6 ROAD DRAINAGE AND WATER ENVIRONMENT

6.1 Introduction

6.1.1 This chapter considers the potential effects on road drainage and the water environment (RDWE), namely hydrology and flood risk, surface and ground water quality, and drainage associated with the construction and operation of the proposed development.

6.1.2 The assessment has been informed by the Design Manual for Roads and Bridges (DMRB) HD45/09 guidance[1] and other SEPA technical guidance stated in Section 6.3 of this chapter.

6.1.3 The specific objectives of the chapter are to:

- describe the approach and methods to assessing the baseline environment and resulting predicted effects on the water environment;
- describe the water environment baseline receptors and assign baseline sensitivity;
- describe the potential effects, including direct, indirect and cumulative effects on receptors;
- describe the mitigation measures proposed to avoid or reduce any predicted significant effects; and
- assess any residual effects remaining following the implementation of mitigation.

6.1.4 Potential effects on the water environment are also intrinsically linked to aquatic ecology, which is reported within Chapter 7: Ecology and Nature Conservation.

6.1.5 This chapter refers to the following Technical Appendices (refer to Volume 3):

- Technical Appendix TA6.1: Water Quality Calculations – provides outline methodologies, input parameters and outputs to assess the potential effects of routine runoff and accidental spillage risk to the Swine Burn associated with operational road drainage; and
- Technical Appendix TA6.2: Winchburgh Junction Flood Risk Assessment (FRA) Report.

6.1.6 This chapter refers to the following Figures (refer to Volume 4):

- Figure 6.1: Flood modelling study area;
- Figure 6.2: Baseline (Pre-Development) Modelling 1:200 year (35% climate uplift) flood event;
- Figure 6.3: Post-Development Modelling 1:200 year (35% climate uplift) flood event; and
- Figure 6.4: Drainage Layout.

6.1.7 The assessment has been carried out by Charlotte Manwaring (originator) and Jon Moore (checker) of Sweco. Charlotte is a Registered Practitioner of the Institute of Environmental Management and Assessment (PIEMA) and Member of the Institution of Environmental Sciences (MIEnvSc). Jon is a Chartered Member of the Chartered Institution of Water and Environmental Management (MCIWEM) and a Chartered Environmentalist (CEnv).

[1] Highways Agency et al. (2009). Volume 11, Section 3, Part 10: Road Drainage and the Water Environment, HD45/09. Available at: http://www.standardsforhighways.co.uk/ha/standards/dmrb/vol11/section3/hd4509.pdf (Accessed 8 November 2019)

6.2 Scope of Assessment

6.2.1 This chapter considers the direct effects on attributes of the RDWE topic, including hydrology and flood risk, surface and groundwater quality, groundwater levels and flow and drainage associated with construction and operation of the proposed development.

6.2.2 The assessment is based on the proposed development as described in Chapter 2: Proposed Development Description.

Scoping and Consultation

6.2.3 Ramboll issued the EIA Scoping Report[2] on behalf of the Applicant to Transport Scotland (the 'competent authority') on 22 July 2018 to seek their 'Opinion' on the proposed scope of the EIA. Furthermore, the Scoping Report was issued to a number of relevant consultees to also seek their comments on the proposed EIA scope.

6.2.4 As presented in Technical Appendix 1.2: EIA Scoping Opinion (in Volume 3), there were comments received from the Scottish Environment Protection Agency (SEPA) relating to RDWE. There were no comments received from West Lothian Council (WLC) at the time of writing in relation to RDWE.

6.2.5 Based upon further discussions with SEPA, Sweco undertook an update to the baseline (pre-development) and post-development flood modelling analysis using the most up to date flood modelling guidance and information available, which superseded the original FRA undertaken in 2005 for the Winchburgh Masterplan site[3].

6.2.6 Table 6.1 summarises the response to SEPA's Scoping Opinion and how these have been addressed in the EIAR.

Table 6.1: Summary of Scoping Report Comments and Actions Taken

Consultee & Date	Summary of Consultation	Comment / Action Taken
SEPA, 3 August 2018	Flood Risk: Flood risk should be considered from all sources in line with Scottish Planning Policy (SPP). As well as increased flood risk associated with proposed extension of Swine Burn culvert[4], there is increased flood risk through loss of floodplain as a result of the development. Landraising within the 1 in 200-year floodplain should be avoided and mitigation may be required, including the provision of 'like-for-like' compensatory storage.	Flood risk for the Winchburgh Masterplan site was assessed in the original 2005 FRA, which concluded that the site was not at flood risk due to the existing constraints on the Swine Burn, including the culvert under the Union Canal and downstream railway culvert, which caused flood water to be held in its upstream reaches, upstream of the Union Canal. The hydrology and flood modelling of the Swine Burn has subsequently been updated using latest available information to assess the impact on flooding as a result of the proposed development, the outputs of which are included in this chapter. The detailed FRA Report is appended (see TA6.2 in Volume 3).
	Surface Water Drainage:	Runoff from the proposed development will be treated prior to outfall, via two levels of

[2] Ramboll (2018). Winchburgh M9 Junction – EIA Scoping Report, 22 June 2018 (amended 04 July)

[3] Carl Bro Group Ltd. (2005). Winchburgh FUTURE Urban Extension: Flood Risk Assessment, Winchburgh Development Initiative, August 2005. Prepared on behalf of CALA Homes

[4] The existing Swine Burn culvert under the M9 will be retained as part of the proposed development, with local steepening of earthworks slopes required to avoid the need to extend. However, a new culvert will be required approximately 20m upstream of the existing culvert to accommodate a realigned access track (this design change occurred after the EIA Scoping Report was issued)

Table 6.1: Summary of Scoping Report Comments and Actions Taken		
Consultee & Date	**Summary of Consultation**	**Comment / Action Taken**
	Adequate space to accommodate Sustainable Drainage Systems (SuDS) should be incorporated within the site layout. The type/level of SuDS should be based on specific site conditions and the 'SuDS train' should follow appropriate CIRIA and SEPA guidance, and any relevant CAR authorisations[5] should be obtained.	SuDS; filter drains and two detention basins prior to outfall to the Swine Burn, in line with CIRIA[6] and SEPA[7] guidance. SuDS will also provide adequate storage and attenuation prior to outfall. Refer to Section 6.7 (Mitigation during Operation) for details on SuDS proposals and likely requirements for CAR authorisation for the proposed development. CAR licence applications will be submitted to SEPA at the appropriate time.
	Pollution Prevention: EIAR to include a Schedule of Mitigation and outline Construction Environmental Management Plan (CEMP) to form the basis of more detailed construction management plans and method statements	Mitigation to avoid, reduce or offset predicted significant effects on the water environment is included in Section 6.7 (Mitigation) of this chapter, and Chapter 10: Schedule of Mitigation.
	Engineering Activities in the water environment: Engineering activities should be avoided in the water environment where possible, and where required, a table detailing justification for the activity, mitigation and a photograph should be provided for the activity. An FRA should be submitted if engineering works are likely to result in increased flood risk to people or property. Opportunities to improve the water environment should also be considered, where possible.	The hydrology and flood modelling have been updated and the outputs are included in this chapter. The inclusion of proposed SuDS is predicted to improve the quality of road runoff outfalling to the Swine Burn (see Section 6.7: Mitigation during Operation) for more information. A detailed FRA Report has been prepared – see TA6.2 in Volume 3.
	Disruption to Wetlands including Peatlands: The layout and design of the proposal should account for any wetlands/peatlands present, and impacts should be avoided, or if necessary minimised and mitigated. A Phase 1 habitat survey, National Vegetation Classification survey, and assessment of potential effects on any groundwater dependent terrestrial ecosystems (GWDTEs) should be undertaken.	No noteworthy wetlands or peatlands are situated in the vicinity of the site and therefore none will be impacted by the proposed development. Relevant ecology surveys and assessments, including assessment of GWDTEs, are included in Chapter 7: Ecology and Nature Conservation.
	Disturbance and re-use of excavated peat	No peatlands or peat soils have been identified in the vicinity of the proposed development and will therefore not be impacted by the proposed development.
	Existing groundwater abstractions	Temporary groundwater abstractions are anticipated during construction of the earthworks/excavations associated with the proposed development. All construction works associated with this activity will

[5] HMSO (2011). Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended)

[6] CIRIA (2015). C753: The SuDS Manual

[7] SEPA (2019). Regulatory Method WAT-RM-08: Sustainable Urban Drainage Systems (SUDS or SUD Systems), Version 6.4, July 2019. Available at: https://www.sepa.org.uk/media/219048/wat-rm-08-regulation-of-sustainable-urban-drainage-systems-suds.pdf (Accessed 21 August 2019)

Table 6.1: Summary of Scoping Report Comments and Actions Taken		
Consultee & Date	**Summary of Consultation**	**Comment / Action Taken**
		follow SEPA's CAR guidance[8], adhering to CAR General Binding Rule (GBR) 15.
	Where water abstraction is proposed we request that the EIAR, or planning submission, details if a public or private source will be used.	No water abstractions (either from a public or private source) are required for the proposed development.
	Scottish Planning Policy (SPP) states (Paragraph 243) that "Borrow pits should only be permitted if there are significant environmental or economic benefits compared to obtaining material from local quarries, they are time-limited; tied to a particular project and appropriate reclamation measures are in place." The EIAR or planning submission should provide sufficient information to address this policy statement.	No borrow bits for construction materials/earthworks are required for the proposed development.

Potential Effects Scoped Out

6.2.7 No elements of the RDWE topic have been scoped out of the assessment.

6.3 Assessment Methodology

Legislation and Policy

6.3.1 The assessment was carried out in accordance with the following legislation and policy:

- Flood Risk Management (Scotland) Act 2009 (FRMS Act);
- Water Framework Directive 2000/60/EC (WFD);
- The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended) (CAR); and
- Scottish Planning Policy (SPP).

6.3.2 Key details of each assessment methodology are provided below.

Baseline Characterisation

6.3.3 In order to assess existing (baseline) flood risk, a hydraulic model was developed, as shown on Figure 6.1. This model incorporates the Swine Burn, extending from approximately 300m downstream of two ponds (source of the burn) on the south side of the Union Canal (NGR NT 0835 7600), to approximately 150m downstream of the existing M9 culvert (NGR NT 0970 7590). The hydraulic model also includes a 750m stretch of the Craigton Burn to its confluence with the Swine Burn, as well as the Beatlie Channel from the culvert inlet under the Union Canal to the confluence with the Swine Burn between the Edinburgh-Glasgow railway line and Beatlie Road (B8020).

6.3.4 A 500 m buffer around the site has been used for the water quality and drainage assessment study area. Further downstream of this, sediment and pollutants are considered to be

[8] SEPA (2019) CAR – A Practical Guide, version 8.3, February 2019. Available at: https://www.sepa.org.uk/media/34761/car_a_practical_guide.pdf (Accessed 21 August 2019)

sufficiently dispersed and diluted, and other potential pollutant sources downstream of the proposed development are considered more likely to have a greater influence on water quality.

Desk Study / Field Survey

6.3.5 In addition to the consultation responses received, a range of other sources of data were used for the assessments, including:

- Winchburgh FUTURE Urban Expansion - Environmental Statement, Chapter 8 Hydrology and Hydrogeology (Carl Bro, August 2005);
- Winchburgh FUTURE Urban Extension Flood Risk Assessment (Carl Bro, 2005);
- river and hydraulic structure survey data obtained in 2005;
- topographic survey data (dated March 2019);
- 1m resolution LiDAR (Phase 2) data from the Scottish Remote Sensing Portal[9];
- National River Flow Archives database[10];
- Flood Estimation Handbook (FEH) online portal[11];
- Ordnance Survey (OS) MasterMap data;
- SEPA online Flood Maps[12];
- SEPA online classification data[13];
- British Geological Society (BGS) geology and hydrogeology mapping, including Groundwater Vulnerability Map of Scotland and Hydrogeological Map of Scotland (1:625,000 scale);
- a site walkover in May 2019 covering sections of the Swine Burn, Craigton Burn and Beatlie Channel, and information obtained from existing drainage surveys; and
- site investigations carried out in 2014 and 2019.

Hydrology and Flood Risk

6.3.6 The SEPA online Flood Maps provide indicative mapping of flood risk from a range of sources (including river, surface water and coastal flooding) and at a range of likelihoods (low, medium and high), and was used to initially review the existing flood risk in the area.

6.3.7 Hydraulic modelling was undertaken to refine the flood risk information available, in line with SEPA's Flood Modelling Guidance[14,15], and using relevant information from the 2005 FRA for the Winchburgh Masterplan.

[9] Scottish Remote Sensing Portal. Available at: https://remotesensingdata.gov.scot/collections (Accessed 21 August 2019)

[10] Centre for Ecology and Hydrology (CEH). National River Flow Archives database. Available at: https://nrfa.ceh.ac.uk/ (Accessed 21 August 2019)

[11] Centre for Ecology and Hydrology (CEH). Flood Estimation Handbook: FEH Web Service. Available at: https://www.ceh.ac.uk/services/flood-estimation-handbook-web-service (Accessed 21 August 2019)

[12] SEPA (2019). Flood Maps. Available at: http://map.sepa.org.uk/floodmap/map.htm (Accessed 21 August 2019)

[13] SEPA (2019). Water Environment Hub. Available at www.sepa.org.uk/data-visualisation/water-environment-hub/ (Accessed 21 August 2019)

[14] SEPA (undated). Flood Modelling Guidance for Responsible Authorities, Version 1.1. Available at: https://www.sepa.org.uk/media/219653/flood_model_guidance_v2.pdf (Accessed 21 August 2019)

[15] SEPA (2019). Technical Flood Risk Guidance for Stakeholders – SEPA requirements for undertaking a Flood Risk Assessment, version 12, May 2019, SS-NFR-P-002. Available at: https://www.sepa.org.uk/media/162602/ss-nfr-p-002-technical-flood-risk-guidance-for-stakeholders.pdf (Accessed 21 August 2019)

6.3.8 A 1D-2D model of the Swine Burn and its floodplain was created in InfoWorks ICM (version 9) software. The model contained a total of 134 cross-sections created using topographic survey data supplemented with 1m resolution LiDAR data. Information obtained from the 2019 survey and OS MasterMap data were used to ensure that roads and embankments were accurately captured in the model.

6.3.9 Hydraulic structures considered to have an impact on flow and flood risk within the area of interest were represented in the model; for the Swine Burn and Beatlie Channel these included various culverts, an inverted syphon under the Edinburgh-Glasgow railway line and a footbridge immediately downstream of the railway line. The inverts and dimensions of the culverts were informed by both the 2005 and 2019 surveys, as well as field observations.

6.3.10 The Manning's 'n' roughness values of the channel bed and banks were based on observations and photographs taken during the 2019 site walkover. The banks of the Swine Burn upstream of the Union Canal culvert were given a Manning's 'n' value of 0.055 to reflect the surrounding woodland and dense vegetation. The channel banks along the reaches of the Swine Burn downstream of the railway syphon were given a roughness of 0.04 to reflect the long grass vegetation. Similarly, the Beatlie Channel upstream of the railway aqueduct was given a channel and bank roughness of 0.04 to reflect the tall grass and scrubland covering both the bed and banks.

6.3.11 The Swine Burn is ungauged and therefore FEH catchment descriptors were used in the hydrological analysis. The overall catchment was divided into ten sub-catchments and associated inflow hydrographs were produced based on a review of the site topography and a simplified direct rainfall model. A climate change uplift of 35% was applied to the peak flows following SEPA's 2019 regional guidance on climate change[16].

6.3.12 For the post development scenario, the baseline model was amended to include the new access road crossing immediately upstream of the M9 embankment. The river reach upstream of the M9 was split into three sections with a cross-section inferred immediately upstream and downstream of the proposed access road crossing. The reach between the two new cross-sections was removed and replaced with a culvert link. The culvert was defined as rectangular, and of sufficient width and height to not impede flow and cause a hydraulic constriction.

6.3.13 The hydraulic model was run for the baseline (pre-development) and post-development scenarios up to the 0.5% Annual Exceedance Probability (AEP) (1 in 200 year) event plus 35% climate change uplift, providing information on:

- in-channel flows;
- flow velocities;
- and flood inundation depths and extents.

6.3.14 Flood maps are presented on Figures 6.2 and 6.3, for the pre- and post-development scenarios, respectively. More detailed information on methodology is presented in the FRA Report (Technical Appendix 6.2 in Volume 3).

Surface Water and Groundwater Quality

6.3.15 The water quality baseline assessment was informed by Water Framework Directive (WFD) data obtained from SEPA's Water Environment Hub[13]. Where no SEPA monitoring data was

[16] SEPA (2019). Land Use Planning System (LUPS-CC1) - Climate change allowances for flood risk assessment in land use planning, v1, April 2019. Available at: https://www.sepa.org.uk/media/426913/lups_cc1.pdf (Accessed 21 August 2019)

available for small watercourses, a review of current and historic surrounding land-uses was undertaken to infer water quality and any potential sources of pollution that could influence existing water quality. The known presence of protected habitats and species within the watercourses was also used as an indicator of water quality, using information from Chapter 7: Ecology and Nature Conservation.

6.3.16 Potential construction impacts were assessed qualitatively and using professional judgement, based on the type/nature of proposed construction works, and the sensitivity and indicative dilution capacity of the receiving waters (i.e. Swine Burn). The operational phase principally focused on potential effects of road drainage discharges from the proposed development, in line with the following DMRB HD45/09 procedures:

- DMRB Method A: Effects of Routine Runoff on Surface Waters – estimate the magnitude of potential short term and longer-term impacts on water quality of the Swine Burn associated with discharge of operational road drainage. This was undertaken using the Highways England Water Risk Assessment Tool (HEWRAT).
- DMRB Method D: Pollution Impacts from Accidental Spillages – estimate the probability of an accidental spillage from a heavy goods vehicle (HGV) leading to a serious pollution incident in the Swine Burn.

6.3.17 These DMRB methods informed the number and type of SuDS measures required to drain the new carriageway elements to protect the Swine Burn and has been discussed and agreed with SEPA. Detailed methodologies and calculations are provided in Technical Appendix 6.1 in Volume 3.

6.3.18 An assessment of the effects of routine runoff on groundwater (DMRB Method C) was not considered necessary as no drainage infiltration is proposed direct to the ground and the detention basins are proposed to be lined.

Groundwater

6.3.19 The groundwater baseline assessment was informed by SEPA online information and site investigation works carried out in 2014 and 2019. Water level data was obtained from the site investigations reflecting groundwater conditions beneath the proposed development.

6.3.20 Potential construction impacts were assessed qualitatively and using professional judgement, based on the type/nature of proposed construction works, and the sensitivity of the groundwater environment. This is in line with DMRB HD45/09 procedures.

6.3.21 The operational phase principally focused on potential effects of disruption to underlying groundwater from the proposed development in line with DMRB HD45/09 procedures.

6.3.22 Significance of effect is a function of the sensitivity (value/importance) of a receptor and the magnitude of potential impact. Tables 6.2 to 6.4 are based on DMRB HD45/09 criteria and were used to guide the assessment.

6.3.23 Receptor sensitivity was categorised on a scale of 'low' to 'very high', using professional judgement guided by the criteria provided in Table 6.2.

Table 6.2: Baseline Sensitivity Criteria

Importance	Criteria	Typical Examples
Very High	Attribute has a high quality and rarity on	Hydrology and Flood Risk: Floodplain containing, or defence protecting, more than 100 residential or non-residential properties

Table 6.2: Baseline Sensitivity Criteria		
Importance	**Criteria**	**Typical Examples**
	regional or national scale	from flooding. Floodplain containing critical civil infrastructure, e.g. hospitals, schools, care homes, emergency service stations. Surface Water and Groundwater Quality: WFD physico-chemical status of 'High', specific pollutants status of 'Pass'. No identified pollutant pressures. Habitats and/or species protected under EU legislation (e.g. Special Area of Conservation (SAC), Special Protection Area (SPA), Ramsar site). Designated salmonid waters under WFD. Groundwater Supply: Aquifer providing a regionally important resource or supporting site protected under EU and UK habitat legislation.
High	Attribute has a high quality and rarity on local scale	Hydrology and Flood Risk: Floodplain containing, or defence protecting, 11-100 residential or non-residential properties from flooding. Floodplain containing locally important civil infrastructure, e.g. electrical sub-stations, major roads and railway lines. Surface Water and Groundwater Quality: WFD physico-chemical status of at least 'Good' or 'Good Ecological Potential' (if heavily modified or artificial). Specific pollutants status of 'Pass'. None or very limited pressures identified. Habitats and/or species protected under EU or UK legislation including Sites of Special Scientific Interest (SSSI). Designated salmonid/cyprinid waters under WFD. Groundwater Supply: Aquifer providing locally important resource or supporting river ecosystem.
Medium	Attribute has a medium quality and rarity on local scale	Hydrology and Flood Risk: Floodplain containing, or defence protecting, 10 or fewer residential or non-residential properties from flooding. Floodplain containing limited civil infrastructure, such as minor roads. Surface Water and Groundwater Quality: WFD physico-chemical status of at least 'Moderate' or 'Moderate Ecological Potential'. Specific pollutants status of 'Pass' or not classified by SEPA. Water quality likely to be affected by pollutant inputs or other pressures. Could support a limited number of protected habitats or species. Groundwater Supply: Aquifer which is of limited value because the water quality does not allow potable or other quality sensitive uses, exploitation may be for agricultural or industrial use but is not extensive; limited connection to surface water and may provide some support to local site of nature conservation interest.
Low	Attribute has a low quality and rarity on local scale	Hydrology and Flood Risk: Floodplain without residential and non-residential properties, and floodplain containing no civil infrastructure. Surface Water and Groundwater Quality: WFD physico-chemical status of at least 'Poor' or 'Poor Ecological Potential' or 'Bad'. Specific pollutants status of 'Fail' or not classified by SEPA. Water quality highly likely to be affected by pollutant pressures. Supports no protected habitats or species. Likely to be heavily modified and with intermittent flow, such as road and field drains. Groundwater Supply: Unproductive strata, with no known past or existing exploitation and not providing baseflow to rivers or supporting a site of nature conservation interest.

6.3.24 The quantity and quality of drainage generated by new development surfaces has the potential to impact upon flood risk and water quality in the study area. Table 6.3 provides criteria for evaluating the magnitude of potential impact and includes consideration of the effects of altered drainage behaviour upon flood risk and water quality, rather than presenting separate drainage-specific criteria.

Table 6.3: Magnitude of Impact Criteria		
Magnitude	**Criteria**	**Typical Examples**
High	Results in loss of attribute and/or quality and integrity of the attribute; or results in major improvement of attribute quality	Hydrology and Flood Risk: Increase or decrease in peak flood level greater than 100mm and/or increased or decreased risk of flooding to more than 100 residential/commercial properties. Significant changes to the existing flow regime as a result of extensive changes to catchment and/or construction footprint. Water Quality: Serious pollution risks from multiple in-channel works resulting in substantial/irreversible deterioration of the quality of existing water and effect on aquatic ecology. Major shift away from baseline conditions. Failure of both soluble and sediment-bound pollutants in HEWRAT and compliance failure with EQS values. Calculated risk of pollution from a spillage >2% annually. Or removal of existing polluting discharge, or removing the likelihood of polluting discharges occurring to a watercourse. Groundwater Supply: Loss of, or extensive change to, an aquifer.
Medium	Results in effect on integrity of attribute, or loss of part of attribute; or results in moderate improvement of attribute quality	Hydrology and Flood Risk: Increase or decrease in peak flood level greater than 50mm and/or increased or decreased risk of flooding to 11-100 residential/commercial properties. Moderate changes to the existing flow regime as a result of changes to catchment and/or construction footprint. Water Quality: Pollution risks from in-channel works or works in close proximity to bank resulting in partial deterioration in the quality of existing water and effect on aquatic ecology. Moderate shift away from baseline conditions. Failure of both soluble and sediment-bound pollutants in HEWRAT but compliance with EQS values. Calculated risk of pollution from a spillage >1% annually and <2% annually. Or moderate reduction of existing polluting discharge resulting in partial improvement in quality of existing water. Groundwater Supply: Partial loss or change to an aquifer.
Low	Results in some measurable change in attribute's quality or vulnerability; or results in some beneficial effect or a reduced risk of negative effect occurring	Hydrology and Flood Risk: Slight changes to the flow regime. Increase or decrease in peak flood level greater than 10mm and/or increased or decreased risk of flooding to less than 10 residential/commercial properties. Water Quality: Minor shift away from baseline conditions. Measurable deterioration in the quality of the water resulting from in-channel or bankside works but of limited duration and extent with only slight effects on aquatic ecology. Failure of either soluble or sediment-bound pollutants in HEWRAT. Calculated risk of pollution from a spillage >0.5% annually and <1% annually. Or minor reduction of existing polluting discharge resulting in slight/perceptible improvement in quality of existing water. Groundwater Supply: Potential medium risk of pollution to groundwater from routine runoff. Minimal loss or change to an aquifer.
Negligible	Results in effect on attribute, but of insufficient magnitude to affect	Hydrology and Flood Risk: Negligible change in peak flood level (less than 10mm) and no measurable change to existing flow regime.

Table 6.3: Magnitude of Impact Criteria		
Magnitude	**Criteria**	**Typical Examples**
	the integrity of the water environment	Water Quality: Imperceptible change to water quality or aquatic ecology. No risk identified by HEWRAT (Pass both soluble and sediment-bound pollutants). Risk of pollution from a spillage <0.5%. Groundwater Supply: No measurable impact upon an aquifer.

6.3.25 The significance of potential impacts (pre-mitigation) and residual effects (post-mitigation) were considered and evaluated during both the construction and operational phases of the proposed development. As per DMRB HD45/09 guidance, where there are two alternatives provided in Table 6.4, a single significance rating was chosen based on professional judgement. To note, impact magnitude and significance can be beneficial as well as adverse.

6.3.26 For the purposes of this chapter and assessment, all Major and Moderate effects are considered to be 'significant' and all Minor and Negligible effects are 'not significant' in EIA terms.

Table 6.4: Significance of Potential Effects Matrix				
Magnitude / Sensitivity	**Negligible**	**Low**	**Medium**	**High**
Low	Negligible	Negligible	Minor	Minor/Moderate
Medium	Negligible	Minor	Moderate	Moderate/Major
High	Negligible	Minor/Moderate	Moderate/Major	Major
Very High	Negligible	Moderate/Major	Moderate/Major	Major

6.4 Baseline Conditions

6.4.1 This section includes a description of current baseline conditions, along with a statement on future baseline conditions under the "do nothing" scenario.

Current Baseline

Hydrology

6.4.2 Swine Burn has a catchment area of approximately 10km^2 and is a tributary of the River Almond. The watercourse is approximately 8km in length and flows in a south-easterly direction through a predominantly rural catchment. The Swine Burn originates from Mounthooly, passing through a groundwater-fed pond then flows parallel to the Union Canal until it passes eastward under the canal just north of Winchburgh. It then flows under two railway embankments and two roads (B8020 and M9 carriageway), before flowing into the River Almond in Kirkliston. Where the Swine Burn flows under the Edinburgh-Glasgow railway line, flood water from the cutting to the south is pumped into the burn on the downstream side of the railway.

6.4.3 Approximately 100m downstream of the M9 carriageway crossing there is a disused quarry in Swineburn Wood, which is currently used as a fishery (Fishery XL; formerly Hopetoun Fishery). The fishery is stocked with trout species. Approximately 1km downstream of the M9 carriageway, the Swine Burn flows into the larger Humbie Reservoir, which has a surface area of approximately 30,000m^2.

6.4.4 The Swine Burn is shallow and has a narrow channel, artificially maintained for the purpose of agricultural field drainage, and contains significantly overgrown riparian and submerged vegetation. The burn has little evidence of natural morphology and is artificially straightened along much of its length. The channel typically conveys a low baseflow throughout most of the year, the erosion potential being very low under normal conditions and has a channel width generally less than 2m.

6.4.5 The Swine Burn flows under the M9 carriageway through a twin box concrete culvert. The River Almond is the nearest natural SEPA-monitored watercourse to the site, located over 3km to the south-east.

6.4.6 The Union Canal flows from near Linlithgow, passing directly north of Winchburgh where it changes course and runs south through the centre of the town, before moving on to Broxburn to the south.

6.4.7 The Beatlie Channel drains arable land to the north-west of Winchburgh with overflows from a pond north of the town. Excess water in the Edinburgh-Glasgow railway cutting is pumped into the burn before it runs northwards into the Swine Burn.

Flood Risk

6.4.8 SEPA's online flood maps identify areas either side of the M9 motorway with a medium likelihood (1 in 200 year return period) of river (fluvial) and surface water (pluvial) flooding. There is also a potential risk of flooding from surface water shown for isolated areas of the M9 carriageway in the vicinity of the study area.

6.4.9 Baseline information relevant to the proposed development from the previous 2005 FRA for the full Winchburgh Masterplan area included:

- Upstream of the Union Canal, a 200m extent of the Swine Burn floods an adjacent low-lying area due to insufficient capacity of the culvert under the canal. It was considered likely that in the upper reaches of the Swine Burn, overtopping into the Union Canal would occur during flood events.
- The Swine Burn flows into the Humbie Reservoir, east of the M9, which would act to attenuate flows in the Swine Burn and minimise the risk of flooding downstream.
- Due to the rural nature of the site, there are limited records of previous flooding. One resident noted that during a storm event in January 2005, the water level within the Swine Burn was approximately 700mm below the soffit of the triple culvert bridge, upstream of the discharge point from the Beatlie Channel. The resident also noted that there was no flooding observed from the burn downstream of the Union Canal. This flood event was estimated to be equivalent to a 3.33% AEP (1 in 30 year) storm.
- During the 2005 storm event, flooding was observed from the Beatlie Channel into the adjacent clay pit. Based on local observations, the Craigton Burn has been known to overtop and discharge into the Union Canal within its upper reaches during flood events.

6.4.10 More up to date baseline information obtained from site surveys and baseline hydraulic modelling identified the following:

- During the design flood event, flood waters spill over the north bank of the Swine Burn towards the Union Canal but does not flow into the Union Canal itself.

- The Union Canal culvert suffers from significant sedimentation, which likely affects flows downstream. One of the twin culverts immediately downstream of the canal was also observed to be approximately 50% blocked.

6.4.11 The hydraulic modelling predicts flooding along both banks of the Swine Burn upstream of the Union Canal culvert for the 0.5% AEP (1 in 200 year) event (with 35% climate change allowance). Flooding in this location relates to the lack of capacity within the Union Canal culvert and the sedimentation observed during the 2019 site visit. This lack of capacity throttles flows, resulting in water backing up upstream of the culvert. The extent of flooding is however limited by the sloping topography adjacent to the western bank of the watercourse as well as the canal embankment. Flooding was also predicted along the Swine Burn upstream of Beatlie Road, as well as between the second railway and M9 culverts. This was found to relate to low points along the channel banks, resulting in overspill onto the adjacent floodplain, rather than insufficient capacity of these culverts. The predicted floodplain peak depth between the second railway culvert and the M9 was 0.11m in the baseline scenario.

6.4.12 Flooding was also predicted along both banks of the Beatlie Channel which flows onto the Edinburgh-Glasgow railway line, and into the clay pit to the south.

6.4.13 The extent and depth of baseline flooding in the study area is shown on Figure 6.2. Refer to Technical Appendix 6.2 (FRA Report in Volume 3) for more information on baseline.

Water Quality

6.4.14 The water quality of the Swine Burn is not monitored by SEPA. However, the burn is heavily modified and culverted, and runs through a predominantly rural catchment, and could therefore receive diffuse nutrient-rich or silt-laden runoff from agriculture. It is also crossed by roads, including the M9 and B8020, and two railway lines and could receive routine runoff and contaminants from these sources.

6.4.15 SEPA's Water Environment Hub[13] indicates that the section of the River Almond at the Swine Burn confluence (SEPA ID: 3000; Maitland Bridge to Cramond) is classified as having an overall condition of "Poor Ecological Potential". The water body has been designated as a heavily modified water body on account of physical alterations that cannot be addressed without a significant impact on an airport or major transport route and the drainage of agricultural land. However, the River Almond has local protected habitats and supports European otter (*Lutra lutra)*, which is a European protected species.

6.4.16 The SEPA data also indicates that the section of the Union Canal (SEPA ID: 8, reach Craigton to Murray Burn) closest to the site is classified as having an overall status of "Good Ecological Potential". Water voles (*Arvicola amphibius)* (also a protected species under the Wildlife and Countryside Act 1981 (as amended)[17]) have been recorded along the Union Canal, which has high connectivity with the River Almond (refer to Chapter 7: Ecology and Nature Conservation for more information).

6.4.17 As stated in the methodology section, a 500 m buffer around the site has been used for the water quality study area, as further downstream of this, sediment and pollutants resulting from the proposed development are considered to be sufficiently dispersed and diluted to not cause a significant adverse effect. The Humbie Reservoir is approximately 1km downstream of the M9 carriageway and has therefore been scoped out of the assessment.

[17] HMSO (1981). Wildlife and Countryside Act 1981 (as amended)

Groundwater

6.4.18 The Hydrogeological Map of Scotland (1:625,000 scale) and online SEPA mapping[18] indicates that the site is situated above a "moderately productive aquifer" in which "…flow is virtually all through fractures and other discontinuities".

6.4.19 The Groundwater Vulnerability Map of Scotland[19] (1:625,000 scale) shows that the site is underlain by "moderately permeable" bedrock, which is noted to "…seldom produce large quantities of water for abstraction" but is "…important for local supplies and for supplying base flow to rivers". The map additionally notes that there are superficial deposits overlying the solid geological strata that may be substantial in thickness, although may be of variable permeability.

6.4.20 The online SEPA mapping[13] indicates that the underlying groundwater 'Livingston' (SEPA ID: 150711) had an overall status of "Poor" from 2012-2017. This is predominantly as a result of poor chemical status, which is understood to be due to a mixture of pressures in the region such as mining.

6.4.21 Information on public and private water supplies in the surrounding area was requested from WLC (email 22nd November 2019). An excel spreadsheet of registered private water supplies was provided by WLC (email of 27th November 2019) and confirmed no registered public or private water supplies within 3km of the proposed development.

6.4.22 Information on authorised private water supplies in the surrounding area was also requested from SEPA (email 19th November 2019). SEPA's response (9th December 2019) indicated there were no abstraction authorisations within 500m of the proposed development.

6.4.23 The site investigations confirmed varying depths of Glacial Till beneath the proposed development of between 1.2 metres below ground level (mbgl) and greater than 25mbgl. These deposits consist generally of sandy clay and overlie weathered mudstone bedrock.

6.4.24 Water level data obtained from site investigations showed that groundwater was encountered in both superficial and bedrock. Along the proposed eastbound diverge route, groundwater was not encountered in the majority of boreholes. Recorded strike depths vary between 1.6mbgl and 2.6mbgl in shallow weathered bedrock and between 1.3mbgl and 8.6mbgl in superficial materials. Monitored groundwater levels generally range from 0.9mbgl and 2.4mbgl (with a deeper level of 9.2mbgl recorded within superficial deposits at one location). Along the eastbound merge route, groundwater strikes were recorded at the majority of borehole locations with depths ranging from 1.8mbgl to 15mbgl in bedrock and from 0.7mbgl to 12.6mbgl in superficial deposits. Monitored groundwater levels range between 0.7mbgl and 2.9mbgl.

6.4.25 Shallow groundwater within superficial deposits beneath the proposed development is considered as perched within predominantly low permeability sandy clay deposits. Local groundwater flow is likely only to be present within limited granular materials, which do not appear to be consistent beneath the proposed development. Shallow groundwater was also encountered within shallow broken bedrock at some locations.

[18] SEPA (2018). Scotland's Environment Web. Available at: https://www.environment.gov.scot/maps/scotlands-environment-map/ (Accessed 12 September 2018)

[19] British Geological Society (2018). BGS hydrogeology 625,000 scale. Available at: http://www.bgs.ac.uk/products/hydrogeology/maps.html (Accessed 12 September 2018)

6.4.26 Local groundwater flow is likely to be east towards the Swine Burn, with regional groundwater flow expected to be towards the north or north-east in the direction of the Firth of Forth, which is consistent with the findings of site investigations undertaken as part of the wider Winchburgh Masterplan development.

Drainage

6.4.27 The majority of the site comprises agricultural land and the existing M9 carriageway. Areas comprising natural pervious soil surfaces drain via infiltration for typical rainfall events.

6.4.28 The Swine Burn is generally narrow and shallow in nature, and like other watercourses in the surrounding area, collects surface runoff from surrounding agricultural land. There are typically low baseflows throughout most of the year.

6.4.29 No road drainage currently exists on the B8020 and surface water simply drains directly into the carriageway grass verge. Surface runoff on the existing M9 motorway is currently drained by:

- filter drain;
- kerb and gully into carrier drain;
- direct outfalls; and/or
- a combination of the above.

6.4.30 The surface water is then conveyed into ditches/swales at the bottom of the embankment slopes on either side of the M9 motorway. These convey from west to east, through existing culverts under the B8020, and eventually outfall into the Swine Burn.

Baseline Summary

6.4.31 Table 6.5 summarises the sensitivity of the water bodies in the vicinity of the site.

Table 6.5: Sensitivity of Water Bodies

Water Body	Attribute	Quality	Sensitivity
Swine Burn	Hydrology and Flood Risk	Flooding predicted upstream of Union Canal culvert, immediately upstream of Beatlie Road culvert and between the second railway culvert and M9. Floodplain consists of agricultural land/woodland only and no sensitive receptors in area of interest. Motorway, railway lines and settlements in close proximity, although not directly impacted by flooding from Swine Burn. Humbie Reservoir provides a hydraulic control downstream of M9.	Medium
	Water Supply/ Quality	WFD status: not monitored. Rural catchment and may receive agricultural runoff and contaminants in road drainage.	Medium
River Almond	Hydrology and Flood Risk	Not applicable (outside of modelled study area)	N/A
	Water Supply/ Quality	WFD Overall status 'Poor Ecological Potential' (heavily modified water body). Local protected habitats and supports otter and water vole.	Medium
Union Canal	Hydrology and Flood Risk	Not applicable (outside of modelled study area)	N/A
	Water Supply/ Quality	WFD Overall status 'Good Ecological Potential' (artificial water body). Supports water vole.	Medium

Table 6.5: Sensitivity of Water Bodies			
Water Body	**Attribute**	**Quality**	**Sensitivity**
Groundwater	Groundwater Quality	Livingston groundwater body WFD overall status 'Poor'.	Medium

6.4.32 As the Union Canal is upstream of the site it is considered unlikely that it would be impacted by the proposed development. The River Almond is also more than 3km downstream of the proposed works, and therefore it could be reasonably assumed that any silt-laden runoff or pollutants entering the Swine Burn during either construction or operation of the proposed development would be sufficiently diluted and dispersed to have any perceptible effect on this downstream watercourse. As a result, the following assessment of effects has focused only on the hydrology, flood risk and water quality of the Swine Burn.

Future Baseline ('Do Nothing' scenario)

6.4.33 The 2012 Department for Environment, Food & Rural Affairs (Defra) 'UK Climate Change Risk Assessment' report[20] categorises the changes anticipated in the UK as a result of climate change and how these might affect different receptors. Key points relevant to the water environment are:

- pressure on water resources as a result of reduced summer rainfall;
- greater variability in the availability of water;
- warming of watercourses and water bodies with indirect effects on biodiversity; and
- increased frequency of droughts and low water levels leading to increased concentrations of pollutants resulting in damage to aquatic ecosystems.

6.4.34 Applying the above climate effects to baseline features in the vicinity of the site could result in:

- Swine Burn (and nearby watercourses) may suffer from more irregular flow and water levels, resulting in adverse effects on flood risk, water quality and aquatic ecology.
- Droughts may affect surrounding soil quality and vegetation cover resulting in either greater infiltration or increased silt-laden runoff to watercourses from exposed surfaces.
- Increased rainfall intensities may increase silt loads in watercourses as a result of increased overland flow. However, any adverse impacts on water quality may be offset by increased river flows and higher pollutant dilution capacities.

6.4.35 Additionally, the 2018 National Planning Policy Framework (NPPF)[21] identifies that rainfall intensities are expected to increase by up to 30% as a result of climate change, whilst peak river flows are expected to increase by up to 20% over the next 100 years. This emphasises the need for climate change resilience measures for flood defences. As stated in Section 6.3 (Assessment Methodology: Hydrology and Flood Risk), based on 2019 SEPA guidance, a 35% uplift has been applied to peak flows to account for climate change for the proposed development.

[10] Department for Environment, Food & Rural Affairs (Defra), 2012. UK Climate Change Risk Assessment: Government Report 2012. Available at: https://www.gov.uk/government/publications/uk-climate-change-risk-assessment-government-report (Accessed 10 August 2018)

[11] Ministry of Housing, Communities & Local Government, 2018. The National Planning Policy Framework. Available at: https://www.gov.uk/government/publications/national-planning-policy-framework--2 (Accessed 10 August 2018)

6.5 Assessment of Potential Effects

6.5.1 This section describes the potential effects on the water environment, in the absence of mitigation, during the construction and operational phases of the proposed development. These impacts are generally temporary in nature. Details of the proposed development are provided in Chapter 2: Proposed Development Description in Volume 2.

6.5.2 Mitigation to avoid, reduce or offset any significant potential effects identified are provided in Section 6.7 (Mitigation).

6.5.3 The new access road upstream of the M9 culvert crosses the Swine Burn and will therefore require the installation of a new box culvert, spanning both banks of the burn so as not to constrict flows.

6.5.4 The design for the proposed development includes cutting sections along the eastbound diverge route of up to 3.6m in depth. The eastbound merge route requires removal and replacement of existing materials up to approximately 3m in depth.

Construction Effects

Hydrology and Flood Risk

- Soil compaction from works traffic may reduce soil infiltration capabilities and increase surface water runoff from temporary access routes, construction compounds and other temporary works areas. This has the potential to increase localised ponding and/or lead to uncontrolled discharge to the Swine Burn.
- Temporary increase in fluvial flood risk as a result of construction activity occurring in the floodplain, particularly during large rainfall events. Construction plant/materials may increase risk of flooding by causing a flow restriction or blockage if not properly secured during flood events.
- Culvert construction for the access road over the Swine Burn will likely require a channel diversion and/or temporary cofferdam with over-pumping to provide a dry working area for construction. This could result in temporary narrowing of the channel and constriction in flow conveyance, resulting in short-term changes to existing flow patterns and velocities.
- Discharge of construction site drainage may have an impact on the flow and sediment regime of the Swine Burn, and in turn affect channel capacity and flow conveyance downstream.
- Inadequate or inappropriate temporary drainage provision may increase surface water (pluvial) flood risk.

6.5.5 Overall, potential impacts during construction on hydrology and flood risk of the Swine Burn (medium sensitivity) are predicted to be of medium magnitude and Moderate significance.

Surface Water and Groundwater Quality

6.5.6 There is greatest potential for silt-laden runoff and pollution of the water environment during the construction phase. Construction activities which present a risk to surface water and indirectly groundwater quality include: soil-stripping and stockpiling, vegetation removal, earthworks and excavations, and construction plant operating in or near the channel, and could result in:

- Sediment release and silt-laden runoff entering the Swine Burn, adversely impacting water quality and aquatic ecology from culvert and drainage outfall construction.
- Accidental release/spillage of oils, fuels and chemicals from mobile and stationary plant directly into the watercourse or contained within runoff from culvert and outfall construction.
- Insufficient temporary drainage provision may result in the discharge of untreated or inadequately treated runoff into the Swine Burn.
- Increased effects of pollution and sediment on water quality and aquatic ecology in smaller watercourses with limited ability to dilute and disperse pollutants and during low flow conditions.

6.5.7 Overall, potential impacts during construction on water quality of the Swine Burn and groundwater (medium sensitivity) are predicted to be of high magnitude and Moderate significance.

Groundwater

6.5.8 Shallow groundwater was encountered beneath the proposed development at depths of 1.3mbgl and up to 15mbgl within superficial materials and bedrock. Earthworks for the proposed construction work involves removal of materials up to 3.6m depth which is likely to encounter small quantities of shallow groundwater. Therefore, temporary groundwater abstractions are anticipated during construction.

6.5.9 Potential impacts during construction on groundwater (medium sensitivity) are predicted to be of low magnitude and Minor significance.

Operational Effects

Hydrology and Flood Risk

- Increased permanent hardstanding/impermeable areas within the Swine Burn catchment could result in an increase in surface runoff (volume and intensity) to the burn, and subsequent increase in flood risk.
- Culverts and channel realignments can affect the flow behaviour of a channel. Undersized structures can constrict flows increasing flood levels upstream. Channel realignment resulting in shorter channels can result in steepening of the channel gradient leading to faster flows downstream.
- Watercourses receiving operational road drainage can alter the catchment response to storm events, which may become 'flashier' and thereby increasing flood risk and stream power downstream if there is no suitably designed SuDS to attenuate runoff.
- A lack of maintenance of the drainage system and SuDS features can increase the risk of blockage and flooding to surrounding areas.

6.5.10 The results of the Swine Burn post development modelling indicated an overall reduction in the flood extent and volume between the second railway culvert and the M9 motorway carriageway for the design flood event. This is due to the low point in the channel, where floodwaters previously spilled onto the floodplain, being filled in by the new access road culvert structure and therefore containing a greater proportion of flows in-channel in the post-development scenario.

6.5.11 The predicted floodplain peak depth in the post-development scenario between the second railway culvert and the M9 is 0.098m (a reduction of 0.012m compared to the baseline scenario of 0.11m depth) with a corresponding reduction in flood extent. The extent and depth of flooding in the post-development scenario, compared to the baseline scenario, is shown on Figure 6.3 in Volume 4. Refer to Technical Appendix 6.2 (FRA Report, Volume 3) for more information on potential effects.

6.5.12 This results in an impact magnitude of 'low beneficial' and therefore an impact of Minor beneficial significance on the Swine Burn (medium sensitivity) for hydrology and flood risk.

Surface Water and Groundwater Quality

6.5.13 There is a risk of contaminants being carried in routine runoff from road surfaces to the Swine Burn and infiltrating to groundwaters. Runoff from road surfaces can contain a wide range of pollutants including metals, suspended solids and contaminants bound to them, organic compounds (such as oils and other hydrocarbons), biodegradable organic material (such as grass cuttings) and de-icing agents. These contaminants can adversely affect water quality and aquatic ecology.

6.5.14 An increase in traffic volumes in the design opening year and beyond will increase the likelihood of pollutant build up on road surfaces and risk of accidental spillages discharging to the Swine Burn and infiltrating into groundwater.

6.5.15 Risk of sub-optimal performance of the road drainage network, due to blockages and sediment build up reducing the capacity and effectiveness of the drainage systems to convey, attenuate and treat runoff.

6.5.16 The routine runoff and accidental spillage risk assessment indicated that:

- The two drainage discharges returned a 'Fail' result at Step 1, as this is for concentrated pollutants in road runoff before mixing (and dilution) in the Swine Burn (i.e. worse case). The results indicate that all soluble pollutants return a 'Pass' result at Step 2 against published thresholds (with in-river mixing prior to any mitigation measures in place).
- The in-combination outfall assessment highlighted a 'Fail' result at Step 2 for sediment-bound pollutants, but a 'Pass' result for all soluble pollutants against published thresholds at Step 2, prior to mitigation.
- Spillage risk is well within acceptable thresholds (1:100 year return period) when considering each outfall in isolation and the combined assessment.

6.5.17 Detailed HEWRAT outputs are presented in Section 6.1.4 of Technical Appendix 6.1 in Volume 3. Overall during operation of the proposed development, the unmitigated impacts associated with routine runoff and spillage risk to the Swine Burn (medium sensitivity) and underlying groundwater (medium sensitivity) are predicted to be of low magnitude and Minor significance.

Groundwater

6.5.18 Reduced ground levels along the route may impact shallow groundwater in the surrounding area.

6.5.19 Potential impacts during operation on groundwater (medium sensitivity) are predicted to be of low magnitude and Minor significance.

6.6 Assessment of Cumulative Effects

6.6.1 There are not considered to be any other developments likely to contribute a cumulative effect on RDWE topic receptors alongside the proposed development. Therefore, no assessment of cumulative effects is included here.

6.7 Mitigation

6.7.1 The following mitigation measures will be implemented to avoid, reduce or offset potential significant impacts predicted in Section 6.5 (Assessment of Potential Effects), during construction and operation of the proposed development.

Mitigation during Construction

6.7.2 Prior to construction, the appointed Contractor will be required to prepare a detailed Construction Environmental Management Plan (CEMP) to be approved by SEPA, describing methods and techniques to be employed during construction to ensure compliance with legislation, best practice and legally-binding mitigation measures identified in this chapter and other chapters of the EIAR.

6.7.3 The CEMP will contain information on pollution control and emergency response/procedures in the event of a pollutant spillage, adhering to SEPA's Guidance for Pollution Prevention series[22] (GPP) 21: Pollution Incident Response Planning, and GPP22: Dealing with spills.

6.7.4 The Contractor will be required to prepare Construction Method Statements to be approved by SEPA prior to construction commencing for construction works which pose a risk to the water environment. This will include activities such as culvert construction on the Swine Burn and any associated diversion/over-pumping required to create dry working conditions and minimise risk of sediment mobilisation and temporary flooding.

6.7.5 Installation of the new culvert will be undertaken during low flow conditions to minimise risk of pollution and sediment release, and the length of channel disturbed will be minimised as much as possible.

6.7.6 Drainage outfalls will be positioned in the river bank to limit the potential for scour around the outfall headwall, following SEPA's guidance on outfalls[23].

6.7.7 The Contractor will be required to adhere to SEPA and CIRIA best practice guidance[24,25] to manage and reduce the risk of water pollution and sediment release during construction activities including SEPA's GPP5 (Works and maintenance in or near water) and PPG6 (Working at construction and demolition sites) for managing concrete operations near surface waters.

[22] SEPA's Guidance for Pollution Prevention (GPP) series is in the process of replacing the original Pollution Prevention Guidelines (PPGs) Available at: http://www.netregs.org.uk/environmental-topics/pollution-prevention-guidelines-ppgs-and-replacement-series/guidance-for-pollution-prevention-gpps-full-list/ (Accessed 21 August 2019)

[23] SEPA, 2008. Engineering in the Water Environment Good Practice Guide: Intakes and outfalls, WAT-SG-28, First edition, October 2008 [online]. Available at: https://www.sepa.org.uk/media/150984/wat_sg_28.pdf (Accessed 21 August 2019)

[24] SEPA (2008). WAT-SG-23: Bank Protection Rivers and Lochs, 1st edition, April 2008. Available at: https://www.sepa.org.uk/media/150971/wat_sg_23.pdf; SEPA (2009). WAT-SG-29: Temporary Construction Methods, 1st edition, March 2009. Available at: http://www.sepa.org.uk/media/150997/wat_sg_29.pdf; SEPA (2010). WAT-SG-25: River Crossings, 2nd edition, November 2010. Available at: https://www.sepa.org.uk/media/151036/wat-sg-25.pdf; SEPA (2010). WAT-SG-26: Sediment management, 1st edition, June 2010. Available at: http://www.sepa.org.uk/media/151049/wat-sg-26.pdf

[25] CIRIA (1997). R142: Control of pollution from highway drainage discharges; CIRIA (2006a). C648: Control of water pollution from linear construction projects: technical guidance; CIRIA (2006b). C649: Control of water pollution from linear construction projects: site guide; CIRIA (2007). C698: Site handbook for the construction of SUDS; CIRIA (2010). C689: Culvert design and operation guide; CIRIA (2015). C753: The SuDS Manual

6.7.8 The Contractor will be required to implement temporary SuDS to provide treatment and attenuation of runoff from the site prior to discharge to surface waters. A network of pre-earthwork drainage (PED) ditches will be constructed at the toe of embankments and top of cuttings to collect and convey surface silt-laden runoff to temporary SuDS measures or clean runoff to surface waters.

6.7.9 In addition, suitable control measures for construction site runoff and sedimentation will include silt/sediment fences and bunds, and cut-off ditches may be required around stockpiles to route any contaminated sediment/materials to temporary SuDS prior to outfall. The Contractor will limit the extent of soil stripping and tree clearance as far as practical during preparatory works and topsoiling/re-seeding will be undertaken as soon as possible after earthworks are completed to reduce potential for sediment runoff. Temporary drainage systems will also help alleviate localised flood risk and prevent obstruction of surface runoff pathways.

6.7.10 The Contractor will sign up to SEPA's Floodline system to receive early warning flood updates. Appropriate action will be taken in the event of predicted heavy rainfall to protect unsecured materials/plant and items located in site compounds or around site to prevent their movement or release. Plant and materials will be stored in safe areas out with the floodplain where practicable.

6.7.11 Topsoil and material stockpiles will be bunded/covered as appropriate to reduce potential for wind-blown debris and silt-laden runoff entering surface waters. Stockpiles will be located in controlled areas (e.g. construction compound) and cement mixing, plant/wheel washing and refuelling activities will be undertaken on impermeable surfaces at least 10m from the Swine Burn and other open drains in line with SEPA's GPP5 (Works and maintenance in or near water).

6.7.12 Sewage from site facilities will be disposed of appropriately either to the foul sewer, with the permission of Scottish Water, or appropriate treatment and discharge agreed with SEPA in advance of construction and in accordance with GPP4: Treatment and disposal of wastewater where there is no connection to the public foul sewer.

6.7.13 The Contractor will be required to apply for CAR authorisation for certain activities which require regulation by SEPA. For the proposed development this is likely to include:

- road drainage via SuDS to the Swine Burn;
- new culvert on the Swine Burn;
- road cuttings (and temporary works) intercepting groundwater resulting in groundwater abstraction. All construction works associated with this activity will follow SEPA's CAR guidance[8], adhering to CAR General Binding Rule (GBR) 15; and
- a construction site licence, which will include a Pollution Prevention Plan (PPP) containing robust measures to deal with surface water runoff from the construction site to the satisfaction of SEPA.

6.7.14 Best practice measures associated with storage of oils and fuel will be followed in compliance with CAR General Binding Rules (GBR) 26 and 28 in SEPA's CAR Practical Guide.

6.7.15 The requirements for water quality monitoring pre, during and post construction will be discussed and agreed with SEPA.

Mitigation during Operation

6.7.16 The new access road culvert on the Swine Burn will include a bed layer to provide a more natural channel bed through the culvert following SEPA guidance[26].

6.7.17 Surface runoff from the permanent road infrastructure will be conveyed to SuDS, where it will be attenuated and treated prior to outfall to the Swine Burn. The proposed drainage design includes two levels of treatment ('treatment train') in the form of:

- filter drains; and
- a lined detention basin on either side of the carriageway.

6.7.18 The indicative pollutant risk reduction factors associated with these SuDS is presented in Table TA6.1.1 of Technical Appendix 6.1 in Volume 3. The proposed drainage layout, including the SuDS provision for the proposed development has also been discussed and agreed with SEPA during a meeting in May 2018, and subsequently accepted by both Transport Scotland and WLC during respective meetings. The drainage layout for the proposed motorway junction is shown on Figure 6.4 in Volume 4.

6.7.19 The detention basins will be designed to attenuate and store the 0.5% AEP (1 in 200-year return period) flood event discharge, plus a 20% allowance for climate change, from the proposed development, and outfall at the 1 in 2-year Greenfield (pre-development) runoff rate. Both detention basins will have vehicular maintenance access provided.

6.7.20 The southern detention basin will outfall to a ditch, whereas the detention basin located north of the M9 will outfall to a conveyance pipe. The ditch is located so that it will also collect the surface runoff from the embankment slopes of the motorway. These pipes/ditches will convey the basin discharge and existing mainline carriageway runoff to the Swine Burn.

6.7.21 The SuDS detention basins will be lined with an impermeable layer to prevent groundwater infiltration and therefore directing all carriageway drainage to the Swine Burn.

6.7.22 The road drainage network and treatment systems will be maintained and periodically inspected by Transport Scotland (trunk road extents) and WLC (local road extents), respectively, to avoid failure and reduce the risk of sub-optimal performance, blockage and flooding.

6.8 Assessment of Residual Effects

6.8.1 This section describes the residual effects on the water environment following the implementation of mitigation as described in Section 6.7.

Residual Construction Effects

Hydrology and Flood Risk

6.8.2 Following implementation of mitigation during construction, including best practice drainage design and temporary SuDS, residual effects are predicted to be of low magnitude and therefore Minor adverse significance on hydrology and flood risk of the Swine Burn (medium sensitivity).

[26] SEPA (2010). Engineering in the water environment: good practice guide – River crossing, 2nd edition, November 2010. Available at: https://www.sepa.org.uk/media/151036/wat-sg-25.pdf (Accessed 21 August 2019)

Surface Water and Groundwater Quality

6.8.3 Following implementation of mitigation during construction, including SEPA and CIRIA best practice measures, residual effects are predicted to be of low magnitude and therefore Minor adverse significance on water quality of the Swine Burn (medium sensitivity).

Groundwater

6.8.4 No significant effects were predicted on groundwater before mitigation and therefore residual effects are considered to be identical.

Residual Operational Effects

Hydrology and Flood Risk

6.8.5 As stated in Section 6.5, the predicted floodplain peak depth in the post-development scenario between the second railway culvert and the M9 is 0.098m (a reduction of 0.012m compared to the baseline scenario of 0.11m depth) with a corresponding reduction in flood extent.

6.8.6 Following implementation of other mitigation including SuDS attenuation and best practice culvert and outfall design, residual effects are predicted to be of 'low beneficial' magnitude and therefore Minor beneficial significance on the Swine Burn (medium sensitivity) for hydrology and flood risk.

Surface Water and Groundwater Quality

6.8.7 Following implementation of mitigation including SuDS, the risk of routine runoff and accidental spillage to the Swine Burn is predicted to reduce even further and falls well within acceptable thresholds (detailed HEWRAT outputs are presented in Section 6.1.4 of Technical Appendix 6.1 in Volume 3). Residual effects are predicted to be of negligible magnitude and therefore Negligible significance on water quality of the Swine Burn and to protect underlying groundwater from road drainage.

Groundwater

6.8.8 No significant effects were predicted on groundwater before mitigation and therefore residual effects are considered to be identical.

6.9 Summary

6.9.1 The assessment has concluded that, with the inclusion of mitigation measures, there are predicted to be no significant effects in relation to road drainage or the water environment as a result of the construction and operation of the proposed development.

6.9.2 The hydraulic modelling of the Swine Burn predicted that the new access road culvert would result in a reduction in the 200 year (including a 35% climate change uplift) flood depth and extent between the second Edinburgh-Glasgow railway culvert and M9 embankment, resulting in an improvement in flood risk compared to existing conditions.

6.9.3 Table 6.6 provides a summary of the predicted residual effects associated with RDWE that are likely to arise as a result of the proposed development.

Table 6.6: Summary of Residual Effects				
Potential Significant Effect	**Mitigation**	**Means of Implementation**	**Residual Effect**	**Outcome**
Construction				
Increase in temporary flood risk	Limit period of exposure of bare surfaces and uncontrolled runoff from construction areas to minimise increase in runoff. Temporary drainage systems will alleviate localised flood risk and prevent obstruction of surface runoff pathways. Materials/plant will be secured in the event of heavy rainfall to prevent their movement or release, and will be stored in areas out with the floodplain where practicable.	The appointed Contractor will implement a CEMP and Construction Method Statements to be approved by SEPA prior to commencement of works. The appointed Contractor will sign up to SEPA's Floodline system to receive early warning flood updates.	Minor adverse	Not significant
Sediment release and silt-laden runoff entering Swine Burn	Adherence to SEPA/CIRIA best practice guidance for silt and sediment control, including SEPA's GPPs. Suitable control measures for construction site runoff and sedimentation, such as silt fences and bunds. Obtain a CAR Construction Site Licence from SEPA and submit a Pollution Prevention Plan. Soil and material stockpiles will be bunded/covered as appropriate and located at least 10m from surface waters and drains. Temporary SuDS prior to outfall. Limit the extent of soil stripping as far as practical. Topsoiling/re-seeding will be undertaken as soon as possible after earthworks are completed.	The appointed Contractor will implement a CEMP and Construction Method Statements to be approved by SEPA prior to commencement of works. The Environmental Site Manager (or equivalent) to ensure that mitigation stated within the CEMP is fully implemented. CAR licence applications will be prepared and will be approved by SEPA prior to commencement of works.	Minor adverse	Not significant
Accidental release/spillage of oils, fuels and chemicals directly into the Swine Burn or contained within runoff	A plan for pollution control and emergency response procedures in line with GPP21 and GPP22. Adherence to SEPA/CIRIA best practice guidance for pollution control, including GPP5 and PPG6 for managing concrete operations near surface waters. Storage and use of oils, fuel and chemicals will comply with CAR General Binding Rules.	As above	Minor adverse	Not significant

Table 6.6: Summary of Residual Effects				
Potential Significant Effect	**Mitigation**	**Means of Implementation**	**Residual Effect**	**Outcome**
Insufficient temporary drainage provision	Temporary SuDS prior to outfall. A pre-earthwork drainage (PED) ditch network will be constructed at toe of embankments and top of cuttings to collect and convey silt-laden runoff to temporary SuDS or clean runoff to surface waters. Sewage from site facilities will be disposed to foul sewer or agreed with SEPA and in accordance with GPP4.	CAR licence applications will be prepared and will be approved by SEPA prior to commencement of works. Drainage design.	Negligible	Not significant
Operation				
Beneficial changes in flood depths and extent with the proposed development in place	The new access road culvert will fill in the low point in the Swine Burn channel where floodwaters previously spilled onto the floodplain, therefore containing a greater proportion of flows in-channel. Implementation of other mitigation including SuDS attenuation and best practice culvert design.	CAR licence application will be prepared for the new culvert to be approved by SEPA prior to commencement of works.	Minor beneficial	Not significant
Sub-optimal performance of road drainage network, due to blockages and sediment build up	Regular maintenance and inspection of road drainage network (including SuDS).	Agreement with Transport Scotland and WLC.	Negligible	Not significant
Increase in likelihood of pollutant build up on road surfaces and risk of accidental spillages discharging to the Swine Burn and entering groundwater	Permanent SuDS (2 levels) prior to outfall, as agreed with SEPA and in line with CIRIA guidance. HEWRAT outputs indicate routine runoff and spillage risk to Swine Burn is well within acceptable limits. SuDS basins are lined therefore preventing infiltration to groundwater.	Agreement with SEPA, Transport Scotland and WLC.	Negligible	Not significant