11 Road Drainage and the Water Environment

11.1 Introduction

11.1.1 This chapter presents the results of the Design Manual for Roads and Bridges (DMRB) Stage 3 Environmental Impact Assessment (EIA) for the A90 Improvements at Laurencekirk; hereafter referred to as the proposed scheme. The chapter assesses the potential impacts of the proposed scheme on the water environment, comprising surface water hydrology, aquatic ecology, groundwater and flood risk (Ref 11.1). The chapter also identifies measures for mitigating any potential impacts.

11.1.2 The water environment is an essential resource that is vital to all life. It also plays a large role in industry, agriculture, waste disposal, recreation and transport. The maintenance and improvement of watercourses, groundwaters and coastal waterbodies is a key aim of European policy, which has subsequently been transposed into UK and Scottish policy.

11.1.3 New road schemes, or the development of existing roads, have the potential to disrupt the water environment during the construction phase and operation, and have the potential to alter the quality and flow patterns of watercourses, increase the risk of pollution events and increase flood risk.

11.1.4 In this chapter, a number of water quality assessments have been completed to support the overall DMRB assessment. These include an assessment of pollution impacts from routine runoff to surface water, an assessment of pollution impacts from routine runoff on groundwater, and an assessment of pollution impacts from spillages.

11.1.5 The chapter is supported by a number of figures and appendices which are cross referenced where appropriate.

11.2 Policy and Legislative Background

11.2.1 There are a number of policies at a European, national and local level which relate to road drainage and the water environment. An assessment of the compliance of the proposed scheme with these policies is given within this chapter. A summary of the policies and guidance which are assessed are given within Table 11-1.

Table 11-1 Statutory and planning review

Policy/Legislation	Description
National Planning Framework 3 (NPF) (Ref 11.2)	NPF 3 is a statutory document and a material consideration in planning decisions. NPF guides Scotland's spatial development setting out strategic development priorities to support the Scottish Government's central purpose to 'create a more successful country, with opportunities for all of Scotland to flourish through increasing sustainable economic growth. The NPF focuses on four outcomes for Scotland; • A low carbon place; • A natural place to invest; • A successful and sustainable place; • A connected place. In regard to the water environment, NPF promotes the following; • Planning for climate change; plans should take a proactive approach to mitigating and adapting to climate change taking into account the long-term implications for flood risk, coastal change, water supply and biodiversity. • Conserving and enhancing the natural environment; plans should contribute and enhance the natural environment. New and existing development should be prevented from contributing to unacceptable levels of soil, air, water or noise pollution or land instability. Development should where possible, help improve local environmental conditions such as air and water quality taking into account relevant information such as river basin management plans.
Scottish Planning Policy: Managing Flood Risk and Drainage (Ref 11.3)	SPP sets out national planning policies which reflect Scottish Ministers' priorities for operation of the planning system and for the development and use of land. • A precautionary approach to flood risk from all sources, including coastal, watercourse (fluvial), surface water (pluvial), groundwater, reservoirs and drainage systems (sewers and culverts), taking account of the predicted effects of climate change. • Flood avoidance: by safeguarding flood storage and conveying capacity and locating development away from functional flood plains and medium to high risk areas. • Flood reduction: assessing flood risk and, where appropriate, undertaking natural and structural flood management measures, including flood protection, restoring natural features and characteristics, enhancing flood storage capacity, avoiding the construction of new culverts and opening existing culverts where possible; and • Avoidance of increased surface water flooding through requirements for Sustainable Drainage Systems (SuDS) and minimising the area of impermeable surface.
Water Environment (Controlled Activities) (Scotland) Regulations (CAR) 2011 as amended. (Ref 11.4)	These regulations outline the need for various levels of consent required for potentially polluting activities carried out in or near water.
Water Environment (Diffuse Pollution) (Scotland) Regulations 2008 (Ref 11.5)	Regulations to control diffuse pollution from storage and application of fertiliser, keeping livestock, land cultivation, water run-off from drainage systems, applying pesticides and sheep dips.

Policy/Legislation	Description
Water Resources (Scotland) Act 2013 (Ref 11.6)	Makes provisions for the development of Scotland's water resources through improved water quality, the creation of contracts for non-domestic sewage services, protection of the public sewer network and the maintenance of private sewage works. It also contains provisions to enable the creation of water shortage orders.
European Union (EU) Drinking Water Directive (Ref 11.7)	The Drinking Water Directive (Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption) concerns the quality of water intended for human consumption. Its objective is to protect human health from adverse effects of any contamination of water intended for human consumption by ensuring that it is wholesome and clean.
The Public Water Supplies (Scotland) Regulations 2014. (Ref 11.8)	These regulations aim to protect human health from the adverse effects of any contamination of water supplied by Scottish Water for human consumption purposes by ensuring that it is wholesome.
The Private Water Supplies (Scotland) Regulations 2006) (Ref 11.9)	These are Scotland's main regulations governing the quality of water supplied by private water supplies. These Regulations supplement the Water (Scotland) Act 1980 and transpose the requirements of the European Council Directive 98/83/EC on the quality of water intended for human consumption.
The Water Environment (Oil Storage) (Scotland) Regulations) 2006 (Ref 11.10)	Water Environment (Oil Storage) (Scotland) Regulations 2006 control the storage of oil and oil products and regulate the storage of products such as petrol and diesel for the purposes of protecting the water environment.
Flood Risk Management (Scotland) Act 2009 (Ref 11.11)	The Flood Risk Management (Scotland) Act 2009 introduces a more sustainable and modern approach to Flood Risk Management. It promotes a joined up and coordinated process to manage flood risk at a national and local level. Specific measures within the act include: • A framework for coordination and cooperation between all organisations involved in flood risk management. • Assessment of flood risk and preparation of flood risk management plans. • New responsibilities for SEPA, Scottish Water and local authorities in relation to flood risk management. • A revised, streamlined process for flood protection schemes. • New methods to enable stakeholders and the public to contribute to managing flood risk, and; • A single enforcement authority for the safe operation of Scotland's reservoirs.

Policy/Legislation	Description
Aberdeenshire Local Development Plan 2017; PR1 Promoting important resources (Ref 11.12)	This policy states that developments will not be approved that have a negative effect on important environmental resources associated with the water environment. New development, including aquatic engineering works, which will generate discharges or other impacts on existing waterbodies, or which could affect water quality, quantity, flow rate, ecological status, riparian habitat, protected species or flood plains of waterbodies (including their catchment area) must not prejudice water quality or flow rates, or their ability to achieve or maintain good ecological status under the Water Framework Directive (WFD) 2008/32/EC. Any such developments must contribute to the objectives set against the relevant waterbodies through the river basin management process as well as the relevant freshwater objectives and targets within the North East Local Biodiversity Plan. Opportunities for the creation, enhancement and management of habitats should be embraced so as to contribute to the improvement of the ecological status of the waterbody. Any aquatic engineering works must be capable of being consented under Controlled Activities Regulations. Adequate buffer strips should be provided to allow for maintenance all year round. Groundwater dependent terrestrial ecosystems (GWDTE), which are types of wetland, are specifically protected under the WFD. If present, the developer should avoid them (with a buffer), or further assessment and appropriate mitigation will be required.
Aberdeenshire Local Development Plan 2017; Policy C4 Flooding (Ref 11.12)	Flood risk assessments will be required for development in the medium to high category of flood risk of 0.5%- 10% annual probability (1 in 200 years to 1:10 years). Assessment may also be required in areas of lower annual probability (0.25-0.5%) in circumstances where other factors indicate a potentially heightened risk. Development should avoid areas of medium to high risk, functional floodplain or other areas where the risks are otherwise assessed as heightened or unacceptable except where; • It is a development to affect flooding or erosion; • It is consistent with the flood storage function or a floodplain; • It would otherwise be unaffected by flooding (such as a play area or car park); • It is essential infrastructure. Maintenance buffer strips must be provided for any waterbody. These measures may also be required in areas of potentially lower risk of flooding (annual probability of more than 1:1000 years) or in coastal areas below the 10m contour should local evidence demonstrate a heightened risk. If development is to be permitted on land assessed as at medium to high risk of flooding it should be designed to be flood resilient. It must not result in increased severity of flood risk elsewhere through altering flood storage capacity or the pattern and flow of flood waters. Development that may contribute to flooding issues elsewhere will not be approved.

Policy/Legislation	Description
Aberdeenshire Local Development Plan' Policy RD1- Providing suitable services (Ref 11.12)	Aberdeenshire Council will support new developments when the developer satisfactorily meets the required standards for water, waste water and surface drainage servicing. Developments must connect to existing public drainage infrastructure or plan to connect to a committed future public drainage infrastructure where there is sufficient capacity to allow that development to happen. Scottish Water and the Scottish Environment Protection Agency are key consultees regarding water and waste water infrastructure and should be approached at an early stage to establish what capacity may be available or if the provision of new capacity can be made available. Surface water drainage must be dealt with in a sustainable manner and in ways that avoid pollution and flooding through the use of an integrated Sustainable Drainage System.

11.3 Methodology

11.3.1 The chapter has been prepared in line with the guidance and techniques outlined within the Design Manual for Roads and Bridges (DMRB), Volume 11, Section 3, Part 10; HD4509/10 Road Drainage and the Water Environment (Ref 11.1). The following elements of the water environment are considered within the assessment;

- Surface waters;
- Aquatic ecology;
- Groundwaters; and
- Flood risk.

Defining the study area

11.3.2 DMRB does not specify a specific study area for assessing the water environment and subsequently, professional judgement was used to ascertain the area to be assessed. A study area of 600m of the centreline of the scheme was therefore selected, extending where appropriate to include features within the broader catchment (such as surface watercourses) that potentially could be impacted by the proposed scheme.

Determining of baseline

Desk study

11.3.3 In order to establish baseline conditions, a desktop study was undertaken. The following information sources were utilised;

- Aberdeenshire Council Local Development Plan 2017; (Ref 11.12)
- British Geology Survey (BGS), ‘Geology of Britain Viewer’; (Ref 11.13)
- BGS, ‘On-Shore Geo-index’; (Ref 11.14)

- BGS, Scotland's Aquifers and Groundwater bodies; (Ref 11.15)
- Department for Food, Environment and Rural Affairs (DEFRA), Multi Agency Geographic Information for the Countryside (MAGIC) Map; (Ref 11.16)
- Meteorological Office, UK Climate Maps; (Ref 11.17)
- Scottish Environment Protection Agency (SEPA) Water Environment Hub; (Ref 11.18)
- SEPA, Interactive Flood Maps; (Ref 11.19) and
- Scotland's Environment, Interactive Map (Ref 11.20)

11.3.4 Relevant policy was identified through the examination of district, county and national level online planning resources.

Consultation

11.3.5 Consultations on the proposed scheme were undertaken with numerous statutory and non-statutory bodies in February 2019. Comments were received from Aberdeenshire Council and SEPA regarding road drainage and the water environment. These comments are summarised in Chapter 5 Consultation.

Assessment method

11.3.6 The detailed assessment is carried out in accordance with the guidance and techniques presented within the Design Manual for Roads and Bridges (DMRB) Volume 11, Section 3, Part 10; HD45/09 Road Drainage and the Water Environment. The assessment process involves:

- Characterising baseline conditions;
- Assigning a value or sensitivity to baseline features;
- Assigning a magnitude of impact on baseline features; and
- Determining a significance of effect on baseline features by combining the magnitude of impact with the sensitivity of the environmental receptor.

11.3.7 Further details about the environmental assessment process are available in Chapter 2 Environmental Assessment.

11.3.8 The criteria for assessing the receptor sensitivity of water environment is set out in Table 11-2. The sensitivity ranges from very high to low.

Table 11-2 Criteria for assessing the sensitivity of the water environment

Sensitivity	Criteria	Typical examples
Very High	Attribute has a high quality and rarity on regional and national scale.	<u>Surface water</u> • European Commission (EC) designated salmonid/cyprinid fishery, Water Framework Directive (WFD) class High, Site protected/designated under EC or • UK habitat legislation (Special Area of Conservation, Special Protection Area, Site of Special Scientific Interest, Water Protection Zone, Wetland of International Importance (Ramsar), salmonid water) • Potable water supply serving >10 properties in remote areas where there is no access to alternative supplies. <u>Groundwater</u> • Major aquifer providing a regionally important resource or supporting site protected under EC and UK habitat legislation. • Aquifer used as a resource for public, private domestic (i.e serving >10 properties) or agricultural/industrial use. • Groundwater locally supports Groundwater Dependent Terrestrial Ecosystem (GWDTE). <u>Flood risk</u> • Water feature with direct flood risk to the adjacent populated areas, with greater than 100 residential properties.
High	Attribute has a high quality and rarity on local scale.	<u>Surface water</u> • WFD Class 'Good', Major Cyprinid Fishery, Species protected under EC or UK habitat legislation. • Potable water supplies serving <10 properties in remote areas where there is no access to alternative supplies and/or use of water for agricultural purposes. <u>Groundwater</u> • Major aquifer providing locally important resource or supporting river ecosystem. • Aquifer used as a resource for private domestic and/or agricultural supply serving <10 properties. • Groundwater supports a GWDTE. <u>Flood risk</u> • Water feature with direct access to adjacent populated areas, between 1 and 100 residential properties.

Sensitivity	Criteria	Typical examples
Medium	Attribute has a medium quality and rarity on local scale	<u>Surface water</u> • WFD Class 'Moderate' • Likely to have deteriorated in water quality as a result of anthropogenic pressures and/ or pollutant sources and/ or potable water supplies, located within the vicinity of a mains water supply and/ or supplies used only for local agricultural purposes. <u>Groundwater</u> • Aquifer providing water for agricultural or industrial use with limited connection to surface water. • Exploitation of groundwater is not extensive. • Minor areas of nature conservation with a degree of groundwater dependency. <u>Flood risk</u> • A water feature with a possibility of a direct flood risk to less populated areas (no residential properties).
Low	Attribute has a low quality and rarity on local scale	<u>Surface water</u> • WFD class 'poor' • Not used for water supplies. <u>Groundwater</u> • Unproductive strata • Exploitation of groundwater is unlikely and/or unfeasible. • No areas of nature conservation with groundwater dependency. <u>Flood risk</u> • A water feature passing through uncultivated agricultural land.

11.3.9 Table 11-3 outlines the criteria for assessing magnitude of impact, which ranges from major adverse to major beneficial.

Table 11-3 Criteria for assessing impact magnitude

Magnitude of impact	Criteria	Typical examples
Major adverse	Results in loss of attribute and/ or quality and integrity of the attribute	<u>Surface water</u> • Failure of both soluble and sediment bound pollutants in HAWRAT and compliance failure with EQS values. • Calculated risk of pollution from a spillage >2% annually. • Loss or extensive change to a fishery. • Loss or extensive change to a designated nature conservation site. • Change in the WFD class of a river reach or pollution of a potable source of abstraction. <u>Groundwater</u> • Major or long-term change to groundwater aquifer(s) flow, water level, quality or available yield. • Potential high risk of pollution to groundwater from routine runoff- risk score >250. • Calculated risk of pollution from spillages >2% annually. • Reduction in waterbody WFD classification. • Significant impact on licenced abstractions and/or local private water supplies. <u>Flood risk</u> • Significant change in the peak flood level with change in flood risk and channel erosion • Substantial loss of floodplain area

Magnitude of impact	Criteria	Typical examples
Moderate adverse	Results in effect on integrity of attribute, or loss of part of attribute	<u>Surface water</u> • Partial loss in productivity of a fishery. • Pollution of a non-potable source of abstraction. • Evident change to hydrological conditions resulting in temporary or consequential decline in baseline conditions (such as short-term exceedance of water quality/quantity UK standards). <u>Groundwater</u> • Moderate changes to groundwater aquifer(s) flow, water level, quality or available yield. • Potential medium risk of pollution to groundwater from routine runoff- risk score 150-250. • Calculated risk of pollution from spillages > 1% annually and <2% annually. • Contribution to reduction in waterbody WFD classification. • Partial loss or localised change to an aquifer but no significant impact on local private water supplies. • Localised change to groundwater supported designated wetlands. <u>Flood risk</u> • Moderate change in the peak flood level with localised change in flood risk and channel erosion. • Loss of floodplain area.
Minor adverse	Results in some measurable change in attributes quality or vulnerability	<u>Surface water</u> • Failure of both soluble and sediment-bound pollutants. • Calculated risk of pollution from spillages >0.5% annually and <1% annually. • Minor decline to water quality/quantity (but within UK standards). • No impact on most sensitive receptors. <u>Groundwater</u> • Minor changes to groundwater aquifer(s) flow, water level, quality or available yield. • Potential low risk of pollution to groundwater from routine runoff- risk score <150. • Calculated risk of pollution from spillages >0.5% annually and <1% annually. • Localised decline in groundwater quantity/quality but no appreciable change in wider groundwater regime or on groundwater supported designated wetlands <u>Flood risk</u> • Small increase in the peak flood level but no overall change in flood risk or channel erosion.

Magnitude of impact	Criteria	Typical examples
Negligible	Results in effect on attribute, but of insufficient magnitude to affect the use or integrity	<u>Surface water</u> • No risk identified by HAWRAT (pass both soluble and sediment bound pollutants) • Risk of pollution from spillages <0.5% <u>Groundwater</u> • Very slight change changes to groundwater aquifer(s) flow, water level, quality or available yield. • No measurable impact upon an aquifer or groundwater receptors and risk of pollution from spillages <0.5%. <u>Flood risk</u> • No or little change from baseline conditions.
Minor beneficial	Results in some beneficial effect on attribute or a reduced risk of negative effect occurring	<u>Surface water</u> • HAWRAT assessment of either soluble or sediment-bound pollutants becomes Pass from an existing site where the baseline was a fail condition. • Calculated reduction in existing spillage risk by 50% or more (when existing spillage is <1% annually). • Minor improvement of water quality/quantity but the proposal does not result in an improvement in class, status, output or other quality indicator. <u>Groundwater</u> • Calculated reduction in existing spillage risk by 50% or more to an aquifer (where spillage risk <1% annually). • Localised improvement <u>Flood risk</u> • Small decrease in the peak flood level but no overall change in flood risk or channel erosion.
Moderate beneficial	Results in moderate improvement of attribute quality	<u>Surface water</u> • Moderate improvement of water quality/quantity which results in some improvement in class, status, output or other quality indicator. <u>Groundwater</u> • Calculated reduction in existing spillage risk by 50% or more (when existing spillage risk is >1% annually). • Localised improvement in groundwater quantity/quality or improvement to local groundwater supported designated wetland. <u>Flood risk</u> • Moderate decrease in the peak flood level / flood risk / channel erosion • Increase in floodplain area.

Magnitude of impact	Criteria	Typical examples
Major beneficial	Results in major improvement of attribute quality	<u>Surface water</u> • Removal of existing polluting discharge or removing the likelihood of polluting discharges occurring to a watercourse. • Substantial improvement of water quality/quantity which results in some improvement in class, status, output or other quality indicator. <u>Groundwater</u> • Removal of existing polluting discharge to an aquifer or removing the likelihood of polluting discharges occurring. • Recharge of an aquifer. <u>Flood risk</u> • Substantial enhancement of floodplain area. • Substantial decrease in the peak flood level / flood risk / channel erosion.

11.3.10 Once both the sensitivity of the receptor and the magnitude of impact have been determined, the overall significance of effect can be determined. The matrix outlined in Table 11-4 illustrates how this is achieved.

Table 11-4: Significance of effect matrix

		Magnitude of impact				
		No change	**Negligible**	**Minor**	**Moderate**	**Major**
Environmental Value (Sensitivity)	**Very High**	Neutral	Slight	Moderate /Large	Large /Very Large	Very Large
	High	Neutral	Slight	Slight /Moderate	Moderate /Large	Large /Very Large
	Medium	Neutral	Neutral /Slight	Slight	Moderate	Moderate /Large
	Low	Neutral	Neutral /Slight	Neutral /Slight	Slight	Slight /Moderate
	Negligible	Neutral	Neutral	Neutral /Slight	Neutral /Slight	Slight

DMRB Assessments

11.3.11 In order to support the overall assessment, three water quality assessments, as outlined within DMRB, have been undertaken. The methods have been used to determine pollution impacts on the following;

- Method A: Assessment of pollution impacts from routine runoff to surface waters;
- Method C: Assessment of pollution impacts from routine runoff on groundwater, and;
- Method D: Assessment of pollution impacts on spillages.

11.3.12 Each of the assessments are detailed in the following paragraphs.

Highways Agency Water Risk Assessment Tool (HAWRAT)

11.3.13 Methods A and D assess the potential impacts on the water environment from routine runoff and accidental spillage risk. Both methods make use of the Highways Agency Water Risk Assessment Tool (HAWRAT). HAWRAT is a Microsoft Excel tool designed to evaluate risks related to the intermittent nature of routine road runoff. It assesses the acute pollution impacts on aquatic ecology associated with soluble pollutants, and the chronic impacts associated with sediment bound pollutants. The tool is an integral part of HD45/09 and is applicable to the trunk road network in Scotland.

Method A: Assessment of pollution impacts from routine runoff on surface waters

11.3.14 Method A uses HAWRAT to assess risks to the watercourse receiving the road runoff, based on the impacts from soluble pollutants and sediment-bound pollutants. The assessment is first carried out for individual outfalls, and then cumulative outfalls in situations when more than one outfall discharges into the same stretch of watercourse. Further information on the proposed drainage setup and the location of the outfalls assessed is detailed in section 11.3.

11.3.15 In Method A, HAWRAT tests for a range of pollutants which have been identified by the Highways Agency as key contaminants in road runoff due to their abundance and their potential to harm aquatic species within the water environment. These include;

- Soluble pollutants associated with acute pollution impacts, expressed as Event Mean Concentrations (µg/l) for dissolved copper (Cu) and zinc (Zn);
- Sediment related pollutants associated with chronic pollution impacts, expressed as Event Mean Sediment Concentrations (mg/kg) for total copper, zinc, cadmium, and (in µg/kg) for pyrene, fluoranthene, anthracene, phenanthrene and total PAH (Polycyclic Aromatic Hydrocarbons).

11.3.16 HAWRAT adopts a tiered consequential approach to the assessment and reporting of the results can take place at the following three stages, depending upon the level of assessment required for any given site;

- Step 1: Runoff quality (prior to any pre-treatment and discharge into a waterbody);
- Step 2: In river impacts (after dilution and dispersion) and;

- Step 3: In river impacts (post mitigation).

Step 1

11.3.17 Step 1 is the initial step to assess the quality of the direct road runoff against toxicity thresholds prior to treatment and discharge to the watercourse. Toxicity thresholds based on Environmental Quality Standards (EQS) for the protection of freshwater aquatic life have been derived from SEPA (Ref 11.17). HAWRAT predicts the statistical distribution of key pollutant concentrations in untreated and undiluted highway runoff (the 'worst case' scenario) over a long release period. The distribution uses a statistical model which is based on a ten-year rainfall series relevant for the chosen site and its climatic region. If Step 1 indicates that the toxicity is acceptable, then no further assessment is necessary.

Step 2

11.3.18 If the outcome of Step 1 is "fail", the assessment then proceeds to Step 2. At Step 2, the acute impacts of soluble pollutants are assessed by taking into account the diluting capacity of the watercourse which receives the run-off. Step 2 also considers the likelihood of sediment deposition to establish the chronic impacts of any sediment bound pollution. For sediment-bound pollutants, Step 2 provides two tiers of assessment; the first is a desk-based assessment and the second is a more detailed assessment allowing the input of estimated or measured dimensions of a watercourse. Passing the first tier avoids a second-tier assessment. For this report, the more conservative Tier 1 desk-based assessment was used.

11.3.19 The following parameters are required for the Step 2 assessment;

- The annual 95%ile river flow (m^3/s);
- Base Flow Index (BFI);
- The impermeable road area which drains to the outfall (ha);
- Any permeable (non-road surface) area which also drains to the outfall (ha);
- The hardness of the receiving water (mg CaCO3/l);
- Whether the discharge is likely to impact on a protected site for conservation;
- Whether there is a downstream structure, lake or pond that reduces the river velocity near the point of discharge;
- An estimate of the river width (m), for Tier 1 assessment.

Step 3

11.3.20 If the outfall fails Step 2 after discharge to the waterbody, the assessment continues to Step 3. Step 3 identifies and assesses the effectiveness of existing and/or proposed treatments for

soluble pollutants. Step 3 does not need to be undertaken using HAWRAT provided that Step 2 is passed, however this does not mean that no mitigation measures are required. This step allows the user to assess the effectiveness of existing and/or proposed drainage treatment systems for soluble pollutants with mitigation in place.

Method C: Assessment of pollution impacts from routine runoff on groundwaters

11.3.21 Method C assesses the potential impact of routine runoff on the quality of groundwater resources. This involves assessing the risk to groundwater from the disposal of road runoff as either direct discharges to the ground or through infiltration. Seven component properties are recognised as influencing pollutant loading and the extent of passage through the soil. These components are; traffic density, annual rainfall, soakaway geometry, unsaturated zone (water table depth), flow type, effective grain size and lithology (rock characteristics). For each component, a risk category is determined, and a subsequent score is calculated based on a weighting factor; as set out within Table C1.2 within DMRB. An overall risk score is then determined which illustrates the level of risk to groundwater; as follows:

- Overall risk score <150 has a low risk of impact;
- Overall risk score 150-250 has a medium risk of impact; and
- Overall risk score >250 has a high risk of impact.

Method D: Assessment of pollution impacts on spillages

11.3.22 Method D assesses the impact of accidental spillages on the road network and is also carried out using the HAWRAT. It estimates the following;

- The risk of a collision (involving a spillage) occurring; and
- The risk of the pollutant reaching and impacting the receiving watercourse.

11.3.23 Although the aim of any new road improvement will be to reduce the overall risk of collisions, there will always be the potential for increased pollution as a result of the general accumulation of pollutants or spillages from accidents being discharged into the local water environment. Any pollution event as a result of an accidental spillage could lead to a reduction in surface water quality, which in turn could affect the quality of groundwater and river base flow. It is therefore important to assess the risk of any potential acute pollution impacts occurring as a result of accidental spillages of any harmful chemicals or materials.

11.3.24 The following parameters are required for input into the HAWRAT;

- Road and junction type and urban/rural setting;
- The length of the road draining to the outfall;

- The Annual Average Daily Traffic (AADT) two-way flow;
- The percentage of the AADT flow that comprises Heavy Goods Vehicles (HGVs);
- The probability of a serious pollution incident occurring as a result of a spillage (expressed as a factor based on the response time to the site).

11.3.25 The risk is expressed as the probability of an incident in any one year and it is initially assessed without any mitigation measures.

11.3.26 DMRB recommends that watercourses should be protected so that the risk of a serious pollution incident has an annual probability of less than 1%. In circumstances where an outfall discharges within close proximity (i.e. within 1km) to a protected area for conservation or could affect important drinking water supplies, a higher standard of protection is required such that the risk of a serious pollution incident has an annual probability of less than 0.5%.

11.4 Baseline Conditions

11.4.1 The following section summarises the baseline conditions within the study area relating to the water environment and considers surface water features, aquatic ecology, groundwater and flood risk.

Surface Waters

11.4.2 The study area lies within the River North Esk (Tayside) catchment, as illustrated in **Figure 11.1**. There are a number of surface waterbodies located within this catchment, some of which flow directly through the study area. The main surface waterbodies are detailed in the following paragraphs and illustrated in **Figure 11.1**. It should be noted that there are no Water Framework Directive (WFD) waterbodies located directly within the 600m study area, yet a number of the watercourses that flow within the study area are hydrologically connected to Luther Water, which is classified under the WFD.

Gaugers Burn

11.4.3 Gaugers Burn is a minor watercourse that flows directly through the study area. The source of the watercourse lies on Hill of Garvock to the south east of the scheme and it is likely fed by runoff from the surrounding landscape and agricultural land. From its source, the watercourse flows westwards following its natural course before it is culverted underneath the existing A90 close to the southern junction at Laurencekirk. It then continues to flow in a north westerly direction to the immediate west of Laurencekirk, under Laurencekirk High Street, before discharging into Luther Water (Source to Dowrie Burn Confluence) (Waterbody ID 5706). As the watercourse has not been classified under the WFD, there is no information relating to the overall water quality of this Burn. Photo 11-1 illustrates the Burn.

Photo **11-1: Gaugers Burn looking north west from A937**

Kirk Burn

11.4.4 Kirk Burn is a minor watercourse that flows directly through the north east of the study area. Its source is unclear from OS mapping, yet it likely commences within the agricultural land located on the Hill of Garvock which lies to the east of the existing A90. From the Hill of Garvock, the watercourse flows in a north westerly direction down through agricultural land and is then culverted under the existing A90 to the south east of Laurencekirk. The burn then continues to flow north westerly adjacent to numerous residential properties located within Laurencekirk, before it is culverted under the railway line that runs through Laurencekirk. As it flows out of Laurencekirk, the burn meanders to the south east and then discharges into Luther Water. As the burn has not been classified under the WFD, there is no information available on the overall water quality. Photo 11.2 illustrates the watercourse as it flows through Laurencekirk.

Photo 11-2: Kirk Burn

Luther Water (Source to Dowrie Burn Confluence)

11.4.5 Luther Water (Source to Dowrie Burn confluence) is a WFD watercourse that flows to the north west of Laurencekirk, out with the 600m study area. While this watercourse does not flow directly within the study area, it is hydrologically connected to Gaugers Burn and Kirk Burn; both of which flow directly through the study area and are culverted under the existing A90. The source of Luther Water lies to the north west of Laurencekirk at Hill of Burnieshag within Drumtochty Forest. It flows in south easterly direction through large clusters of woodland, agricultural land and adjacent to numerous minor roads before it reaches Laurencekirk. It bypasses Laurencekirk to the north west and continues to flow south east through flat agricultural land. Under WFD, the watercourse is classified as having an overall ecological status of moderate ecological potential. The watercourse has been designated as heavily modified on account of physical alterations that cannot be addressed without a significant impact on the drainage of agricultural land.

Luther Water (Dowrie Burn to North Esk Confluences)

11.4.6 To the south west of Laurencekirk, a minor burn (Dowrie Burn) flows into Luther Water, and at this point Luther Water (Source to Dowrie Burn) becomes Luther Water (Dowrie Burn to North Esk Confluences) (Waterbody ID 5705). While this watercourse also flows outside the study area, it is hydrologically connected to the previous section of Luther Water and subsequently Gaugers Burn and Kirk Burn. From this point, Luther Water flows south west and through agricultural land and into the River North Esk. This section is classified as having an overall status of moderate. Pollutant pressures on this source include diffuse source pollution from rural sources and point source discharges from waste water (sewage) disposal.

River North Esk (Confluence with Cruick Water to Estuary)

11.4.7 The River North Esk (Confluence with Cruick Water to Estuary) (Waterbody ID 5700) flows out with the study, yet it is connected to Luther Water which is ecologically connected to the study area by Kirk Burn and Gaugers Burn. SEPA have classified this watercourse as having an overall condition of moderate, a water quality condition of good and a physical condition of good. Water flows and levels are classified as moderate because of pressures from water abstraction for commercial purposes.

Minor unnamed watercourses

11.4.8 In addition to the aforementioned watercourses, there are a number of minor unnamed streams/ drainage channels that flow sporadically throughout the study area, many of which flow within close proximity to the existing A90. These are summarised in the following paragraphs. Photo 11-3 illustrates a typical minor drainage channel in the study area.

Photo 11-3: Typical minor drainage channel present in the study area.

11.4.9 One minor stream flows directly through the south of the study area adjacent to the agricultural property, Mains of Newtown. The minor watercourse is fed by numerous field drainage channels to the east of the agricultural property. These channels converge to form the watercourse, which then flows in a north westerly direction and is culverted under the existing A937. The stream continues north west past Mains of Newton, before it is culverted under the existing A90. It then flows past the agricultural properties Oatyhill and Burnfoot, before it discharges into Luther Water (Source to Dowrie Burn Confluence).

11.4.10 A large network of drainage channels lie within the agricultural land to the east of the existing A90 close to Johnston Lodge and Johnston Mains. To the south east of the A90/A937 junction, one drain flows through the farmland in a north easterly direction and discharges into Gaugers

Burn. Beyond Johnston Lodge and Johnston Mains, a large network of drainage channels flow sporadically throughout the farmland at this point.

11.4.11 A further drainage channel flows parallel to the B9120 and is likely culverted underneath the A90 to the south west of the A9120. The exact point at which the watercourse crosses the carriageway cannot be determined from OS mapping.

11.4.12 It should also be noted at this point that the entire study area is designated as part of the Strathmore and Fife Nitrate Vulnerable Zone (NVZ). NVZs are areas designated at risk from agricultural nitrate pollution. Runoff from such areas holds the potential to pollute surface watercourses and groundwater bodies.

Surface Water Abstractions

11.4.13 The study area lies within the Whitehillocks drinking water regulation zone, as illustrated in **Figure 11.4**. This zone represents the extent of the drinking water supply by Scotland's water authority, Scottish Water. From the figure, it is evident that the Whitehillocks zone lies to the west of the existing A90, located partially within the 600m study area.

Private water supplies

11.4.14 According to the Drinking Water Quality Regulator for Scotland, there are no Type A private water supplies (PWS) located within the 600m study area. There are however numerous Type A supplies located within the wider area. A private supply is classified as Type A when;

- Supply on average more than $10m^3$ of water per day, or;
- Serve more than 50 people, or;
- Supply a commercial or public activity, regardless of volume (e.g food producers, hotels, holiday let accommodation, bed & breakfast establishments and village halls).

11.4.15 This classification applies to both surface water and groundwater abstractions. The Type A private water supplies fed by surface water located within the wider area surrounding Laurencekirk are listed in Table 11-5.

Table 11-5: Type A Private Water Supplies (surface water) within 2km of study area

Location	Approximate distance from scheme	Approximate number of properties on supply
Supply at Laurencekirk (Haulkerton)	1.6km north west	14

11.4.16 The Scottish Drinking Water Quality Regulator indicates that there are numerous Type B private water supplies located within the study area. Type B supplies supply domestic properties only.

This classification can again apply to both surface water and groundwater abstractions. The locations of the Type B likely fed by surface water supplies are summarised in Table 11-6.

Table 11-6: Type B Private Water Supplies (surface water) within study area

Location	Approximate distance from scheme	Approximate number of properties
Victoria Building, Aberdeen Road, Laurencekirk	600m north west	1

11.4.17 In order to improve the accuracy of the locations of the PWS within the vicinity, interviews with local landowners were undertaken in October 2017. The results revealed that the majority of the local landowners utilised PWS drawn from groundwater fed supplies. Further details on groundwater supplies are detailed in paragraph 11.4.26.

Aquatic ecology

11.4.18 The study area is ecologically diverse and contains several species of wildlife which are dependent on the water environment. While there are no designated ecological sites or wetlands within the study area itself, the water environment is a habitat for several species. It is determined that the area is a prime habitat for water vole due to the grassy embankments and the vast number of drainage ditches which are present within the agricultural land. In addition to this, several otter sightings have also been recorded at points along Luther Water which flows a short distance to the north west of the study area and is hydrologically connected to Gaugers Burn, Kirk Burn and many of the unnamed drainage channels that flow throughout the study area. It should be noted however that there is no evidence of otter or water vole directly within the study area itself.

11.4.19 Site analysis for Freshwater Invertebrate Surveys has indicated that Gaugers Burn has very good or excellent water and habitat quality with predominantly very fast flowing water. It should also be considered a site of national importance for aquatic invertebrates due to its high biodiversity and the presence of two species of conservation concern, namely the lesser diving beetle *Oreodytes davisii* which is considered threatened in the UK, but widespread in Scotland, and pale watery mayfly *Mayfly genus procloeon* which is data deficient and has an unknown distribution. Further information on aquatic ecology is provided in Chapter 10 Nature Conservation and Biodiversity.

Groundwater features/abstractions

11.4.20 According to the British Geological Survey (BGS), the study area is underlain by the bedrock aquifer Old Red Sandstone (South) (Ref 11.13). This is the principal aquifer for the region and is classified as a sedimentary aquifer which is dominantly non-calcareous. The aquifer is defined by the BGS as of moderate to very high productivity. The groundwater flow depth for this aquifer

ranges from tens of meters to hundreds of meters, while the dominant groundwater age is estimated to be approximately decades to centuries old. The dominant overlying strata is generally thick with moderate to high permeability, while the groundwater flow is determined to be fractured (minor inter-granular). The dominant groundwater flow path length is approximately 1km and the flow usually follows the main river body catchments.

11.4.21 SEPA's Water Environment Hub indicates that the study area lies within the Laurencekirk bedrock and localised sand and gravel aquifers groundwater body (ID 150653), as shown in **Figure 11.2**. This is classified as having an overall status of good in 2017. The entire study area is further classified as a Drinking Water Protection Zone for groundwater.

11.4.22 It should be noted that there are no designated sites within the study area which are designated for groundwater. Habitat surveys have also confirmed that there are no areas of wetland within the study area. It is therefore unlikely that groundwater within the area support any GWDTE. Further information on the types of habitat within the study area is available in Chapter 10 Nature Conservation.

11.4.23 Historic ground investigation data within the study area is available from BGS. There over 50 borehole records within the study area, many of these having been undertaken along the alignment of the existing A90 or slightly adjacent to it. The records reveal that the majority of the boreholes were drilled to depths varying between 1-5m and the majority of these revealed no groundwater present. Only two of the boreholes undertaken along the alignment of the A90 close to the southern junction struck groundwater below 1m, and these only recorded 'slight seepage' and 'damp' conditions. The remaining boreholes were recorded as dry. A further two borehole records are available within the study area close to Mains of Newton. Both of these were drilled to a depth of 120m. Groundwater at this location was struck at 4m, 18m, 27m, 48m and 88m.

Groundwater abstractions

11.4.24 The following Type A private water supplies fed by groundwater located within the wider area surrounding Laurencekirk are listed in Table 11-7.

Table 11-7: Type A private water supplies (groundwater) within wider area

Location	Approximate distance from scheme	Approximate number of properties on supply
South west of Laurencekirk	2km south west	11
South of Laurencekirk (adjacent to Craig of Garvock)	2km south	Unknown

11.4.25 The Type B private water supplies likely fed by groundwater are listed in Table 11-8.

Table 11-8: Type B private water supplies (groundwater) within the study area

Location	Approximate distance from scheme	Approximate number of properties
Johnstone Lodge, Laurencekirk	400m south east	6

11.4.26 As discussed in paragraph 11.4.17, interviews with local landowners were undertaken in October 2017 to help ascertain the locations of private water supplies within the area. The results below summarise the findings:

- Burnton Farm, located to the east of the A90, utilises one private water supply which supplies both the farmhouse and the farm steading. The supply is drawn from one spring and one well. Approximately eight farm cottages located on the premises of the farm also draw from the private supply. The source of the supply is determined to be from the east of the property at Garvock Hill.
- Mains of Newton, located to the south east of the A90, utilises both public and private water supplies. The private water supply is drawn from a spring and an irrigation pond which are used to supply the farm steading. The supply is determined to originate from the east at Stonneydale Farm in the Garvock Hill area.
- Johnston Mains, located to the south east of the A90, utilises one private water supply. The supply is drawn from one spring and used for both the farmhouse and farm steading. The source supplies a further seven properties which were previously part of the wider Johnston Mains Estate. The source of the supply is determined to be in the Garvock Hill area.
- Conveth Mains Farm makes use of one private water supply which is used to supply the farm steading. The water is provided from a reservoir and the supply originates from Keilburn Farm who are responsible for the day to day management and maintenance of the supply. The source is unconfirmed, yet it is likely to be from a groundwater source given the lack of watercourses surrounding this farm.

11.4.27 Historic maps and data from the BGS indicate that there are no groundwater wells located within the 600m study area.

11.4.28 Further information on groundwater within the study area is available in Chapter 13 Geology and Soils.

Flood risk

11.4.29 A review of SEPA's flood maps indicate that there are limited areas at risk of river flooding and surface water flooding within the study area as shown in **Figure 11.3**. Areas to the either side of Luther Water along the entire watercourse are designated as high, medium and low risk of

fluvial flooding yet these areas do not extend to the A90 carriageway. The A90 carriageway within the study area is thus determined to lie outwith the floodplain of Luther Water.

11.4.30 The floodplains of the smaller watercourses are not shown on SEPA's flood maps, yet despite this, a risk of flooding remains possible; all watercourses will have an associated floodplain to some extent.

11.4.31 SEPA's flood maps identify several areas at risk of surface water flooding. These include;

- The A90 where Gaugers Burn is culverted beneath the carriageway;
- The A90 where a minor unnamed drainage stream crosses under the carriageway near Conveth Mains at approximate NGR NO 72599 71990 and NO 72616 7204;
- The A90 carriageway to the north west of Keilburn Farm at approximate NGR NO 72834 72800;
- An area to the south of the A937 at Gaugers Burn at approximately NGR NO 71038 70677;
- A small area to the north west of the A90 at Drumforber Farm, approximately NGR NO 72371 73355 and;
- The railway line which runs through the centre of Laurencekirk to the west of the A90 carriageway.

11.4.32 There are no areas of groundwater flooding present within the study area based on SEPA's flood maps, yet information from ground investigations undertaken indicate that there is potential for groundwater flooding at the surface based on the underlying geological conditions. These conditions extend throughout the entire study area and beyond.

Road Drainage

11.4.33 The existing drainage setup within the study area along the A90 mainline consists of a series of carrier drains, filter drains and catch pits. Runoff from the carriageway is captured and transported via these methods to catch pits before it is eventually discharged into the surrounding minor watercourses which are present within the study area.

11.4.34 In Scotland it is a statutory requirement to provide two levels of Sustainable Drainage Systems (SuDS) to control and treat surface water runoff from trunk roads.

11.5 Impact Assessment

Sensitivity of receptors

11.5.1 The sensitivity of each element of the water environment has been assessed in accordance with Table 11-2.

Surface waters/abstractions

11.5.2 Surface water features within the study area are determined to be of medium sensitivity. While there are no WFD classified watercourses that flow directly within the study area, surface water features are highly connected and Gaugers Burn, Kirk Burn and many of the minor drainage channels which flow within close proximity to the existing A90 carriageway are hydrologically connected to Luther Water and subsequently, the River North Esk. Luther Water (Source to Dowrie Burn Confluence) holds an overall quality of moderate ecological potential, while Luther Water (Dowrie Burn to North Esk Confluence) and River North Esk both hold an overall quality of moderate.

11.5.3 Further to this, there are private water supplies fed by surface water which are likely to be used by residential properties within the area, which suggests that the minor surface water features present within the area are of some use to the local community.

Aquatic ecology

11.5.4 The sensitivity of aquatic ecology within the study area is determined to be of medium sensitivity. None of the watercourses within the study are designated sites, and they are not hydrologically connected to any Special Protection Area (SPA), Special Area of Conservation (SAC) or Wetland of International Importance (Ramsar). A river habitat survey was undertaken on Gaugers Burn in June 2018, the full details of which can be viewed in Chapter 10 Nature Conservation and Biodiversity. This survey indicated the presence of fish barriers within the watercourse, suggesting that fish populations are likely to be low within the burn.

11.5.5 The study area is considered to be a prime habitat for water vole, yet no records of this species have been identified and the species have subsequently been scoped out of the assessment. Otter are also likely to be present in the wider area and there have been sightings of this species along Luther Water which flows within close proximity to the study area. Despite this however, there is no evidence of otter within any of the watercourses that flow directly within the study area.

11.5.6 Gaugers Burn has been surveyed for aquatic invertebrates with the watercourse scoring very high for conservation value. Two species of conservation concern on a national scale have also been found to be present within the burn.

Groundwater features/abstractions

11.5.7 Groundwater for the area is determined to be of high sensitivity. The study area lies above a groundwater body which is classified as good by SEPA and the aquifer which underlies the study area is classified by the British Geological Survey to be of moderate to very high productivity. A number of ground investigation boreholes have been undertaken throughout the area, yet many of these recorded have no groundwater. A number of private water supplies fed by groundwater sources, including springs and wells, lie within the study area, which illustrates that groundwater is of some use to the area, particularly for agricultural purposes.

Flood risk

11.5.8 Flood risk within the study area is determined to be of low sensitivity. A review of SEPA's flood maps indicate that there is a low risk of surface water flooding and fluvial flooding. Luther Water is designated to be of high risk of fluvial flooding however this watercourse does not flow directly within the study area.

Temporary impacts during construction

11.5.9 The following section details the potential impacts on the surface water environment throughout the construction phase of the proposed scheme. Potential impacts on the water environment as a result of construction activities include;

- Water pollution from silt laden runoff draining into watercourses untreated;
- Chemical/ fuel spillages and leaks from plant and machinery entering watercourses;
- Inappropriate disposal of foul water from the construction site;
- Increased runoff rates from temporary paved surfaces or roofed areas of site compounds;
- Changes to catchment characteristics from ditch or drainage diversions;
- Increased runoff rates and a greater risk of surface water pollution risk as a result of vegetation clearance and earthworks;
- Increased flood risk as result of de-vegetation, and the potential for mud/debris to block surface water drainage systems.
- Formulation of stagnant water puddles; often on construction sites if drainage from site is not managed there can be a formation of stagnant pools. On impermeable surfaces where the water has no drainage route, it picks up pollutants as it flows into storm drains. The contaminated water then flows into the surrounding watercourses impacting the quality of surface water.

Magnitude of impacts

Surface water features/ abstractions

11.5.10 The proposed scheme will involve the creation of a new full diamond junction to the south of Laurencekirk with the creation of a new access track to Johnston Lodge to the east of the existing A90 and a further Non-Motorised User track (NMU). The junction will be constructed in land that is currently arable farmland. As a result, the scheme lies offline and will subsequently require large scale site clearance, vegetation clearance, excavations and earthworks during the construction phase. Such activities will have the potential to increase surface water runoff rates, which could subsequently lead to surface water pollution events.

11.5.11 The proposed new access track will also intersect Gaugers Burn and the minor drainage ditch that flows immediately adjacent to it. The track will further intersect the minor drainage ditch that flows parallel to the B9120. Direct construction work will be required at Gaugers Burn where a culvert will be installed to allow the access track to pass over it. Construction work within the remaining watercourses is unlikely given their size, yet large scale site clearance and excavation works will take place in their immediate vicinity, potentially resulting in pollution events from silty runoff.

11.5.12 It should be noted that three SuDS basins will be constructed as part of the scheme design and access tracks to maintain these basins will also be constructed. The basins are located to the north of the scheme at Gaugers Bridge and to the south west of the scheme at Oatyhill. Site clearance will be required at these points to accommodate the basins and maintenance tracks which therefore has the potential to increase runoff rates, and subsequently increase the risk of surface water pollution events. This is particularly relevant as the basins lie within close proximity to Gaugers Burn, and the unnamed watercourse that flows to the south of Mains of Newton.

11.5.13 Kirk Burn is not directly intersected by the proposed scheme, yet it flows approximately 190m to the north of the proposed Johnston Lodge access track at its closest point. This is subsequently close enough to the footprint of the scheme to be impacted by runoff from construction activities.

11.5.14 In addition to this, there is at least one private water supply fed by surface water within the study area. While this won't be directly impacted upon, there is potential for runoff from construction activities to pollute such supplies if appropriate mitigation measures are not in place.

11.5.15 Prior to mitigation, a magnitude of moderate adverse is determined for surface water during the construction phase.

Aquatic ecology

11.5.16 Impacts on aquatic ecology can be linked to the quality of the surface water environment and it is determined that any adverse impact on the quality of surface water can adversely impact aquatic habitats. For instance, construction activities have the potential to lead to silty runoff entering the surrounding surface watercourses. Such runoff can lead to increased sedimentation and a lack of dissolved oxygen levels, which will create detrimental conditions for aquatic species.

11.5.17 Noise and lighting from construction activities could also impact foraging and commuting for species such as otters, however, this impact is likely to be minimal as there is no evidence of otter directly within the study area.

11.5.18 Given the minor footprint of the scheme however, and the localised area of Gaugers Burn that will be directly impacted by construction, a magnitude of negligible adverse is determined for aquatic ecology prior to mitigation. Further impacts on aquatic ecology are discussed in Chapter 10 Nature Conservation and Biodiversity.

Groundwater

11.5.19 The construction of the proposed scheme will take place primarily offline, with the full diamond junction being constructed within land which is currently arable farmland. As a result, large scale offline excavations will therefore be required to accommodate the new southern junction, the realigned A937 and the Johnston Lodge access track.

11.5.20 During the excavation process, there is greater potential for pollution of the groundwater environment as excavations will reduce the depth to the water table, resulting in less material between the potentially pollution creating construction activities and the groundwater. There is therefore potential for contaminates to infiltrate down into the groundwater environment during the construction phase, particularly if any large-scale fuel or chemical spillages occur.

11.5.21 The deepest cutting for the scheme will be approximately 3.5m which will occur at the southbound diverge. Given the historical groundwater depths recorded within the study area, the risk of groundwater being struck during excavation is therefore considered to be low. Dewatering is therefore unlikely to be required on site as the quantities of groundwater likely to be exposed are such that they will be catered for through standard construction site drainage. Impacts upon groundwater levels and flow are therefore determined to be limited.

11.5.22 It should be noted that no groundwater abstraction points will be impacted during the construction of the proposed scheme.

11.5.23 A magnitude of moderate adverse is determined for groundwater quality during the construction phase, while a magnitude of negligible adverse is determined for groundwater flows and levels.

Flood Risk

11.5.24 As noted, the proposed scheme will require large scale offline excavations to accommodate the full diamond junction, Johnston Lodge access road, SuDS basins and the SuDS basins maintenance tracks. The clearance of vegetation and grassland can enhance runoff rates and subsequently increase the risk of surface water flooding events.

11.5.25 In addition to this, haul roads and construction compounds will be required throughout the duration of the construction phase which will result in a greater level of impermeable surface within the study area. This impermeable surface could contribute to greater runoff rates during the construction phase and could enhance the risk of surface water flooding events. During periods of heavy rainfall, large amounts of impermeable surfaces generate large amounts of runoff. This sudden influx of runoff into rivers and surface water drainage systems can cause flash flooding and erosion of stream banks and could also contribute to groundwater flooding.

11.5.26 A magnitude of moderate adverse is determined for flood risk during the construction phase.

Significance of effects

11.5.27 In accordance with DMRB, the significance of effects on baseline features can be determined by combining the magnitude of impact with the sensitivity of the environmental receptor. This is achieved by using the significance of effects matrix shown in Table 11-4. Table 11-9 provides a summary of the significance of effect on the water environment during the construction phase.

11.5.28 From the table, it is evident that there will be significant effects upon surface water and groundwater during the construction phase, prior to mitigation.

Table 11-9: Significance of effect for construction phase

Water environment feature	Resource sensitivity	Magnitude of impact	Significance of effect
Surface Water	Medium	Moderate	Moderate
Aquatic ecology	Medium	Negligible	Slight
Groundwater quality	High	Moderate	Moderate
Groundwater flow and levels	High	Negligible	Slight
Flood risk	Low	Moderate	Slight

Permanent impacts during operation

11.5.29 As discussed in section 11.2, a number of water quality assessments have been undertaken to support the overall road drainage and water environment assessment. These have been completed in line with DMRB HD 45/09. The results of each assessment are detailed below and illustrated in greater detail in Appendix 11.1.

11.5.30 Before any discussion on operational impacts can take place, it is important that the proposed drainage, which will be built into the design of the scheme, is explained. The design indicates that the accumulated flow from the proposed scheme, including the A90 mainline, proposed full diamond junction and associated slip roads, will be transported via filter drains, carrier pipes and open drain ditches to three Sustainable Drainage Systems (SuDS) basins, named on the scheme design as Attenuation Basins A, B and C. Attenuation basin A lies in the south west of the study area close to the railway line and the agricultural property Oatyhill and it accepts the majority of the drainage from the A90 mainline. The basin discharges via a swale to a minor unnamed watercourse which flows in a north westerly direction past Oatyhill before discharging into Luther Water. Attenuation basins B and C lie to the north of the existing A90 to the west of Gaugers Burn and accept drainage from the A937 Link road and the de-trunked A937. They both discharge to Gaugers Burn which flows a short distance north before discharging into Luther Water.

Method A Assessment of pollution impacts from routine runoff on surface waters

11.5.31 The assessment of routine runoff to surface waters has been undertaken using the three step HAWRAT process. As detailed within the methodology section, if the toxicity levels yield a 'pass' at any stage of the assessment, then no further assessment is required.

11.5.32 It should be noted at this point that DMRB recommends that the point of assessment for the Method A assessment should be within an identified natural downstream receiving watercourse. If a discharge is into a drain or ditch that discharges into a natural watercourse after a short distance, then the designer (for the purpose of HAWRAT) should focus the environmental assessment on the natural watercourse and not the ditch or drain. As detailed within the baseline section, drainage from the proposed scheme will discharge into three SuDS basins, before discharging to two minor watercourses; Gaugers Burn and a further unnamed watercourse to the south of Mains of Newton. Both Gaugers Burn and the unnamed watercourse are minor in nature and hold the characteristics of field ditches for much of their route as they flow through the study area. Both of the watercourses discharge into Luther Water a short distance north of the study area, which is classified under the WFD. Following the guidance outlined within DMRB, the assessment points for the Method A assessment have therefore been taken as the points where the watercourses discharge into Luther Water. These locations are illustrated in **Figure 11.1**.

11.5.33 The two outfalls assessed failed the initial HAWRAT Step 1 assessment for direct road runoff against toxicity thresholds. As per DMRB guidance, the HAWRAT proceeded to a Step 2 assessment. The parameters detailed within paragraph 11.2.18 were inputted into the HAWRAT. The results generated from the Step 2 assessment are illustrated in Table 11-10.

Table 11-10: Method A Assessment of pollution impacts from routine runoff on surface water results

Outfall assessed	HAWRAT Annual Average Concentrations (µg/l)		Environmental Quality Standard for Water Hardness Band> 250 mg/l CaCO3		Pass under Environmental Quality Standards? (EQS)	Impacts of sediment deposition within acceptable limits
	Dissolved Copper (µg/l)	Dissolved Zinc (µg/l)	Dissolved Copper (µg/l)	Dissolved Zinc (µg/l)	Yes/No	Yes/No
Gaugers Burn outfall	0	0.00	1	10.9	Yes	Yes
Unnamed watercourse outfall	0.01	0.02			Yes	Yes

11.5.34 From the table, it is evident that the annual average concentrations for soluble pollutants do not exceed the relevant Environmental Quality Standards (EQS). Sediment deposition levels are further within acceptable limits. As a result, the proposed outfalls are subsequently determined to pass the HAWRAT assessment for road runoff and as a result, a Step 3 assessment is not required.

11.5.35 The full results of the Method A assessment are illustrated in Appendix 11.1.

Method C Assessment of pollution impacts from routine runoff on groundwater

11.5.36 The results of the Method C groundwater assessment are outlined in Table 11-10. As outlined within the methodology section, the Method C assessment requires a number of site-specific parameters, which help determine an overall groundwater risk score. The inputs include traffic density, rainfall, soakaway geometry and information on geological baseline. These inputs have been applied to the matrix represented by Table 11-11. Each input or component has been given a risk score according to the scale of the given parameter. A weighting is then applied depending upon the influence of each of the components (in accordance with the DMRB Volume 11, Section 3, Part 10).

Table 11-11: Method C Assessment of pollution impacts from routine runoff on groundwater

Component	Weighting Factor	Site Data	Risk	Risk Score
Traffic density	15	<50,000	1 (Low)	15
Rainfall (Annual Average)	15	740-1060mm	2 (Medium)	30
Rainfall intensity	15	Even	1 (Low)	15

Component	Weighting Factor	Site Data	Risk	Risk Score
Soakaway geometry	15	Single point or shallow soakaway (e.g. SuDS basin)	2 (Medium)	30
		Continuous linear (e.g. swale)	1 (Low)	15
Unsaturated zone- water table depth	20	Depth to water table <15>5m	2 (Medium)	40
Flow type	20	Fracture (Minor) Intergranular	2 (Medium)	40
Effective grain size	7.5	Coarse sand	2 (Medium)	15
Lithology	7.5	<15->1% clay materials	2 (Medium)	15
Overall risk score	200 (SuDS Basin) 185 (Swale)			

11.5.37 As evident within the table, the assessment has determined a medium risk to groundwater during operation as the overall risk score is calculated as 200 (for SuDS basin) and 185 (for swale). For a medium risk, mitigating measures should be implemented in order to reduce the risk to groundwater. These mitigating measures are detailed in section 11.6.

Method D: Assessment of pollution impacts on spillages

11.5.38 The results of the Method D spillage assessments are summarised in Table 11-2 and Table 11 13 and illustrated in full within Appendix 11.1. The results have been calculated using the parameters outlined within paragraph 11.2.23 of section 11.2. It should be noted that attenuation basin B has not been included within this assessment as the two roads which drain to this basin (Old A90 and Denlethen Wood Access) are not included within the traffic model and so traffic figures are not available to input into the HAWRAT.

11.5.39 Table 11-12 summarises the results of the Method D assessment for surface water.

Table 11-12: Results of Method D Assessment of pollution impacts on spillages- surface water

Road section draining to outfall	Threshold of acceptability for annual probability of a serious pollution incident %	Calculation of annual probability of a serious pollution incident %	Within acceptable limits (Yes/No)	Threshold of acceptability for risk of pollution incident (1 in Years)	Calculation of risk of a pollution incident (1 in Years)	Within acceptable limits (Yes/No)
Attenuation Basin A- Mainline Pond						
A90 Mainline	<1	0.00017	Yes	1 in 100 Year	5830	Yes
Northbound Slip roads	<1	0.00002	Yes	1 in 100 Year	5208	Yes
Southbound Slip roads	<1	0.00002	Yes	1 in 100 Year	4732	Yes
North roundabout	<1	0.00001	Yes	1 in 100 Year	4616	Yes
South roundabout	<1	0.00001	Yes	1 in 100 Year	4498	Yes
A937 Montrose	<1	0.00000	Yes	1 in 100 Year	4428	Yes
Attenuation Basin C- North pond						
A937 Link Laurencekirk	<1	0.00001	Yes	1 in 100 Year	137,807	Yes

11.5.40 The results show that the risk of a serious pollution incident for all the outfalls assessed has an annual probability far below the 1% quoted within DMRB HD45/09 for outfalls that are not within 1km of a protected area. Therefore, the assessment has identified that measures are not required to mitigate against spillage risk.

11.5.41 Table 11-13 summarises the results of the Method D assessment for groundwater.

Table 11-13: Results of Method D Assessment of pollution impacts for spillages- groundwater

Road section draining to outfall	Threshold of acceptability for annual probability of a serious pollution incident %	Calculation of annual probability of a serious pollution incident %	Within acceptable limits (Yes/No)	Threshold of acceptability for risk of pollution incident (1 in Years)	Calculation of risk of a pollution incident (1 in Years)	Within acceptable limits (Yes/No)
Attenuation Basin A- Mainline pond						
A90 Mainline	<1	0.00009	Yes	1 in 100 Year	11,660	Yes
Northbound Slip roads	<1	0.00001	Yes	1 in 100 Year	10,415	Yes
Southbound Slip roads	<1	0.00001	Yes	1 in 100 Year	9464	Yes
North roundabout	<1	0.00000	Yes	1 in 100 Year	9232	Yes
South roundabout	<1	0.00000	Yes	1 in 100 Year	8996	Yes
A937 Montrose	<1	0.00000	Yes	1 in 100 Year	8855	Yes
Attenuation Basin C- North Pond						
A937 Link Laurencekirk	<1	0.00000	Yes	1 in 100 Year	275,615	Yes

11.5.42 Similar to Table 11-12, Table 11-13 illustrates that the risk of a serious pollution incident for groundwater has an annual probability far below the recommended 1%.

Magnitude of impacts

11.5.43 Using the criteria outlined within Table 11-3, the magnitude of impact for the water environment for the operation phase can be determined. It should be noted at this point that the majority of mitigation for the operational phase will be built into the design of the scheme, including filter drains, carrier drains, swales and SuDS basins lined with protective membranes or clay. As a result of this, adverse impacts on the water environment during the operation phase are considered to be limited.

Surface water

11.5.44 During operation, impacts upon the surface water environment are anticipated to be limited. The proposed scheme will not directly intersect any WFD watercourse within the study area, yet Gaugers Burn will be impacted by the permanent installation of a culvert. During the operation phase, appropriate drainage systems will be built into the design of the scheme as embedded mitigation which will capture and treat road runoff before it enters the surface water environment. Filter drains, carrier drains, swales and three SuDS basins will be included as part of the design.

11.5.45 As evident within Table 11-10, the two outfalls assessed passed the Method A Routine Runoff to Surface Water Assessment at Step 2. The Method D Assessment of Pollution Impacts on Spillages also indicated that the risk of a serious pollution incident has an annual probability far below 0.5%.

11.5.46 Despite this, adverse impacts on the surface water environment from carriageway runoff cannot be ruled out entirely and it is possible that small amounts of pollutant laden runoff may enter surrounding watercourses during extreme weather events.

11.5.47 In line with Table 11-3, a negligible adverse magnitude of impact is determined for surface water during the operation phase.

Aquatic ecology

11.5.48 As previously noted, it is considered that any adverse impact upon the surface water environment will have a subsequent adverse impact upon aquatic ecology. During the operation phase, mitigation to protect the surface water environment will have been built into the design of the scheme and therefore adverse impacts upon the surface watercourses are unlikely. As a result, levels of sedimentation and oxygen levels within the surrounding watercourses will remain largely unimpacted by the scheme.

11.5.49 A permanent culvert will be installed in Gaugers Burn which could potentially prevent adult aquatic invertebrates from depositing eggs. The culvert however could also have a beneficial impact for these species by providing protection from predators. The addition of three SuDS basins could also create additional habitat for such species, resulting in a beneficial impact.

11.5.50 A magnitude of negligible beneficial is determined for aquatic ecology during the operational phase.

Groundwater

11.5.51 Impacts upon the groundwater environment will be limited during the operation phase, primarily as a result of the embedded mitigation which will be included as part of the design. The proposed scheme will not intersect any water wells or private groundwater abstraction points during the operation phase, and given the historic groundwater levels in the area, impacts on levels and

flows will also be minimal. The Method D Assessment of Pollution Impacts on Spillages indicated that the risk of a serious pollution incident for groundwater has an annual probability of far below 0.5%, while the Method C groundwater assessment resulted in a score of >150, which indicates a medium risk of impact from runoff infiltration. Drainage systems will be built into the design of the scheme, including three SuDS basins to attenuate runoff and swales. These features will also be lined as part of the design in order to ensure that contaminates do not infiltrate down into the groundwater environment. No direct discharges into the groundwater environment will take place.

11.5.52 In line with Table 11-3 and considering the built-in mitigation, a minor adverse magnitude of impact is determined for groundwater during the operation phase.

Flood risk

11.5.53 During the operation phase, the level of impermeable surface within the study area will have increased due to the completion of the full diamond junction, Johnston Lodge access track, NMU track and SuDS basin maintenance tracks. This will have the potential to increase surface water flooding within the area due to the potential for increased runoff rates, placing pressure on drainage systems and surrounding watercourses. Appropriate drainage systems will however be built into the design of the scheme to accommodate the greater levels of runoff. Surface water flooding during severe weather events will likely remain a possibility.

11.5.54 A minor adverse magnitude of impact is determined for flood risk during the operation phase.

Significance of effect

11.5.55 In accordance with DMRB, the significance of effect can be determined by combining the magnitude of impact with the sensitivity of the receptor. This is achieved using the significance of effect matrix in Table 11-14.

11.5.56 Table 11-14 summarises the significance of effects during the operation. From the table, it is evident that no significant adverse effects are determined for the water environment during the operation phase.

Table 11-14: Significance of effects for operation phase

Water resource	Resource sensitivity	Magnitude of impact	Significance of effect
Surface water	Medium	Negligible adverse	Slight adverse
Aquatic ecology	Medium	Negligible beneficial	Slight beneficial
Groundwater quality	High	Minor adverse	Slight adverse
Groundwater flow and levels	High	Negligible adverse	Slight adverse
Flood risk	Low	Minor adverse	Slight adverse

11.6 Mitigation Measures

11.6.1 Mitigation measures to reduce adverse impacts on the water environment are detailed below and take into account best practice, legislation, guidance and professional experience. The objectives of the mitigation measures are to avoid/prevent, reduce or offset the potential impacts detailed in the previous sections.

11.6.2 It should be noted that in addition to the mitigation measures proposed within this section, the design of the scheme includes embedded mitigation, which has been incorporated as an iterative process after consultation with SEPA. This includes the scheme drainage and SuDS basins with protective liner.

Construction

11.6.3 To mitigate the risk of any deterioration to the surface water environment during construction, the following mitigation measures will be implemented as a minimum requirement. The main impacts during construction will be risks from surface water management and accidental spillages.

- A Construction Environmental Management Plan (CEMP) will be produced;
- A SEPA construction site licence will be required as the footprint of the scheme exceeds an area of 5 hectares. As a result of this licence, a Pollution Prevention Plan will be implemented on site to ensure surface water is managed accordingly throughout the entirety of the construction phase. This will likely be through a series of temporary SuDS basins.
- The construction of the project will comply with SEPA's construction site guidance WAT-SG-75;
- Spill kits will be present on site and located in areas where spillages may be likely to occur (e.g. fuel storage areas)
- COSHH stores on site will be bunded and locked when not in use;
- Concrete washout will be stored in an appropriate designated area, away from watercourses;
- Drip trays and plant nappies will be placed under all stationary plant;
- Water quality monitoring will take place at the main watercourses within the study area in order to ensure no detrimental impacts on water quality are occurring;
- Dust suppression techniques will be implemented during activities likely to create high levels of dust;

- Where required, filter drains will be covered in order to prevent contamination from construction entering the surface water drainage system;
- Haul roads and construction compounds will be designed and sited to minimise the potential for increased surface runoff;
- Where haul roads run within close proximity to watercourses and drainage channels, silt fencing and splash boards will be installed to ensure silty runoff is not entering the watercourses.

Operation

11.6.4 As noted, mitigation relating to the post construction phase will be embedded as part of the design through the inclusion of SuDS basins, filter drains and swales, which will treat and attenuate runoff from the carriageway before it is dispersed to the water environment. This approach is detailed in CIRIA C697, The SuDS Manual, and outlines the most appropriate uses and combinations of SuDS measures to treat surface water runoff and improve water quality through each stage of the surface water management system.

11.6.5 Drainage systems will intercept surface water runoff from the carriageway and remove pollutants as near to the source before disposal to the on-site conveyance network. This network will comprise of components such as:

- Carrier and filter drains;
- Grass swales and unlined ditches adjacent to the carriageway;
- Gullies;
- Kerb and drainage systems on the roundabout sections;
- Catchpits and manholes;
- SuDS ponds for attenuation;
- Headwalls.

11.6.6 In regard to groundwater, the SuDS basins and swales will be lined with clay or an artificial membrane and planted with appropriate vegetation, in order to limit any potential infiltration of pollutants into the groundwater environment. The lining should then be covered with several layers of soil in order to prevent it from tearing and allowing sediment laden water to infiltrate down into the groundwater environment.

11.7 Residual Effects

11.7.1 After the implementation of the mitigation measures outlined within section 11.6, adverse impacts on the water environment will be limited.

Construction

11.7.2 During the construction phase, the use of spill kits, drip trays and the implementation of dust suppression/damping down techniques will likely reduce the risk of contaminated runoff entering the surrounding water environment. Table 11-15 illustrates the residual effects for the construction phase. From the table, it is evident that there are no significant adverse effects are determined.

Table 11-15: Construction residual effects

Water resource	Resource sensitivity	Magnitude of impact	Significance of effect
Surface Water	Medium	Minor adverse	Slight adverse
Aquatic ecology	Medium	Negligible adverse	Slight adverse
Groundwater quality	High	Minor adverse	Slight adverse
Groundwater flow and levels	High	Negligible adverse	Slight adverse
Flood risk	Low	Minor adverse	Slight adverse

Operation

11.7.3 As noted in section 11.5, mitigation measures during the operation phase will be incorporated into the design of the scheme though the appropriate drainage systems, including filter drains, carrier drains, swales and SuDS basins. Appropriate measures will also be in place at the SuDS basins and swales to ensure the protection of the groundwater environment. The residual operational impacts are therefore considered to be identical to the operational impacts detailed in Table 11-14.

11.8 Impacts on Policy and Legislation

11.8.1 Table 11-16 summarises the impacts of the scheme on the main plans and policies relating to the water environment.

Table 11-16: Impacts on policies and legislation

Legislative Instrument	Relevance to scheme	Scheme achieves objectives
National Planning Framework 3 (NPF)	The scheme has adopted a proactive approach to mitigating and adapting to climate change through the design of appropriate SuDS. The scheme will not contribute to unacceptable levels of water pollution.	Yes
Scottish Planning Policy; Managing Flood Risk and Drainage	A precautionary approach to flood risk has been adopted by the scheme. SuDS have been incorporated into the design of the scheme to manage flood risk and drainage. No areas of flood storage will be impacted by the scheme.	Yes
Water Environment (Controlled Activities) (Scotland) Regulations (CAR) 2011 as amended	The scheme will involve construction activities which will require to be authorised under CAR. All conditions outlined with any CAR licence or registration will be adhered to.	Yes
Water Environment (Diffuse Pollution) (Scotland) Regulations 2008	All runoff from the proposed scheme will be controlled and treated via SuDS.	Yes
Water Resources (Scotland) Act 2013	The proposed scheme will not adversely impact water quality.	Yes
The Public Water Supplies (Scotland) Regulations 2014	The proposed scheme will not lead to any contamination of public or private water supplies.	Yes
Water Environment and Water Services (Scotland) Act 2003	The scheme will not impact the overall WFD status of any surrounding surface watercourses, waterbodies or groundwater.	Yes
The Water Environment (Oil Storage) (Scotland) Regulations 2006	During construction of the scheme, all construction materials (including oil and oil products) will be securely stored away from watercourses.	Yes
Aberdeenshire Local Development Plan 2017; PR1 Promoting important resources.	The proposed scheme will not have a significant negative effect on any important environmental resource associated with the water environment. No GWDTE will be impacted by the scheme.	Yes
Aberdeenshire Local Development Plan; Policy C4 Flooding	The proposed scheme will not take place in an area which is at high risk of flooding. Appropriate SuDS will be incorporated into the design which will manage flood risk. The scheme will not contribute to flooding issues elsewhere in the local area.	Yes

Legislative Instrument	Relevance to scheme	Scheme achieves objectives
Aberdeenshire Local Development Plan 2017; RD1 Providing suitable services.	Surface water drainage from the proposed scheme will be dealt with in a sustainable manner and in a way that avoids pollution and flooding. Appropriate SuDS have been incorporated into the design of the scheme. SEPA have been consulted on the SuDS and their feedback has been incorporated into the design.	Yes

11.9 Limitations and Assumptions

11.9.1 The road drainage and water environment assessment is limited due to the availability of construction plans. At this stage, detailed construction plans are not yet available and as a result, the location of haul roads, construction compounds and site accesses are unknown. This has therefore limited the assessment of the construction phase.

11.9.2 Further to this, the DMRB Method A assessment should be caveated due to a lack of gauging data available for the watercourses located within the study area. Due to the minor nature of these watercourses, it has not been possible to determine the inputs required for the HAWRAT, including the Q95 and the Base Flow Index. As a result, the Method A assessment points have been taken at the points where Gaugers Burn and the unnamed watercourse at Mains of Newton discharge into Luther Water, where the Q95 and BFI could be determined.

11.10 Conclusion

11.10.1 This chapter has been undertaken to provide an assessment of the likely impacts of the proposed scheme on the water environment.

11.10.2 The assessment has been undertaken in line with DMRB Volume 11, Section 3, Part 10 Road Drainage and the Water Environment. Three water quality assessments have been undertaken as outlined within DMRB;

- Method A: Assessment of Pollution Impacts from Routine Runoff to Surface Waters;
- Method C: Assessment of Pollution Impacts from Routine Runoff on Groundwater;
- Method D: Assessment of Pollution Impacts on Spillages.

11.10.3 It is determined that there are no significant adverse effects on the surface water environment. The outfalls assessed passed the Method A assessment at Step 2, indicating that the predicted runoff discharge meets the Environmental Quality Standards for toxicity as set out by SEPA. The assessment also indicated that levels of sediment deposition are within acceptable limits.

11.10.4 The Method C assessment indicated that there is a medium risk to groundwater, yet no significant adverse impacts are determined for this receptor given the mitigation built into the design of the scheme, including SuDS basins which will be lined with either a protective geotextile membrane or clay in order to prevent infiltration of contaminated runoff into the groundwater environment. The barrier will be protected by levels of soil to prevent tearing. The risk to groundwater will therefore be reduced due to the presence of this barrier and can further be reduced through appropriate mitigation measures such as the lining of SuDS basins with a geotextile membrane or clay.

11.10.5 The Method D assessment indicated that the risk of a spillage causing a serious pollution incident is less than 0.5% for both surface water and groundwater, which is within the threshold of acceptability as outlined within DMRB.