall. The drainage ditch is of Low importance with regard to hydromorphology, resulting in a neutral effect with no further assessment of this watercourse considered necessary.

11.7.9 The agricultural ditch to the west of the roadside ditch (on the western side of the current hedge) will be realigned with the Scheme. This is not hydraulically connected to the local drainage network and appears to be a soakaway feature. The realignment of this ditch is considered to be a no change impact. As it is of Low importance this results in a neutral effect (not significant) to the hydromorphology of the Cocker Beck catchment area.

11.7.10 South of the A612 another roadside ditch will be culverted. The modifications proposed to this ditch would have a negligible impact on any receiving water courses as discharge rates and sources of flow will not change. On this basis, and coupled with the Low importance of this drainage ditch with regard to

hydromorphology, this is considered to be a neutral effect, and no further assessment of this watercourse is considered necessary.

Groundwater flow and quality

11.7.11 Excavations and other construction activities have the potential to intercept groundwater or perched groundwater levels and could create pathways for contaminants near the surface to the underlying groundwater body. Furthermore, wherever construction works are undertaken, there is potential for spillages or leakages of oil, fuel or other liquid chemicals to contaminate the ground and subsequently leach into underlying groundwater causing pollution and potentially making the water unfit for use. The risk is likely to be significant in locations where there is naturally high groundwater and abstractions.

11.7.12 There was no groundwater level information available on the BGS logs in the vicinity of the site. The BGS groundwater flooding susceptibility maps show that there is a potential for groundwater flooding to occur at the surface. Therefore, groundwater levels in the area are likely to be generally high.

11.7.13 The Scheme is an at-grade junction. A shallow ditch will be constructed on the western side of the A6097 north of the roundabout. This is a replacement of the existing roadside ditch. The agricultural ditch adjacent to this will be realigned.

11.7.14 The construction of the attenuation pond to the north-west of the roundabout has the potential to intercept a local groundwater table. This could temporarily require dewatering during construction.

11.7.15 With the implementation of mitigation measures contained within the CEMP, it is considered that the magnitude of impact on groundwater quality during construction for the Scheme would be negligible. As groundwater is a Medium importance receptor, this results in a neutral effect (not significant).

Potential risk of flooding from fluvial sources during construction

11.7.16 The updated baseline modelling shows the majority of the works are not contained in Flood Zone 3. The updated baseline modelling takes into account existing Cocker Beck flood defences. There will be no works to highway ditches close to the existing drainage network. The baseline risk of surface water flooding could potentially be exacerbated during construction by the temporary increase in the rate and volume of surface water runoff from an increase in impermeable areas such as compacted soils, and the presence of stockpiled materials and equipment temporarily stored on the site. Sediment, construction materials and equipment could be washed downstream where it may block the drainage network and lead to or increase the risk of flooding.

11.7.17 However, with the implementation of standard construction methods and mitigation as described in the CEMP this risk can be effectively managed (for example by monitoring weather forecasts and Environment Agency flood warnings, by undertaking works to the drainage network during periods of dry weather, by ensuring an adequate temporary drainage system was in place and maintained throughout the construction phase, and avoiding stockpiling material on floodplains). As such, the magnitude of flooding from these sources during construction, on site and further downstream, is negligible resulting in a neutral effect (not significant). The effect is not considered a slight effect due to the results from the updated modelling, and the majority of the works taking place in an area not at risk of flooding in a 1% AEP event plus 39% climate change allowance.

Potential risk of flooding from surface water sources during construction

11.7.18 The Scheme is in general at a low risk from surface water flooding, although in some areas (mainly associated with the A6097) there are areas of medium risk as outlined in the baseline (Section 11-5) and the FRA (Appendix 4-3 of Volume 3).

During the works, existing surface flow paths may be disrupted and altered due to site clearance, earthworks, and excavation work. The exposure and compaction of bare ground and the construction of new impermeable surfaces may increase the rates and volume of runoff and increase the risk from surface water flooding. However, with the implementation of standard construction methods and mitigation measures (see Section 7), this risk can be effectively managed. As such, the impact of flooding from surface water is negligible resulting in a neutral effect (not significant).

Potential risk of flooding from drainage infrastructure and artificial sources during construction

11.7.19 The Scheme is at low risk of flooding from sewers and artificial sources. As such, with the implementation of the measures outlined in the CEMP, flooding from these sources is considered to be negligible, resulting in a neutral effect (not significant).

Potential risk of flooding from groundwater sources during construction

11.7.20 The Scheme is potentially at a medium risk of flooding from groundwater sources. Excavations have the potential to encounter and liberate groundwater in some areas, potentially leading to groundwater flooding. With the implementation of the measures outlined in the CEMP, it is considered there would be a negligible magnitude of impact resulting in a neutral effect (not significant).

Potential increase risk of flooding from artificial sources and sewers.

11.7.21 The risk of flooding from artificial sources and sewers is of Low importance. The construction of the Scheme will not change the risk of flooding from artificial sources and sewers. Therefore, there is considered to be a no change impact and a resultant neutral effect.

Operation

Surface Water and Groundwater Quality: Routine Road Runoff

11.7.22 The Scheme would result in an overall increase in impermeable area of 1,100m^2 in the area of the roundabout where pollutants (including hydrocarbons, heavy metals and sediments) can accumulate and be washed into receiving watercourses as routine road runoff, if not treated. The drainage design proposes to tie into the existing drainage system for the road network, which drains to the existing roadside ditches which subsequently drain to the Cocker Beck. This would occur through three existing outfalls.

11.7.23 Catchment 1 discharges into the Cocker Beck at approximately 100 m south of the junction with Station Road, Catchment 2 discharges into an existing roadside ditch to the west of the A6097. Catchment 3 discharges into a 525 mm carrier drain flowing south-east adjacent to residential housing.

11.7.24 The HEWRAT assessment was undertaken to determine the effectiveness of the drainage strategy in providing treatment for pollutants in routine road runoff and accidental spillages. This is a method for assessing the impact of routine runoff on receiving surface waters by considering the copper and zinc content of the runoff (as proxies for dissolved metal pollutants typically found in highway runoff), together with the potential for chronic sediment-bound impact on the receiving watercourse. Appendix 11-2 in Volume 3C contains the detail of the HEWRAT assessment.

11.7.25 The results indicate that the outfall passes the assessment for soluble acute impacts (relating to dissolved copper and dissolved zinc) and chronic sediment impact without the mitigation of an attenuation pond within Catchment 3 and a ditch within Catchment 2.

11.7.26 However, because the ambient copper concentration in the receiving watercourses is currently high (with an average of 4.42 µg/l for data collected in 2015-16 in the

Cocker Beck at Trent confluence) the assessment of annual average copper against the environmental quality standard fails for the outfall to the Cocker Beck. However, the addition of road drainage would only increase the ambient copper concentration by 0.05 µg /l over and above that already monitored within the Cocker Beck by the Environment Agency (at 4.42 µg /l).

11.7.27 The use of the Metals Bioavailable Assessment Tool has been used to determine the concentration of dissolved copper which is bioavailable. The calculations show the amount of bioavailable copper in the Cocker Beck is 0.28 µg /l. This passes the assessment, as a concentration of over 1 µg /l would fail the annual Environmental Quality Standard concentration for dissolved copper.

11.7.28 It is likely that there is a wider road surface impermeable area feeding into these catchments which discharge to the Cocker Beck. The exact area is now known. However, a sensitivity analysis has been undertaken to examine how an increased impermeable area outfalling to the Cocker Beck would affect the calculations. Due to the road being within the lower traffic band (>10,000 to <50,000 AADT), the hardness of the receiving water and the Q95 of the receiving watercourse being able to provide dilution; even with an impermeable area of 10 ha the fictitious catchment would pass the assessment.

11.7.29 As there is only a minimal increase in impermeable area as a result of the Scheme (approximately 1,700 m^2), the impact on the Cocker Beck is considered to be a no change impact, resulting in a neutral effect.

Groundwater quality: routine road runoff

11.7.30 Weighting factors are applied to each of these components in the assessment to reflect the fact that some of these components have a greater or lesser influence on the magnitude of the risk to groundwater. For example, in most circumstances, the depth of the unsaturated zone has a greater influence on risk than unsaturated zone clay content, and so is weighted more heavily. The component score for each parameter is established (low risk = score 1, medium risk = score 2, high risk = score 3) and the relevant score multiplied by the weighting factor to provide total scores for each category. The total category scores are summed to give an overall risk score, with a lowest score of 100 and highest of 300. Scores below 150 show a low risk of impact to groundwater, scores of 150-250 show medium risk to groundwater, and scores over 250 indicate a high risk to groundwater. Full details of the assessment approach are given in DMRB LA 113.

11.7.31 Results of the groundwater assessment for the ditches which convey runoff to the Cocker Beck are shown in Table 11-9. Best estimations of the assessment components have been made using available geology and borehole information.

11.7.32 The assessment indicates a low risk to groundwater. However, as described above the drainage design includes treatment measures in the form of an attenuation pond for Catchment 3, and a roadside ditch for Catchment 1. These are SuDS features and provide a degree of treatment, prior to the outfall to the Cocker Beck. Furthermore, drainage occurs to this watercourse under the existing situation with only a small increase in impermeable area of approximately 1,100m^2).

11.7.33 On this basis, the impact on groundwater from routine road runoff is considered negligible. This results in a neutral effect (not significant) on groundwater as a Medium importance receptor.

Table 11-9: Routine Road Runoff -Groundwater Assessment

Component Number	Property	Weighting Factor	Site Data	Component Score
1	Traffic Flow	10	<50,000	>10,000 to <50,000
2	Rainfall Depth	10	< 740 mm rainfall	Cold-dry
3	Drainage Area Ratio	10	<50	Lincoln (Standard Annual Average Rainfall 600mm)
4	Infiltration Method	15	Continuous – shallow linear, unlined ditch	Cocker Beck= 0.12 m^3/s
5	Unsaturated zone	40	Depth to water >5 to <15m bgl	From Via Geology information
6	Flow type	20	Mixed Fracture and intergranular flow	Geology baseline, alluvial deposits overlying sandstone
7	Unsaturated zone clay content	5	>15% clay minerals	Alluvial deposits
8	Organic carbon	15	<1%soil organic matter	Alluvial deposits
9	Unsaturated zone soil pH	5	pH >8	Typical result
Overall risk Score		**130**		
Risk Level		**Low**		

Accidental Spillages

11.7.34 The HEWRAT tool described in DMRB LA 113 also provides a method that gives an indication of the risk of an accidental spillage resulting in a serious pollution incident on a receiving water body, and guides the need for spillage containment measures. Where the risk is greater than the allowable standard (1 in 100 year return period), spillage containment measures should be built into the drainage designs to reduce the risk.

11.7.35 For the Scheme, the probability that a spillage would cause a pollution incident has been calculated for the outfall to the ditches that discharge to the Cocker Beck. This includes road lengths draining to each outfall, and modelled traffic data.

Table 11-10: Data used within the HEWRAT spillage risk assessment

Parameter	Value	Source
AADT (2037 Design Year, two way) / % HGV (Do Minimum)	A6097NW: 22102 / 3% Southwell Road: 10489 / 2.7% A6097 SE: 24323 / 3.7 % A612: 15988 / 3.8%	AECOM Traffic data

Parameter	Value	Source
AADT (2037 Design Year, two way) / % HGV (Do Something)	A6097NW: 23335 / 3% Southwell Road: 10983 / 2.7% A6097 SE: 25229 / 3.7 % A612: 17323 / 3.8%	AECOM Traffic data
Length of Road	All road lengths taken to be 1km, with additional 250m roundabout for catchments 1 and 2, A6097 NW and SE	Measured from Magic Maps
Road Type / urban or rural	A road / Rural trunk road	Ordnance Survey Map
Spillage Risk Factor	0.29 for no junction, 3.09 for the roundabout and 0.93 with side road	Spillage Factor from HEWRAT Spillage Risk Tool
Emergency Response Time	20-60 mins	Estimated from distance to local large town

11.7.36 For the Do Something scenario in the design year, the traffic flows increase which leads to a 0.0003, or 1 in 3266 years risk that a spillage would result in a significant pollution incident.

11.7.37 This is less than the 1%, which is considered acceptable. The risk of is therefore considered acceptable for the outfalls to the Cocker Beck without mitigation. Based on these results and when taking into account the risk reducing benefits of the proposed drainage system, it is considered that there would be negligible impacts on surface water quality from accidental spillages as a result of the Scheme.

11.7.38 The junction is currently in existence and the proposed road improvement would result in a small increase in traffic in the design year (e.g. on the A6097 north-west the AADT would increase from 22,102 to 23,335 in the design year). Therefore, it is considered there would be a no change impact and neutral effect (not significant) on the Cocker Beck from accidental spillages.

Surface Water Quality: Surface De-icing

11.7.39 During cold periods, which typically occur between October and April each year when temperatures are around 4°C or less, de-icing salts would likely be applied (when required) to the Scheme road network to maintain a safe driving surface and to help clear away any snow fall. The application of de-icant salts tends to be intermittent and can be very variable between years depending on how many cold days there are and the duration. During this time, highway runoff (that may also include snow melt) may contain sodium chloride (NaCl) and lesser amounts of clay, cyanide, sediment, and several metals. De-icing salts can also be corrosive to metals and may potentially increase the mobilisation of heavy metals in sediments. Similarly, NaCl can potentially trigger the release into solution of accumulated nutrients and heavy metals absorbed to suspended solids.

11.7.40 Generally, it is considered that because de-icing salts are used only infrequently and in the colder months, over short periods and with frequent higher flows in between in which to dilute and disperse ‘salty’ water, and when flora tends to have died back and fauna less active and dormant, as such, significant long-term adverse effects are not likely to occur. SuDS systems may also provide some dilution of salt, although they are not generally considered to reduce salinity and there is a risk that the ‘salty’ water can re-mobilise metals deposited in the

sediments.

11.7.41 While de-icing salts have often been linked to detrimental impacts to aquatic ecosystems, and macroinvertebrates in particular (Bent, 2009), there are also numerous scientific reports indicating that road salts do not induce significant acute negative responses on macroinvertebrate communities, but that responses are variable at the species level, where different tolerances are observed (Fleetwood, 2017 and Blasius *et al*, 2002). These latter studies considered short-term/pulsed exposures of road salt on macroinvertebrate communities where there were short residence times for the de-icant. It was considered that salt could accumulate and have more detrimental impacts in more restricted-flow systems leading to potential chronic effects on fauna.

11.7.42 As a broad indication of spreading rates, the Highways Winter Maintenance: A Practical Guide (Institute of Civil Engineers, 2000) suggests 10 to 20 g/m^2 of salt in a precautionary salting, increasing to 20-40 g/m^2 prior to snowfall or rain followed by freezing. Given that there are existing outfalls to the watercourses in the study area, it is expected that the aquatic communities of these watercourses may already be adapted to seasonal exposure to de-icant salts. It is anticipated that effects from de-icing salts would be greatest where receiving waterbodies are small and have limited dilution. However, the Cocker Beck is of sufficient size in this area to provide dilution.

11.7.43 The NCC Gritting map (NCC, 2021b) shows that Lowdham Roundabout and the surrounding roads are all part of the main routes for gritting. While the Scheme increases the impermeable area at Lowdham Roundabout area by a small amount (1,700m^2) in comparison to the existing situation; this is not considered to be a significant amount in the context of the local catchment area. Additionally, the flow from the A6097 will be directed through a roadside ditch and the flow from Catchment 3 will be directed through an attenuation pond. As such, on balance there is considered to be a no change impact to water quality from surface de-icing in comparison to the existing situation, resulting in a neutral effect (not significant) to the Cocker Beck.

Groundwater flow

11.7.44 Once the Scheme is operational the magnitude of impact to groundwater flow, given that the Scheme is to be constructed at grade, is no change. As such, given that the groundwater body is of Medium importance and the magnitude of the impact is no change, the significance of effect is considered to be neutral (not significant).

Flood Risk Effects

Potential increased risk of fluvial flooding

11.7.45 The proposed development at Lowdham Roundabout lies in areas designated Flood Zone 2 and 3, which are areas at medium and high fluvial risk, based on the Environment Agency Flood Map for Planning. This model does not contain the existing Cocker Beck flood defences.

11.7.46 However, updated baseline hydraulic modelling, which includes the existing Cocker Beck flood defences for a 1% AEP event plus a 39% allowance for climate change, shows that the Scheme is not inundated by fluvial flooding.

11.7.47 The incorporation of the Scheme in the hydraulic model shows no change to the updated baseline model. Therefore, there is a ‘no change’ impact to the existing fluvial flood risk during operation.

11.7.48 The surface water drainage strategy with the incorporation of a pond and an attenuation tank on Catchments 3a and 3b respectively, will ensure that flood risk is not increased to the Scheme or elsewhere. Thus, the impact on flood risk is

considered to be ‘no change’. This results in a neutral effect (not significant) on fluvial flooding.

Potential increased risk of surface water flood risk

11.7.49 The surface water drainage system has been designed to ensure no worsening of surface water drainage rates discharging from the site. As outlined in Section 11-6 this will include an attenuation pond for Catchment 3a and an attenuation tank for Catchment 3b.

11.7.50 The aim of the surface water drainage strategy is to ensure that the scheme does not increase the risk of surface water flooding both on and off site. For the catchments where attenuation is needed as a result of increasing impermeable area within a catchment, the storage requirements have been calculated based on attenuating the flow from the entire catchment, therefore bettering the existing surface water scenario.

11.7.51 Taking into account the proposed design of the surface water drainage system, with the construction of attenuation to ensure no increase in surface water discharge rates as a result of the scheme, it is considered there is a ‘no change’ impact to surface water flooding risk. This results in a neutral effect (not significant).

Potential increased risk of flooding from groundwater

11.7.52 For groundwater flood risk, the risk posed to the Lowdham Roundabout before the proposed works is medium. The construction of the Scheme is at grade and the same as the existing junction. Therefore, the groundwater flooding risk remains medium. The Scheme results in a ‘no change’ impact, resulting in a neutral effect (not significant).

Potential increase risk of flooding from artificial sources and sewers.

11.7.53 The risk of flooding from artificial sources and sewers is of Low importance. The Scheme will not change the risk of flooding from artificial sources and sewers. Therefore, there is considered to be a ‘no change’ impact and a resultant neutral effect.

11.8 Additional Mitigation

11.8.1 No additional mitigation is considered to be required.

11.9 Residual Effects

11.9.1 The residual effects of the Scheme in relation to road drainage and the water environment are outlined in Table 11-11 below. No significant residual effects are expected.

Table 11-11 Residual Effects

Description of Effect	Sensitivity of Receptor	Magnitude of Impact	Initial Classification of Effect (with embedded mitigation)	Additional Mitigation	Residual Effect Significance
Construction					
Surface water quality (Cocker Beck)	High	Negligible	Slight	Not required	Slight adverse
Hydromorphology (A6097 roadside ditch)	Low	Negligible	Neutral	Not required	Neutral
Hydromorphology (A612 roadside ditch)	Low	Negligible	Neutral	Not required	Neutral
Groundwater flow and quality	Medium	Negligible	Neutral	Not required	Neutral
Flooding from fluvial sources	Low	Negligible	Neutral	Not required	Slight adverse
Flooding from surface water sources	Medium	Negligible	Neutral	Not required	Slight adverse
Flooding from groundwater	Medium	Negligible	Neutral	Not required	Slight adverse
Flooding from artificial sources and sewers	Low	No change	Neutral	Not required	Slight adverse
Complete and Operational					
Surface water quality – routine run-off (Cocker Beck)	High	No change	Neutral	Not required	Neutral
Surface water quality – de-icing (Cocker Beck)	High	No change	Neutral	Not required	Neutral
Groundwater quality	Medium	Negligible	Neutral	Not required	Neutral
Groundwater flow	Medium	No change	Neutral	Not required	Neutral
Accidental spillages (Cocker Beck)	High	No change	Neutral	Not required	Neutral
Flooding from fluvial sources	Low	No change	Neutral	Not required	Neutral
Flooding from surface water sources	Medium	No change	Neutral	Not required	Neutral
Flooding from groundwater	Medium	No change	Neutral	Not required	Neutral

Description of Effect	Sensitivity of Receptor	Magnitude of Impact	Initial Classification of Effect (with embedded mitigation)	Additional Mitigation	Residual Effect Significance
Flooding from artificial sources and sewers	Low	No change	Neutral	Not required	Neutral

12. CLIMATE

12.1 Introduction

12.1.1 This chapter reports the findings of an assessment of the likely significant effects on climate as a result of the proposed Scheme at Lowdham Roundabout. It also considers the impacts of climate change on the Scheme. The overall Project summary detailing the cumulative impacts of all the Schemes which compose the Project are detailed in Volume 1 Chapter 12: Climate.

12.1.2 To align with the requirements of the EIA Regulations and DMRB LA 114 Climate (Highways England, 2021b), the following two separate aspects have been considered for the potential for likely significant effects:

- **Lifecycle greenhouse gas (GHG) impact assessment** – the effects on the climate of GHG emissions arising from the construction of the Scheme; and
- **Vulnerability of Scheme to climate change assessment** – the resilience of the Scheme to climate change, including how the Scheme design will be adapted to take account for the projected impacts of climate change.

12.1.3 The following lifecycle stages were scoped out of the GHG impact assessment for the Scheme, including the Lowdham Roundabout Scheme:

- **Pre-construction stage:** as the Scheme consists of improvements to existing junctions, it is anticipated there will be limited enabling works or land clearance necessary. Due to this, land use change was also scoped out.
- **Operation stage:** it is anticipated the operation of associated road corridor, signalling and maintenance (including resurfacing) will be similar to the baseline scenario. In addition, traffic count and traffic speed are expected to remain comparable. Therefore operational effects would be unlikely to be significant and were scoped out of the GHG assessment.
- **Decommissioning:** it is anticipated the Scheme will be in use beyond the design life of the road infrastructure. Any future decommissioning would require a separate planning submission. Therefore, the decommissioning of the Scheme was also scoped out of the GHG assessment.

12.2 Legislation and Policy

12.2.1 Information relating to relevant climate legislation and policy can be viewed in Volume 1, Chapter 12: Climate.

12.3 Consultation

12.3.1 A summary of the climate related responses from the Scoping Opinion, which relate to the Scheme at Lowdham Roundabout is included in Table 12-1.

Table 12-1: Comments raised in Scoping Opinion

Stakeholder	Comment raised	Response and where addressed in the ES
Nottinghamshire County Council	As part of the GHG impact assessment consideration should be given to the impact of emissions arising from increased traffic growth and potential to ease congestion	As noted in the Transport Assessment (AECOM, 2021), the Scheme is designed to relieve congestion, and results in very limited re-routing of traffic or significant traffic growth.

Stakeholder	Comment raised	Response and where addressed in the ES
	The need for accurate modelling of GHG emissions identified by Nottinghamshire Wildlife Trust should be noted.	During operation it is anticipated that the operation of associated road, signalling and maintenance (including resurfacing) will be similar to the baseline scenario.
Nottinghamshire Wildlife Trust	In the face of the climate emergency, it is essential that accurate modelling for changes in GHG emissions are undertaken in advance, and that NCC considers how they could be reduced through this Scheme.	The nature of the assessment ensures that GHG emissions related to the Scheme are modelled as per the methodology in Section 12.4.

12.4 Greenhouse Gas Assessment Methodology

12.4.1 The GHG emissions calculation methodology is based upon a lifecycle assessment. Lifecycle stages and the activities applicable to the Scheme are presented in Table 12-2 below. This approach is consistent with the principles set out in DMRB LA 114.

Table 12-2 Potential GHG emissions sources for the lifecycle GHG Impact Assessment of the Scheme

Lifecycle stage	Activity	Primary Emission Sources
Product stage	Raw material extraction and manufacturing of products required to build the Scheme	Embodied GHG emissions
Construction process stage	On-site construction activity Transport of construction materials (where these are not included in embodied GHG emissions) Transport of construction workers Disposal of any waste generated during the construction processes	GHG emissions from energy (electricity, fuel, etc.) consumption for plant, vehicles and generators on site. Fuel consumption from transport of materials to site (where these are not included in embodied GHG emissions) GHG emissions from fuel use for worker commuting GHG emissions from disposal of waste and GHG emissions from fuel consumption of transportation of waste

Baseline Conditions

12.4.2 For the purposes of the GHG emissions impact assessment, the baseline conditions are defined as the ‘Do Minimum’ scenario where the Scheme does not go ahead. The baseline for the Scheme comprises of existing carbon stocks and sources of GHGs within the boundary of the existing site relating to construction of the Scheme.

12.4.3 The scope of the assessment for the Scheme does not include decommissioning or operational carbon emissions therefore the baseline is effectively zero.

Study Area

12.4.4 The identified receptor for GHG emissions is the global climate. As the effects of GHGs are not geographically constrained, “*any GHG emissions might be*

considered significant" (IEMA, 2017) due to their combined environmental effect in the atmosphere. In order to assess the magnitude of impact of GHG emissions from Scheme, UK Carbon Budgets have been used as a proxy for the climate.

12.4.5 The methodology for calculating GHG emissions and removals is consistently used across the baseline, construction, and operations phases of the Scheme, and is as described next.

12.4.6 In line with British Standard ISO14064 (BSI, 2019a, 2019b), principles of the GHG Protocol (WRI & WBCSD, 2015) and Defra reporting guidance (Defra BEIS, 2020), the GHG emissions have been calculated by multiplying activity data by a relevant emission factor:

Activity data x GHG emissions factor = GHG emissions value.

12.4.7 Activity data is a quantifiable measure of activity, such as operating hours or volumes of fuels used. Emission factors convert the activity data into GHG volumes. Activity data has been sourced from information provided by Via. Where specific data is not available, a mix of assumptions and industry benchmarks have been used to fill data gaps. Where this is not possible, then a qualitative approach to assessing the GHG impacts has been followed, in line with the IEMA guidance (IEMA, 2017).

12.4.8 Emission factors have been sourced from publicly available sources, such as Defra (Defra BEIS, 2020), IPCC (IPCC, 2019), the Bath University ICE v3.0 (University of Bath, 2019), and EcoInvent database (EcoInvent, 2021).

12.4.9 In line with the British Standard ISO14064 (BSI, 2019a, 2019b) and the principles of the GHG Protocol (WRI & WBCSD, 2015) when calculating GHG emissions, the seven Kyoto Protocol (UNFCCC, 1997) GHGs have been considered, specifically:

- carbon dioxide (CO_2);
- methane (CH_4);
- nitrous oxide (N_2O);
- sulphur hexafluoride (SF_6);
- hydrofluorocarbons (HFCs);
- perfluorocarbons (PFCs); and
- nitrogen trifluoride (NF_3).

12.4.10 These gases are broadly referred to in this report under an encompassing definition of 'GHGs', with the unit of tCO_2e (tonnes CO_2 equivalent) or Mt CO_2e (mega tonnes of CO_2 equivalent).

Methodology for Determining Construction Effects

12.4.11 To determine the effects of the Scheme, the Do Minimum scenario is compared with a Do Something scenario where the Scheme is built. The Do Something scenario includes emissions associated with the construction of the proposed Scheme.

12.4.12 Direct and indirect emissions sources from different lifecycle stages of the development are detailed in Table 12-2.

Significance Criteria

Sensitivity of Receptor

12.4.13 There is currently no published standard definition for receptor sensitivity of GHG emissions. All GHG emissions are classed as being capable of being significant on

the basis that all emissions contribute to climate change. The global climate has been identified as the receptor for the purposes of the GHG assessment. The sensitivity of the climate to GHG emissions is considered to be 'High'. The rationale supporting this includes:

- GHG emission impacts could compromise the UK's ability to reduce its GHG emissions and therefore the ability to meet its future carbon budgets;
- The need to reduce GHG emissions to reduce the risks and impacts of climate change, as broadly identified by the climate science community and agreed under the Paris Agreement which aims to keep global temperature rise this century below two degrees above pre-industrial levels, (Paris Agreement UNFCCC, 2016). Additionally, a recent report by the IPCC highlighted the importance of limiting global warming below 1.5°C (IPCC, 2018); and
- A disruption to global climate is already having diverse and wide-ranging impacts to the environment, society, economic and natural resources. Known effects of climate change include increased frequency and duration of extreme weather events, temperature changes, rainfall and flooding, and sea level rise and ocean acidification. These effects are largely accepted to be negative, profound, global, likely, long-term to permanent, and are transboundary and cumulative from many global actions.

Magnitude of Impact

12.4.14 In GHG accounting, it is considered good practice to contextualise emissions against pre-determined carbon budgets (Committee on Climate Change, 2020). In the absence of sector-based or local emissions budgets, the UK Carbon Budgets can be used to contextualise the level of significance and this approach has been adopted in the present case as a cogent and reasonable basis. DMRB LA 114 states that it is considered unlikely that a project in isolation will have a significant effect on climate.

12.4.15 Both the Department of Energy and Climate Change (Department of Energy and Climate Change, 2012) and the PAS 2050 Specification (BSI, 2011) allow emissions sources of <1% contribution to be excluded from emission inventories and these inventories to still be considered complete for verification purposes. This exclusion of emission sources that are <1% of a given emissions inventory is on the basis of a 'de minimis' (relatively minimal) contribution.

12.4.16 On this basis, where GHG emissions from the Scheme are equal to or more than 1% of the relevant annual UK Carbon Budgets, the impact of the proposed development on the climate is considered to be of high magnitude. This is summarised in Table 12-3. Impacts that are considered to be of a high magnitude are considered to result in major adverse significant effects on climate as noted in Table 12-4.

Table 12-3 Magnitude criteria for GHG emissions

Magnitude	Magnitude Criteria Description
High	Estimated GHG emissions from the Scheme equate to equal to or more than 1% of total emissions across the relevant 5-year UK Carbon Budget period in which they arise
Low	Estimated GHG emissions from the Scheme equate to less than 1% of total emissions across the relevant 5-year UK Carbon Budget period in which they arise

Significance of Effect

Table 12-4 Significance of GHG Emissions

Magnitude	Significance of Effect
High	Major adverse (significant)
Low	Minor adverse (not significant)

12.4.17 GHG emissions have been assessed against the relevant UK carbon budgets to determine significance. Where a Scheme stage extends over multiple carbon budget periods, the Scheme's GHG emissions are considered against each carbon budget for each Scheme stage. A Scheme is only considered to have a significant effect where increases in GHG emissions will have a material impact on the ability of Government to meet its carbon reduction targets. Consideration will be given to how the Scheme will operate in line with the UK Government's target to achieve "net zero emissions by 2050" since the current carbon budgets are based on the 80% reduction target up until 2032, the 5th carbon budget. The UK Carbon Budgets are detailed in Table 12-5.

Table 12-5 UK Carbon Budgets

UK Carbon Budget Period	UK Carbon Budget ($MtCO_2e$)
3rd (2018-2022)	2,544
4th (2023-2027)	1,950
5th (2028-2032)	1,725
6th (2033-2037)	965

12.5 Climate Change Vulnerability Assessment Methodology

12.5.1 The CCV assessment has followed the method detailed in the DMRB LA 114. This was completed in liaison with the Scheme design team and the other EIA technical disciplines by considering the UKCP18 data (Met Office, 2020a) for the geographical location and timeframe of the Scheme (from construction through to operation).

12.5.2 The potential impacts for the Climate Change Vulnerability (CCV) assessment are based upon the UKCP18 data. Climatic parameters that were taken into account include those identified in Table 12-6.

Table 12-6 Climatic Parameters for the Climate Change Vulnerability Assessment

Climatic Parameter	Scoped in or out	Rationale for inclusion conclusion
Extreme weather events	In	The Scheme may be vulnerable to extreme weather events such as storm damage to structures and assets.
Temperature	In	Increased temperatures may increase cooling requirements of the Scheme and could impact on structural integrity of roads and materials.

Climatic Parameter	Scoped in or out	Rationale for inclusion conclusion
Sea level rise	Out	The Scheme is not located in an area that is susceptible to sea level rise.
Precipitation	In	The Scheme may be vulnerable to changes in precipitation, for example, pressure on water supply during periods of reduced rainfall, and damage to structures and drainage systems during periods of heavy precipitation.
Wind	Out	The impacts of wind on receptors in the surrounding environment are likely to be no worse relative to baseline conditions.

Baseline Conditions

12.5.3 For the purposes of the CCV assessment, the baseline conditions are based upon historic climate change data obtained from the Met Office recorded by the closest meteorological station to the Scheme (Watnall).

Study Area

12.5.4 The receptor for the CCV assessment is the construction and operation of the Scheme itself, including associated scheme users (construction workers and members of the public).

Methodology for Determining Construction Effects

12.5.5 DMRB LA 114 details how to assess the relevance of potential impacts during operations, significance criteria, evaluation of significance and when further design and mitigation measures are required. As the construction phase is 36 weeks and is expected to occur in the immediate future (October 2024 to April 2025), the vulnerability analysis will be described through a descriptive approach as future climate change impacts are not considered material.

12.5.6 Construction phase receptors may include the workforce, plant, machinery and materials.

Methodology for Determining Operational Effects

12.5.7 The CCV assessment has addressed the resilience of the Scheme to climate change impacts in operation. It included all infrastructure and assets associated with the Scheme and assessed resilience against both gradual climate change, and the risks associated with an increased frequency of extreme weather events.

12.5.8 The assessment assumed that the Scheme will be designed to be resilient to impacts arising from current weather events and climatic conditions, and designed in accordance with current planning, design and engineering practice and codes. The assessment took into account the existing resilience and adaptation measures for each risk either already in place or in development for infrastructure and assets.

12.5.9 Climate change projections for the operational phase are produced using UKCP18 data (Met Office, 2020a).

Significance Criteria

12.5.10 The likelihood and consequences to Scheme receptors were assessed according to Table 12-7, Table 12-8 and Table 12-9 as per DMRB LA 114.

Table 12-7 Measure of likelihood for CCV assessment

Likelihood	Description (probability and frequency of occurrence)
Very high	The event occurs multiple times during the lifetime of the Scheme (60 years) e.g. approximately annually, typically 60 events
High	The event occurs several times during the lifetime of the Scheme (60 years) e.g. approximately once every five years, typically 12 events.
Medium	The event occurs limited times during the lifetime of the Scheme (60 years) e.g. approximately once every 15 years, typically 4 events.
Low	The event occurs during the lifetime of the Scheme (60 years) e.g. once in 60 years.
Very low	The event can occur once during the lifetime of the Scheme (60 years).

Table 12-8 Measure of consequence for CCV assessment

Consequence of impact	Description
Very large adverse	National level (or greater) disruption to strategic route(s) lasting more than 1 week.
Large adverse	National level disruption to strategic route(s) lasting more than 1 day but less than 1 week or regional level disruption to strategic route(s) lasting more than 1 week.
Moderate adverse	Regional level disruption to strategic route(s) lasting more than 1 day but less than 1 week.
Minor adverse	Regional level disruption to strategic route(s) lasting less than 1 day.
Negligible	Disruption to an isolated section of a strategic route lasting less than 1 day.

12.5.11 The significance of each climatic impact has been evaluated using a matrix as detailed in Table 12-9. Conclusions are based on and incorporate confirmed embedded design and mitigation measures, as described by DMRB LA 114.

Table 12-9 Significance matrix ('S' significant, 'NS' not significant)

		Measure of Likelihood				
		Very Low	**Low**	**Medium**	**High**	**Very High**
Measure of consequence	**Very Large**	NS	S	S	S	S
	Large	NS	NS	S	S	S
	Moderate	NS	NS	S	S	S
	Minor	NS	NS	NS	NS	NS
	Negligible	NS	NS	NS	NS	NS

12.5.12 In line with the DMRB LA 114 and for the purposes of the CCV assessment, a lifespan of 60 years is used.

Assumptions and Limitations

12.5.13 Detailed design of the Scheme has not been undertaken at this stage. As a result, some data are not available to provide a fully quantified assessment of the GHG emissions from the construction and operation of the Scheme. Accordingly, appropriate industry estimates and averages have been used. The following assumptions, inclusions and exclusions, made on a precautionary basis, have been used in this calculation:

12.5.14 Products (construction):

- where materials size was not specified, it was assumed the largest diameter and depth of materials;
- it was assumed precast concrete to be worst-case scenario for the following materials: gullies, catch pits, outlets, and linear ditch;
- it was assumed that flow control chamber materials were the same as plastic inspection chamber;
- both carrier drains and attenuation were assumed to be polypropylene;
- it was assumed that there was no embodied carbon associated with the ditch as this would be included in earth works;
- it was assumed that the materials of base, sub-base and capping were all fill, aggregate and sand;
- it was assumed that the depth of layers in the access road are the same depth as the main road and that the depth of layers in the hardstanding are the same depth as the footway;
- it was assumed that the acceptable and unacceptable materials are accounted for in the disposal of them;
- it was assumed that the ditch and compaction of fill had no associated embodied carbon that was not already included; and
- topsoil assumed to be in situ therefore no associated embodied carbon.

12.5.15 Waste (construction):

- the walls of all pipes were assumed to be 0.3 inches thick;
- the density of fill, aggregate and sand was assumed to be the same as sand;
- the amount of waste material was calculated as 5% of each construction materials;
- unacceptable material was assumed to be fill, aggregate and sand; and
- 50% of topsoil was assumed to be disposed on site.

12.5.16 Fuel use on site (construction):

- the fuel use on site is based on an assumption that is calculation based on Scheme value; and
- the Scheme value has been calculated based on the cost of civils for each junction and one quarter of the total cost given for land and fees (cost for total works divided into four junctions evenly).

12.5.17 Material Transport (construction):

- assumed a single trip distance of 50 km.

12.5.18 Land use change:

- scoped out.

12.5.19 Limitations associated with the approach taken for the GHG assessment include the material densities used to calculate the weight of materials. Material density was assumed based on the assumed material input. The following material densities have been used as per the Highways England Carbon Tool:

- Surface and Binder were assumed to be Asphalt and have a resultant material density of 1.7 t/m^3
- Base, Sub-base and Capping were assumed to be Fill, aggregate and sand with a resultant material density of 1.85 t/m^3
- Soil was assumed to have a material density of 1.7 t/m^3
- unacceptable material was assumed to be Aggregate and soil and have a resultant material density of 1.7 t/m^3
- attenuation was assumed to be Polypropylene with a resultant material density of 1.4 t/m^3

12.5.20 Information provided by Via used higher densities than the Highways England Carbon Tool. For example, aggregate densities of 2.2 to 2.4 t/m^3 and 1.3 t/m^3 for soil. For both materials this gives an average difference in weight of circa ± 28% and therefore would have the same impact on the GHG emissions associated with the materials in construction and disposal.

12.5.21 Limitations associated with the approach taken for the climate resilience assessment relate to uncertainties inherent within UK Climate Projections (UKCP18 data) (Met Office, 2020a). By its very nature, climate change is associated with a range of assumptions and limitations. UKCP18 are currently the leading climate change projections for the UK.

12.5.22 While the projections used in the vulnerability assessment represent anticipated average weather conditions, they do not capture the full range of possible future severe weather events (i.e. droughts, heatwaves and prolonged heavy rainfall).

12.5.23 Assessments being made in relation to climate change risk and impact likelihood and severity are relying on professional judgement and evidence gathered through other EIA discipline assessments.

12.6 Baseline Conditions

GHG Impact Assessment

12.6.1 The current and future baseline for the lifecycle GHG impact assessment is a ‘business as usual’ scenario where the Scheme is not constructed, and the existing road remains (Do Minimum scenario).

12.6.2 As detailed within Chapter 8: Biodiversity, the ecological baseline conditions consider current and future baseline conditions including habitats lost due to the construction and habitats retained/ or planted during the Scheme. No material change is expected to the baseline conditions of the carbon stocks due to the Scheme comprising primarily of improvements to the junction and no significant removal or addition of habitat.

CCV Assessment

12.6.3 The current baseline for the vulnerability assessment is based on historic climate data obtained from the Met Office (Met Office, 2020b) recorded by the closest meteorological station to the Scheme (Watnall, 17km from Lowdham) for the period

1981-2010. These data are listed in Table 12-10.

Table 12-10 Historic Climate Data

Climatic Variable	Month	Value
Average annual maximum daily temperature (ºC)	-	13.4
Warmest month on average (ºC)	July	21.3
Coldest month on average (ºC)	January	6.6
Mean annual rainfall levels (mm)	-	709.4
Wettest month on average (mm)	October	71.2
Driest month on average (mm)	February	47.2

12.6.4 The Met Office historic 10-year averages for the 'Midlands' identify gradual warming between 1971 and 2020, with increased rainfall also. Information on mean maximum annual temperatures (°C) and mean annual rainfall (mm) is summarised in Table 12-11.

Table 12-11 Historic 10-year averages

Climate Period	Climate Variable	
	Mean maximum annual temperatures (ºC)	**Mean annual rainfall (mm)**
1971-1980	12.7	739.7
1981-1990	13.0	768.8
1991-2000	13.4	796.2
2001-2010	13.8	794.6
2011-2020	14.1	825.1

12.6.5 The future baseline for the vulnerability assessment is based on UK Climate Projections 2018 (Met Office, 2020a). This projection data provides probabilistic indications of how global climate change is likely to affect areas of the UK using pre-defined climate variables and time periods.

12.6.6 For the purpose of the CCV assessment, UKCP18 probabilistic projections for pre-defined 20-year periods for the following average climate variables have been obtained and will be further analysed:

- mean annual temperature;
- mean summer temperature;
- mean winter temperature;
- maximum summer temperature;
- minimum winter temperature;
- mean annual precipitation;
- mean summer precipitation; and

- mean winter precipitation.

12.6.7 Projected temperature and precipitation variables are presented in Table 12-12 and Table 12-13 respectively. UKCP18 probabilistic projections have been analysed for the 25 km grid square in which the scheme is located. These figures are expressed as temperature/ precipitation anomalies in relation to the 1981-2000 baseline.

12.6.8 UKCP18 uses a range of possible scenarios, classified as Representative Concentration Pathways (RCPs), to inform differing future emission trends. These RCPs *"… specify the concentrations of greenhouse gases that will result in total radiative forcing increasing by a target amount by 2100, relative to preindustrial levels*". RCP8.5 has been used for the purposes of this assessment as a worst-case scenario. RCP 8.5 highlights the UKs worst-case scenario, representing a 4.3°C temperature increase by 2081 – 2100, where GHG emissions continue to grow unmitigated.

12.6.9 The Scheme's design life is 60 years. The projected climate variables presented in Table 12-12 and Table 12-13 show time periods that intersect the design life. The 2020-2039 time period intersects the construction stage and earliest operations. The 2040-2059 time period covers the majority of the operations of the Scheme. The 2060-2079 time period intersects the end of the design life of the Scheme.

12.6.10 The vulnerability assessment considers an RCP scenario that reflects a high level of GHG emissions at the 10%, 50% and 90% probability levels to assess the impact of climate change over the lifecycle of the Scheme. A 10% probability result indicates that 10% of model results were below this figure. A 50% probability results indicates that 50% of model results were above and below this figure. A 90% result indicated that 90% of model results were below this figure.

Table 12-12 Projected Changes in Temperature Variables (°C), 50% Probability (10% and 90% probability in parenthesis)

	Climate Period		
	2020-2039	**2040-2059**	**2060-2079**
Mean annual air temperature anomaly at 1.5 m (°C)	+1.0 (+0.3 to +1.7)	+1.8 (+0.8 to +2.8)	+2.8 (+1.3 to +4.4)
Mean summer air temperature anomaly at 1.5 m (°C)	+1.2 (+0.4 to +2.1)	+2.3 (+0.9 to +3.7)	+3.4 (+1.1 to +5.8)
Mean winter air temperature anomaly at 1.5 m (°C)	+0.9 (-0.0 to +1.9)	+1.6 (+0.4 to +2.9)	+2.4 (+0.7 to +4.2)
Maximum summer air temperature anomaly at 1.5 m (°C)	+1.3 (+0.2 to +2.6)	+2.6 (+0.8 to +4.5)	+3.9 (+1.1 to +6.8)
Minimum winter air temperature anomaly at 1.5 m (°C)	+0.8 (-0.1 to +1.9)	+1.6 (+0.3 to +3.0)	+2.4 (+0.7 to +4.3)

Table 12-13 Projected Changes in Precipitation Variables (%), 50% Probability (10% and 90% probability in parenthesis)

	Climate Period		
	2020-2039	2040-2059	2060-2079
Annual precipitation rate anomaly (%)	+1.1 (-3.4 to +6.0)	-1.7 (-8.5 to +5.4)	-0.7 (-6.4 to +5.1)
Summer precipitation rate anomaly (%)	-7.7 (-28.6 to +14.4)	-20.2 (-43.2 to +3.0)	-26.9 (-56.6 to +3.4)
Winter precipitation rate anomaly (%)	+5.2 (-4.7 to +15.7)	+8.2 (-5.4 to +22.5)	+15.2 (-1.7 to +33.1)

12.7 Design, Mitigation and Enhancement Measures

GHG Emissions

12.7.1 Mitigation measures would be implemented to reduce lifecycle emissions across the Scheme as shown in Table 12-14.

Table 12-14 Embedded GHG emission mitigation measures

Lifecycle Stage	Mitigation Measures	Delivery Mechanism
Construction	The Principal Contractor would develop and implement a plan to reduce energy consumption and associated carbon emissions. This could include the consideration of renewable and/or low or zero carbon energy sources and record percentage of savings implemented. Energy consumption and materials use would be recorded and reported on an ongoing basis during the construction phase.	CEMP by the Principal Contractor
	Where practicable, measures would be implemented to manage material resource use during construction including: using materials with lower embodied GHG emissions and water consumption; using sustainably sourced materials; and using recycled or secondary materials.	CEMP by the Principal Contractor
	Use of well-maintained plant, and no idling of plant or vehicles when stationary.	CEMP by the Principal Contractor
	Use contractors/suppliers with low emission fleet vehicles	CEMP by the Principal Contractor
	Waste management measures to reduce wastes include: Agreements with material suppliers to reduce the amount of packaging or to participate in a packaging take-back scheme; Implementation of a ‘just-in-time’ material delivery system to avoid materials being stockpiled, which increases their risk of damage and disposal as waste;	SWMP by the Principal Contractor

Lifecycle Stage	Mitigation Measures	Delivery Mechanism
	Attention to material quantity requirements to avoid over-ordering and generation of waste materials; Re-use of materials wherever feasible, e.g. re-use of excavated soil for landscaping. Concrete will be taken off-site for crushing and re-use; Segregation of waste at source where practical; and Re-use and recycling of materials off-site where re-use on-site is not practical (e.g. through use of an off-site waste segregation facility and re-sale for direct re-use or re-processing).	
	During the detailed design phase, opportunities to reduce wastes include: waste arisings will be prevented and designed out where possible; opportunities to re-use material resources will be sought where practicable, such as the re-use of existing on-site lighting if in adequate condition; and where re-use and prevention are not possible, waste arisings will be managed in line with the waste hierarchy.	Detailed design and SWMP

Climate Change Vulnerability

12.7.2 Mitigation measures would be implemented to reduce climate change vulnerability across the lifecycle of the Scheme. Measures to mitigate the potential impact of climate change impacts are summarised in Table 12-15.

Table 12-15 Embedded climate change vulnerability mitigation measures

Lifecycle Stage	Mitigation Measures	Delivery Mechanism
Construction	The Principal Contractor would develop and implement a plan to prevent or reduce the likelihood of climatic hazards affecting construction staff and assets.	CEMP, SWMP and Site Safety Plan
	Net gain of biodiversity through retained, enhanced or created habitats through landscaping	Landscape Proposals and BNG strategy (see Appendix 2-2 of Volume 3C and BNG Report (Volume 3 Appendix 4-2)
Operation	The Proposed Scheme has been designed to accommodate a 1 in 100-year flood event (with a climate change allowance of 40 % added.	Flood Risk Assessment (Appendix 4-3 of Volume 3)
	A range of measures would be put in place to improve the resilience of the scheme to climate change during the scheme operation, including maintenance plans for drainage systems to allow them to operate effectively, and temperature and extreme weather resilient surfaces.	Operation and Maintenance Manuals

Lifecycle Stage	Mitigation Measures	Delivery Mechanism
	The detailed landscaping proposals are to include drought, and extreme weather -tolerant species where appropriate.	Landscape Proposals (Appendix 2-2 of Volume 3C)

12.8 Assessment of Likely Significant Effects

Construction

12.8.1 As described in Chapter 2: The Scheme, the construction stage is anticipated to take approximately 36 weeks and includes junction improvements to Lowdham Roundabout, the A6097/ A612 Nottingham Road/ Southwell Road roundabout.

12.8.2 In order to assess the magnitude of the impact of the Scheme on the climate, GHG emissions associated with the construction of the Scheme have been calculated based on the methodologies discussed in Section 12.4.

12.8.3 As is usual with projects of this nature, a detailed design of construction activities has not been undertaken for this stage of design, the GHG emissions calculations are based on the following conditions using a mixture of existing Scheme data and information, industry benchmarks and professional judgement. These are detailed in Section 12.5. As detailed in Table 12-16 the total GHGs estimated to be emitted from construction associated with the Scheme have been calculated to be 735 tCO_2e over the course of the 36-week construction period. The majority of emissions are associated with embodied carbon in transport of materials to site accounting for approximately 53% of all construction emissions.

12.8.4 All these emissions are considered ‘additional’ and are included in the impact assessment of the Scheme. They are defined as additional as they are considered new and would not occur if the Scheme did not go ahead.

Table 12-16 Estimated Construction GHG Emissions

Emission Source	Emissions (tCO_2e)	Percentage of Stage Emissions
Embodied carbon in raw materials	251	34%
Fuel usage onsite	25	3%
Transport of materials to site	390	53%
Disposal of construction waste	31	4%
Employee commuting	38	5%
Total emissions	735	

GHG Emissions Significance

12.8.5 As stated in Section 12.4, all emissions are considered to be capable of being significant due to their combined environmental effect in the atmosphere. To contextualise the level of significance, these emissions have been compared to the UK Carbon budgets. As highlighted in Table 12-17, detailing the construction

emissions against that of the relevant UK Carbon Budgets, the Scheme contributes 0.00004% to the 4th Carbon Budget only.

12.8.6 The magnitude of impact during construction is therefore considered to be Low. As per Table 12-3 and Table 12-4, this is considered to be a minor adverse not significant effect.

Table 12-17 Contribution of the Construction Emissions to the UK Carbon Budgets

UK Carbon Budget Period	UK Carbon Budget ($MtCO_2e$)	Do Something Construction Phase Emissions ($MtCO_2e$)	Do Something Percentage Contributions to UK Carbon Budget
4th (2023-2027)	1,950	0.000735	0.00004

12.9 CCV Assessment

Construction

12.9.1 During construction works, receptors such as the construction work force, construction plant, vehicles, materials and workplan may be vulnerable to a range of climate risks. These could include:

- inaccessible construction site due to severe weather event (flooding, snow and ice, storms) restricting working hours and delaying construction;
- health and safety risks to the workforce during severe weather events;
- unsuitable conditions (due to very hot weather or very wet weather, for example) for certain construction activities; and
- damage to construction materials, plant and equipment, including damage to temporary buildings/facilities within the site boundary, such as offices, compounds, material storage areas and worksites, for example as a result of stormy weather.

12.9.2 In consideration of the embedded and design mitigation and management measures described in Section 12.5, the resulting significance matrix for climate vulnerability has been undertaken in Table 12-18. No significant vulnerability impacts have been identified for the construction phase of work.

Table 12-18 Construction Stage Climate Vulnerability Significance Assessment

Climate Variable	Potential Impacts from Climate Variables	Likelihood (Probability and Frequency of Occurrence) 2020-2039	Measure of Consequence	Significance Level
Increased frequency and severity of extreme weather events (such as heavy and/or prolonged precipitation, storm events and heatwaves)	Flooding and storm damage to site and site assets, danger to construction workers, inaccessible work site, possible power disruption, overheating of electrical equipment	Low	Minor Adverse	Not Significant

Climate Variable	Potential Impacts from Climate Variables	Likelihood (Probability and Frequency of Occurrence) 2020-2039	Measure of Consequence	Significance Level
Increased winter precipitation	Flooding of construction site, damage to site assets, danger to construction workers, inaccessible work site	Low	Minor Adverse	Not Significant
Decreased summer precipitation	Drought	Low	Negligible	Not Significant
Increased summer and winter temperatures	Heat stress to construction workers, deterioration of materials and assets, overheating of electrical equipment	Medium	Minor Adverse	Not Significant

Operation

12.9.3 During operations, receptors such as the road users, physical assets, maintenance workers, maintenance plant and maintenance vehicles may be vulnerable to a range of climate risks. These could include:

- inaccessible maintenance site due to severe weather event (flooding, snow and ice, storms) restricting working hours and delaying construction;
- health and safety risks to the workforce and road users during severe weather events;
- unsuitable conditions (due to very hot weather or very wet weather, for example) for certain construction activities; and
- damage to assets, landscaping, materials, plant and equipment as a result of stormy weather, flooding and excessive heat.

12.9.4 In consideration of the embedded and design mitigation and management measures described in Section 12.7, the resulting significance matrix for climate vulnerability has been undertaken in Table 12-19. No significant vulnerability impacts have been identified for the operational phase of work.

Table 12-19: Operational Stage Climate Vulnerability Significance Assessment

Climate Variable	Potential Impacts from Climate Variables	Likelihood (Probability and Frequency of Occurrence) 2020-2039	Measure of Consequence	Significance Level
Increased frequency and severity of	Flooding and storm damage to site and site	Medium	Minor Adverse	Not Significant

Climate Variable	Potential Impacts from Climate Variables	Likelihood (Probability and Frequency of Occurrence) 2020-2039	Measure of Consequence	Significance Level
extreme weather events (such as heavy and/or prolonged precipitation, storm events and heatwaves)	assets, danger to maintenance workers and road users, inaccessible work site, possible power disruption, overheating of electrical equipment, damage and deterioration of assets, 'summer ice' slippery roads after prolonged periods of no rain, land subsidence, traffic related rutting and migration of road material, damage to landscaping			
Increased winter precipitation	Flooding of the site, damage to site assets, danger to maintenance workers and road users and drainage systems, inaccessible work site, damage to roads, land subsidence, damage to landscaping	Low	Minor Adverse	Not Significant
Decreased summer precipitation	Drought, damage to landscaping	Medium	Negligible	Not Significant
Increased summer and winter temperatures	Heat stress to maintenance workers, deterioration of materials and assets, overheating of electrical equipment, thermal expansion and movement of bridge joints and paved surfaces, damage to landscaping	Medium	Minor Adverse	Not Significant

12.10 Residual Effects

12.10.1 There will be unavoidable GHG emissions resulting from the construction phase as materials, energy and fuel use, and transport will be required. The effects are of Low magnitude and therefore not likely to be significant. No mitigation measures further to the ones detailed in the 'Environmental Design and Management' section of this ES chapter have been identified.

12.10.2 The residual effects resulting from the Scheme are summarised in Table 12-20 and Table 12-21.

Table 12-20 Project Wide Residual Effects of GHG Assessment

Description of Effect	Sensitivity of Receptor	Nature of Effect/ Geographic Scale	Magnitude of Impact	Initial Classification of Effect (with embedded mitigation)	Additional Mitigation	Residual Effect Significance
Construction						
Effect of GHG emissions on global climate	High	Long-term global	Low	Minor Adverse	No further mitigation measures are proposed	Low Significance

Table 12-21: Project Wide Residual Effects of CCV Assessment

Description of Effect	Sensitivity of Receptor	Nature of Effect/ Geographic Scale	Magnitude of Impact	Initial Classification of Effect (with embedded mitigation)	Additional Mitigation	Residual Effect Significance
Construction						
Increased frequency and severity of extreme weather events (such as heavy and/or prolonged precipitation, storm events and heatwaves)	Medium	Long-term, isolated to the Scheme	Minor adverse	Not significant	No further mitigation measures are proposed.	Not significant
Increased winter precipitation	Medium	Long-term, isolated to the Scheme	Minor adverse	Not significant	No further mitigation measures are proposed.	Not significant
Decreased summer precipitation	Medium	Long-term, isolated to the Scheme	Minor adverse	Not significant	No further mitigation measures are proposed.	Not significant
Increased summer and winter temperatures	Medium	Long-term, isolated to the Scheme	Minor adverse	Not significant	No further mitigation measures are proposed.	Not significant
Complete and Operational						
Increased frequency and severity of extreme weather events (such	Medium	Long-term, isolated to the Scheme	Minor Adverse	Not Significant	No further mitigation measures are proposed	Not Significant

Description of Effect	Sensitivity of Receptor	Nature of Effect/ Geographic Scale	Magnitude of Impact	Initial Classification of Effect (with embedded mitigation)	Additional Mitigation	Residual Effect Significance
as heavy and/or prolonged precipitation, storm events and heatwaves)						
Increased winter precipitation	Medium	Long-term, isolated to the Scheme	Minor Adverse	Not Significant	No further mitigation measures are proposed	Not Significant
Decreased summer precipitation	Medium	Long-term, isolated to the Scheme	Minor Adverse	Not Significant	No further mitigation measures are proposed	Not Significant
Increased summer and winter temperatures	Medium	Long-term, isolated to the Scheme	Minor Adverse	Not Significant	No further mitigation measures are proposed	Not Significant

13. SUMMARY

13.1 Introduction

13.1.1 This chapter summarises the findings of the assessments, not the residual environmental effects, and states the proposed mitigation and monitoring measures to be implemented during construction and operation of the Scheme.

13.2 Summary of Significant Effects

13.2.1 The following chapters reported no likely significant residual environmental effects during the construction or operation phases of the Scheme:

- Air quality;
- Cultural heritage;
- Landscape and visual;
- Biodiversity;
- Geology and soils;
- Road drainage and the water environment; and
- Climate.

13.2.2 The assessments reported in the following chapters identified likely significant environmental effects during the construction phases of the Scheme:

- Noise and vibration.

13.2.3 Table 13-1 summarises the likely significant effects associated with the construction and operation of the Scheme as detailed in Chapters 5 to 12 of this report.

Table 13-1 Summary of Likely Significant Residual Effects

Topic	Receptor	Phase	Proposed Mitigation and Monitoring	Residual effect
Construction Noise	35no. receptors	Construction	BPM and temporary screening where feasible	Significant adverse
Construction vibration	28no. receptors	Construction	BPM	Significant adverse

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15. ABBREVIATIONS

Abbreviation	Definition
AADT	Annual Average Daily Traffic
AAWT	Average Annual Weekday Traffic
AEP	Annual Exceedance Expectations
ALC	Agricultural Land Classification
AM	Morning peak
ANC	Association of Noise Consultants
AAOD	Above Ordnance Datum
APIS	Air Pollution Information System
AQMA	Air Quality Management Area
AQO	Air Quality Objective
AQS	Air Quality Strategy
ARN	Affected Road Network
AW	Ancient Woodland
BAP	Biodiversity Action Plan
BEIS	Department for Business, Energy and Industrial Strategy
Bgl	Below ground level
BGS	British Geological Society
BMV	Best and Most Versatile
BNG	Biodiversity Net Gain
BPM	Best Practicable Means
BS	British Standard
BSI	British Standards Institution
CAMS	Catchment Abstraction Management Strategy
CCV	Climate Change Vulnerability
CEMP	Construction Environmental Management Plan
CERC	Cambridge Environmental Research Consultant
CH_4	Methane
CIEEM	Chartered Institute of Ecology and Environmental Management
CL:AIRE	Contaminated Land: Application in Real Environments
CO_2	Carbon Dioxide
CRTN	Calculation of Road Traffic Noise
cSAC	Candidate Special Area

Abbreviation	Definition
CSM	Conceptual Site Model
CWS	County Wildlife Site
dB	Decibel
Defra	Department for the Environment Food and Rural Affairs
DfT	Department for Transport
DCLG	Department for Communities and Local Government
DM	Do Minimum
DMFY	Do Minimum Future Year
DMOY	Do Minimum Opening Year
DMRB	Design Manual for Roads and Bridges
DTM	Digital Terrain Model
DS	Do Something
EcIA	Ecological Impact Assessment
ECoW	Ecological Clerk of Works
EHTO	Environmental Health Technical Officer
EIA	Environmental Impact Assessment
EQS	Environment Quality Standard
ES	Environmental Statement
ETRO	Environmental Health Technical Officer
EU	European Union
FRA	Flood Risk Assessment
GCN	Great Crested Newt
GBC	Gedling Borough Council
GHG	Greenhouse Gas
GLVIA	Guidelines for Landscape and Visual Impact Assessment
GWDTE	Groundwater Dependent Terrestrial Ecosystem
HDV	Heavy Duty Vehicle
HE	Historic England
HER	Historic Environment Record
HEWRAT	Highways England Water Risk Assessment Tool
HFC	Hydrofluorocarbons
HGV	Heavy Goods Vehicle
HSI	Habitat Suitability Index

Abbreviation	Definition
ICD	Inscribed Circle Diameter
ICE	Inventory of Carbon and Energy
IEMA	Institute of Environmental Management and Assessment
IOA	Institute of Acoustics
IP	Inter-peak
LAQM	Local Air Quality Management
LBAP	Local Biodiversity Action Plan
LCA	Local Character Area
LGS	Local Geology Site
LNR	Local Nature Reserve
LOAEL	Local Observed Adverse Effect Level
LRA	Land Research Associates
LVIA	Landscape and Visual Impact Assessment
LWS	Local Wildlife Site
MAGIC	Multi-agency Geographic Information Centre
MCZ	Marine Conservation Zone
MMP	Materials Management Plan
MHCLG	Ministry of Housing, Communities and Local Government
MRN	Major Road Network
MPA	Marine Protection Area
Mt CO_2e	Mega tonnes of CO_2 equivalent
N_2O	Nitrous Oxide
NaCl	Sodium Chloride
NBGRC	Nottinghamshire Biological and Geological Records Centre
NCA	National Character Area
NCC	Nottinghamshire Country Council
NERC	Natural Environment and Rural Communities
NEWP	National Environment White Paper
NF_3	Nitrogen Trifluoride
NGR	National Grid Reference
NHLE	National Heritage List for England
NIA	Nature Improvement Area
NIA	Noise Important Area

Abbreviation	Definition
NIR	Noise Insulation Regulations
NMU	Non-Motorised User
NNR	National Nature Reserve
NO_2	Nitrogen Dioxide
NO_X	Nitrogen Oxides
NOEL	No Observed Effect Level
NPPF	National Planning Policy Framework
NPSE	Noise Policy Statement for England
NRMM	Non-Road Mobile Machinery
NSDC	Newark and Sherwood District Council
NSR	Noise Sensitive Receptors
NVZ	Nitrate Vulnerable Zone
NWT	Nottingham Wildlife Trust
OP	Overnight
PCM	Pollution Climate Mapping
PDBE	Polybrominated diphenyl ethers
PFOS	Perfluorooctance sulfonate
PM	Afternoon peak
PM_{10}	Particulate Matter
PPG	Pollution Prevention Guidance
ppSPA	Possible Potential Special Protection Area
ProPG	Professional Practice Guidance: Planning & Noise
PRoW	Public Right of Way
pSAC	Possible Special Area of Conservation
pSPA	Potential Special Protection Area
PWS	Private Water Supply
PZ	Policy Zone
RBC	Rushcliffe Borough Council
RBMP	River Basin Management Plan
RCP	Representative Concentration Pathway
RDC	Southwell District Council
RIGS	Regionally Important Geological Sites
RLCA	Regional Landscape Character Area

Abbreviation	Definition
ROWIP	Right of Way Improvement Plan
SAC	Special Area of Conservation
SCI	Sites of Community Importance
SEO	Statements of Environmental Opportunity
SF_6	Sulphur Hexafluoride
sHRA	Shadow Habitat Regulations Assessment
SINC	Sites of Importance for Nature Conservation
SLNCI	Sites of Local Nature Conservation Importance
SOAEL	Significant Observed Adverse Effect Level
SPA	Special Protection Area
SPZ	Source Protection Zone
SRN	Strategic Road Network
SSSI	Site of Special Scientific Interest
SuDS	Sustainable Urban Drainage
SWMP	Site Waste Management Plan
tCO_2e	Tonnes CO_2 equivalent
UK	United Kingdom
UNFCCC	United Nations Framework Convention on Climate Change
WBCSD	World Business Council for Sustainable Development
WFD	Water Framework Directive
Via	Via East Midlands Ltd
ZoI	Zone of Influence
ZTV	Zone of Theoretical Visibility

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