Cottam Parkway Railway Station

Flood Risk Assessment

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2022/08/05

Lancashire County Council

Cottam Parkway Railway Station

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P03	05/08/22	Update to include revised climate change projections	Charles Dennison	Chris Isherwood	Chris Isherwood	Pippa Hamshaw

Contents

1. Introduction

1.1 Commission

Jacobs UK Ltd (Jacobs) was commissioned by Lancashire County Council (the Applicant) to carry out a Flood Risk Assessment (FRA) to accompany the planning application and development of the Environmental Statement (ES) for the proposed Cottam Parkway Railway Station scheme (hereafter referred to as "the Scheme").

1.2 Planning Background

This FRA has been undertaken in accordance with National Planning Policy Framework[1] (NPPF) and National Planning Practice Guidance[2] (NPPG). The policies referred to in this report are referenced in Appendix 1-3.2 of this ES and where applicable to planning and flooding are discussed in Section 4 of this report.

1.3 Flood Risk Assessment

1.3.1 Aims and objectives

The aim of this FRA is to demonstrate that the Scheme would be safe for the development's lifetime and would not increase flood risk elsewhere.

In line with NPPF, the objectives of the FRA are to:

- Assess the sources of flood risk that are likely to affect the Scheme;
- Assess where the Scheme would increase flood risk elsewhere; and
- Set out the measures proposed to mitigate these risks and affects.

1.3.2 Scope

The assessment of flood risk has been undertaken in accordance with NPPF and its NPPG and in line with the development of the Water Environment Chapter for inclusion in the ES and the scheme design.

The scope includes the following:

- Consultation with key stakeholders include the Environment Agency, Lancashire County Council in its role as Local Lead Flood Authority (LLFA), and the Canal and River Trust to collect key datasets such as flood history and local drainage information.
- A review of local development and flood risk policies and relevant studies such as the Preston and South Ribble Strategic Flood Risk Assessment (SFRA).
- An assessment of existing flood risks from all sources and the potential risk of flooding to the proposed scheme.
- An assessment of potential Scheme impacts on existing flood risk. This assessment has considered the embedded mitigation contained within the design process (e.g. flood design standards) and good practice that would be applied during the construction and operational phases of the Scheme.
- A qualitative assessment of flood risk during the construction period.
- The identification of flood mitigation measures in addition to embedded mitigation and good practice.

[1] Ministry of Housing, Communities and Local Government (2021). National Planning Policy Framework. [Online] Available at: https://www.gov.uk/government/publications/national-planning-policy-framework--2 [Accessed: June 2021].
[2] Ministry of Housing, Communities and Local Government (2019). Planning practice guidance. [Online] Available at: https://www.gov.uk/guidance/flood-risk-and-coastal-change [Accessed: March 2021].

1.3.3 Sources of Information

The following sources of information have been reviewed and assessed for the purpose of this FRA:

- Conceptual designs for the Scheme provided by the Applicant;
- Drainage design and culvert sizing calculation provided by the Applicant;
- Asset data and historical flood records of the Lancaster Canal provided by Canal and River Trust;
- Environment Agency Flood Map for Planning[3];
- Environment Agency Risk of Flooding from Surface Water Mapping (RoFSW)[4];
- Environment Agency Reservoir Flood Mapping[2];
- British Geological Survey (BGS) Geology of Britain viewer[5];
- Topographical Survey and 1m LiDAR Digital Terrain Model (DTM);
- DEFRA Multi-Agency Geographic Information for the Countryside (MAGIC) online mapping tool[6];
- Site visit information (from 7th April 2021), aerial photography and Google Streetview;
- Lancashire Area Preliminary Flood Risk Assessment[7];
- Central Lancashire Strategic Flood Risk Assessment[8];
- Ribble Catchment Flood Management Plan (CFMP)[9];
- Lancashire and Blackpool Local Flood Risk Management Strategy[10];
- Central Lancashire Core Strategy[11];
- Preston Local Plan 2012-2026 (Site Allocations)[12];
- Central Lancashire Design Guide Supplementary Planning Document[13];
- Central Lancashire Biodiversity and Nature Conservation Supplementary Planning Document[14];

[3] Environment Agency (n.d.). Flood map for planning. [Online] Available at: https://flood-map-for-planning.service.gov.uk/ [Accessed: March 2021].
[4] Environment Agency (2021). Risk of Flooding from Surface Water Mapping. [Online] Available at: https://flood-warning-information.service.gov.uk/long-term-flood-risk/map [Accessed: March 2021].
[5] British Geological Survey (2021) Geology of Britain viewer (classic). [Online] Available at: https://mapapps.bgs.ac.uk/geologyofbritain/home.html. [Accessed: January 2021].
[6] DEFRA (2021) Multi-Agency Geographic Information for the Countryside (MAGIC) online mapping tool. [Online] Available at: https://magic.defra.gov.uk/MagicMap.aspx [Accessed: January 2021].
[7] Lancashire County Council (2011). Lancashire Area Preliminary Assessment Report May 2011. [Online] Available at: https://new.fylde.gov.uk/wp-content/uploads/2019/11/Lancashire-Preliminary-Flood-Risk-Assessment-2011.pdf. [Accessed: March 2021].
[8] Scott Wilson (2007). Central Lancashire Strategic Floor Risk Assessment – Level 1 – Final Report. [Online] Available at: https://chorley.gov.uk/media/625/Central-Lancashire-Strategic-Flood-Risk-Assessment-2007/pdf/Strategic_Flood_Risk_Assessment_v1.pdf??m=637384552746000000&ccp=true#cookie-consent-prompt [Accessed: March 2021].
[9] Environment Agency (2009). Ribble Catchment Management Plan. Summary Report December 2009. [Online] Available at: https://www.gov.uk/government/publications/ribble-catchment-flood-management-plan [Accessed: March 2021].
[10] Lancashire County Council and Blackpool Council (2013). Lancashire and Blackpool Local Floor Risk Management Strategy. Draft for Consultations. [Online] Available at: https://www.lancashire.gov.uk/media/900474/lancashire-and-blackpool-local-flood-risk-management-strategy-consultation-draft.pdf [Accessed: March 2021].
[11] Preston City Council, Chorley Council and South Ribble Council: Central Lancashire Core Strategy (2012). [Online] Available at: https://www.preston.gov.uk/article/1194/Central-Lancashire-Core-Strategy- [Accessed: March 2021].
[12] Preston City Council (2015). Preston Local Plan 2-12-25. Site Allocations & Development Management Policies. [Online] Available at: https://www.preston.gov.uk/media/1952/Preston-s-Local-Plan/pdf/Preston-Local-Plan-2012-2026-_8.pdf?m=637056240884300000 [Accessed: March 2021].
[13] Preston City Council, South Ribble Borough Council, Chorley Council (2012). Central Lancashire Design Guide: Supplementary Planning Document. [Online] Available at: https://www.southribble.gov.uk/media/137/Design-guide/pdf/SRE007_-_SPD_-_Design_Guide.pdf?m=637369819386330000. [Accessed: March 2021].
[14] Preston City Council, South Ribble Borough Council, Chorley Council (2015). Central Lancashire Biodiversity and Nature Conservation Supplementary Planning Document. [Online] Available at: http://programmeofficers.co.uk/Preston/CoreDocuments/LCC007.pdf [Accessed: March 2021].

- North West Preston Masterplan - Supplementary Planning Document[15];
- Preston, South Ribble and Lancashire City Deal[16];
- Combined Ground Investigation Report (GIR) Cottam Parkway: Access Road and Car Park Geotechnical Report No. CLM07b-LCC-RP-600-0001

1.3.4 Limitations and Assumptions

The FRA has been undertaken with the following key limitations and assumptions:

- The assessment has been based on the design details that were available at the time of writing (June 2022). Any subsequent changes would require the conclusions of this FRA to be revisited.
- This FRA relies upon third party data including assessments undertaken as part of the design of the culvert and the drainage system. It is assumed that all third party data provided is accurate.

[15] Preston City Council (2017). Doc 02: North West Preston Masterplan. Supplementary Planning Document. [Online] Available at: https://www.preston.gov.uk/media/965/North-West-Preston-Masterplan/pdf/02-SPD-Doc-2-NW-Preston-Masterplan-2017-LOW-RES.pdf?m=636941215583170000 [Accessed: March 2021].

[16] Preston City Council, South Ribble Borough Council, Chorley Council, Lancashire Enterprise Partnership (n.d.) Preston, South Ribble and Lancashire city Deal. [Online] Available at: https://www.preston.gov.uk/media/1216/City-Deal/pdf/City-Deal.pdf?m=636958571683130000 [Accessed: March 2021].

2. Site Description

This section of the FRA outlines key information regarding the location of the Scheme.

2.1 Site Location

The Scheme is to be situated within a semi-rural area approximately 4km north-west of central Preston and to the immediate south-west of the largely residential area of Cottam. The central grid reference for the Scheme is SD 48714 31645. Land use within the planning application site comprises pastureland used for grazing and/or fodder production.

The planning application boundary used is defined on Figure 1. The Lancaster Canal and the Preston Fylde Junction to Blackpool North line both run east to west through the site area, whilst Sidgreaves Lane leading to Darkinson Lane runs north to south along the eastern boundary of the Scheme. The section of railway line to the south of the Scheme runs along an embankment approximately 2m high.

2.2 Existing Land Use and Topography

The Scheme lies within existing open countryside comprising pastoral farmland. There are no residential dwellings within the site area. However, there are several properties (including Halsall's Farm, Park Dene and Railway Cottages off Darkinson Lane) that are situated to the south outside of the site area of the Scheme.

The Lancaster Canal runs east to west through the centre of the site area. This poses a key access constraint, which requires bridging in order to connect the Scheme with Preston Western Distributor Road (PWDR)/ East-West Link Road (EWLR) (the Cottam Link Road) to the north.

Topographically, the high point of the site is at the junction of Darkinson Lane and Sidgreaves Lane. The topography of the site slopes from the north at approximately 24m Above Ordnance Datum (AOD) south-easterly towards the railway line. The lowest point within the site area is where an unnamed watercourse referred to as the Central Watercourse passes beneath the railway at 15.7m AOD. The land immediately north of the railway is approximately 18m AOD, whilst the railway to the south is at a level of approximately 20m AOD. Digital Terrain Model (DTM) data is shown on Figure 1 in Appendix A.

2.3 Hydrology, Geology and Hydrogeology

The Scheme is located within the Savick Brook catchment (total catchment of 49.5km^2), a main river tributary of the River Ribble located approximately 3km downstream of the site (confluence location is at SD 48135 28750). Savick Brook rises in the village of Longridge and is largely rural in nature prior to running through Preston City Centre. Savick Brook is also referred to as the Millennium Ribble Link as it is a navigable watercourse with locks that connect to the Lancaster Canal.

The Scheme is also located near to three ordinary watercourses comprising two unnamed watercourses and Lady Head Runnel, which all drain to Savick Brook. Each ordinary watercourse flow southwards through the site towards the Lancaster Canal and the railway line where they enter culverts before converging and joining to Savick Brook (confluence locations are at SD 48700 30500 and SD 49750 30800). Figure 2 (Appendix A) illustrates the location of Savick Brook, the Lancaster Canal and the three identified ordinary watercourses.

- The eastern ordinary watercourse is referred to as Lady Head Runnel. It has three culverts upstream from the railway line and starts to flow uncovered from Lea Road at the south side of the railway line.
- The middle ordinary watercourse is referred as Central Watercourse in this report. It flows through the site area from north to south via five culverts.
- The western ordinary watercourse is around 350m to the west from the Central Watercourse is referred as Western Watercourse in this report.

Geological data and hydrogeological information have been obtained from the BGS online mapping viewer[17], DEFRA MAGIC online mapping tool[18] and from the Environment Agency's online maps.

The underlying bedrock geology comprises the Sherwood Sandstone Group. This was formed approximately 250 million years ago in an environment dominated by rivers. The rocks were formed through the deposition of sands and gravel, with fine silt and clay forming floodplain alluvium. There is superficial alluvium along the course of Savick Brook. The overlying superficial deposits largely comprise Glacial Till (Diamicton). These rocks were formed in cold periods with Ice Age glaciers scouring the landscape and depositing moraines of till with outwash sand and gravel deposits from seasonal and post glacial meltwaters. Therefore, the Scheme is located over a highly permeable bedrock which is potentially confined by low permeability glacial deposits.

Hydrogeological maps indicate that the site area is underlain by bedrock designated as a Principal aquifer. These are layers of rock or drift deposits that have high intergranular and/or fracture permeability, meaning that they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale.

The superficial deposits are designated as Secondary (undifferentiated) aquifers. These are layers assigned in cases where it has not been possible to attribute either category A or B to a rock type. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type.

An intrusive Ground Investigation has been undertaken to inform the design of the Scheme. This has confirmed that the Scheme is underlain by low permeability glacial deposits. The thickness of the superficial deposits was observed to vary between 15.6 m below ground level (bgl) to 17.9 mbgl and. Groundwater within the superficial deposits was observed to be limited to small, perched groundwater bodies within per permeable layers. Groundwater monitoring of boreholes within the Bedrock aquifer identify that the bedrock is confined by the superficial deposits resulting in the potential for water to be held under artesian pressures.

[17] British Geological Survey (2021) Geology of Britain viewer (classic). [Online] Available at: https://mapapps.bgs.ac.uk/geologyofbritain/home.html. [Accessed: January 2021].

[18] DEFRA (2021) Multi-Agency Geographic Information for the Countryside (MAGIC) online mapping tool. [Online] Available at: https://magic.defra.gov.uk/MagicMap.aspx [Accessed: January 2021].

3. Development Proposal

This section of the FRA provides an overview of the Scheme and its key characteristics. Further details of the Scheme are contained within Chapter 3 Description of the Scheme in volume 2 of this ES.

3.1 Cottam Parkway

The Scheme includes the following:

- Railway station building, associated structures and car park(s);
  - Western and Eastern Car Parks
  - Station Forecourt
  - Railway Station / Building, Railway Station platforms and footbridge
  - Secondary Means of Escape (SME)
  - Bus Gate
- Access road including a new public highway;
  - Cottam Link Road Roundabout and Access Road
  - Lancaster Canal Access Road Bridge
  - Shared Use Cycle Track
- Associated surface water drainage system.

It is expected that the construction of the Scheme would begin in 2023). Image 1, illustrates the location of the Scheme elements. Further details of the key elements are also provided in succeeding sections.

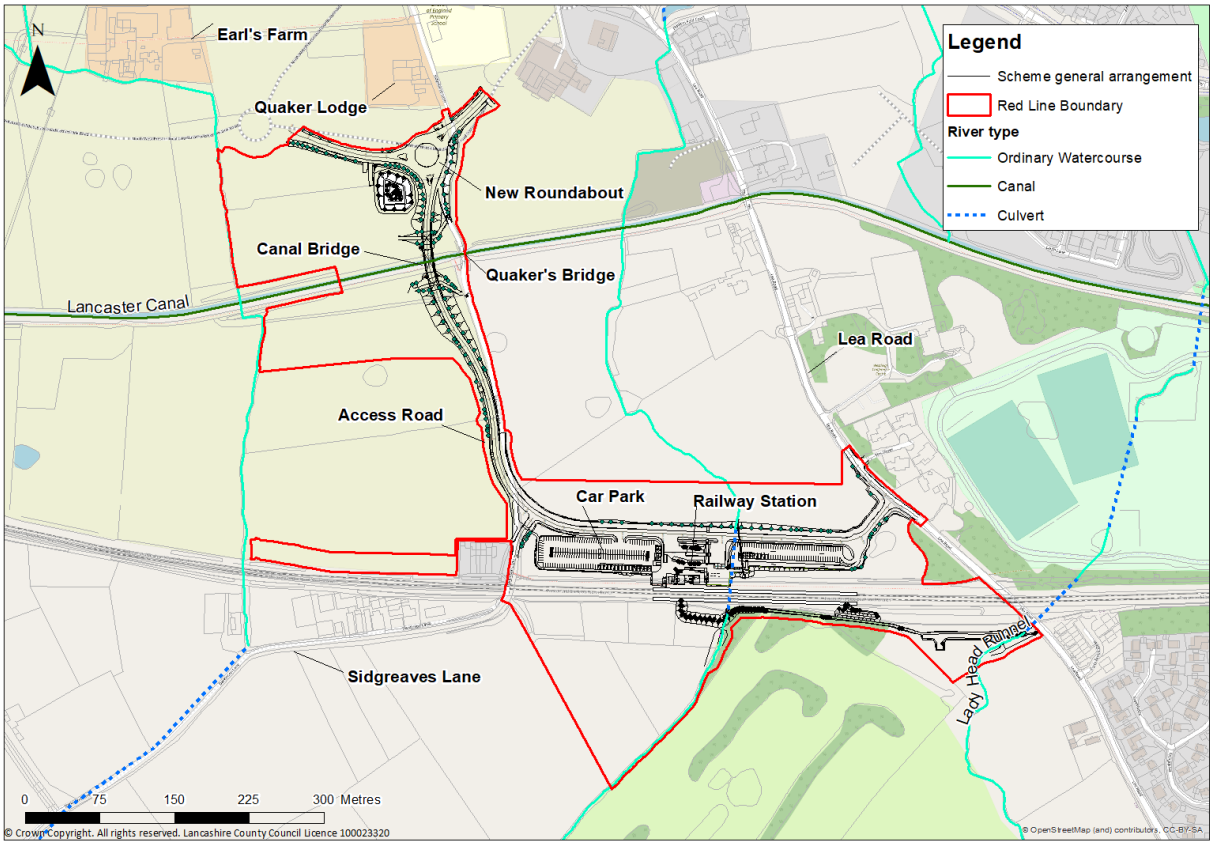


Image 1: Scheme design

3.1.1 Railway Station

The Scheme includes a railway station consisting of a:

- Railway Station building with two platforms;
- Car park;
- Footbridge over the railway;
- Access road; and
- Associated earthworks or embankments.

The car park is intended to provide a park and ride facility for the city of Preston and would be located north of the Preston Fylde Junction to Blackpool North line, to the east of Sidgreaves Lane and west of Lea Road. It would also provide associated features such as cycle parking, bus shelters, signage, lighting and barriers. The main surfaces of the hard-landscaped areas would be permeable block/tarmac material dependent on suitability. The proposed design life of the railway station platforms is 100 years.

3.1.2 Access Road

The access road would start with a new roundabout from the 'Cottam Link Road' (under construction) between Earl's Farm and Quaker Lodge at the north end of the Scheme. An attenuation pond is proposed next to the new roundabout to manage drainage from the highway and help to restrict runoff to greenfield rates. The roundabout proposed approximately 100m to the north from Quaker's Bridge next to Sidgreaves Lane. As the route of the access road would cross the Lancaster Canal, a new access road bridge is proposed with associated earthworks and embankments. The new roundabout would be connected through alterations to the existing road network, including Sidgreaves Lane and Lea Road; providing a segregated footway and cycle track along the existing Sidgreaves Lane; creating a bus gate onto Lea Road and providing a new 'T-junction' to the east of Railway Cottages.

3.1.3 Access Road Bridge

The access road bridge would be a new highway bridge situated to the west of a bridge known as Quaker's Bridge that presently carries Sidgreaves Lane over the Lancaster Canal. Quaker's Bridge would be retained and used for non-vehicular traffic to include a segregated footway and cycle track.

The access road bridge would be a three-span design (see Appendix D). The central span would cross the Lancaster Canal with a minimum headroom from the canal to soffit of the structure of 3.5m, with a 2.7m headroom clearance on the towpath. The width of this central span would be a total of 23.2m. A sheet pile wall would be extended along the canal for the full width of the proposed canal bridge, required to reinforce the bank to for a new engineered bank side on the northern side. The northern and southern span would span over non-vehicular access tracks with a 3m clear headroom, the spans would be 12.8m wide each. The carriageway carried by the structure would comprise of a 1m hardened verge with two 3.25m wide lanes. The proposed design life of the main structural elements of the bridge is 120 years.

3.1.4 Drainage System

A new surface water drainage system has been designed to serve the new railway station, car park and access road. The surface water drainage systems have a proposed design life is 60 years. Appendix B contains details of the surface water drainage strategy, which includes:

- Drainage arising from the proposed realigned access road roundabout approaches would be collected by a combination of road gullies and filter drains and piped to discharge to the PWDR Cottam Link Road drainage system. The catchment area represents a net reduction on the existing catchment area the at outfall location 1.

- The drainage of the roundabout on the southern approach and station access road to the apex of the new canal bridge would drain to a new attenuation pond before discharge into the Western Watercourse.
- The twin cattle creeps under the minor arch spans of the bridge would be collected through filter drains containing filter material to remove animal effluent, and it would be piped independently into the Western Watercourse (OF3).
- The highway drainage for the remaining length of the access road, from the apex of the bridge to its junction with Lea Road, including the carpark, railway station building and concourse would be attenuated by a combination of online storage through system surcharge and an attenuation tank located under the eastern car park and railway station concourse. The highway drainage discharges to a replacement culvert (described below) under the proposed car park associated with the Central Watercourse.
- The existing 225mm diameter field culvert, culverting the Central Watercourse north of the existing Network Rail under-rail culvert, would be replaced by a new 900 diameter culvert providing continuity of flow and increased capacity. The replacement culvert would be constructed with a new chamber on the upstream headwall of the existing Network Rail culvert to operate as a culvert extension and point of discharge for attenuated surface water.
- The southern section of the proposed station platform, the footbridge and the secondary means of escape would be piped and stored in oversize pipes before discharging into the Central Watercourse or a tributary of this south of the railway.

3.2 Construction

The activities that would be undertaken during the construction of the Scheme and could impact the flood risk would comprise of:

- Site set-up, including establishing access routes, working area boundaries, site administration locations, and material-storage locations;
- Advance accommodation works, Statutory Utility service diversions;
- Site clearance, including tree clearance;
- Installation of kerbs and concrete edging on footways;
- Excavation of the existing topsoil and temporary stockpiling of the material for subsequent re-use in verges or landscape features;
- Earthworks operations;
- Construction of the surface water drainage features, including pollution control measures, storm water drainage, culverts, open channels, and outfalls;
- Construction of the subsequent highway pavement layers;
- Construction of landscape and other environmental mitigation measures; and,
- Construction of temporary compounds for approximately 24 months.

4. Planning Policy Review

This section of the FRA introduces the key national and local planning, development and flood risk policies that are relevant to the Scheme.

4.1 National Planning Policy

The NPPF sets out the Government's policies for the planning system in England which have the overall objective of contributing towards the achievement of sustainable development. The Planning Practice Guidance[19] (PPG) is available online to support the policy documented within the NPPF.

The principle aim of the NPPF assessment of flood risk is detailed in paragraph 159 ***"Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk (whether existing or future). Where development is necessary in such areas, the development should be made safe for its lifetime without increasing flood risk elsewhere."***

The NPPF requires an FRA to be produced in the following scenarios:

- All proposals for new development (including minor development and change of use) in Flood Zone 2 and 3;
- Proposals in an area within Flood Zone 1 which has critical drainage problems (as notified to the local planning authority by the Environment Agency) or greater than one hectare in size;
- Where land identified in a strategic flood risk assessment as being at increased flood risk in future; or
- Where proposed development or a change of use to a more vulnerable class may be subject to other sources of flooding.

4.1.1 Assessment of Flood Risks

The main source of flood risk information that is used to steer development at the planning stage, is the Environment Agency's Flood Map for Planning (FMfP) (rivers and sea). This map defines three zones of different flood risk, the third of which is subdivided into two categories. Table 4.1 shows the different classifications of flood zone which relate to the probability of flooding.

Table 4.1: Flood Zone Classification[20]

Flood Zone	Description
Zone 1 Low Probability	Land having a less than 1 in 1,000 annual probability of river or sea flooding.
Zone 2 Medium Probability	Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding.
Zone 3a High Probability	Land having a 1 in 100 or greater annual probability of river flooding; or land having a 1 in 200 or greater annual probability of sea flooding.
Zone 3b The Functional Floodplain	This zone comprises land where water has to flow or be stored in times of flood. Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency.

[19] Ministry of Housing, Communities and Local Government (2021). Planning practice guidance. [Online] Available at: https://www.gov.uk/guidance/flood-risk-and-coastal-change [Accessed: June 2022].

[20] Ministry of Housing, Communities & Local Government: Flood Risk and Coastal Change Guidance (2014). [Online] Available at: https://www.gov.uk/guidance/flood-risk-and-coastal-change#flood-zone-and-flood-risk-tables [Accessed: March 2021].

The Scheme is located entirely in Flood Zone 1. The nearest mapped floodplain is associated with Savick Brook and is approximately 500m to the south of the site area. The flood risk from main rivers and ordinary watercourses is detailed further in Section 5.1.1. Although the Scheme is located in Flood Zone 1, and therefore has a low probability of flooding from main river fluvial sources, the NPPF also requires that developers consider flood risk from all other sources, including surface water, groundwater, ordinary watercourses, artificial drainage systems, canals and reservoirs, where relevant.

4.1.2 Sequential Test

The NPPF requires a risk-based, sequential approach to determine the suitability of land for development, in flood risk areas, which should be applied at all stages of the planning process. The Sequential Test should be applied to demonstrate that there are no reasonably available sites in areas with a lower probability of flooding that would be appropriate to the type of development proposed.

The Environment Agency's Flood Zones are the starting point for the Sequential Test and refer to the probability of sea and river flooding. They are defined on a 'worst case' basis, ignoring the presence of existing defences. The overall aim of the Sequential Test is to steer new development to areas with the lowest probability of flooding.

It is understood that several factors, including flood risk, were taken into account in identifying the preferred location of the station platforms by Network Rail and the location of the station access road alignment by the applicant. The proposed area is entirely located within Flood Zone 1 and largely avoids areas at a high and medium likelihood of flooding from Ordinary Watercourses and surface water. The Scheme also has a necessary connectivity to the highway network (PWDR), which links directly to the M55 and is currently under construction. In light of this, it can justifiably be shown that the applicant has actively sought to avoid areas of flood risk. Therefore, it is considered that the Sequential Test has been applied passed.

4.1.3 Vulnerability Classification

Table 4.2 illustrates the flood risk vulnerability categories and flood zone compatibility matrix for England, taken from Table 3 of the NPPF[21]. The proposed scheme is classified as 'Essential infrastructure' because it comprises essential transport infrastructure that is required for North West Preston as a strategic location within the Preston City Council Local Plan and delivery of PWDR and EWLR.

Table 4.2: Vulnerability classification (situation of the Scheme is highlighted)

Flood Zones	**Flood Risk Vulnerability Classification**				
	Essential infrastructure	**Highly vulnerable**	**More vulnerable**	**Less vulnerable**	**Water compatible**
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test required	✓	✓	✓
Zone 3a	Exception Test required	✗	Exception Test required	✓	✓
Zone 3b	Exception Test required	✗	✗	✗	✓

[21] Flood Risk and Coastal Change Guidance, Flood Zone and flood risk tables, Table 3. [Online] Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/575184/Table_3_-_Flood_risk_vulnerability_and_flood_zone__compatibility_.pdf [Accessed: March 2021].

As discussed in Section 4.1.1, the proposed scheme would be located in Flood Zone 1, meaning that the risk of fluvial flooding is considered low. The development of Essential Infrastructure in Flood Zone 1 and 2 is considered acceptable. The application of the Exception Test is therefore not required.

4.1.4 Exception Test

The Exception Test, as set out in paragraph 160 of the NPPF, is a method to demonstrate and help ensure that flood risk to people and property would be managed satisfactorily, while allowing necessary development to go ahead in situations where suitable sites at lower risk of flooding are not available. For the Exception Test to be passed it should be demonstrated that:

- *"The development would provide wider sustainability benefits to the community that outweigh the flood risk*
- *The development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall."*[22]

Exception Test is not required for this scheme as the development is an Essential Infrastructure in Flood Zone 1.

4.1.5 Climate Change

The UKCP18[23] is the latest generation of national climate projections for the United Kingdom. The high level trends presented in UKCP18 suggest that summers would become hotter and drier whilst winters would become milder and wetter along with an increase in the frequency and intensity of extremes. This could affect the seasonality and frequency of flooding from all sources. Climate change is predicted to increase the frequency and severity of storm events in the future, which will increase river flows and cause sea levels to rise.

The NPPF in Chapter 14 ('*Meeting the Challenge of Climate Change, Flooding and Coastal Change*') requires the impact of future climate change to be taken into account when determining if the proposed development is safe for its lifetime without increasing flood risk elsewhere.

In doing so, NPPF states that advice from the Environment Agency and other relevant flood risk management authorities, such as LLFAs, should be taken into account.

4.1.5.1 Environment Agency Guidance

Using the UKCP18 projections, the Environment Agency guidance[24] for accounting for climate change provides guidance on how and when climate change allowances in flood risk assessments should be considered. This guidance has recently been updated to reflect the latest UKCP18 projections providing climate change uplifts on peak fluvial flows and peak rainfall intensity across a range of locations, timescales and emissions scenarios.

Table 4.3 provides the predicted increases to fluvial flows within the River Ribble catchment relevant to this assessment. The range of allowances is based on percentiles. A percentile describes the proportion of possible scenarios that fall below an allowance level:

- Central allowance is based on the 50th percentile;
- Higher allowance is based on the 70th percentile; and,
- Upper allowance is based on the 90th percentile.

[22] Ministry of Housing, Communities and Local Government (2019). National Planning Policy Framework. [Online] Available at: https://www.gov.uk/guidance/national-planning-policy-framework/14-meeting-the-challenge-of-climate-change-flooding-and-coastal-change#para160 [Accessed: March 2021].

[23] Met Office (2019). UK Climate Projections (UKCP). [Online] Available at: https://www.metoffice.gov.uk/research/approach/collaboration/ukcp/index [Accessed: March 2021].

[24] Environment Agency (2022). Guidance - Flood risk assessments: climate change allowances. [Online] Available at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances [Accessed: July 2022].

Table 4.3: Peak river flow allowances for the River Ribble catchment[24]

Allowance category	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2070s' (2070 to 2115)
Upper	27%	44%	71%
Higher	**19%**	**29%**	**46%**
Central	16%	23%	36%

Environment Agency guidance[24] states that the flood risk vulnerability classification of the proposed development needs to be considered to apply the right climate change allowance. The higher allowance needs to be applied for essential infrastructure within Flood Zone 2 and 3 or in an area Flood Zone 1, which could become Flood Zone 2 in the future. The Scheme is within Flood Zone 1, therefore the higher allowance has been used to inform design e.g. the proposed new culvert and based on the 60 year design life, the 2070s epoch values have been adopted.

Table 4.4 shows the anticipated changes in peak rainfall intensity within the River Ribble catchment. In accordance with the Environment Agency Guidance, the upper allowance has been considered. Again, based on the 60 year design life of the surface water drainage systems, the 2070s epoch values have been adopted.

Table 4.4: Peak rainfall intensity allowances for the River Ribble catchment[26]

Allowance category	Total potential change anticipated for the '2050s' (2040 to 2069)		Total potential change anticipated for the '2070s' (2070 to 2115)	
	3.3% AEP event	1% AEP event	3.3% AEP event	1% AEP event
Upper	35%	40%	**40%**	**50%**
Central	25%	25%	30%	35%

4.1.5.2 DMRB Guidance

In addition to the Environment Agency guidance, the design has also adopted guidance within the Design Manual for Roads and Bridges (DMBR) CG501[25] during the design of highway drainage systems. This guidance recommends:

- A 20% uplift in rainfall intensity be taken into account in designs; and,
- A 40% uplift in rainfall intensity be considered as a sensitivity test.

4.2 Design Standards

The DMRB has been adopted for the Scheme to inform the design standards of the road, bridge and sustainable drainage systems (SuDS). Network Rail standards (NR/L2/CIV/003/F1990[26], Technical Design Requirements for BS EN 1990) have been adopted for the rail station.

To ensure that both the DMRB and Environment Agency flood risk and climate change guidance was met, a precautionary approach was taken. A summary of adopted flood risk design standards is presented in Table 4.5.

[25] Highways England, Transport Scotland, Welsh Government, Department for Infrastructure. (2020). Design Manual for Roads and Bridges: Drainage General Information. CG501 – Design of highway drainage systems. Revision 2. [Online] Available from https://www.standardsforhighways.co.uk/prod/attachments/ada3a978-b687-4115-9fcf-3648623aaff2?inline=true [Accessed July 2022]

[26] Network Rail (2020). NR/L2/CIV/003 - Engineering and Architectural Assurance of Building and Civil Engineering Works. [Online] Available at: https://standards.globalspec.com/std/14282032/NR/L2/CIV/003. [Accessed: March 2021].

Table 4.5: Summary of design standards

Flood Source	Design Requirements	Design Event	Climate Change Allowance	Freeboard	Notes
Rainfall	No surcharge of road drainage.	50% AEP rainfall event	20% with sensitivity test of 40%	N/A	DMRB CG501
Rainfall	No surcharge above cover level.	20% AEP rainfall event			
Rainfall	No surface water flooding beyond the site boundary and runoff rates restricted to greenfield.	1% AEP rainfall event	50%	N/A	Environment Agency guidance - Flood risk assessments: climate change allowances.
Rainfall	No flooding to critical assets or flood risk impacts.	1% AEP rainfall event	50%	150mm	
River Flows	Free flow conditions within culverts.	1% AEP fluvial event	46%	300mm	
River Flows	No flooding to critical assets or flood risk impacts.	1% AEP fluvial event	46%	300mm	

4.3 Local Policies and Plans

NPPF is supplemented at a local level by additional development plans and flood risk policies put in place by the local authorities. Locally set flood risk policies relate to specific, local issues, such as drainage requirements for development within critical drainage areas, restrictions on infill development or minimum threshold levels for properties within the floodplain.

The Scheme is located in the administrative area of Lancashire County Council and Preston City Council. It should be noted that within this area Lancashire there is a two-tier system of local government, with Lancashire County Council being responsible for matters such as strategic highways, minerals waste planning and the developments promoted by the County Council (County Matters – regulation 3 applications under the Planning Act 1990), whilst the District Councils are responsible for commercial and domestic applications. Lancashire County Council has made transport infrastructure development a key part of their local Infrastructure Delivery Plan. Consequently, the following local documents have been reviewed.

4.3.1 Central Lancashire Core Strategy

The Central Lancashire Core Strategy[27] was adopted in 2012 by South Ribble Borough Council, Preston City Council and Chorley Council. The Core Strategy is a key document in Central Lancashire's Local Development Framework. Its purpose is to help co-ordinate development in the area and contribute to boosting investment and employment in line with national policies. The document encourages sustainable managed growth, whilst protecting and enhancing green spaces and access to open countryside. Key policies and objectives relevant to the Scheme includes:

- **Policy 18** looks at the use of green infrastructure to manage and improve environmental resources. It highlights the need to protect and enhance the natural environment where it already provides benefit and

[27] Preston City Council, Chorley Council and South Ribble Council: Central Lancashire Core Strategy (2012). [Online] Available at: https://www.preston.gov.uk/article/1194/Central-Lancashire-Core-Strategy- [Accessed: March 2021].

invest in and improve the natural environment at other places for example the canal networks including the Lancaster Canal into Preston.

- **Policy 29** looks at the issue of water management; it highlights the need to slow down run off rate in areas of development to reduce the risk of surface water flooding and encourages the use of SuDS.
- **Strategic Objective 23** focuses on the management of flood risk across the area and directs attention to the threats posed by the River Ribble.

The Core Strategy states that there is a low risk of fluvial and tidal flooding in Central Lancashire, and the risk of groundwater flooding is also low, but due to climate change, likely to be more so in the future. It places the responsibility on developers to demonstrate that proposed developments are not in areas where there is a high risk of flooding and would not increase flood risk in other areas, in particular, not to encourage it near to the River Ribble.

4.3.2 Central Lancashire Local Plan (CLLP)

The Strategic Plan[28] for the area of Central Lancashire districts (Preston City Council, South Ribble Borough Council and Chorley Council) until 2036 is currently a draft document. A key theme within this document is collaboration to ensure the sustainable location of development and investment opportunities to meet local needs in this increasingly integrated and interdependent region.

4.3.3 Preston Local Plan 2012-2026 (Site Allocations)

The Preston Local Plan[29] was adopted in July 2015 and identifies North West Preston as a strategic location for growth and investment. It identifies the scale of development and allocates sites to meet the development needs of Preston over a 15-year period in order to achieve the vision for growth as outlined in the Central Lancashire Core Strategy. It also sets out detailed development management policies which will be used by decision makers to determine planning applications. In determining these allocations account of future climatic changes and how flood risk may increase in the future have been considered.

The plan aims to reduce the amount of development in high flood risk zones and help with the implementation of flood alleviation measures in high risk areas. Therefore, an assessment of the flood risk in the area of interest is required due to the proposed future uses of the land. This plan identifies the need for directing development away from areas at high risk of flooding which is included in the site selection process. The plan encourages new developments to deploy sustainable drainage systems for surface water which could be incorporated into the green infrastructure network.

The area to the north and north east of Cottam is identified as the North West Preston Strategic Location (NWPSL) where housing growth would be focused. The site comprises mostly greenfield land to the north west of Preston's City Centre. The Local Plan confirms the delivery of a new railway station is a key part of the delivery of the North West Preston Masterplan. The local plan also identifies Cottam Parkway Railway Station within Policy IN1 (Preston Western Distributor) and policy IN3 (Park and Ride sites). The Core Strategy also confirms the Central Lancashire Highways and Transport Masterplan proposes a new parkway rail station in the Cottam area.

4.3.4 Central Lancashire Design Guide Supplementary Planning Document (SPD)

The aims and objectives of the Central Lancashire Design Guide SPD[30] are to ensure that all new development in the Preston, South Ribble and Chorley areas achieve a high level of design quality. Achievement of high-quality

[28] Preston City Council, South Ribble Borough Council and Chorley Council: Central Lancashire Local Plan (2022). [Online] Available at: https://centrallocalplan.lancashire.gov.uk/about/ [Accessed: March 2021].
[29] Preston City Council: Preston Local Plan 2012-2026 (Site Allocations) (2015). [Online] Available at: https://www.preston.gov.uk/media/1952/Preston-s-Local-Plan/pdf/Preston-Local-Plan-2012-2026-_8.pdf?m=637056240884300000 [Accessed: March 2021].
[30] Central Lancashire Design Guide Supplementary Planning Document (SPD) (2012). [Online] Available at: https://www.southribble.gov.uk/media/137/Design-guide/pdf/SRE007_-_SPD_-_Design_Guide.pdf?m=637369819386330000 [Accessed: March 2021].

design in buildings, assists in creating better urban realm and the definition of place; it also contributes towards economic development and climate change objectives.

The SPD expects all Major Schemes to meet the following standards:

- BREEAM – Very good for non-residential schemes / buildings;
- Secured by Design; and
- Manual for Streets 1 & 2.

4.3.5 Central Lancashire Biodiversity and Nature Conservation SPD

Central Lancashire Biodiversity and Nature Conservation SPD[31] adopted 2015 is a supplementary planning document that provides further advice and guidance for dealing with matters concerning biodiversity across Central Lancashire.

"88. Sustainable Drainage System (SuDS) can create new and enhance existing wildlife sites, particularly soft engineering SuDS features such as ponds, swales and wetlands. They can form links with the wider ecological network to create a coherent 'blue infrastructure' of water habitats in Lancashire. SuDS are encouraged within the drainage strategy of proposed developments and the positive impact that they can have for biodiversity and for ecological networks should be taken into account in scheme design."

4.3.6 Ribble Catchment Flood Management Plan (CFMP)

This Ribble CFMP[32] provides an overview of the flood risk across the River Ribble catchment and recommended ways of managing the flood risk now and over the next 50 to 100 years. As a strategic document, CFMP's should be used to inform planning and decision making by key stakeholders.

The plan identifies areas and watercourses in and around Preston at risk from fluvial and surface water flooding. The effects of tidal flooding are also highlighted as it causes a backing up effect on many watercourses which are linked to the tidal Ribble Estuary. Heavy urbanisation in this area generates high surface water runoff rates. This can generate localised flooding when combined with the number of sewer overflows and highway drainage discharges in the area. There are numerous sources of flooding in the area and the existing high flood risk is expected to increase significantly due to climate change.

The Scheme lies within sub-area 9 (Preston and Walton-le-Dale) of the Ribble CFMP. The preferred policy option for Preston is Policy Option 5: Areas of moderate to high flood risk where we can genuinely take further action to reduce flood risk. The policy promotes the application of rigorous planning control for any new development in Preston using the principles in Planning Policy Statement 25 and encourage the implementation of SuDS. The Scheme lies in the same policy unit as the city centre, but it likely does not have the same flood issues due to its location outside of the urban centre.

4.3.7 Lancashire and Blackpool Local Flood Risk Management Strategy (LFRMS)

Lancashire and Blackpool Councils have jointly produced a LFRMS[33] to manage local flood risk issues more effectively, which include flooding from ordinary watercourses, surface water and ground water. This strategy should be consulted as part of the planning process to ensure that flood risk management issues are adequately considered.

[31] Central Lancashire Biodiversity and Nature Conservation Supplementary Planning Document (2015). [Online] Available at: http://programmeofficers.co.uk/Preston/CoreDocuments/LCC007.pdf [Accessed: 09 March 2021].
[32] Environment Agency (2009). Ribble Catchment Flood Management Plan. [Online] Available at: https://www.gov.uk/government/publications/ribble-catchment-flood-management-plan. (Accessed: March 2021).
[33] Lancashire County Council and Blackpool Council (2013). Lancashire and Blackpool Local Flood Risk Management Strategy. [Online] Available at: https://www.lancashire.gov.uk/media/900474/lancashire-and-blackpool-local-flood-risk-management-strategy-consultation-draft.pdf. (Accessed: March 2021).

Key strategic objectives contained in the LFRMS relevant to the Scheme include:

- Understanding Risk 4: Take account of climate changes when fulfilling duties and responsibilities in flood risk management.
- Sustainable Flood Risk Management 1: Integrate economic, social and environmental improvements with local flood risk management in line with sustainability principles.
- Sustainable Flood Risk Management 2: Development should be managed so that it reduces flood risk.
- Sustainable Flood Risk Management 3: The use of SuDS should be promoted.

4.3.8 Lancashire Area Preliminary Flood Risk Assessment (PFRA)

A PFRA[34] was produced in 2009 by LCC in response to requirements of the Flood Risk Regulations (2009) for LLFAs to identify significant historic flood events and potential future flood risks.

The PFRA contains a map of historic flooding within the county; however, this does not identify the area surrounding the proposed scheme as having any historic records of flooding. Further to this it has a record of historical flood events and the sources of these floods. These records indicate that there have been no flood events recorded in the area for the Scheme.

The PFRA also contains a groundwater vulnerability map for Lancashire. The map indicates that the Scheme is not in an area susceptible to groundwater flooding. Given the coarse scale of the mapping, it is not possible to determine the specific location of the Scheme to assess whether it lies in the susceptible area.

The PFRA[35] and flood risk areas for LCC were reviewed during 2017, using all relevant current flood risk data and information and not identified new FRAs or changes from the original PFRA in 2011.

4.3.9 Central Lancashire SFRA

The SFRA[36] is compiled for Central Lancashire in December 2007 on behalf of the combined administrative areas of Preston City Council, South Ribble Borough Council and Chorley Borough Council. It is a Level 1 SFRA, which sets out to provide sufficient information to inform decisions regarding development sites and enable the application of the Sequential Test.

The SFRA provides a summary of information on flood risk for Central Lancashire, including Preston. The catchments of the River Wyre, River Ribble and River Douglas define the main hydrological influences for Central Lancashire.

The SFRA confirms that the fluvial and tidal flood risk to large parts of the site area is low. However, areas adjacent to watercourses are a higher risk. The normal tidal limits are on the outskirts of Preston for the River Ribble. Likewise, there are little or no records of sewer flooding or groundwater flooding. However, the presence of major aquifers and areas of more permeable superficial deposits mean that there may be potential for rising groundwater following periods of sustained rainfall. The majority of sewers are built to the guidelines within "Sewers for Adoption" (WRC, 2006). These sewers have a design standard to the 1 in 30-year flood event and therefore it is likely that the majority of sewer systems would surcharge during rainstorm events with a return period greater than 30 years (e.g. 100 years). The risk of flooding from the canal network or reservoirs is also identified as low, though residual risk remains.

[34] Lancashire County Council and Blackpool Council: Lancashire Area Preliminary Assessment Report (2011). [Online] Available at: https://new.fylde.gov.uk/wp-content/uploads/2019/11/Lancashire-Preliminary-Flood-Risk-Assessment-2011.pdf. [Accessed: March 2021].

[35] Environment Agency: Preliminary flood risk assessment: Lancashire County Council (2017). [Online] Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/698402/PFRA_Lancashire_County_Council_2017.pdf [Accessed: March 2021].

[36] Preston City Council, South Ribble Borough Council and Chorley Borough Council: Central Lancashire Strategic Flood Risk Assessment Level 1 (2007). [Online] Available at: https://chorley.gov.uk/media/625/Central-Lancashire-Strategic-Flood-Risk-Assessment-2007/pdf/Strategic_Flood_Risk_Assessment_v1.pdf??m=637384552746000000&ccp=true#cookie-consent-prompt [Accessed: March 2021].

The SFRA also highlights the presence of flood management structures on Savick Brook. This comprises a flood storage area which provides additional capacity adjacent to Savick Brook.

5. Assessment of Flood Risk to the Scheme

This section of the FRA contains the assessment of flood risk to the Scheme and owing to the site location, all sources of flooding have been considered apart from tidal sources. It is also considered unlikely that other sources of flooding assessed would be influenced by extreme tidal levels due to the elevation of the scheme is approximately 19m AOD.

5.1 Flood Risk from Fluvial Sources

Fluvial flooding refers to flooding from rivers, streams and other inland watercourses. Fluvial flooding is usually caused by prolonged or intense rainfall, generating high rates of runoff which overwhelm the capacity of the channel. When this occurs, excess water spills onto low-lying areas of land adjacent to the channel. It can also occur when the watercourse has a high level downstream, perhaps due to structures or blockage, thus limiting conveyance. This creates a back-up of water that results in water overtopping the banks. Typical flooding issues occur when the natural floodplain has been urbanised and the river has been confined or straightened.

Fluvial flood risk can be divided between risk from main rivers and risk from ordinary watercourses. Main rivers are usually larger rivers and streams where the Environment Agency carries out maintenance, improvement, or construction work to manage flood risk. Ordinary watercourses are any other watercourses not designated as main rivers. More information on the watercourses present within the Scheme can be found in Section 2.3.

5.1.1 Flood Risk from Main Rivers

The Environment Agency's Flood Map for Planning (FMfP) shows the undefended extent of fluvial flooding, represented by Flood Zones as illustrated in Image 2. This shows the extents of Flood Zone 2 and 3 related to Savick Brook (main river) approximately 440m to the south from the scheme.

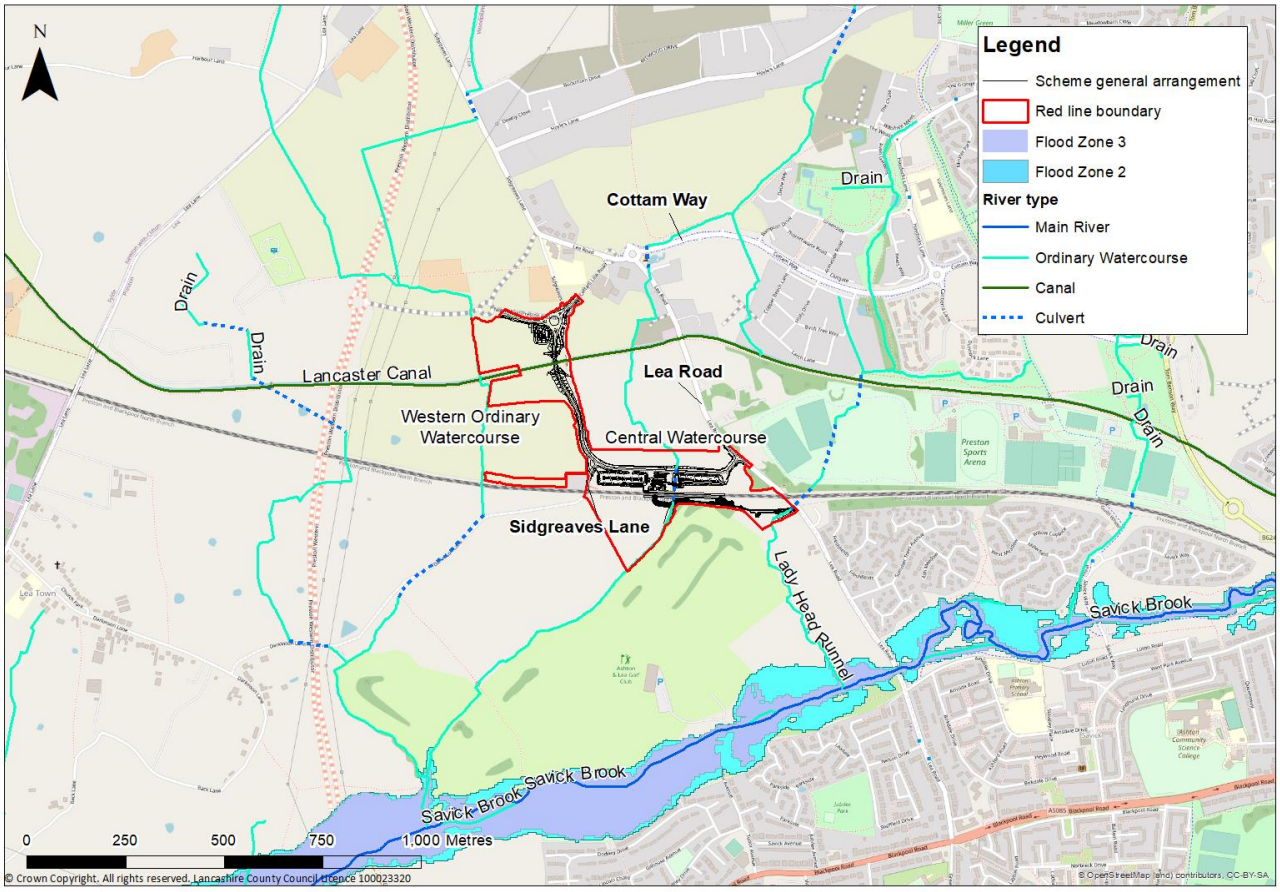


Image 2: Flood Zone Outlines (FMfP)

The Central Lancashire SFRA states that generally the fluvial flood risk across the area is low. There are no known Environment Agency flood defences along the stretch of Savick Brook immediately south of the Scheme and there are no historical flood records identified within 250 m of the Scheme.

All the design elements of the Scheme are located with Flood Zone 1, indicating that the risk of fluvial flooding from main rivers at the Scheme is less than 0.1% annual exceedance probability (AEP).

The NPPF requires consideration of the impact of future climate change to be taken into account for a new proposed development (see Section 4.1.5). However, as the development is proposed in Flood Zone 1 approximately 440m from Flood Zone 2, the risk of fluvial flooding from main rivers at the scheme for the 100-year design life is considered to remain low throughout the life of the development. Therefore, no fluvial flood risk mitigation requirements are required.

5.1.2 Flood Risk from Ordinary Watercourses

The scheme is located within the Savick Brook catchment. There are three ordinary watercourses identified in close proximity to the site area for the proposed scheme, which all flow north to south and are tributaries of Savick Brook. These minor tributaries are generally unnamed on OS mapping. The Central Watercourse (Image 3 below) passes through the proposed railway station and car park itself, whilst Lady Head Runnel is around 300m to the east and the Western Watercourse is around 350m to the west. More information about these watercourses can be found in Section 2.3.

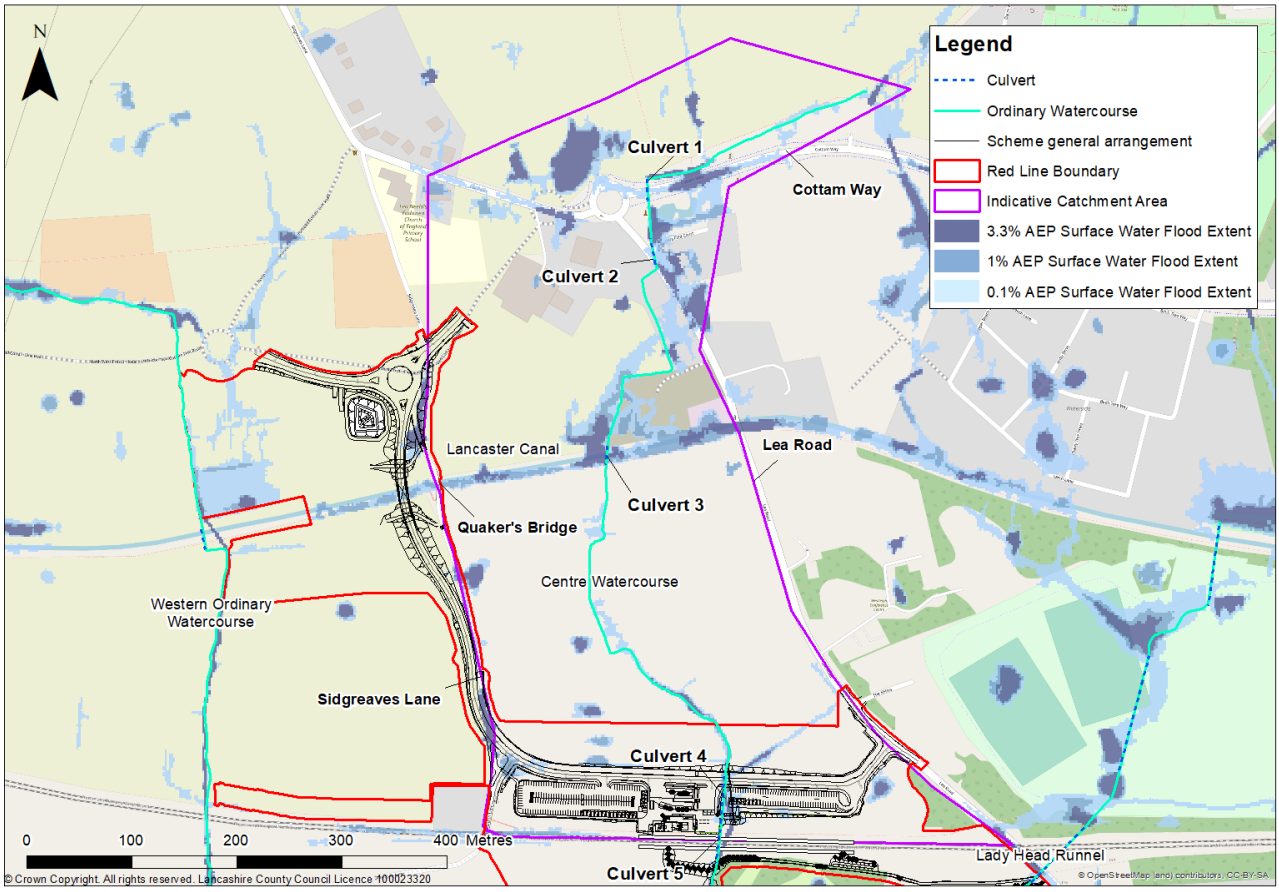


Image 3: Culverts along Central Watercourse

The drainage catchment of the Central Watercourse is approximately 23ha (see Image 3 above as estimated in the LCC Surface Water Drainage Strategy. The catchment is predominantly flat with levels falling from approximately 24m AOD to approximately 18m AOD over approximately 1km. Land use is generally agricultural although the catchment upstream of the Lancaster Canal is more urbanised with recent residential developments.

No historical records of flooding have been identified for these ordinary watercourses and no evidence of recent flooding has been identified during the site visit; however, the absence of records of flooding does not mean that they do not pose a risk of flooding to the Scheme.

The extent of flooding from the Central Watercourse is not represented in the Environment Agency FMfP. Therefore, the probability of flooding along the length of the watercourse has been inferred from the Environment Agency's Risk of Flooding from Surface Water (RoFfSW) Mapping, which is presented in Figure 3 (Appendix A). This mapping suggests that flooding from the Central Watercourse is generally restricted to narrow floodplains with a generally low probability of flooding (between the 1% and 0.1% AEP). This mapping suggests that the risk of flooding to the Scheme from the Western Watercourse or Lady Head Runnel is very low. It must however be noted that the Environment Agency's RoFfSW is a simple representation of overland flow paths and does not take into account structures such as bridges and culverts that would transfer flow underneath roads, the canal and railway line. Therefore, whilst it does help to provide a good indication of risk, it may not present a true representation.

The Central Watercourse is crossed in several location upstream of the proposed railway station. These crossing locations are identified on Image 3 above and details of the crossings from north to south are provided in Table 5.1.

Table 5.1: Culverts along Central Watercourse

Culvert Number	Location	Description
1	Cottam Way roundabout	Culvert diameter is 600mm with trash screen.
2	Lea Road	Inlet diameter is 700mm with trash screen, outlet diameter is 500mm twin pipe.
3	Lancaster Canal	Inlet and outlet were not visible during site visit due to vegetation and no information from records. The culvert was not free flowing which indicates that there may be a degree of blockage or sedimentation (See Images 5 and 6 below).
4	Upstream of Preston to Blackpool railway line	The existing pipe diameter is 225mm. As part of the proposed scheme this culvert would be replaced with a 900mm under the proposed car park
5	Under Preston to Blackpool railway line	Culvert diameter is 975mm under railway.

Site observations on 7th April 2021 confirmed that there are many existing drains, narrow and deep ditches and some ponds along the Central Watercourse between the Lancaster Canal and the railway line. The channel capacity of the Central Watercourse is large and potentially artificially deepened. Therefore, significant flow would be required for out of bank flooding to occur, which potentially supports the Environment Agency's RoFfSW mapping. Most of the culverts were found to be free flowing except the culvert under the canal (culvert number 3), which indicates that there may be a degree of blockage or sedimentation (See Images 4, 5 and 6 below). As these drains are within agricultural land, any flooding that does occur is unlikely to significantly affect people or property. In conclusion, the site visit appears to confirm the understanding of potential low levels of flood risk.

Image 4: Central Watercourse north to the Lancaster Canal

Image 5: Culvert number 3 assumed inlet

Image 6: Culvert number 3 assumed outlet

Image 7: Culvert number 4 north to the railway line, which proposed to be replaced

Whilst a detailed assessment of the hydraulic performance of the existing culverts has not been undertaken, the analysis undertaken by Lancashire County Council as part of the culvert design (see Appendix C) does allow some conclusions to be drawn.

During the 1% AEP event, based on the predicted water levels, the capacity of the 225mm culvert upstream of the railway (culvert number 4) would be exceeded. Analysis of local topography and the Environment Agency's RoFSW mapping indicates that exceedance floodwater would then flow overland along the route of this culvert resulting in localised flooding before returning to the channel downstream at the inlet to the railway culvert (culvert number 5). Whilst the probability of localised flooding between culvert 4 and 5 may be high, the consequences would be limited to shallow flooding of pastoral farmland. With the significantly larger railway culvert 5 (975mm) capable of passing flow during the 1% AEP flood event and with the railway raised 2m above the surrounding ground levels, the risk of flooding to the railway would be low. Therefore, the current flood risk is also considered to be low.

As part of the Scheme, the 225mm culvert 4 (see Image 7) would be replaced to enable the construction of the station car park in this location. In line with Environment Agency guidance, the new culvert should be sized for the 1% AEP fluvial event, plus a 45% increase for climate change and 300 mm freeboard (as outlined in Table 4.5).

However, the existing 975 mm masonry railway culvert (culvert 5) downstream limits the size of the new culvert immediately upstream to be replaced. Therefore, a new 900 mm culvert has been chosen as this is the closest match to the existing railway culvert that is available using pre-cast concrete culvert pipes.

To assess the fluvial flood risks associated with the proposed 900 mm culvert, the hydraulic performance of the culvert was undertaken by Lancashire County Council using estimated flows from the upstream catchment and the Manning's Equation. Further details of this assessment are provided in Appendix C, with key details summarised in Table 5.2.

This testing was undertaken in 2021 and therefore, it used climate change uplifts based on Environment Agency guidance from 2021. Whilst it is acknowledged that Environment Agency climate change guidance has been updated (Section 4.1.5), the range of uplifts applied at the time (e.g. +35%, +70% and +95%) include estimates greater than the current guidance (+46%) and therefore can still be used to assess compatibility with current design standards.

Table 5.2 shows that the with the 900 mm culvert in place, peak flows would remain in-bank with a minimal 0.03m of freeboard to soffit level during events upto the 1% AEP event plus a 70% uplift for the allowance of climate change. Whilst the 70% uplift is greater than the current 46% to be applied, freeboard levels are well below to 300 mm required. However, with a 95% uplift applied, the hydraulic performance assessment confirms the peak flood water would remain in-bank albeit the culvert will be fully submerged.

The risk of fluvial flooding to the station from this source is therefore low.

Table 5.2: Summary of culvert performance during flow events

Flow Scenario tested	Discharge Rate	Upstream Water Level	Bank Level	Status
1% AEP +35%	0.419m^3/s	16.452m AOD	16.97m AOD	Flow in-bank, 0.1m freeboard to culvert soffit
1% AEP +70%	0.528m^3/s	16.526m AOD	16.97m AOD	Flow in-bank, 0.03m freeboard to culvert soffit
1% AEP +95%	0.605m^3/s	16.574m AOD	16.97m AOD	Flow in-bank, culvert inlet submerged

Residual risks would however remain from flood events that would exceed the 1% AEP + 95% event or should the culvert become blocked. In the unlikely event of blockage or flows that exceeded the capacity of the channel, an analysis of the local topography indicates that flood flows would pass eastwards to Lea Road. From here water would then flow to south, following the road and under the railway before discharging into Lady Head Runnel. In this event, access from the station to Lea Road would be cut off by flood flows. However, flow would be directed away from the main access to the PWDR, the car park and the station itself.

The probability of a flood flow exceeding the capacity of the culvert is therefore considered to be very low. During the detailed design and permitting stage, the applicant would consider the installation of the debris screen on the upstream face of the culvert to further reduce the probability of flooding due to blockages in liaison with the LLFA. Routine inspection and maintenance of the culvert by Lancashire County Council would help further manage these risks. Therefore, no additional mitigation measures are considered to be necessary.

An extension is also proposed to the culvert that conveys Lady Head Runnel beneath Lea Road to enable the construction of the turning head to the means of secondary escape. This culvert extension would match the

dimensions of the existing culvert to avoid a constriction in flow and the impact on flood risk is considered to be negligible.

5.2 Flood Risk from Surface Water

Surface water flooding is defined as water flowing over the ground that has not yet entered a drainage system or watercourse. It usually occurs as a result of an intense period of rainfall, which exceeds the infiltration capacity of the ground or sewer system. Typically, runoff occurs on sloping land or where the ground surface is relatively impermeable. The ground can be impermeable either naturally due to the soil type or geology, or due to development which places impervious material over the ground surface (e.g. paving and roads).

The Environment Agency's online RoFfSW [37] are presented on Image 8 below (and Figure 3 in Appendix A for further detail) and identifies areas that are at risk from surface water flooding:

- High risk – area that has a chance of flooding of greater than 3.3% AEP;
- Medium risk – area that has a chance of flooding between 1% and 3.3% AEP;
- Low risk – area that has a chance of flooding between 0.1% and 1% AEP; and
- Very low risk – area that has a chance of flooding of less than 0.1% AEP.

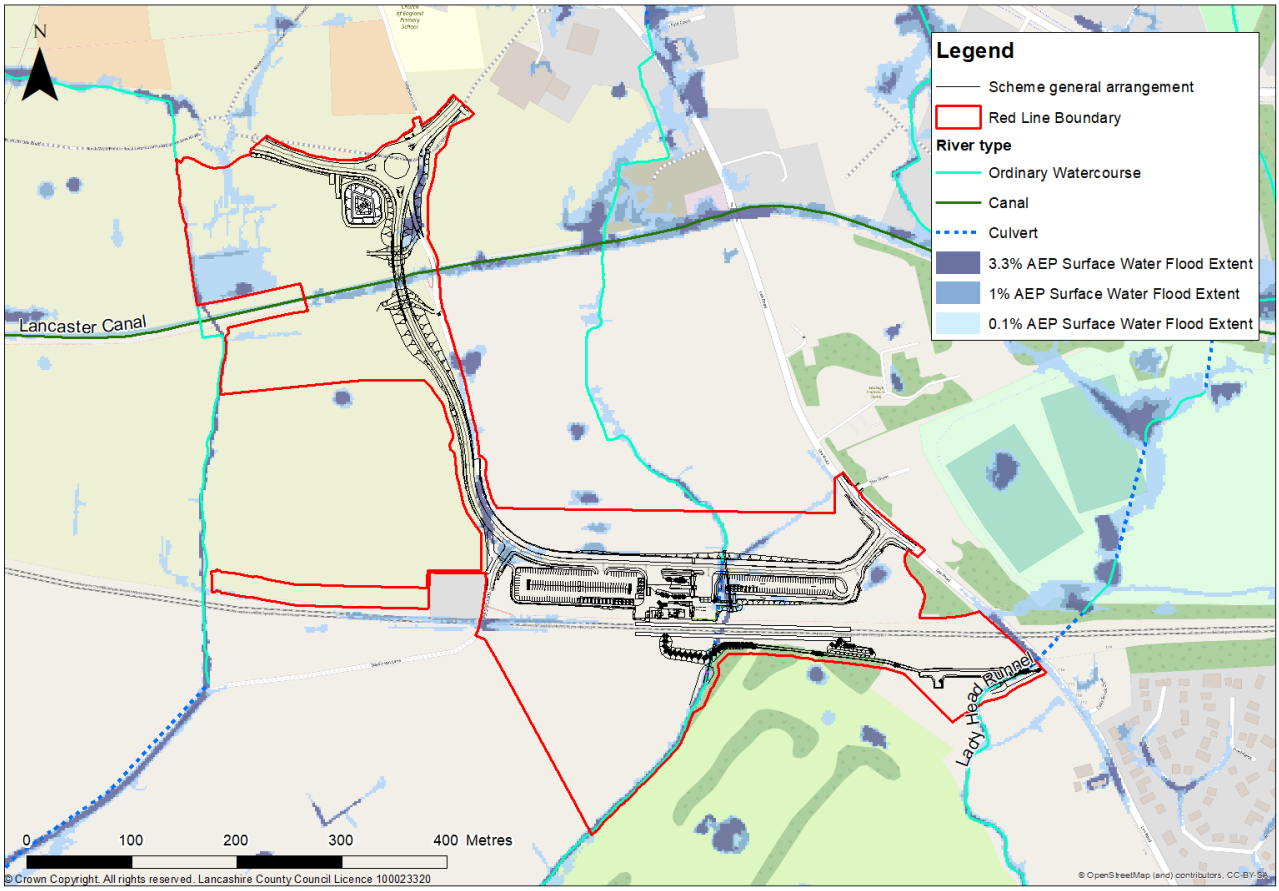


Image 8: Surface Water Flood Extent (3.33%, 1% and 0.1% AEP)

The Environment Agency's mapping indicates that the risk of surface water flooding across the site area is generally very low (less than 0.1% AEP). However, there are some localised areas with a medium to high risk. These

[37] Environment Agency (2021). Risk of Flooding from Surface Water Mapping. [Online] Available at: https://flood-warning-information.service.gov.uk/long-term-flood-risk/map [Accessed: March 2021].

are largely restricted to isolated pockets of land associated with local depressions of existing ponds, stretches of existing ordinary watercourses, the Lancaster Canal, and a stretch on the existing Sidgreaves Lane. The mapping identifies one prominent flow route during the 0.1% design event, with surface water running from Lea Road to the culvert under the railway line (culvert number 4 and 5).

The risk of surface water flooding to the Scheme is therefore considered to be low with the Scheme features located away from areas at risk of deeper surface water ponding. To manage the risk of surface water flooding to the Scheme, a new surface water drainage system would be constructed serving the access roads, car park and railway station. Further details of this system are presented in Appendix B.

The drainage strategy has been designed in accordance with DMRB CG 501 and Environment Agency guidance regarding the impact of climate change on rainfall intensity with the higher values adopted from each set of guidance where they differ. Therefore the system has been designed to ensure that:

- There would be no surcharge allowed in pipes for a 50% AEP storm return period including a 40% increase for climate change;
- There would be no surcharge to cover level on the highway drainage network in a 20% AEP storm return period including a 40% increase for climate change;
- Exceedance flow would be routed towards attenuation features (pond or tank) that have capacity to attenuation flow during a 1% AEP rainfall event including a 50% increase in rainfall intensity due to climate change;
- For all outflows a hydrobrake outflow control system has been assumed to be used to reduce the risk of blockages; and
- Outfalls would be set at a minimum clearance of 400mm above watercourse bed level is to be used, or enough clearance above this to ensure that during heavy periods of rainfall the flow in the receiving watercourse does not cause sufficient problems due to a drowned outlet.

The proposed drainage system discharging into the local ordinary watercourses are described in Section 3.1.4 based on the Drainage Strategy (see Appendix B) and include:

- Three outfall locations of the Scheme (OF2, OF3a, OF3b) would discharge into the Western Watercourse;
- Four outfall locations of the scheme (OF4, OF5, OF7 and OF8) would discharge into the Central Watercourse; and
- One outfall location of the Scheme (OF6) is discharging into a ditch that forms a tributary to the Central Watercourse.

There would remain a risk of blockages or of rainfall events that exceed the capacity of the drainage system. However, the likelihood of this would be low and the consequences would be limited to short term disruption of the access road and car park. Therefore, the risk posed by surface water is considered to remain low throughout the life of the Scheme and no further mitigation is required.

5.3 Flood Risk from Groundwater

Groundwater flooding is caused by the emergence of water from beneath the ground at either point or diffuse locations when the natural level of the water table rises above ground level. This can result in deep and long-lasting flooding of low-lying or below-ground infrastructure such as underpasses and basements. Groundwater flooding can cause significant damage to property, especially in urban areas, and can pose further risks to the environment and ground stability.

As outlined in Section 2.3, the underlying solid geology of the scheme is a Principal aquifer, whilst superficial deposits are considered to be a Secondary (undifferentiated) aquifer. The SFRA does not contain any records of groundwater flooding.

Based on data from the ground investigation a conceptual understanding of groundwater flood risk has been developed. Further details of the hydrogeology of the area around the site is presented in Chapter 11 of the Environmental Statement and a summary is provided below.

Whilst the Sherwood Sandstone Bedrock is highly permeable and is an important source of water at a strategic scale, it is overlain by glacial deposits which have a low permeability. These low permeability deposits hold limited volumes of groundwater within perched water bodies located in more permeable lenses of material. The glacial deposits would, therefore, have limited potential to result in groundwater flooding and would also restrict the movement of water within the underlying bedrock aquifer to the surface. In summary, the risk of groundwater flooding is considered to be low.

5.3.1 Flood Risk from Canals

Flooding from canals can be the result of structural failure such as embankment breaches or overtopping of the canal during high intensity rainfall event. Structural failure can be extremely dangerous as it can involve the rapid release of large volumes of water at high velocity. This can result in deep and widespread flooding, potentially resulting in significant damage. However, it is typically limited to reaches of canal that are raised above the surrounding ground level on one or both side and where watercourses or other structure pass beneath the canal.

The Lancaster Canal is a navigable waterway that runs parallel to Savick Brook approximately within 1km distance. The Lancaster Canal is 67km in length and does not have any locks between Kendal and Preston, providing a navigable link between Lancaster Canal and the River Ribble through Savick Brook (via locks on Savick Brook). Consultation was undertaken with the Canal and River Trust in December 2020. Data provided included details of canal assets and historical flooding from the canal and current maintenance activities. The Canal and River Trust reported that there is one culvert under the canal upstream of the Scheme (OS Grid Reference: SD 49226 31668), which connects the Central Watercourse to its upstream catchment.

5.3.2 Breach and culvert collapse

The Canal and River Trust identified several historical flood events associated with the Lancaster Canal. The most serious of these is a breach of the canal that occurred in 1935 due to a culvert failure allowing canal water to escape over time. The location of this breach was approximately 2km east from the site area (this location is identified as BA on Image 9).

The canal embankment at this breach location is reported to have had numerous problems over the years. It has since received a more durable wall of steel piles driven down into the embankment and a repaired culvert. It is considered that this maintenance of the canal by the Canals and Rivers Trust would ensure that the likelihood of another breach resulting from a culvert collapse is low.

The section of canal running through the site area is cut into the land and is not embanked. Therefore, there is no embankment which could fail and result in flooding and mechanisms for canal flooding would be limited to overtopping, release of bed drain valves and collapse of the culvert.

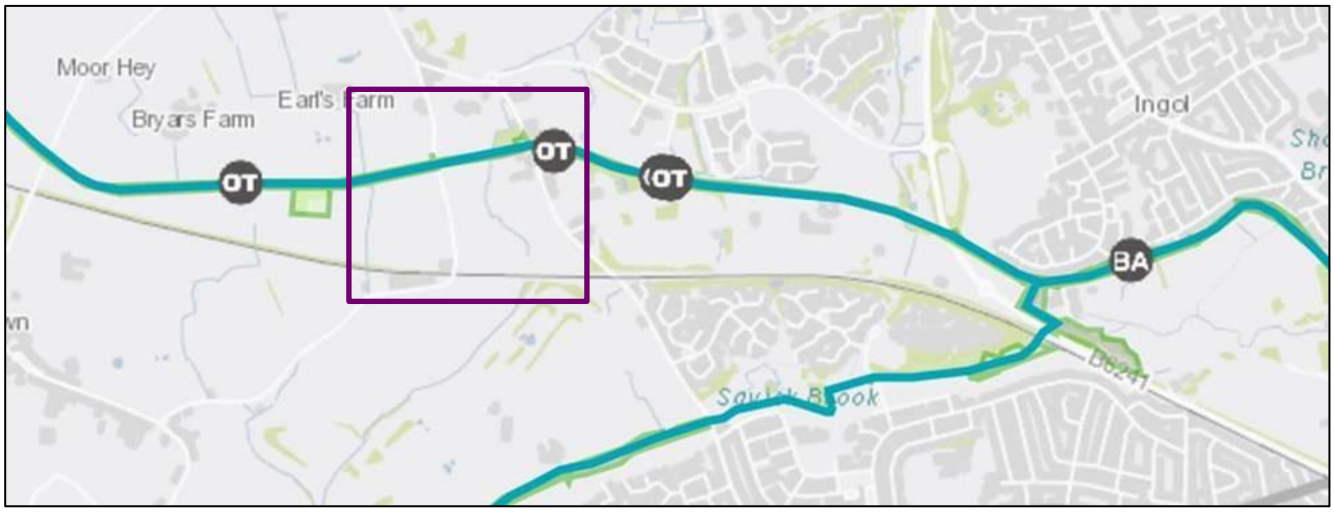


Image 9: Overtopping and breach locations along the Lancaster Canal in close proximity to the proposed scheme (image provided by the Canal and River Trust)

Whilst a similar collapse of a culvert resulting in a sudden release of water into the watercourse is considered unlikely, there is the possibility of localised failure of canal bed which could release large volumes of canal water (as there are no locks along the Lancaster Canal) into the Central Watercourse downstream. The volume of water from the canal could overwhelm the proposed 900mm culvert 4. Local topography suggest that any exceedance flows would be routed away from the Scheme onto Lea Road. However, given the uncertainty regarding the potential volume and velocity of flood flows from a breach, flooding of the car park and station cannot be ruled out. The railway itself is approximately 2m above the local ground levels and it is assumed would remain safe.

Although the probability of this event remains low, large volumes of canal water from a localised failure of canal bed may have significant consequences. Therefore, there is considered to be a moderate risk of flooding from this mechanism and additional mitigation is recommended. This mitigation is detailed in Section 5.3.5.

5.3.3 Overtopping

Image 9 shows the recorded overtopping events (identified as OT on Image 9) in close proximity to the Scheme. The Canal and River Trust reported that the closest recorded overtopping incident occurred at Lea Lane in 2014 approximately 300m to the east of the proposed canal bridge with three other overtopping events recorded within 1km from the site area.

The Canal and River Trust is aware that this canal has had issues on a number of occasions with pluvial flows coming into the northern end of the canal. Groundwater inflows at locations along the whole length of the Lancaster Canal have also been noted as contributing to overtopping issues along the canal. Whilst there are waste weirs to divert excess water into adjacent watercourses and rivers, these are occasionally overwhelmed leading to the canal overtopping at low points. These waste weirs are discharging into Savick Brook near Cadley approximately 2km to the east from the Scheme.

All the historical records of canal flooding in the vicinity of the Scheme provided by the Canal and River Trust indicate that floodwater spills onto the north side of the canal, rather than to the southside where it could potentially impact on the Scheme. The historical flood records indicate that low spots along the canal tend to be along the northern towpath but detailed survey to verify this is not available. Therefore, it is assumed that flow could also overtop towards to the south. Given the relatively high frequency of overtopping events and the uncertainty regarding the consequences of flooding from this source, a precautionary approach has been taken and the risk is assumed to be moderate. Additional mitigation to manage this risk is detailed in Section 5.3.5.

5.3.4 Release of bed drain valves

This canal was built with a large number of bed-drain valves, the closest ones to the site area are 500m to the west and 600m to the east from Lea Road (see green circles on Image 10). Typically, these would have been operated with a chain to open the door in the canal bed and drain it at that point between temporary dams at key points upstream and downstream. Bed drain valves could cause leakage from the canal in case of their failure. However, no bed drain valves are indicated to drain into the Western Ordinary Watercourse. No historical flood events have been attributed to bed drain valve release. Therefore, the likelihood of flooding to the Scheme from this mechanism is considered to be low.

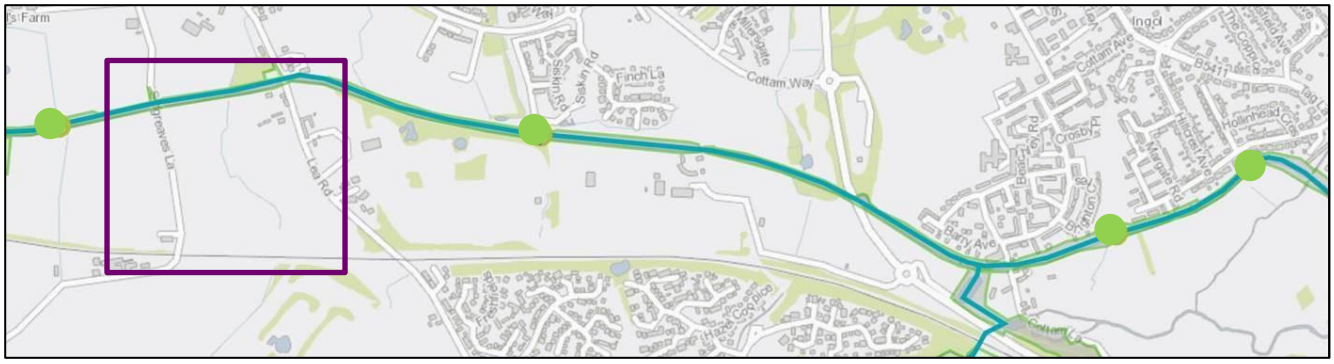


Image 10: Location of bed drains in close proximity to the proposed scheme (image provided by the Canal and River Trust)

5.3.5 Summary of canal flood risk and mitigation

In summary, a moderate risk of flooding has been identified associated with canal overtopping and culvert failure. To manage this risk, it is suggested risk register or health and safety file for the Scheme should include details of how any issues with the canal can be reported to the Canal and River Trust to ensure that defects can be repaired before they pose a risk to the Scheme. An emergency response plan should also be put in place to enable the safe evacuation of the site if serious defects are identified. With an effective emergency response plan in place to manage the safe evacuation of the site and liaison with the Canal and River Trust to enable effective emergency repairs, the risk of flooding from canals would be low.

5.4 Flood Risk from Sewers and Artificial Drainage Systems

Flooding from sewers and drainage systems primarily occurs when flow entering a system exceeds available capacity or if the network capacity has been reduced through blockage or collapse. In the case of surface water sewers that discharge to watercourses, the same effect can be caused as a result of high-water levels in the receiving watercourse. When these situations occur, water can begin to surcharge the sewer network, emerging at ground level through gullies and manholes and potentially causing flooding to highways and properties. If this occurs, flooding can represent a significant hazard to human health in addition to a risk to people and property due to the potential for contaminants in flood water.

The Scheme area is located in a predominantly rural area with a limited number of existing sewers. All historical sewer related incident data reported with the existing SFRA and PFRA are located outside the site area in the urban areas of Grimsargh, Walton-le-Dale, Euxton and Preston. The risk of flooding from sewers and drainage systems is therefore considered to be very low and no mitigation would be required.

5.5 Flood Risk from Reservoirs

Reservoir failure can be a particularly dangerous form of flooding as it results in the sudden release of large volumes of water that can travel at high velocity. This can result in deep and widespread flooding, potentially

resulting in significant damage. The likelihood of reservoir flooding occurring is however extremely low even with all large reservoirs (over 25,000 m^3) managed in accordance with the Reservoirs Act 1975.

There are no reservoirs upstream of the site area and as a result, the Environment Agency's reservoir flood mapping does not indicate that the Scheme is potentially at flood risk from reservoirs.

6. Impact of the Scheme on Flood Risk

This section assesses what impact the Scheme would have on flood risk elsewhere. Temporary construction phase impacts are discussed in Section 7. Only flood sources identified to be present in Section 5 have been assessed, thus impacts on main rivers, tidal sources and reservoirs are not considered.

6.1 Impact on Fluvial Flood Risk

As described in Section 5.1.2, one Ordinary Watercourse flows through the site area. Unmitigated, the Scheme could have the following potential impacts:

- Impacts in fluvial flood flow regime as a result of changes to the railway culvert; and
- Impacts on surface water runoff rates and volumes as a result of an increase in impermeable surfaces entering local watercourses.

6.1.1 Impacts of the proposed culvert on fluvial flood risk

As outlined in Section 5.1.2, the applicant plans to replace the existing 225mm culvert upstream of the railway culvert with a larger 900mm culvert that would tie into the railway culvert. This has been designed to convey the 1% AEP + 35% design event and has been tested against a range of events up to the 1% AEP +95% flow event. This would reduce the risk of fluvial flooding upstream of the Scheme.

The replacement of the existing culvert with one with larger diameter would however have the potential to increase pass forward flows, which could increase the risk of flooding downstream. However, at present, flood flows that exceed the capacity of the existing 225mm culvert would still be able to enter the 975mm railway culvert as these are not continuous. Therefore, the existing 225mm culvert would have a limited throttling effect on flows.

The Lidar data and the RoFSW mapping indicate that the channel of the Central Watercourse downstream of the railway is deeply incised with a narrow floodplain. Therefore, any minor increase in peak flow through the culvert may increase flood depths in the channel but is unlikely to increase the extent of flooding. Also, the land use downstream of the railway comprises golf courses and farmland with no highly vulnerable receptors identified. Therefore, any minor changes in flood extent would have a negligible consequence and the impact on flood risk would be negligible.

6.1.2 Impacts on increased surface water runoff on fluvial flood risk

The Scheme would increase the area of impermeable surfaces by 3.69ha. To manage surface water from the Scheme, a drainage strategy has been developed by the applicant as outlined in Section 3.1.4 and Appendix B.

In accordance with the drainage hierarchy, infiltration drainage was initially considered. However, this was dismissed as the low permeability superficial deposits are generally not suitable for this type of drainage solution. This was confirmed by falling head tests during the ground investigation. Therefore, the design has been based on the capture and attenuation before discharge to local watercourses as the next most sustainable option. The discharge from attenuation ponds would be restricted either by hydrobrakes or similar devices to prevent impacts on fluvial flow in receiving watercourses.

Runoff from the Scheme would be attenuated to greenfield runoff rates using an attenuation pond for the northern section of the access road. The southern section of access road, car park and the northern platform of the station would drain to an 756m^3 attenuation tank. These drainage measures have been calculated to be sufficient to limit runoff rates to greenfield rates during events up to the 1% AEP rainfall event plus an increase of 50% to account for the increase in rainfall intensity due to climate change. Runoff from the southern platforms would be attenuated in oversized pipes prior to discharge to Lady Head Runnel to the south of the railway.

This attenuation of flows would ensure that there would be no increase in peak flow rate or volume into the receiving watercourses. Therefore, the impact on fluvial flood risk would be negligible and no further mitigation is required.

6.2 Impact on Surface Water Flood Risk

As described in Section 5.2, surface water flood risk is generally low. However, unmitigated, the Scheme could have the following impacts on surface water flooding:

- Localised changes in topography as a result of the Scheme could impact surface water flow paths and flooding.
- Impacts on surface water runoff rates and volumes as a result of an increase in impermeable surfaces across the Scheme associated with new access road, carriage ways, cycle ways, car park, railway station building.

To manage the potential impacts on surface water flooding, a drainage strategy has been prepared to manage surface water runoff prior to discharge. This includes discharge to local ordinary watercourses at the greenfield runoff rate of 6.5l/s/ha as described in Section 3.1.4. With this drainage strategy in place, any residual impacts would be limited to flood flows during rainfall events that exceed the capacity of the drain or in the event that the drainage system becomes blocked. A programme of maintenance and inspection would help to reduce the risk of blockages.

Therefore, with the proposed drainage strategy in place, the impact on surface water flood risk would be negligible and no additional mitigation is recommended.

6.3 Impact on Groundwater Flood Risk

As outlined in Section 5.3, the glacial deposits are generally low permeability and typically don't hold large volumes of groundwater, but more permeable layers have been observed. In contrast the underlying bedrock aquifer is classified as a principal aquifer and is a strategic level water resource.

A hydrogeological assessment has been undertaken as part of the environmental impact assessment process. This is presented in Chapter 11 of the Environmental Statement for the Scheme.

The introduction of piled foundations in the ground associated with the station and bridge structures and may reduce groundwater storage and could result in water level changes to facilitate movement of groundwater around these impermeable structures. Under such circumstances groundwater flow paths could be impacted. However, due to low permeability of the glacial till and given its areal extent is much greater than the proposed works, any impacts on groundwater flow and/or quality is likely to be minimal. Other works such as the construction of embankments and deep excavations would also have potential to alter groundwater levels within the superficial deposits at a local level. However, these have been assessed as being of minor magnitude.

Foundations and other excavations are not anticipated to extend into the Sherwood Sandstone and no impacts on this aquifer have been identified.

In summary, no significant impacts on hydrogeology are predicted and the risk of groundwater flooding would remain low.

6.4 Impact on Canals Flood Risk

The Scheme includes a new three-span design canal bridge (see Section 3.1.3) west to the existing Quaker's bridge. The only impacts would be potential damage to the canal during construction of the bridge. Any surface water runoff from the proposed scheme would be managed and discharged to the nearest Ordinary Watercourse and not the canal. Detailed investigation and consultation with the Canal and River Trust would ensure that the risk of any adverse impacts would be low. Therefore, the Scheme would pose a low risk to the safety of the canal and the impact on canal flooding would be negligible.

6.5 Impact on Sewers and Artificial Drainage Systems Flood Risk

As outlined in Section 5.4, the Scheme is remote from any public or private sewer networks and there are no proposals to discharge any surface water to sewers. There is not expected to be any interaction between the Scheme and any existing sewers with all surface water runoff routed to local watercourses via attenuation storage. Sections 6.1 and 6.2 highlight the impacts on ordinary watercourses and local drainage systems.

Foul drainage from the Scheme would flow into a wastewater treatment tank prior to discharge into the Central Watercourse. Maintenance of this foul drainage system would ensure that the risk of blockages and other failures which could result in flooding would be low. In the event that flooding did occur form this source, the shallow flows would be intercepted by the surface water drainage network and the risk to the Scheme would be low.

7. Construction Phase

Detailed construction plans and method statements were not available at the time of preparing this FRA. It is expected that the appointed Contractor would develop these at a later stage. The assessment of flood risk to the construction works is therefore not scheme specific. It is the Contractor's responsibility to assess the flood risk to work areas, to assess the flood risk resulting both to and from temporary works, and to provide appropriate mitigation measures where necessary.

This section of the FRA therefore provides an overview of potential flood risks for the Contractor to consider during the construction phase, to set out high-level requirements with respect to managing flood risk, and to provide general guidance to assist the Contractor in doing this.

7.1 Potential Short-term Impacts

Temporary works can themselves be at risk of flooding and have the potential to impact flood risks both to work areas and to receptors beyond the work site. Critically, there is a risk to life from flooding to those working on site, and the construction works also have the potential to affect the existing risk to life from flooding beyond the construction site. The design of the temporary works therefore needs to consider these factors.

Table 7.1 outlines the broad categories of temporary works required during the construction phase and highlights some of the potential impacts of the temporary works with respect to flooding.

Table 7.1: Typical construction elements

Temporary Works	Description	Potential Short-Term Impacts
Temporary earthworks	Including excavation for access road cuttings, pre-earthworks drainage, trenches; and filling for access roads, site compound areas and temporary spoil storage	Excavation works could result in the pooling of pluvial runoff, the emergence of groundwater, the creation of an impounded body of water or a water mains strike. Works associated with filling could result in the diversion of overland flow routes, a reduction in floodplain storage, impacts on floodplain conveyance, and increased volumes of surface water runoff.
Construction of access road bridge	Including construction of canal bridge and access road	Temporary construction works of the bridge could damage the canal structure itself, which could impact potential canal flood mechanism.
Temporary drainage	Including site compound drainage, temporary road drainage, pre-earthworks drainage	Temporary drainage could increase both the rate and volume of pluvial runoff to a receiving watercourse or sewer and has the potential to transfer sediment to the receiving watercourse or sewer (potentially affecting the flooding mechanisms of the watercourse).
Works within or adjacent to watercourses	Including installation of the culvert	Temporary work located within or adjacent to watercourses could affect the frequency, depth, extent and duration of fluvial flooding.
General site activities	Including site compounds and the storage of construction materials and equipment; and works traffic	The location of site compounds and the storage of construction materials and equipment on site could potentially reduce floodplain storage and divert flood flow routes. Placing working sites within the floodplain could also place human life at risk. Works traffic could also damage existing

Temporary Works	Description	Potential Short-Term Impacts
		sewers or land drains, and could also compact ground, which could increase pluvial runoff.

The construction of the Scheme would take place within Flood Zone 1 and in areas which generally have a low risk of flooding from all sources. The overall guiding principle would be to avoid temporary works in areas at risk of flooding including along the Central Watercourse. The Contractor should take into account the frequency, depth and velocity of flooding and local site conditions to place more vulnerable works in lower risk areas. Consideration should be given to the siting of offices, welfare facilities and car parking areas. The Contractor must also provide measures to mitigate the risk of flooding using the below mitigation principles as a starting point.

7.1.1 Mitigation Principles

7.1.1.1 General guidance

The Contractor should follow the general guidance below concerning the management of flood risk during the construction period of the Scheme including:

- Signing up to the Environment Agency's Flood Warning service and also be responsible for monitoring forecasts and weather conditions on site.
- Consulting with the LLFA and the Canal and River Trust to ensure that all works are consented.
- Preparation of flood response plans and emergency evacuation plans for each construction area following continuous heavy rainfall, identifying safe access and egress routes and refuge points for the workers.
- Providing standby pumping equipment to remove any surface water runoff that enters the working area.
- Ensure site drainage is not discharged to a local sewer.
- Contacting the LLFA during a flooding event that impacts the construction works.

7.1.1.2 Temporary earthworks

- Review local groundwater data prior to extensive or deep excavations.
- Where dewatering of excavations is undertaken, discharge to attenuation ponds or to a watercourse (with appropriate treatment where necessary) at the greenfield runoff rate of 6.5l/s/ha according to the Drainage Strategy (see Section 3.1.4 and Appendix B).
- Undertake initial desk-based services searches before digging on site. The Contractor should also undertake appropriate survey (Cable Avoidance Tool scans, Ground Penetrating Radar survey, etc.) on site to verify the location or presence of underground services before digging.
- Avoid trafficking areas with known vulnerable services. Assess ground loading in these areas and provide additional cover protection if necessary. Plan abnormal load routes.
- Minimise trafficking and loading of unprotected site areas. Consider protecting large site areas subject to heavy traffic loads and methods to alleviate soil compaction post works, as soil compaction may lead to an increased runoff rate.
- Locate stockpiles outside of areas susceptible to prominent surface water flows. Where this is not possible, stockpiles should be constructed with regular spaces between heaps (with each stockpile not exceeding 25 m in length) to preserve existing low points and flow paths, and to prevent surface water backing up behind the structure and being re-directed elsewhere.
- Store excavated materials outside of the floodplain. Excavated material should only be placed in 'at risk areas' when required for use.
- Construct haul roads and access roads as close to ground level as possible when crossing the floodplain.

- Construct temporary drainage measures along access road / temporary diversion edges to collect runoff and direct to treatment facilities.

7.1.1.3 Temporary drainage

- All construction works shall be undertaken having adherence to Pollution Prevention Guidelines (PPGs) which set out good practice advice for works which may have the potential to cause water pollution.
- The contractor would be required to comply with a Construction Environmental Management Plan (CEMP) which would be adopted in the light of good practice and the planning conditions attached to any future planning permission.
- Drainage receiving runoff, which is expected to contain sediment, should be directed towards a suitable sized temporary settlement pond that provides sufficient treatment before being discharged to a watercourse.

7.1.2 Residual risks

Given that the Contractor follows and correctly implements the principles outlined in this section of the report, the main residual flood risks during the construction phase of the Scheme are considered to be:

- Fluvial, surface water or canal flood events, which exceed the design standard of the temporary works or general site work;
- Blockages within temporary surface water drainage; and
- Failure (including blockage) of temporary works within watercourses.

In the event of flood events of greater magnitude than the design standard, or blockages causing temporary drainage systems to surcharge, flooding within construction areas could occur. The main risk is likely to be to the site operatives in this event. Assuming that conditions on site and weather forecasts are monitored appropriately, and site evacuation plans are in place, the residual risk is considered low. However, the contractor should understand the potential for delays to the construction programme that could occur in the event of repeated or long-lasting flood events.

In the majority of cases, failure of temporary works within watercourses is unlikely to result in a significant detrimental impact to the flood risk on the watercourse affected, as flows are unlikely to be impacted. Again, the main risk is likely to be to site operatives in this event; however, assuming that the Contractor has emergency plans in place given failure of works where operatives are at significant risk, then the residual risk is considered low.

8. Summary and Conclusion

8.1 Summary

This FRA has been prepared to support the planning application for the new Cottam Parkway Railway Station and supporting infrastructure.

Several alignment options have been considered for the Scheme and numerous factors, including flood risk, have been taken into account in reaching a preferred option. The Scheme would be constructed in land categorised as Flood Zone 1 (i.e., low risk of flooding) therefore the Scheme would avoid areas at medium and high risk of fluvial flooding. It is therefore assumed that the Sequential Test (Section 4.1.2) has been passed.

Based on NPPF, the development is classified as "Essential Infrastructure", which is permitted in Flood Zone 1. The Exception Test is, therefore, not applicable. In accordance with NPPF and NPPG, this FRA has still been undertaken to demonstrate that the Scheme would be safe for the development's lifetime and would not increase flood risk elsewhere.

The assessment of flood risk has been undertaken using readily availability information supplied by key stakeholders including Lancashire County Council, the Environment Agency and the Canal and River Trust. This assessment has considered the embedded mitigation contained (e.g., flood design standards) within the design process and good practice that would be applied during the construction and operational phases of the Scheme.

Table 8.1 summarises the existing flood risk within the vicinity of the scheme. Table 8.2 provides a summary of the impact on flood risk by the Scheme.

Table 8.1: Summary of existing flood risks to the scheme

Flood Source	Risk Assessment	Mitigation Required
Tidal	Low – Flood Zone 1	No
Fluvial Main Rivers	Low – Flood Zone 1	No
Fluvial Ordinary Watercourse	Very Low – based on Environment Agency FMfSW and proposed culvert upgrade upstream of the railway, would accommodate the 1% AEP flood flow plus a 70% increase due to climate change. Freeboard would remain to provide capacity for residual flood risk such as blockage.	No
Surface water	Low – baseline risk is generally low with localised areas of high risk with some surface water flow path and ponding areas. Surface water drainage associated with the proposed design, together with the application of good practice would manage the risk posed to these features.	No
Groundwater	Low – a hydrogeological assessment based on a ground investigation has concluded that the risk of groundwater flooding would be low.	No
Canal	Low – moderate risk associated with potential localised failure of canal, which would pose a risk to the proposed scheme. With mitigation measures in place, the risk should be low. These could comprise preparation of a site risk register with additional discussion with the Canal and River Trust to determine if further action would need. The proposed crossing is raised above the level of the canal and likely would not impact on its use or any local flood risk associated with it.	Yes
Sewers and artificial drainage	Very Low - no known sewer infrastructure nearby.	No

Flood Source	Risk Assessment	Mitigation Required
Reservoir	Low - no nearby reservoirs, no risk from reservoir flooding.	No

Table 8.2: Impact of the Scheme on flood risk elsewhere

Source of Flooding	Impact to or from Scheme	Mitigation Required
Fluvial Ordinary Watercourse	Low - embedded mitigation including the proposed surface water drainage systems would manage the impact on local ordinary watercourses.	No
Surface Water	Low – the Scheme is not located over any major surface water flow paths and the proposed surface water drainage systems would manage the impact on surface water flooding.	No
Groundwater	Low - Impacts on groundwater within the superficial deposits would be localised and would not increase the risk of flooding. Impacts on the bedrock aquifer are considered to be unlikely as foundations and other excavations would not extend down to this geological unit.	No
Canal	Low – no works are proposed that would influence the probability of canal failure.	No
Sewers and Artificial Drainage	Low – the Scheme would not discharge surface water to local sewers. Unknown at this stage how the scheme would connect to the local foul or combine network.	No

8.2 Conclusion

The FRA has shown that the Scheme would be at low to very low risk of flooding from all sources throughout its design life. The Scheme would also have a low impact on flood risk from all sources assuming implementation of the mitigation measures identified. Minor additional flood risk management measures have been recommended to help manage residual risks and these should be captured within the site risk or H&S register.

Appendix A. Figures

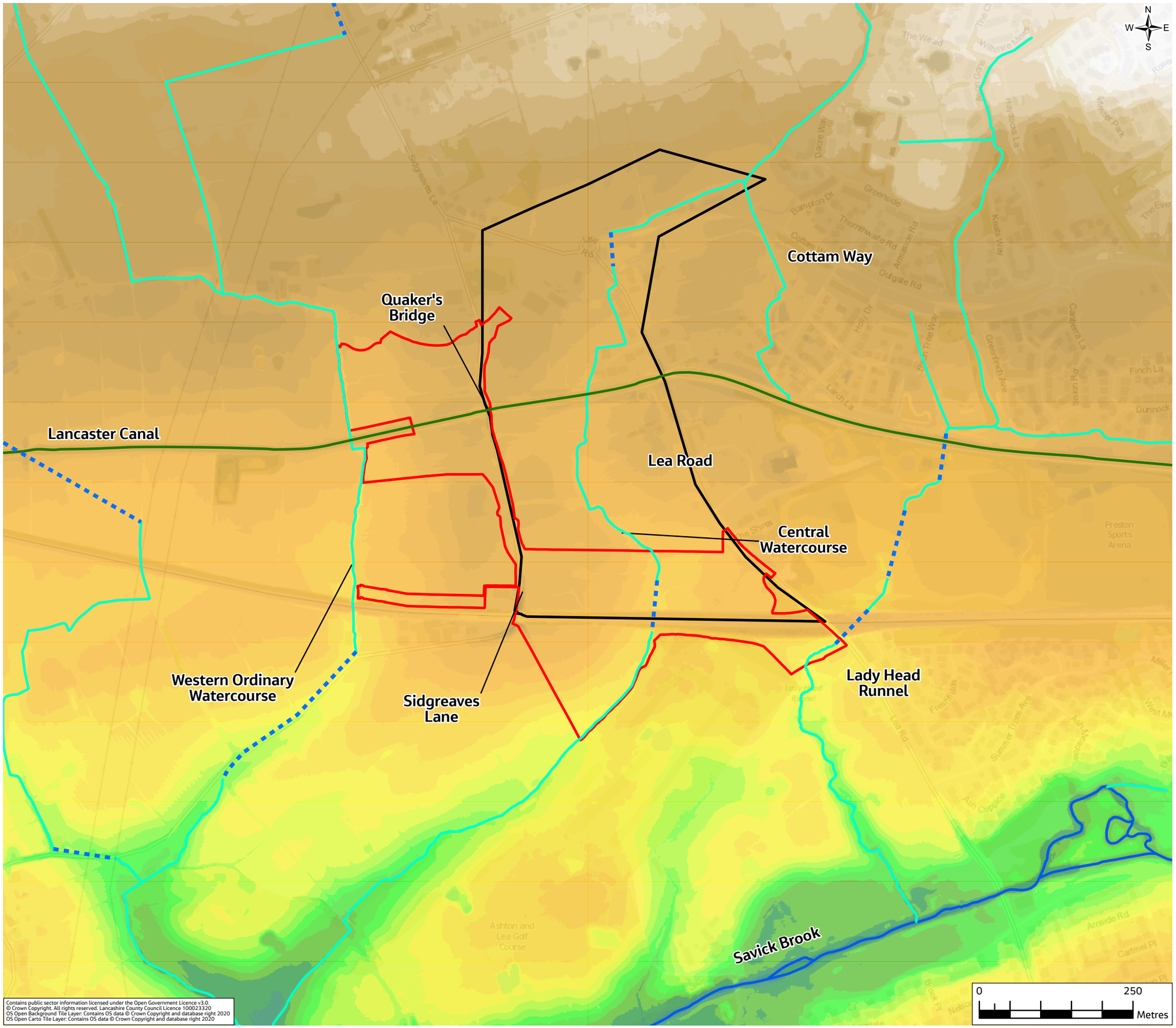


FIGURE 1

Legend

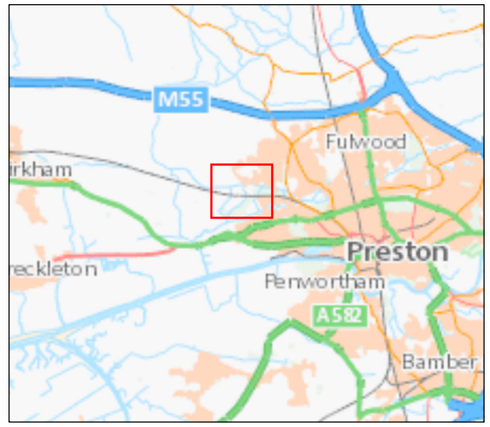
- Site Boundary
- Indicative Catchment Area

River Type

- Main River
- Ordinary Watercourse
- Canal
- Culvert

1m DTM

High : 34
Low : 6



Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
P02	JUN 2022	Final Issue	MS	JP	CD	PH
P01	APR 2021	Initial Issue	RW	JP	CD	PH

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Drawing Title: SITE LOCATION PLAN

Drawing Status: FINAL

Scale @ A3	1:6,000	DO NOT SCALE
Jacobs No.	B2327FEF	
Client No.	5932	

Drawing No.: B2327FEF-JAC-EWE-00-DR-ENV-0001

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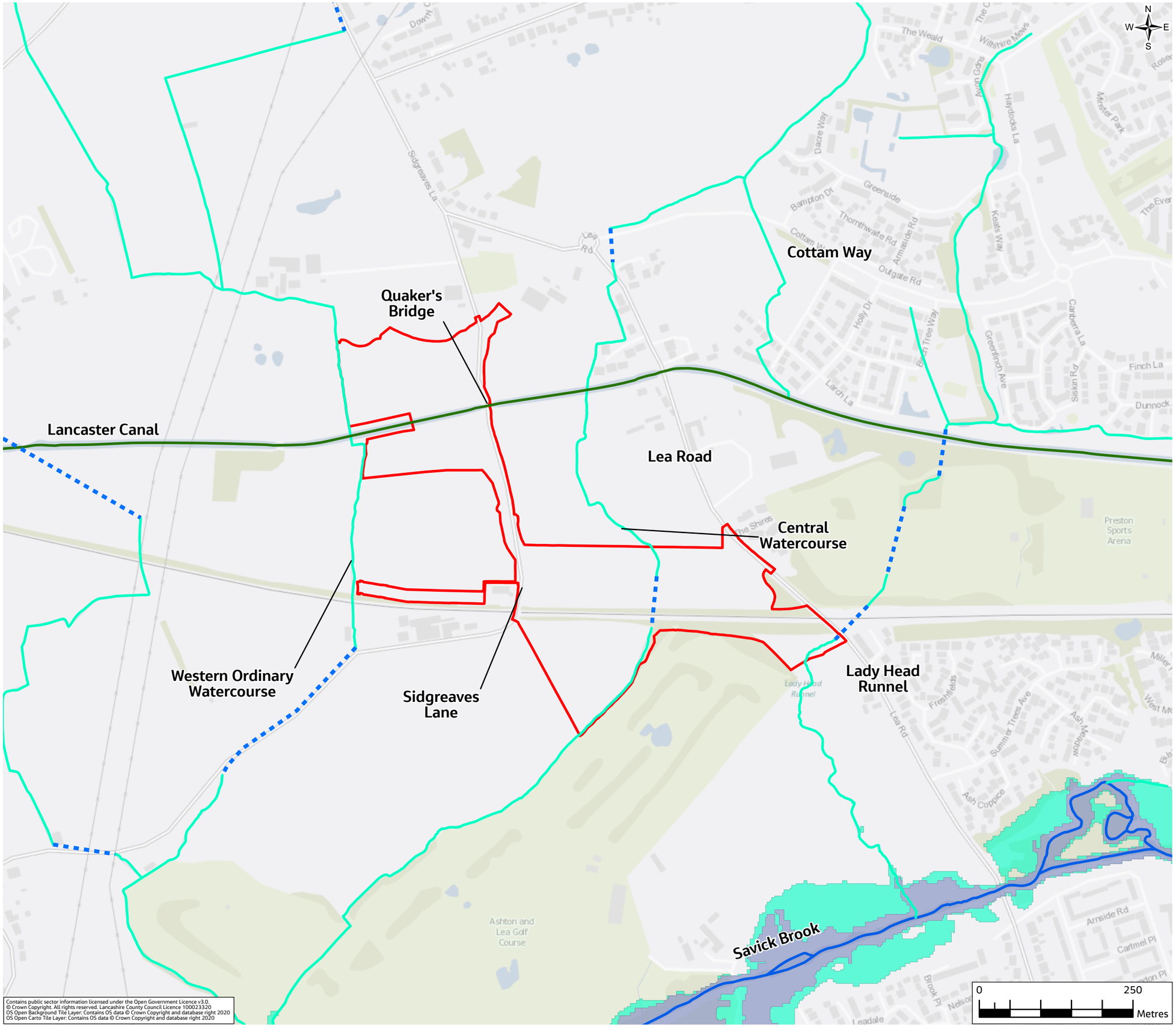
FIGURE 2



Legend

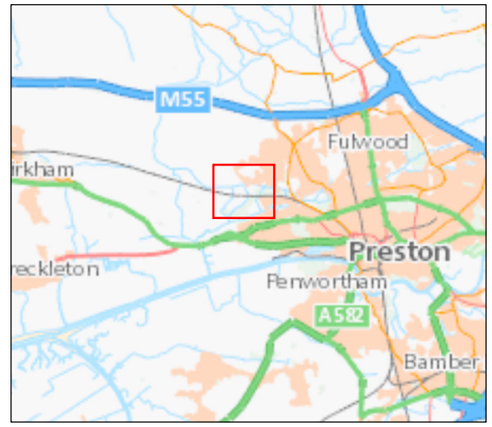
- Site Boundary

Flood Map (Rivers and Sea)

- Flood Zone 2
- Flood Zone 3

River Type

- Main River
- Ordinary Watercourse
- Canal
- Culvert



Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
P02	JUN 2022	Final Issue	MS	JP	CD	PH
P01	APR 2021	Initial Issue	RW	JP	CD	PH

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Client: Lancashire County Council

Project: COTTAM PARKWAY RAILWAY STATION

Drawing Title: FLUVIAL FLOOD MAP

Drawing Status: FINAL

Scale @ A3	1:6,000	DO NOT SCALE
Jacobs No.	B2327FEF	
Client No.	5932	

Drawing No.: B2327FEF-JAC-EWE-00-DR-ENV-0002

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