Part Two

2/4 Water Quality, Drainage & Hydrogeology

2/4.1 Introduction

Water is a resource that is essential to all animal and plant life. It is also necessary for industry, agriculture, waste disposal, many forms of transport, and recreation and sport. The maintenance and improvement of the quality of our drinking water, watercourses, groundwater resources and coastal waters is central to government policy.

Run-off from road drainage may cause pollution due to accidents, general vehicle and road degradation, incomplete fuel combustion, and small oil or fuel leaks.

This section presents the results of the assessment of impacts on water resources and water quality caused by the operation of the proposed scheme. Impacts resulting from construction of the road are addressed in Section 2/13.

2/4.2 Methods

The assessment of water quality and drainage has been carried out in accordance with the methods of Volume 11 of the Design Manual for Roads and Bridges.

Baseline conditions were identified through consultations with statutory consultees, site visits and the ground investigation undertaken in 2000. Mitigation measures have been based on discussions with the Scottish Environment Protection Agency (SEPA) and on current good practice for highway drainage design, including the guidance provided in 'Sustainable Urban Drainage Systems

2/4.3 Baseline Conditions

The Forth Estuary

The main water feature in the vicinity of the proposed scheme is the Forth Estuary. The proposed scheme passes within 50m of the mean spring highwater mark of the Forth Estuary to the immediate east of Kincardine Bridge. The quality of water within the Forth Estuary is an important environmental issue, not only as an estuarine water resource, but also in view of the international ecological importance of the estuary for waterfowl and waders (see Section 2/5).

The water quality of estuarine waters is classified by SEPA under the Estuary Classification Scheme as shown in Appendix 3. Under the system, specific reaches of estuary are allocated a class of A, B, C or D based on the aesthetic, biological and chemical condition of the waters. Class A is 'excellent', B is 'good', C is 'unsatisfactory' and D is 'seriously polluted'. A given stretch of estuary is classified by allocating it to the lowest class to which all of its condition criteria conform.

SEPA has indicated that the water quality of the Forth Estuary is Class B (good quality) in the vicinity of Kincardine. SEPA records also indicate that the water quality of the estuary near Kincardine Bridge has been improving slowly over the last few years. However, historical pollution has resulted in the presence of organic contaminants in the estuary bed sediments. During spring tides these sediments can be disturbed and become suspended in the water. The contaminants create a demand for oxygen. When

combined with low summer fluvial flows, this can result in low levels of dissolved oxygen. Although water quality data collected over the last 20 years indicate a reduction in the length of river affected by low dissolved oxygen concentrations, it is considered unlikely by SEPA that the estuary will improve to the extent of becoming a Class A estuary.

Watercourses and Ditches

There are three ditches in the vicinity of the proposed scheme and these are shown on Figure 2/4.1. One issues just south of the C5 on the fringe of Kincardine and flows from north approximately 200m east of Kincardine sewage works (Ditch 1). It joins a railway ditch (Ditch 2) that runs alongside the railway from north-west to south-east. The water in this ditch flows under the railway in a culvert and issues onto the estuary mudflats approximately 500m south-east of the sewage works. Another ditch is located near Inch Farm (Ditch 3). It flows close to C5 in a roughly north-west direction. Ordnance Survey maps indicate that the flow from the ditch sinks into the ground where it meets the hedgeline of the C5. The flow (assumed to be from the same ditch) re-emerges to the south of the farm and flows from north to south towards the estuary. Further ditches may be located alongside field boundaries.

The River Classification Scheme of SEPA categorises watercourses on the basis of water chemistry, biology, nutrient status, aesthetic condition and concentration of toxic substances. There are five classes comprising A1, A2, B, C and D in decreasing order of quality. Class A1 is excellent and Class D is seriously polluted (Refer to Appendix 4). The class allocated to a particular reach of watercourse defaults to the poorest class determined from the water chemistry, biology, nutrient, aesthetic and toxicity assessments.

SEPA does not monitor the ditches between Kincardine and Longannet Road. Observations made during a site visit in September 2000 revealed that the steep-sided ditch 200m east of the sewage works (Ditch 1) was approximately 1m wide with a flow depth of some 0.05m (following heavy rain). The water was clear and the ditch appeared to be regularly maintained. It appears from plans supplied by East of Scotland Water that a storm sewage overflow pipe discharges into this ditch approximately 40m upstream of the proposed road crossing as shown in Figure 2/4.1.

The majority of fields in the vicinity of the proposed scheme have a system of land-drains. In the vicinity of Kincardine sewage treatment works, land drains are connected to a leader drain running parallel to the railway. Flows from this leader drain are pumped to an open ditch which discharges to the estuary.

All ditches/watercourses in the area drain directly or indirectly into the Forth Estuary. SEPA has stated that the water quality of the minor watercourses to the north of the estuary is likely to be relatively poor due to low flows and ferruginous water from coal measures.

Fisheries

Migratory salmonids, both salmon and sea trout, utilise the Forth Estuary on their passage upstream and downstream. Both species spawn in freshwater but spend part of their adult lives in the sea.

SEPA regularly trawl the upper estuary during the summer months to provide information on fish populations. Fish species include plaice, whiting, goby, flounder,

herring, sprat and smelt. There has been an increase in the number of fish caught over the last 20 years, which correlates with the increases in dissolved oxygen concentrations recorded (fish are adversely affected by low dissolved oxygen concentrations).

The District Salmon Fishery Boards have been consulted and have indicated that there are no streams or burns of concern for fisheries over the length of the proposed route. There are two licensed salmon net fisheries at Kincardine, one on the west bank and one on the east bank of the Forth. Some fishing for sprats takes place in the Forth near Kincardine.

Wetlands/Flood Risk

One small area of marshy ground has been identified near the western end of the proposed scheme (see Section 2/5 and Figure 2/5.1). The Hydrology Department of SEPA considers that there is a low risk of flooding from watercourses in the area. However, there are no available data on flood risk or the history of flooding as there is no gauging station in the area.

The tidal bunds, which pass to the estuarine side of the railway line, offer significant protection against tidal flooding and consultation with both Fife Council and the local landowner has uncovered no evidence of such an event having occurred. The Shoreline Management Plan (1999) for the Kincardine area, states that these coastal defences will be maintained. Therefore based on the above the risk of tidal flooding occurring to the south east of Kincardine is considered negligible.

Groundwater

The proposed route alignment is along the northern edge of alluvial deposits as further discussed in Section 2/3. Drift deposits, comprising clay and silt (alluvial deposits), cover the majority of the area. Boulder Clay is present in the vicinity of the eastern end of the proposed scheme. Drift deposits tend to have variable permeability depending on composition. In general, the higher the proportion of clay (very fine particles), the less permeable the deposits. The Hydrogeological Map of Scotland (British Geological Survey, 1988) describes the alluvial deposits as being an aquifer of limited potential. The Lower Coal Measures aquifer that is located throughout the area of the proposed scheme from Kincardine to approximately 0.5km east of Longannet Road is described as being of local importance with generally poor water quality and with detrimental levels of iron and fluoride commonly present. The Groundwater Vulnerability Map for Scotland classifies the Lower Coal Measures along the proposed route alignment as 'moderately permeable'. Such rocks are fractured or potentially fractured and do not have a high primary permeability, or comprise other formations of variable permeability. Although these formations seldom produce large quantities of water for abstraction, they are important for local supplies and in supplying base flow to rivers.

Coal Measures are present in the vicinity of the scheme (see Section 2/3). Where these have been worked and subsequently abandoned, groundwater levels may be rising. However, there is no history of breakouts (i.e., where contaminated groundwater issues at ground surface or from old mine adits) in the vicinity of the proposed scheme.

As part of the ground investigation, groundwater levels were measured during August and September 2000. The results indicated that west of Longannet Road, where the proposed route is to be constructed on embankment, levels ranged from ground level to 3 metres below ground level with the highest levels occuring in the vicinity of Kincardine

sewage works. East of Longannet Road, where the proposed route will be in cut, trial pits to a depth of 4-5 metres only found areas of perched groundwater. The actual water table was not encountered at these levels.

SEPA has no information on groundwater quality in the vicinity of the proposed scheme. There are, however, potential sources of contamination due to previous mine working in the area, which could affect groundwater quality. Potential contaminants resulting from former mine workings include metals such as iron, copper, nickel, lead and zinc and other substances such as sulphates and sulphides. Groundwater contaminated by mine workings tends to be acidic. Potential sources of contamination are discussed in Section 2/3.

Abstractions

Groundwater resources around the proposed route and to the south are of limited value due to the potential for saline intrusion from the adjacent estuary and contamination from the extensive workings in the Lower Coal Measures. The latter are known to extend throughout the study area.

No licences for abstracting water are required as yet in Scotland and therefore SEPA do not hold records of abstractions. There are existing abstractions at Crosshill Wellfield, approximately 2km north of the proposed route. These wells serve Kilbagie Paper Mill, 1km north of Kincardine, that also abstracts water from the Peppermill Dam 2km north of the existing A985. Scottish Power is proposing to construct a wellfield to the north of Longannet Power Station. This development is currently awaiting planning permission. If the development is implemented, the nearest well could be some 600m to the south-east of the proposed scheme. The Crosshill wellfield and the site of the proposed Scottish Power wellfield are in the Passage Group strata, that is located to the north of Kincardine and approximately 1km south-east of the town adjacent to the Mill Coal and Glenfuir Coal (Lower Coal Measures). Evidence suggests that there is not a high degree of connectivity between the Passage Group aquifer and the Coal Measures aquifer, i.e. the two aquifers can be considered as largely separate as groundwater movement between them is likely to be limited.

It is possible that other abstractions may exist in the vicinity of the scheme.

Discharges and Sewerage

The main existing discharges are from Kilbagie Papermill (a Part A process under the Integrated Pollution Control (IPC) Regulations 1991), Airth sewage works and Kincardine sewage treatment works. In addition, there are a number of minor discharges from septic tanks in the area. SEPA records indicate that there are consented septic tank discharges to the Forth estuary from Inch House and from Longannet Mine, as shown on Figure 2/4.1.

Kincardine sewage works has a discharge consent. Sewerage plans supplied by East of Scotland Water indicate there is a discharge from the sewage works to the estuary as shown on Figure 2/4.1 and that the main sewer alignment is from Walker Street east of Kincardine House to the sewage works.

Importance of Water Features

The importance of water features and resources is defined as outlined in Table 2/4.1.

Table 2/4.1 Definition of Importance of Water Feature or Resource

Importance of Water Feature or Resource	Description
Very high	International designation: e.g. Special Protection Area, Ramsar Site; Aquifer providing potable water to large population (>100,000); EC designated Salmonid fishery;
High	National designation: e.g. SSSI; Class A reach of estuary; Aquifer providing potable water to small population (<100,000); EC designated Cyprinid fishery;
Medium	Regional value; Class B/C reach of estuary; Aquifer providing abstraction water for agricultural or industrial use;
Low	Local value.

Based on Table 2/4.1, the non-designated areas of the estuary are of at least medium importance whilst the designated areas are of very high importance. For the purpose of this assessment, the non-designated area of the estuary alongside Kincardine for 2km downstream of the bridge is considered to be of high importance, to take account of the proximity of the international designations.

The ditches in the vicinity of the proposed scheme are considered to be of low importance (local importance).

Groundwater present in the Lower Coal Measures aquifer and the drift deposits aquifer is of low importance, whilst that present in the Passage Group Strata aquifer is of medium importance.

2/4.4 Mitigation Measures

Sustainable Urban Drainage Systems

The drainage system will be designed in accordance with the principles contained in "Sustainable Urban Drainage Systems: design manual for Scotland and Northern Ireland" (CIRIA C521) (SUDS).

SUDS can include measures such as infiltration basins known as source control techniques, and filter drains, swales and detention ponds to reduce or attenuate flows entering surface water drains and watercourses. Such systems can have the benefit of providing a "naturalised" system of pollutant removal and reduce the likelihood of downstream flooding and will therefore retain a proportion of the suspended solids present in the runoff and settle out hydrocarbons and metals.

Measures to reduce potential impacts during operation include the following:

- filter drains;
- gully pots in some locations (mainly on side roads and where the proposed scheme ties into the existing highway drainage system);
- an oil interceptor prior to discharge at Ditch 1; and
- spillage control (interceptor catchpits) at Ditch 1 and the roundabout junction with Longannet Road.

Filter Drains and Gully Pots

Filter drains consist of a perforated pipe laid in a trench backfilled with gravel, and will be constructed along the length of the route. Filter drains will be used to convey highway drainage waters to the discharge point and to filter out pollutants including suspended solids, hydrocarbons, iron, copper and zinc. They will also provide some attenuation of flows.

East of Longannet Road, where the proposed scheme is in cutting, there is a greater probability of the groundwater level being in close proximity to the finished road profile. In this location the filter drain design for each verge will be considered individually. The westbound verge which due to the road super elevation is required to take all carriageway run-off will include an impermeable liner to minimise risk of pollution to groundwater. The eastbound verge however will be unlined as it will only require to deal with run-off from the earthworks slope and verge. Being unlined will have the added benefit of assisting in maintaining the groundwater level before sub-formation.

Filter drains will be designed in accordance with the Design Manual for Roads and Bridges, taking cognisance of guidance contained in the CIRIA design manual for SUDS.

Gully pots consist of a pot below the level of the drainage pipe. They are designed to trap sediments and other debris and retain a proportion of the suspended solids present in the runoff and settle out hydrocarbons and metals. They will be used on side roads which are kerbed and where drainage ties into the existing highway drainage system.

Oil Interceptor/Spillage Control Facilities

Due to the ecological importance of the estuary, measures to reduce the risk of hydrocarbons reaching the estuary (as a result of run-off or oil or chemical spillage from vehicle collision or accident) will be installed as part of the drainage system. A large proportion of hydrocarbons present in operational runoff is associated with sediment and therefore hydrocarbons will tend to accumulate in the filter drains or gully pots. The risk of vehicular collision is assumed to be greatest at roundabouts. Spillage control facilities comprising interceptor catchpits will therefore be provided at the roundabout junction near Longannet Road and prior to discharge to Ditch 1. An oil interceptor will also be installed prior to discharge to the ditch. At both Ditch 1 and at Longannet Road, a minimum of 20m^3 of storage will be provided. This will further protect the water quality of the ditch and reduce the risk of oils reaching the estuary.

Other Measures

It would be preferable if herbicides were not used on highway embankments, cutting or verges. However, the authority responsible for maintenance may consider this impractical in terms of adequate management of the highway verge vegetation. If herbicides were to be used, it would be most appropriate if those recommended by SEPA for use near watercourses were applied in accordance with the manufacturer's instructions.

The discharge outfall at Ditch 1 will be provided with scour protection to protect the banks and bed of the ditch and to limit erosion.

Prior to construction, ground investigations will be undertaken to ascertain the level of the water table and to identify any existing groundwater contamination at the Eastern Tie-in where the scheme is in cutting. Based on the results, specific measures will be

agreed between SEPA and the Contractor on adequate treatment measures to address the potential release of any contaminants into the drainage system.

Flooding

No significant risk of flooding from the proposed scheme is predicted. However, the Contractor for the scheme will undertake an engineering risk assessment, which will include any potential flooding issues to be addressed.

A summary of the mitigation measures and the level of mitigation associated with each measure is provided in Table 2/4.2.

Table 2/4.2 Summary of Proposed Measures to Address Potential Impacts on Water Quality.

Type of Measure	Description
Prevent	Engineering risk assessment to include flooding risk to be undertaken by the Contractor to address any potential for flooding.
Reduce	A Sustainable Urban Drainage System will be provided to filter out pollutants and reduce the level of pollution from operational run-off entering watercourses and the Forth estuary. Recommended that if required to be used, herbicides recommended by SEPA for use near watercourses are applied in line with manufacturer's instructions to reduce pollution of watercourses. Provision of scour protection at the drainage discharge outfall to protect the banks and bed of the receiving ditch and to limit erosion. Where necessary, treatment measures to be agreed between SEPA and the Contractor to reduce the risk of existing ground contamination entering the road drainage system.
Offset	None provided.
Enhance	None provided.

2/4.5 Predicted Impacts

The new road surface will create run-off that will be conveyed to a watercourse mainly via the new highway drainage system, as described in Section 2/4.4. Run-off from tie-ins will be discharged to the existing drainage system where applicable.

The main discharge point for the road drainage will be Ditch 1. Discharge from Ditch 1 will allow flows to continue by gravity to the estuary via the ditch running along the railway (Ditch 2). An alternative to discharging to Ditch 1 would be to discharge to the leader drain and to utilise the existing pumping system which pumps flows from the leader drain to a ditch that discharges to the estuary. For the purpose of the assessment, it has been assumed that the highway drainage will discharge into the estuary via Ditch 1.

An assessment has been made of the predicted effects of road drainage on water features and resources. The magnitude of impacts and the significance of effects are as defined in Tables 2/4.3 and 2/4.4.

Table 2/4.3 Definition of Magnitude of Impacts Criteria for Water Quality

Magnitude of Impact (irrespective of importance)	Description of Degree of Impact
Major	Loss of substantial part of feature; loss of integrity of feature; and/or serious pollution resulting in substantial derogation of quality of feature.
Moderate	Loss of noticeable proportion of feature; contribution of a significant proportion of effluent to a receiving watercourse, estuary or aquifer; and/or reduction in economic value of feature.
Minor	Measurable deterioration in feature but of limited proportion, degree or extent; and/or no change in quality classification.
Negligible	Discharges to surface water or groundwater but effects are unlikely to be measurable.

Table 2/4.4 Definition of Impact Significance for Water Quality

	Importance of feature/resource			
Magnitude	**Very High**	**High**	**Medium**	**Low**
Major	Very Significant	Highly significant	Significant	Low Significance
Moderate	Highly Significant	Significant	Low Significance	No Significance
Minor	Significant	Low Significance	No Significance	No Significance
Negligible	Low Significance	No Significance	No Significance	No Significance

Details of the existing drainage system in the vicinity of the proposed scheme have been requested from the relevant authorities, but no organisation has been able to provide information by way of as-built records. Discussions with the local authorities have, however, led to the conclusion that currently all existing road drainage discharges directly to the estuary via the nearest watercourse. . The drainage design for the new road will therefore have a beneficial impact on the quality of highway drainage discharged into the estuary from the trunk and local road network as the existing network is unlikely to include oil interceptors. Pollutants contained in run-off from vehicles using the new road will be intercepted by pollution control measures discussed in Section 2/4.4, prior to discharge to receiving waters and the estuary. These pollutants can include:

- suspended solids;
- hydrocarbons from diesel, petroleum and lubricating oil leakages;
- hydrocarbons from exhaust emissions;
- heavy metals from corrosion of catalytic converters;
- copper, zinc, cadmium, iron, lead and chromium;
- tyre wear deposits including lead, zinc and hydrocarbons;
- de-icing agents (e.g. rock salt) during winter months;
- chemicals used in windscreen washes such as detergents; and
- herbicides if used on roadside verges.

The drainage provided is predicted to be an improvement on that provided for all existing roads in the vicinity. Current run-off from high volumes of traffic using the existing road network is understood to discharge to the estuary via a highway drainage system that is assumed to have a lesser degree of pollution control than that to be provided for the proposed scheme. As the new road is predicted to take 40% of the traffic from existing roads, this will result in a reduction in the polluting load from run-off discharged to the estuary from the local road network.

An assessment of the polluting potential of routine run-off from the new road into Ditch 1, as the receiving watercourse, has been undertaken using the method set out in DMRB Volume 11. Routine run-off is surface water from the road resulting from rain falling on the road and draining into the highway drainage system. Routine run-off contains some of the pollutants deposited on the road surface but does not include run-off seriously polluted as a result of vehicular collision. The DMRB method assesses the impact of copper and zinc on the water quality of the receiving waters. These metals have been used as indicators of the level of impact as they are generally the main metallic pollutants associated with road drainage and can be toxic to aquatic life. The method uses a calculation to predict the concentrations of dissolved copper and total zinc in the receiving watercourse. The assessment assumes that there is no current highway drainage from the trunk road network into Ditch 1. It therefore represents a worst case scenario, not taking into account the overall improvement in drainage to the estuary as a whole.

The method takes into account water quality and Environmental Quality Standards (EQSs) relating to the receiving water (Ditch 1) and assumes baseline concentrations of copper and zinc, low summer flows and hardness. Although the water quality of the receiving water has been described as poor, for the purposes of the assessment, it has been assumed to be B (fair quality) to provide a worst-case scenario in terms of impact. The SEPA River Classification Scheme considers whether a particular stretch of watercourse complies with EQSs for various substances. EQSs are principally ecological standards, specified for a range of parameters at levels required to protect aquatic life. EQSs are provided for copper and zinc. Based on these assumptions, the EQS for the dissolved copper is 22μg/l and total zinc is 700μg/l for the receiving ditch (Ditch 1). Using the DMRB method, it is assumed that the concentration of copper and zinc upstream of the discharge point (baseline concentration) at Ditch 1 is 50% less than the EQS. This means that the assumed baseline concentration of dissolved copper is 11μg/l and the concentration of total zinc is 350μg/l upstream of the discharge point. The low summer flow has been assumed to be 1 litre per second. Hardness is assumed to be 50-100mg/l, based on the presence of the Lower Coal Measures. Detailed calculations are shown in Appendix 5.

The calculations as shown in Table 2/4.5A indicate that the resulting dissolved copper (dCu) concentration in the ditch downstream of the discharge point with the road in operation would be 70μg/l and the total zinc (Zn) concentration would be 645μg/l. This means that although the total zinc concentration would increase by 295μg/l, it would comply with the Environmental Quality Objectives for a B Class watercourse (700μg/l). The dissolved copper concentrations would increase by 59μg/l and would not meet the EQSs for a B Class watercourse (22μg/l). Without mitigation measures in place, the total zinc concentration predicted would have an impact of minor magnitude on Ditch 1, which is of low importance, resulting in an impact which is not significant. Predicted copper concentrations would have an impact of moderate magnitude on the ditch that, because of the low importance of the ditch, would also result in an impact that is not significant.

Table 2/4.5A Predicted Impact of Total Zn and dCu on the Receiving Watercourse (Ditch 1) Without Mitigation

Parameter	Importance of Ditch	EQS μg/l	Baseline Upstream Levels (μg/l)	Downstream Discharge (μg/l)	Magnitude (Increase μg/l)	Significance
Total Zinc	Low	700	350	645	Minor (295)	Not Significant
Dissolved Copper	Low	22	11	70	Moderate (59)	Not Significant

With mitigation in place, the filter drains will substantially reduce the concentration of copper and zinc discharged to the ditch. Estimates given in DMRB suggest that the pollutant removal efficiency of filter drains could be 70-80% for total zinc and 10-30% for dissolved copper. As Table 2/4.5B shows, this would reduce predicted levels of total zinc without mitigation to 425μg/l and levels of dissolved copper to 58μg/l. This means that total zinc levels would still meet the EQS for a B grade watercourse. A total zinc level of 425μg/l would be an increase of 75μg/l on the baseline situation. This increase is of negligible magnitude, resulting in an impact of no significance as the ditch is of low importance. Dissolved copper levels would continue to fail the EQS. However, due to the low importance of the receiving ditch, the increase of 47μg/l on the baseline situation would be of moderate magnitude, representing an impact of no significance. With mitigation in place, no significant adverse impacts on the quality of the receiving water are predicted.

Table 2/4.5B Predicted Impact of Total Zn and dCu on the Receiving Watercourse (Ditch 1) With Mitigation

Parameter	Importance of Ditch	EQS μg/l	Baseline Upstream Levels (μg/l)	Downstream Discharge (μg/l)	Magnitude (Increase μg/l)	Significance
Total Zinc	Low	700	350	425	Negligible (75)	Not Significant
Dissolved Copper	Low	22	11	58	Moderate (47)	Not Significant

The mudflats and the estuary, into which the receiving ditch drain, lies at an approximate distance of 400m from the point of discharge to the estuary. Discharges to the mudflats and estuary therefore benefit from dilution effects, such that the level or magnitude of total zinc and dissolved copper discharged will be negligible. Although the waters are of high importance, the resulting impact will not be significant, either with or without mitigation.

An estimate of the potential effect of the proposed highway drainage discharge on estuarine water quality has been made using a methodology based on the DMRB. The following assumptions have been made:

- upstream dissolved copper concentration is based on SEPA monitoring at Alloa (highest annual average from 1998 to 2000, i.e. 2.88μg/l in 1998);
- upstream total zinc concentration is based on SEPA monitoring at Alloa (highest annual average from 1998 to 2000, i.e. 4.55μg/l in 1999);
- all the zinc present in the highway discharge is dissolved (in practice a substantial proportion would be associated with suspended solids); and
- assumed discharge of highway drainage direct to estuary (in practice, the highway drainage will be discharged to a ditch prior to entering the estuary).

The assessment is based on the following parameters:

- EQS for dissolved copper of 5μg/l (annual average);
- EQS for dissolved zinc of 40μg/l (annual average);
- dilution calculated from flow generated by a neap tide 1 hour before and 1 hour after a high tide;
- contribution of fluvial flow negligible (i.e. assuming a low summer river flow);
- average of measured tidal velocities approximately 2km upstream of the discharge point;
- estimated channel width of 800m; and
- estimated average water depth of 2m.

The calculation predicts that, owing to the dilution available during a neap tidal cycle, there would not be any significant effect on the estuarine water quality (see Summary Table 2/4.6).

Table 2/4.6 Estimate of Potential Pollution from Routine Run- Off from Proposed Highway - Summary Table

	Assumed conc. in ditch upstream of proposed highway discharge point	Predicted conc. in ditch immediately downstream of discharge point (without mitigation)	Predicted conc. in ditch immediately downstream of discharge point (with mitigation)[A]	EQS[B,C] for the ditch	Assumed conc. in estuary upstream of proposed highway discharge point (based on SEPA monitoring at Alloa)	Predicted conc. in estuary immediately downstream of discharge point (without mitigation)[D]	Predicted conc. in estuary immediately downstream of discharge point (with mitigation)[A D]	EQS[B,E] for the estuary
Dissolved copper (μg/l)	11	70	58	22	2.880	2.881	-	5
Total zinc (μg/l	350	645	425	700			-	-
Dissolved zinc (μg/l)					4.550	4.553	-	40

Notes:
[A] assumes mitigation measures reduce dissolved copper concentrations in discharge by 20% and total zinc by 75%
[B] assuming hardness of 50 – 100mg/l $CaCO_3$
[C] annual average
[D] based on a neap tide cycle
[E] 95 percentile (i.e. if a series of samples are taken, 95% of values should be above this concentration)

Groundwater and Sub-Surface Water

Along the length of the route all severed land drains will be picked up by either the proposed pre-earthworks drains or verge drains where applicable. West of Longannet Road, where groundwater levels are closest to the surface, the proposed route has been designed on embankment to ensure that the water table is not adversely affected.

The area where there is potential for groundwater to be intercepted, is east of Longannet Road where the proposed road will be in cut. The super-elevation of the

carriageway is such along this section of the route run-off from the road will be discharged to the westbound verge only. Therefore, by lining the filter drain in this verge, the potential for highway drainage water infiltrating the ground water at this location is avoided. On the eastbound verge where no carriageway run-off is expected, the requirement for lining the drain is not required. The filter drain will be able to accommodate any additional flows from perched water and therefore ensure the water table remains below sub-formation. .

Spillage Risk Assessment

Along any road, there is a risk of vehicular collision that can result in spillage of fuels or chemicals, particularly if tankers are involved. With regards to the proposed scheme, a risk assessment of a serious spillage causing pollution has been undertaken using the DMRB method. Detailed calculations are provided in Appendix 5.

The method is based on a number of assumptions and therefore provides an estimate of the risk. Key factors assumed are shown in Table 2/4.7. Predicted traffic flows are based on those in 2018 with high growth traffic. It is assumed that the emergency services would take less than 20 minutes to respond.

Table 2/4.7 Key Factors Used in Spillage Risk Assessment

Factor	Proposed Scheme
Predicted Traffic Flow	18,226 AADT
% HGVs	16%
Length of Road	2.2km
Type of Junction	Roundabout (risk is higher at roundabouts)

The method calculates the risk of a pollution incident for discharge to two categories of watercourse as shown in Table 2/4.8. These comprise aquifers and sensitive watercourses, and all other watercourses. This risk is measured against acceptable thresholds for each category. Predicted spillage risks of once in less than 100 years for aquifers and sensitive waters and once in less than 50 years for all other watercourses is considered unacceptable. For the purposes of this assessment, the estuary is considered to be sensitive waters due to its international ecological importance. The receiving ditch (Ditch 1) comes under the category of all other watercourse as shown in Table 2/4.8.

Table 2/4.8 Spillage Risk Assessment - Summary

Category	Feature	Threshold of Acceptability	Calculation for Spillage Risk	Within Acceptable Limits?
Aquifers and sensitive watercourses	Aquifer Forth Estuary	1:100	1:105	Yes
All other watercourses	Ditch 1 receiving drainage discharge	1:50	1:105	Yes

The calculations show that there is a spillage risk of 1:105 to Ditch 1 where the majority of the highway drainage is discharged. This means that there is likely to be a serious spillage resulting in pollution once in 105 years, which is within acceptable limits.

A predicted spillage risk of once in less than 100 years is considered unacceptable for sensitive waters and all other watercourses. The prediction of once in 105 years is within the acceptable limits but close to the once in less than100 year threshold.

Spillage control facilities, as discussed in Section 2/4.4, will mitigate potential pollution effects on the estuary. With these in place, the predicted effects of pollution on the estuary and the ditch receiving the highway drainage discharge are assessed as not being significant.

Flooding/Fisheries/Abstractions and Discharges

The reclaimed land between Walker Street and the estuary, in the vicinity of Kincardine Sewage Works is low-lying but protected by tidal defences. Therefore, based on discussions with Fife Council and the local landowner we can reasonably assume that the Eastern Link Road does not cross an area affected by tidal flooding. The successful contractor will be required to provide a drainage design that will ensure that no flooding occurs as a result of the new road.

2/4.6 Conclusions

There will be an overall reduction in the pollution load from road run-off discharging to the Forth Estuary from the local road network. This will result from the improved drainage along the proposed scheme (vis a vis existing drainage along the existing road network), which will treat run-off from 40% of the traffic travelling across Kincardine Bridge.

The proposed scheme will cross Ditch 1 to the east of Kincardine. The majority of highway drainage will be conveyed to this ditch, which discharges to the estuary approximately 500 m south-east of Kincardine Sewage Works. The proposed highway drainage system includes measures to reduce pollutant concentrations of run-off from the road and to slow down flows. It is proposed that these measures will reduce potential impacts on the water quality of the ditch and the Forth Estuary, such that they do not give rise to significant effects.