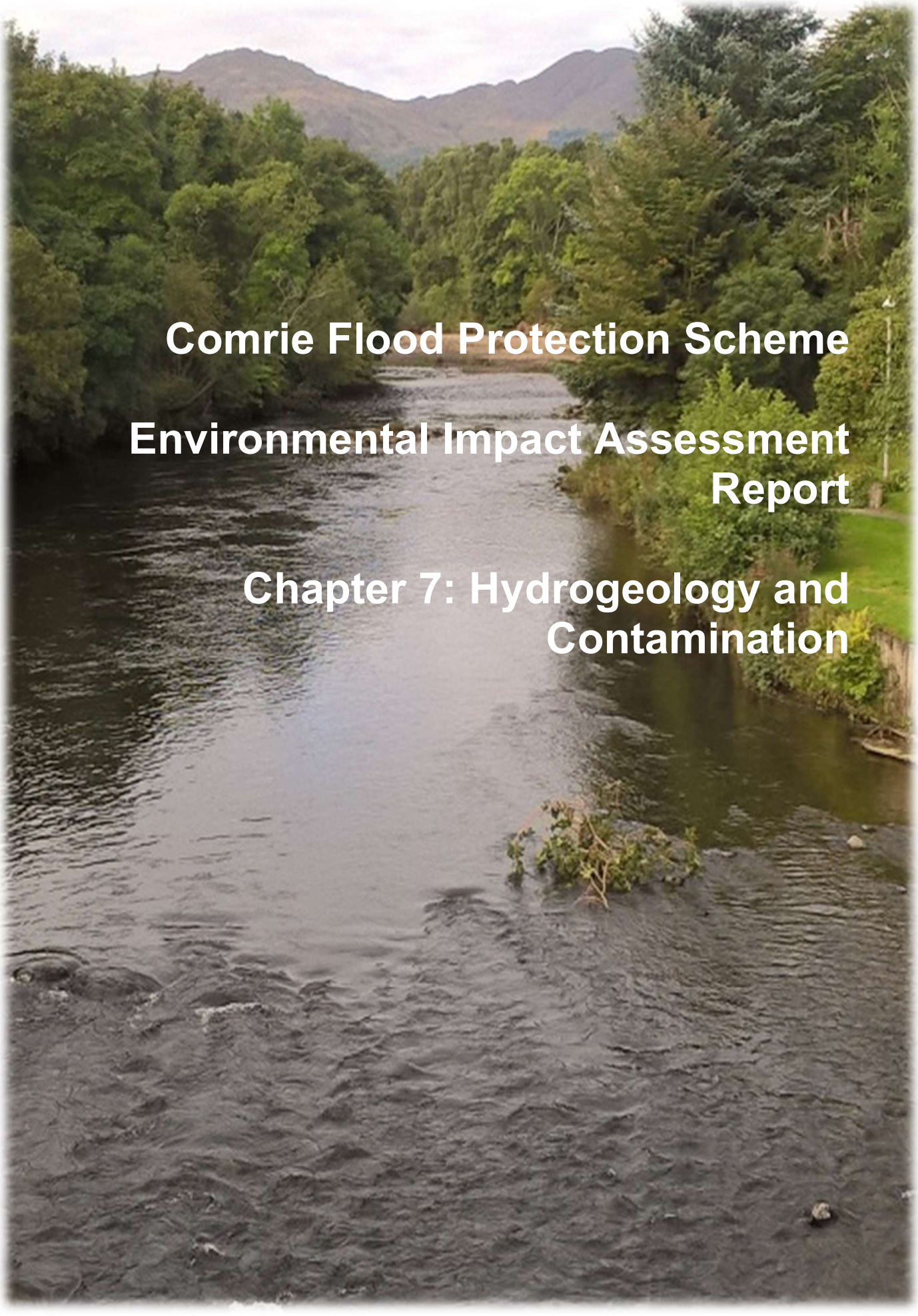

Comrie Flood Protection Scheme

Environmental Impact Assessment Report

Chapter 7: Hydrogeology and Contamination

Document Control

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FIGURES

APPENDICES

7 Hydrogeology and Contamination

7.1 Introduction

7.1.1 This chapter provides an assessment of the effects of the Comrie Flood Protection Scheme on hydrogeology as well as any significant environmental issues associated with potential contamination. The chapter should be read in conjunction with the table in **Appendix 7.1**.

7.1.2 Aspects of the Comrie Flood Protection Scheme that are considered within the assessment are associated with potential construction of flood defence walls, earth embankments and erosion protection measures, as outlined in **Figure 3.1** and described in **Chapter 3: Scheme Description & Alternatives**.

7.1.3 The EIA Scoping Report Update, November 2017 concluded that likely impacts to geology and soils are considered to be low and these topics have therefore been scoped out of the assessment. Further details of potential effects on surface water and drainage, including flood risk, are considered separately in the section on **Chapter 6: Water Environment & Fluvial Geomorphology**.

7.2 Guidance and best practice

7.2.1 The assessment was carried out in accordance with the following legislation, published guidance and other relevant sources:

- Scottish Environment Protection Agency (SEPA) Position Statement (WAT-PS-10-01);
- SEPA Supporting Guidance (WAT-SG-53) Environmental Quality Standards and Standards for Discharges to Surface Waters (Feb 2018);
- The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended) (CAR);
- CIRIA C552:Contaminated Land Risk Assessment – A guide to good practice;
- Land Use Planning System SEPA Guidance Note 31, Version 3, 11/09/2017: Guidance on Assessing the Impacts of Development Proposals on Groundwater Abstractions;
- BS 5930:2015 Code of practice for ground investigations and BS 10175: 2011+A1:2013 Investigation of potentially contaminated sites: code of practice;
- CAR Practical Guide v8.2 (SEPA, 2018); and,

Information Sources

7.2.2 The following sources of desk-based information have been used for this assessment:

- British Geological Society (BGS) website – Historical boreholes, geology, hydrogeology and land use information from the GeoIndex Onshore Online Maps: http://www.bgs.ac.uk/;
- BGS GIS digital mapping – Groundwater Vulnerability map 1:50,000 (Sourced from the Council);
- BGS GIS digital mapping – Aquifer Productivity map 1:50,000 (Sourced from the Council);
- BGS GIS Digital mapping – Solid Geology and Superficial Deposits;
- Scotland's Environment Website – Interactive Map: http://map.environment.scotland.gov.uk; and
- The Drinking Water Quality Regulator (DWQR) for Scotland Interactive Map of Private Water Supply Locations http://dwqr.scot/private-supply/information-for-pws-owners-and-users/pws-location-map/.

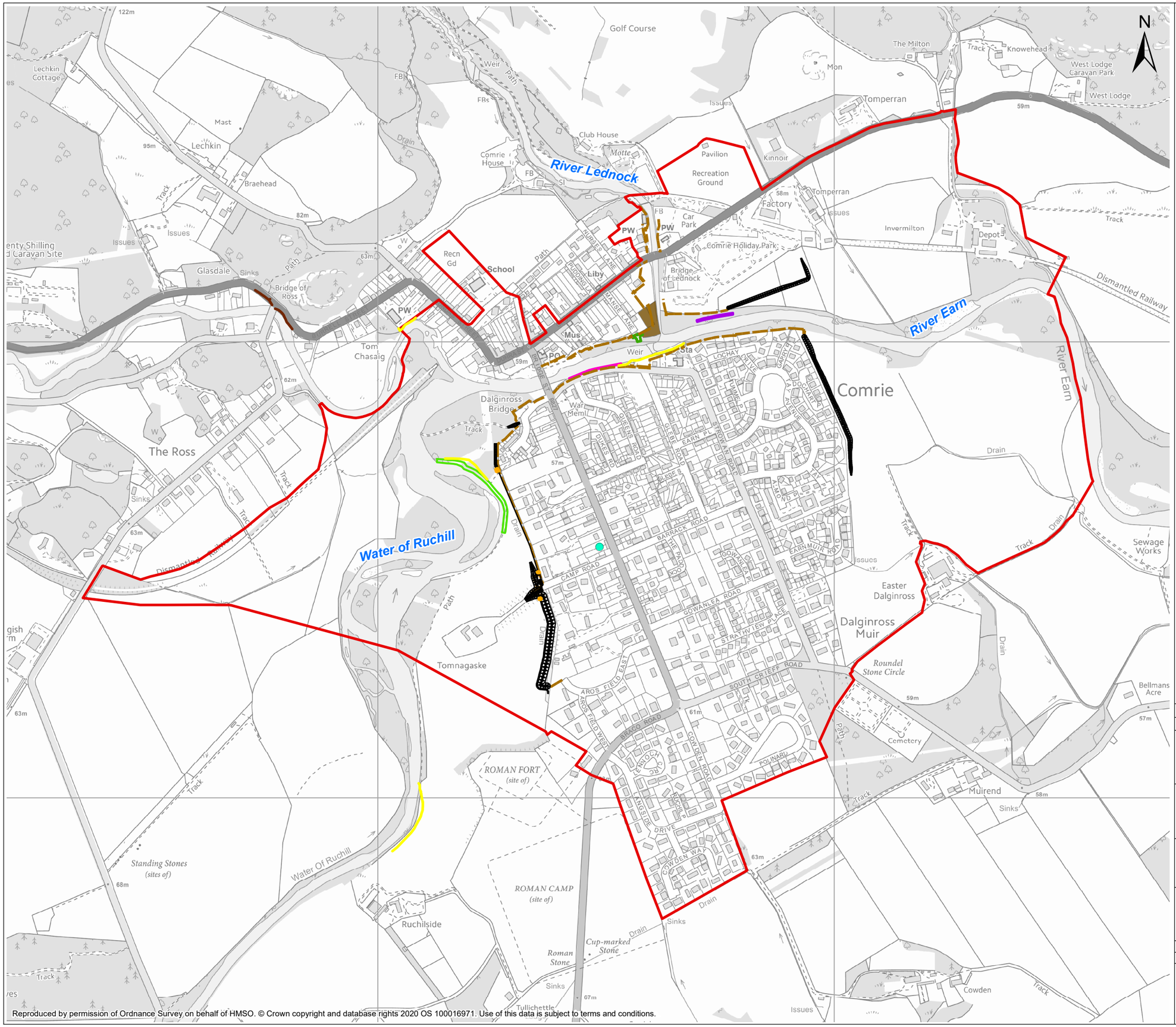
7.3 Methodology

Study Area

7.3.1 The towns of Comrie and Dalginross are located approximately 40km west of Perth at the confluence of the following three watercourses: the River Earn, the River Lednock and the Water of Ruchill (**Figure 7.1**). The two towns are separated by the River Earn with Dalginross located on the south bank and the historic town of Comrie on the north bank. The two towns are linked together by a steel beam bridge which crosses the River Earn downstream of its confluence with the Water of Ruchill. The town is situated on the A85 between Perth and Crianlarich.

7.3.2 Three areas located within the Scheme, defined in **Figure 3.1**, were investigated as part of the geo-environmental assessment (in addition, investigations extended beyond the boundary to the west to investigate ground conditions at existing protection areas). The investigation areas were located northwest of Comrie, including the River Earn Scheme area (as defined in **Chapter 3: Scheme Description & Alternatives**), to the northeast of Comrie including the River Lednock Scheme area (as defined in **Chapter 3: Scheme Description & Alternatives**) and the area around Dalginross including the Water of Ruchill Scheme area (as defined in **Chapter 3: Scheme Description & Alternatives**).

7.3.3 The Preliminary Sources Study Report, Sweco, December 2018, assessed all information within the Scheme area to identify areas of potential contamination and to determine the hydrogeological regime beneath the proposed Scheme and within the wider area.



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Legend

- EIA Study Area
- Existing Rock Protection
- Retaining / Wing Walls

Proposed Designs

- Embankment
- Flood wall
- Culvert
- Reinforced grass - flood gate

Proposed Erosion Protection

- Root Wad Revetment
- Stacked Stone Wall
- Coil Roll Wall

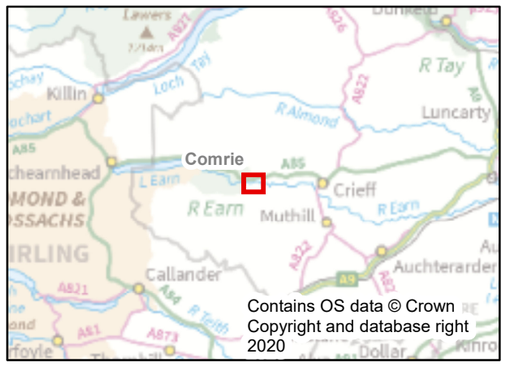
Contamination

- Approximate extent of Former Gas Works Site Investigation

Hydrogeology

- Private Water Supply location at Tigh Bhan, Dalginross (information provided by Perth and Kinross Council)

0 200 400 Metres



Rev.	Rev. Date	Drawing Suitability	Drawn	Appr'd
P01.1	04/02/2020	For Information	JB	RMcL

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PERTH & KINROSS COUNCIL

Project

Comrie Flood Protection Scheme 2020

Drawing Title

Figure 7.1 - Contamination and Hydro-geology Key Constraints Location Plan

Scale @ A3	1:8,000
Project No.	119702

7.3.4 Following identification of potential contamination across the Scheme area, further site investigation and geo-environmental assessment was carried out targeting areas along the proposed Scheme structures.

7.3.5 A separate site investigation was carried out at a former gas works, located within EIA study area, due to particular risks associated with contamination at the site. The investigation boundary is indicated on **Figure 7.1.**

Limitations to the Assessment

7.3.6 The assessment is limited to desk based hydrogeological information and records provided by consultees, and there is potential for unrecorded private water supplies (PWS) within the Study area.

7.3.7 The contamination investigation comprised desk-based assessment of the Scheme area (reported in the PSSR, see **Section 7.3.8**) and targeted site investigations based on the specific locations of Scheme structures. There is therefore potential for other unidentified areas of contamination within the Scheme area that may be encountered during works for the Scheme.

Baseline Data Gathering

7.3.8 In addition to the above information sources, baseline information relating to hydrogeology and contamination has been collated as part of previous and recent assessments as listed below. This includes desk study information, intrusive site investigation, consultation with SEPA and the Councils Contaminated Land Officer (CLO) and geoenvironmental assessments to identify potential contamination risks that could affect the Scheme.

- Preliminary Sources Study Report (PSSR), Sweco, 119398-DOC-200-201 Rev P03, December 2018. This report summarises all available desk-based information and walk over survey data and provides a preliminary assessment of potential geotechnical and geo-environmental constraints;
- Ground Investigation Report (GIR), Sweco, 119398-300-007, February 2019, V3. This report summarises ground investigation data across the Scheme to inform the design and construction of flood defence structures;
- Contamination Assessment Report, Sweco, 119398/CFPS/CAR/2019 Issue 1, March 2019. This report presents interpretation and a risk assessment of the potential impact on receptors from encountered contamination, following intrusive investigation across the scheme;
- Former Gasworks, Contamination Assessment Report, 119398 v2, January 2019. This report presents interpretation and a risk assessment of the potential impact on receptors from potential contamination within the site of a former gas works at the confluence of the River Earn and the River Lednock, based on detailed intrusive site investigation; and,

- Former Gasworks, Remediation Strategy, 119398/RS/DEP/2019 Issue 2, January 2019. This report provides a summary of the available ground investigation data and the resulting contamination assessment, before setting out a strategy for dealing with the identified contamination.

7.3.9 The baseline information is presented in **Section 7.5** and was used to determine potential effects on the identified hydrogeology and contamination receptors.

Assessment of Significance and Mitigation

7.3.10 Potential effects have been identified by predicting the changes (impacts) that would be caused by the construction and operation of the Scheme in relation to the baseline situation.

- The significance of the effect has been defined by taking into account the sensitivity of the receiving environment, the potential likelihood or probability of the impact occurring and magnitude of the change. Professional experience is used to inform the assessment; and
- The sensitivity of a receptor to change is based upon its capacity to accommodate the type of changes that may occur as a result of the Scheme.

7.3.11 **Table 7.1** provides examples of the characteristics that have been used to define the sensitivity of each receptor (contamination and hydrogeology).

Table 7.1: Sensitivity Criteria

Importance (Sensitivity)	Definition & Examples
Very High Receptors with a high quality and/or rarity, regional or national scale and limited potential for substitution / replacement	**Contamination:** The sensitivity associated with potential contamination relates to the potential contamination receptor, e.g. very high sensitivity contamination receptors would include people, such as residents, construction workers and maintenance staff and very sensitive surface water or groundwater bodies (e.g. used for public consumption).
	Hydrogeology: Hydrogeological catchment area is of very high value and importance i.e. provides river baseflow and is used extensively for private and public water supplies, e.g. groundwater abstractions for public or private drinking within 0-250m of the Scheme (greater than 1m depth excavations) or 0-100m (excavations less than 1m depth), Groundwater typically also has a vulnerability classification of 4 or 5.
High Receptors with a high quality and/or rarity, local scale and limited potential for substitution/	**Contamination:** The sensitivity associated with potential contamination relates to the potential contamination receptor, e.g. high sensitivity contamination receptors would include sensitive surface water or groundwater bodies

Importance (Sensitivity)	Definition & Examples
replacement or receptor with a medium quality and rarity, regional or national scale and limited potential for substitution / replacement	**Hydrogeology:** Hydrogeological catchment area is of high value and importance i.e. provides baseflow and used for local private water supplies, e.g. groundwater abstractions for private supply within 250m of the Scheme (greater than 1m depth excavations) or 0-100m (excavations less than 1m depth). Groundwater typically also has a vulnerability classification of 3.
Medium Receptors with a medium quality and/ or rarity, local scale and limited potential for substitution/ replacement or receptor with a low quality and rarity, regional or national scale and limited potential for substitution / replacement	**Contamination:** The sensitivity associated with potential contamination relates to the potential contamination receptor, e.g. medium sensitivity contamination receptors would include buildings or infrastructure, and less sensitive surface water or groundwater bodies.
	Hydrogeology: Hydrogeological catchment area is of medium value and importance and is not generally used for public or private water supplies. Groundwater typically also has a vulnerability classification of 2.
Low Receptors with a low quality and/or rarity, local scale and potential for substitution/ replacement. Environmental equilibrium is stable and is resilient to changes that are greater than natural fluctuations, without detriment to its present character	**Contamination:** The sensitivity associated with potential contamination relates to the potential contamination receptor, e.g. low sensitivity contamination receptors would include landscaping vegetation.
	Hydrogeology: Hydrogeological catchment area is of low value and importance and is not used for public or private water supplies. Groundwater typically also has a vulnerability classification of 1.

7.3.12 The magnitude of a potential impact includes consideration of its timing, scale, size and duration, which for the purposes of this assessment are defined in **Table 7.2**.

Table 7. 2: Impact Magnitude Criteria

Magnitude	Criteria
High	Results in loss of attribute, i.e. long term, permanent change to receptors resulting from activities associated with the Scheme and issues arising from potential contamination, e.g. major changes to the hydrogeological regime, significant effects on Human Health, and significant pollution of the Water Environment.
Medium	Impacts integrity of attribute or results in loss of part of attribute, i.e. short to medium term change to receptors resulting from activities associated with the Scheme and issues arising from potential contamination, e.g. non-significant alteration to the chemical properties of groundwater or surface water.
Low	Results in minor impact on attribute, i.e. detectable but non-material and transitory changes to receptors resulting from activities associated with the Scheme and issues arising from potential contamination, e.g. minor alteration to the chemical properties of groundwater or surface water.

Magnitude	Criteria
Negligible	Results in an impact on attribute but of insufficient magnitude to affect the use/integrity, i.e. no perceptible changes to receptors resulting from activities associated with the Scheme and issues arising from potential contamination.

7.3.13 The sensitivity of the receiving environment, the magnitude of the potential impact and consideration of its likelihood of occurring, helps to evaluate the significance of predicted environmental effects prior to and after application of mitigation measures. The significance of effect has been defined using professional judgement, guided by the criteria outlined in **Table 7.3**. Effects of moderate significance and above (adverse and beneficial) are considered 'significant' and mitigation measures would be considered to avoid, reduce or offset any predicted significant effects. A minor or negligible level of effect is not considered to be significant and therefore no mitigation measures are generally required.

Table 7.3: Significance of Effects

	Sensitivity			
Magnitude	**Very High**	**High**	**Medium**	**Low**
High	Major	Major	Moderate	Minor
Medium	Moderate	Moderate	Moderate	Minor
Low	Minor	Minor	Minor	Negligible
Negligible	Negligible	Negligible	Negligible	Negligible

7.4 Consultation

7.4.1 Consultation has been undertaken with statutory organisations regarding the predicted effects of the Scheme, especially in relation to potential contamination, to inform the scope of assessment. The consultation responses received are summarised in **Table 7.4**.

Table 7.4: Consultation undertaken

Consultee & date of consultation	Summary of consultation	Comment/ Action taken
Perth & Kinross Council (the Council) via email on 18/12/2017.	Request for information regarding private water supplies within the Scheme layout.	• The Council's reply by email was received on 15/1/2018 supplied information on known private water supplies within the Scheme layout and beyond the boundary.

Consultee & date of consultation	Summary of consultation	Comment/ Action taken
Perth & Kinross Council (the Council) via email on 18/12/2017.	Request for information regarding areas of potentially contaminated land.	• The Council's reply by email on 15/1/2018 supplied a map locating areas of potentially infilled ground and previous land uses within the Scheme layout and beyond the boundary. • The Council referred to the former gasworks and indicated that some work had been carried out that identified hydrocarbon and heavy metal contamination. • The Council referred to a former decommissioned filling station on Drummond Street and that more information could be given if requested.
SEPA via email on 18/12/2017	Request for information regarding private water supplies.	• SEPA's reply by email on 18/1/2018 indicated that private water supply information is held by the Council.
SEPA via email on 18/12/2017	Request for information regarding licenced activities within the Scheme layout.	• SEPA's reply by email on 18/1/2018 indicated several licenced activities relating to private sewage works. No groundwater abstractions were noted.

7.5 Baseline Environment

Hydrogeology

7.5.1 Superficial quaternary granular alluvial deposits with localised alluvial cohesive deposits and glacial deposits are present in the vicinity of the surface waters and are defined as concealed aquifers of limited or local potential, without significant groundwater. Deposits typically comprise fine-grained sands, silts and clays with occasional sand, gravel and cobbles. The underlying Precambrian crystalline impermeable basement rocks are generally without groundwater except at shallow depth.

7.5.2 Records from the Council indicate the presence of one PWS location within the Scheme area within the Water of Ruchill catchment approximately 150m east of a proposed cut-off wall (to approximately 1m depth). The location of the PWS is shown on **Figure 7.1**. A further seven locations were provided by the Council, although these are all located more than 800m from the proposed works and outwith the study area, so are not considered further in this assessment. The Council provided this information in their information request response (email on 15th January 2018).

7.5.3 The British Geological Survey Digital Groundwater Vulnerability map of Scotland (sourced from the Council on 16th February 2016) indicates a high vulnerability groundwater classification of 4a beneath the Scheme (i.e. vulnerability to those pollutants not readily adsorbed or transformed), which

relates to the predominantly granular nature of the superficial soils across the Scheme.

7.5.4 The British Geological Survey Digital Bedrock Productivity map of Scotland (sourced from the Council on 16th February 2016) indicates the groundwater beneath the Scheme is Low productivity with predominantly fracture flow.

7.5.5 The online SEPA groundwater classification, accessed via Environment Scotland[1], indicates the Scheme is underlain by Strathearn sands and gravels with a classification of 'Good'.

7.5.6 Groundwater was encountered across the majority of the Scheme area during Site Investigations within superficial deposits, at elevations suggesting strong connectivity with the adjacent surface waters. Site specific permeabilities within superficial sands, gravels and silts vary across the Scheme between 7.28e-5m/s and 2.01e-3m/s, which indicates the presence of relatively permeable materials beneath the Scheme area.

7.5.7 Groundwater vulnerability classification beneath the Scheme indicates high vulnerability, however considering the urban location of the works, the limited use of the hydrogeological resource as a public or private water supply and the scale of the catchment area, the water environment within the study area is considered to be of Medium Sensitivity to potential impacts.

Contamination

7.5.8 An initial assessment of potential contamination risk as documented in the PSSR identified the following potential contamination sources:

- Former gas works within the south-eastern corner of the area near the convergence of River Earn and River Lednock;
- Graveyard located at the junction of Bridge Street and A85;
- Smithy located to the west of the graveyard;
- Disused railway running approximately parallel to the A85 at the distance of circa 100m to the north;
- Garage located off Burrell Street (near Comrie Parish Church);
- Disused historic railway station and sidings extending beneath majority of the Comrie Holiday Park (full extent unknown due to limited historical data);
- Woollen mill located at the Lednock Bridge;
- Substation located near the junction of Strowan Road and Queens Road; and,
- Made ground likely to be present throughout the Scheme area associated with the existing infrastructure.

[1] https://www.sepa.org.uk/data-visualisation/water-classification-hub

7.5.9 Site investigations and a Contamination Assessment were carried out across the Scheme including the three Scheme areas; the River Earn, the River Lednock and the Water of Ruchill to further determine contamination risk to Human Health and the Water Environment from identified contamination sources (reported in the Comrie FPS Contamination Assessment Report, March 2019).

7.5.10 The assessment of the wider Scheme area indicates the presence of made ground along the left and right banks of the River Lednock, east and southeast of Comrie Holiday Park, at Dalginross Bridge and along the west border of Dalginross. Assessment of chemical analysis data indicated that the risk to Human Health from contamination encountered across the Scheme (excluding the gas works) is considered Low for current use and future use. The risk to the Water Environment from identified sources is considered Low/Moderate and localised made ground materials may not be suitable for reuse within the Scheme.

7.5.11 Due to the particular risks from contamination associated with the former gas works, situated immediately northwest of the confluence of the River Earn and River Lednock, a separate investigation and risk assessment was carried out (reported in the Former Gas Works Contamination Assessment Report, January 2019). The risk to Human Health and the Water Environment from identified made ground sources encountered at the former gas works is considered Moderate for current and future use, due to metals and organic contaminant concentrations in excess of published criteria and due to the localised presence of asbestos fibres. A strategy to remediate this contamination was presented in the Former Gasworks, Remediation Strategy, January 2019, which comprises predominantly removal of made ground and the placement of clean cover soils, and which will be undertaken as part of the Scheme.

7.5.12 The contamination assessments concluded that the risk from ground gas to infrastructure across the Scheme (including the former gas works) is considered Low for current use and future use.

7.6 Potential Effects

7.6.1 A construction effect is short term and will only occur during the construction phase of the Scheme (e.g. contamination exposure to construction workers, spillage of oils or chemicals). An operational effect is one that could potentially occur due to impacts during construction but will have a longer lasting effect e.g. alteration of the groundwater regime.

7.6.2 A number of potential effects on the identified baseline hydrogeology and contamination receptors associated with the Scheme have been identified and are detailed in the Construction and Operation subsections below.

7.6.3 The full detail of the assessment to determine the significance of these effects is detailed in the table in **Appendix 7.1**.

Construction Effects

7.6.4 A number of effects predominantly relating to the exposure of human or Water Environment receptors to contamination and the temporary alteration of the groundwater regime may arise from the construction stage. The assessment of potential construction effects takes into account the site conditions, baseline sensitivities and construction activities anticipated. The following potentially significant construction effects have been identified:

- accidental release, leakage or spillages of hydrocarbons, chemicals, fuel or oils from storage tanks or construction plant during construction causing contamination of groundwater;
- localised increase in alkalinity from spillages of concrete or unset cement causing pollution of groundwater, the severity of which may be increased during times of heavy or prolonged rainfall;
- Potential contamination of the water environment due to the disturbance of contamination (especially at the former Gasworks) associated with construction works and in particular deep excavations (e.g. foundations for cut off walls or the mobilisation of contaminants due to groundwater pumping);
- Potential for cross-contamination (including invasive species) across ownership boundaries during investigation or construction;
- Human exposure to contamination (especially at the former gas works), including ground gas and any asbestos present within materials, during construction of flood protection structures; and,
- Localised and temporary alteration of the groundwater regime during construction of the flood protection structures, especially deep excavations (e.g. cut off walls along the rivers Lednock, Earn and Water of Ruchill).

Operational Effects

7.6.5 Potential operational effects on hydrogeology and contamination are expected to occur (or continue to occur) once the Scheme is in operation. The following subsections detail the identified potential effects associated with the operation stage.

Hydrogeology

7.6.6 The following potential effects on hydrogeology have been identified (note that risks to surface water associated with similar effects are considered further in **Chapter 6: Water Environment & Fluvial Geomorphology**):

- Dewatering and alteration of the groundwater regime (drift aquifer) including potential disruption to private water supplies caused by the Scheme, especially from excavations and the construction of deep foundations (e.g. for cut off walls up to 3m depth);

- Potential contamination of water environment by leachable contamination from imported fill materials; and,
- Reduction in infiltration caused by increased hardstanding cover or compaction of soils, resulting in impacts on groundwater.

Contaminated Land

7.6.7 The following potential effects associated with existing contamination (especially the gas works) within the Scheme area have been identified:

- Potential contamination of water environment by increased mobilisation of existing contamination (e.g. through deep excavations or dewatering of excavations);
- Human exposure to contamination (including ground gas) by users of the Scheme, and by maintenance workers on proposed structures; and
- Potential for human exposure to contamination in adjacent areas (including redirection of ground gas caused by Scheme structures).

7.7 Significance of Effects

7.7.1 The identified effects in **Section 7.6** have been assessed following the sensitivity and magnitude assessment process in **Section 7.3**. The results of this assessment are presented in the table in **Appendix 7.1**, along with specific justification for each of the decisions.

7.7.2 In summary, the assessment indicated that the effect on the groundwater flow regime is considered to be of Minor significance during construction and operation, but that there are potential construction and operational risks of Moderate significance associated with Human Health and contamination of the Water Environment that require mitigation.

7.8 Mitigation Measures

7.8.1 The following mitigation measures are required to avoid, reduce or offset any significant predicted effects identified in **Section 7.6**. These are split into mitigation during construction and operational phases of the Scheme.

Embedded Mitigation

7.8.2 No embedded mitigation measures have been identified in relation to hydrogeology and contamination.

Construction Mitigation

7.8.3 Measures to mitigate potentially significant effects arising from the construction of the Scheme are based on standard best practice on site and

are presented below. Further details of the mitigation measures for each of the effects are set out in the assessment table in **Appendix 7.1**, and a summary of the proposed mitigation as follows.

Hydrogeology

7.8.4 The effect on hydrogeology is considered to be of Minor significance during construction therefore no mitigation measures are considered necessary.

Contamination

7.8.5 Measures to mitigate potentially significant effects on receptors from identified contamination which arises from the construction of the Scheme are based on standard best practice on site. These will be included within a Construction Environmental Management Plan (CEMP), and are summarised below. Further details of the committed mitigation measures for each of the effects are set out in the assessments in **Appendix 7.1**.

- Emergency spill kits will be provided on site to protect against accidental release, leakage or spillage of potentially contaminative substances and materials;
- All fuel and other chemicals would be stored in accordance with best management practice within the site compounds. All oil and fuel storage facilities and small static plant would be well managed to minimise the risks of leaks to soil and groundwater;
- Construction plant will be checked regularly and will undergo regular maintenance to ensure the minimisation of leakages and spillages;
- Suitable management measures will be implemented during construction to ensure the control and management of dust;
- Construction activities will be halted should unexpected contamination be identified during construction (e.g. hydrocarbon impacted soils, asbestos) until a suitably qualified professional is consulted to assess the situation and provide advice;
- Any contaminated ground (including invasive species) that is encountered will be dealt with according to best practice and contained in the works or disposed of following best practice to a suitably licensed disposal facility;
- Any concrete and cement mixing and washing areas will be located at appropriate distances from surface watercourses to limit potential pollution of the water environment;
- Site drainage measures, including drainage ditches and silt traps to collect and treat increased surface run-off, will be implemented where required;
- Construction traffic will be limited to allocated routes within the development area;

- The appropriate level of CAR authorisation will be required for all groundwater dewatering activities during the construction phase and groundwater will be collected and treated where necessary;
- Control and management of dust will be implemented through the cleaning of construction plant (e.g. wheel washes and wash down areas) to minimise cross contamination across ownership boundaries; and
- An assessment of potential risks to construction workers from deep excavations or enclosed spaces will be undertaken prior to works being carried out and will include provision of suitable protective measures.

Operational Mitigation

Hydrogeology

7.8.6 No mitigation measures are considered necessary for effects from dewatering or reduction in infiltration as they are considered to have a Minor significance.

Contamination

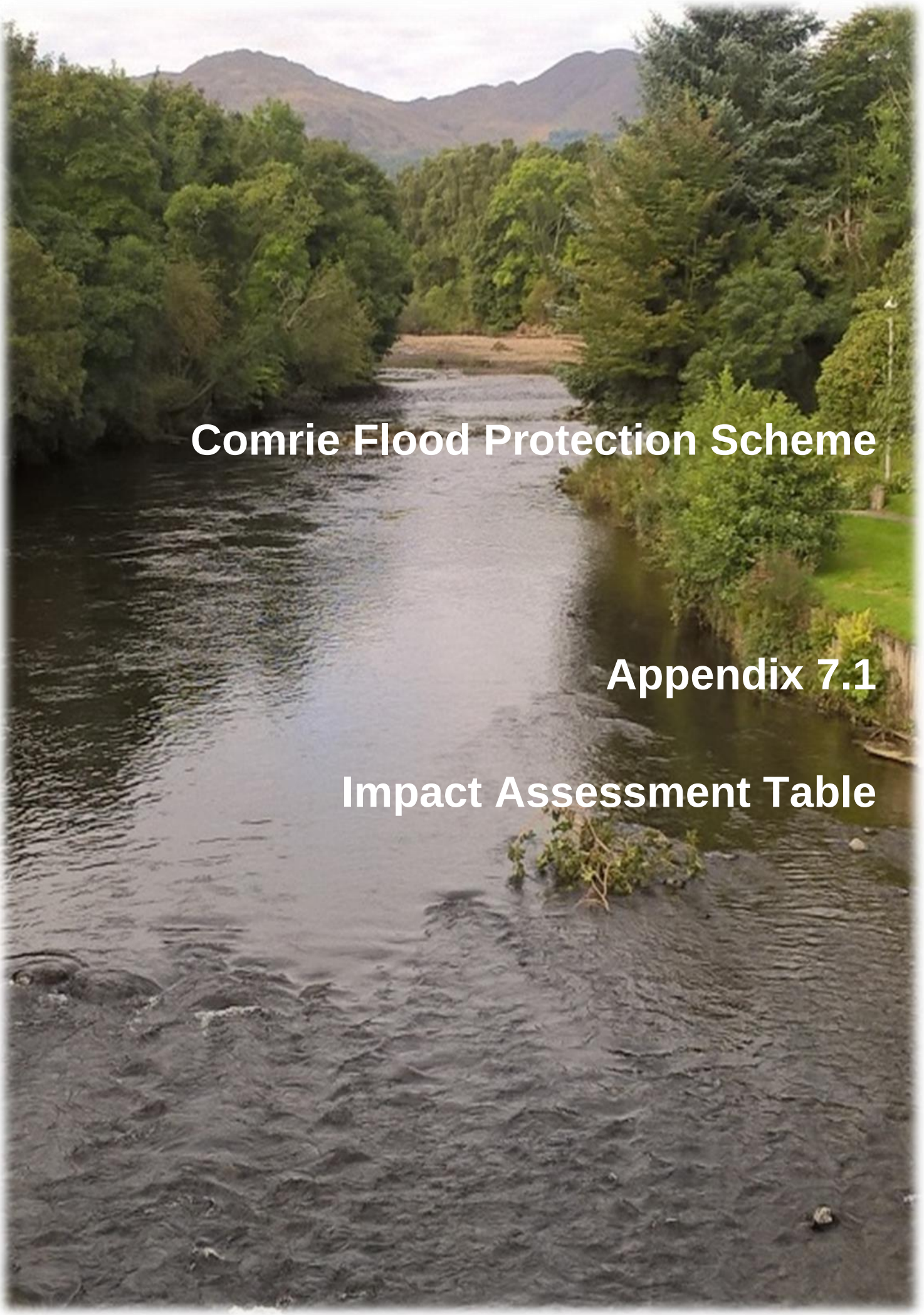
7.8.7 Measures to mitigate potentially significant effects (Moderate significance) on water environment receptors from potential contamination associated with the reuse of contaminated soils within the Scheme are required. Mitigation measures should comprise chemical analysis and assessment of any site-won or imported fill materials to ensure their suitability for use. Further details can be found in the assessment table in **Appendix 7.1**.

7.8.8 A number of potentially significant effects (Moderate significance) associated with the operation of the Scheme have been identified relating to impact on Human Health from contamination associated with the former gas works. Site specific measures to mitigate these potentially significant effects on identified receptors are detailed in the Remediation Strategy and summarised in the following subsection, with further details for each of the identified effects given in the assessment table in **Appendix 7.1**.

7.8.9 The primary source of the contamination within the former gas works will be removed to address potential risks to Human Health, which will also reduce any risks to the Water Environment. This will comprise excavation and removal of 1m depth of made ground and placement of a geotextile membrane to act as a demarcation layer to any residual contaminated soils at depth, with placement of clean cover soils above to a depth of 0.4m.

7.9 Residual Effects

7.9.1 All of the identified potentially significant effects on identified hydrogeology and contamination receptors during the construction and operational stages are considered to be mitigated to a non-significant level (Minor significance) following implementation of the identified mitigation measures. Therefore, no significant residual effects are predicted.



Comrie Flood Protection Scheme

Appendix 7.1

Impact Assessment Table

Impact Assessment Table - Comrie Flood Protection Scheme

SWECO

	PHASE		POTENTIAL EFFECTS (WITHOUT MITIGATION)	SIGNIFICANCE OF POTENTIAL EFFECT (PRE MITIGATION)			JUSTIFICATION		MITIGATION MEASURES	SIGNIFICANCE OF POTENTIAL EFFECT (POST
				SENSITIVITY	MAGNITUDE	SIGNIFICANCE	SENSITIVITY	MAGNITUDE		
HYDROGEOLOGY AND CONTAMINATION	CONSTRUCTION	CONTAMINATION	Accidental release, leakage or spillage of hydrocarbons, chemicals, fuel or oils from storage tanks/construction plant during construction causing contamination of groundwater	Medium	Medium	MODERATE	Due to the limited use of the hydrogeological resource as a public or private water supply and the scale of the catchment area, the water environment within the Scheme area is considered to be of Medium sensitivity to the potential increased mobilisation of contamination during construction.	If this effect were to occur, it is considered likely that it would result in a short to medium term change to the quality of the groundwater body underlying the study area.	Considering the medium sensitivity of the groundwater body underlying the study area and the potential short to medium term change likely to occur, the identified potential effect is considered to be of Moderate Significance. A number of measures to mitigate against this potential effect will be detailed in the CEMP and implemented during construction stage, including: emergency spill kits available on site to protect against accidental release, leakage or spillage of potentially contaminative substances and materials; construction plant will be checked regularly for leakages and will undergo maintenance on a regular basis; construction traffic will be limited to allocated areas of the proposed development area; concrete and cement mixing and washing areas will be sited at appropriate distances from any surface watercourses to limit potential pollution of the water environment; site drainage measures, including drainage ditches and silt traps to collect and treat increased surface run-off, will be implemented where required.	MINOR
			Localised increase in alkalinity from spillages of concrete or unset cement causing pollution of groundwater, severity may be increased during heavy or prolonged rainfall	Medium	Medium	MODERATE	Due to the limited use of the hydrogeological resource as a public or private water supply and the scale of the catchment area, the water environment within the study area is considered to be of Medium sensitivity to the potential increased mobilisation of contamination during construction.	If this effect were to occur, it is considered likely that it would result in a short to medium term change to the quality of the groundwater body underlying the study area.		MINOR
			Potential contamination of the water environment due to the disturbance of contamination (especially at the former Gasworks) associated with construction works and in particular deep excavations (e.g. foundations for cut off walls or the mobilisation of contaminants due to groundwater pumping)	Medium	Medium	MODERATE	Due to the limited use of the hydrogeological resource as a public or private water supply and the scale of the catchment area, the water environment within the study area is considered to be of Medium sensitivity to the potential increased mobilisation of contamination during construction.	If this effect were to occur, it is considered likely that it would result in a short to medium term change to the quality of the groundwater body underlying the study area.		MINOR
			Potential for cross-contamination (including invasive species) across ownership boundaries during investigation or construction	Very High	Low	MINOR	Due to the sensitivity of potential receptors (such as residential land use) to potential cross-contamination across ownership boundaries the sensitivity is considered to be Very High.	The effect is unlikely to result in a detectable or significant impact on the surrounding land uses.	Considering the high sensitivity of the receptors but the low likelihood of a detectable change occurring, a Minor Significance is considered appropriate and therefore no mitigation measures are required. However, standard best practice during the construction stage will minimise cross contamination across ownership boundaries, for example through the control and management of dust and through the cleaning of plant (e.g. wheel washes and wash down areas) where in contact with contaminated soils or invasive species.	MINOR
			Human exposure to contamination (especially at the former Gasworks), including ground gas and any asbestos present within materials, during construction of flood protection structures	Very High	Medium	MODERATE	Considering the potential increased exposure of human receptors (e.g. construction workers, public users of the site) within the study area to potential contamination during the construction stage, the sensitivity of human health is considered to be Very High.	Moderate risk to Human Health receptors from contamination and Low risk from ground gas was identified so a moderate significance has been assigned to increased exposure to potential contamination during the construction stage.	Considering the very high sensitivity of human health, but the relatively low risks identified associated with contamination, a Moderate Significance is considered appropriate and mitigation methods are required, especially for the former gas works. A Construction Environmental Management Plan (CEMP) and associated Risk Assessment and Method Statement will be completed by contractor for the works, which will include the following specific considerations: precautions to protect site operatives and the general public from health hazards associated with dangerous fumes, dust and other contamination arising during the course of the works; adequate precautions to prevent fire or explosion caused by gas or volatile vapours, and provision for the prevention or suppression of dust and odour generation.	MINOR
		HYDROGEOLOGY	Localised and temporary alteration of the groundwater regime during construction of the flood protection structures, especially deep excavations (e.g. cut off walls along the rivers Lednock, Earn and Water of Ruchill)	Medium	Low	MINOR	Due to the limited use of the hydrogeological resource as a public or private water supply (the only known PWS is greater than 100m from a proposed cutting wall up to 1m in depth and considered Medium sensitivity) and the scale of the catchment area, the water environment within the study area is considered to be of Medium sensitivity to the potential localised and temporary alteration of the groundwater regime during construction.	If this effect were to occur, considering the scale of the catchment relative to the likely alteration to the groundwater flow regime, it is considered likely that it would result in a detectable but localised and non-material change and so a Low magnitude is considered appropriate.	Considering the Minor significance, mitigation measures are not considered necessary for this potential effect.	MINOR
	OPERATION	HYDROGEOLOGY	Dewatering and alteration of the groundwater regime (drift aquifer) including potential disruption to private water supplies caused by the Scheme, especially from excavations and the construction of deep foundations (e.g. for cut off walls up to 3m depth)	Medium	Low	MINOR	Due to the limited use of the hydrogeological resources as public or private water supplies (only 1 private water supply identified greater than 100m from a cutting wall 1m in depth) and the scale of the hydrogeological catchment area, the groundwater body underlying the study area is considered to be of Medium sensitivity.	If this effect were to occur, considering the scale of the catchment relative to the likely alteration to the groundwater flow regime, it is considered likely that it would result in a detectable but localised and non-material change and so a Low magnitude is considered appropriate.	Considering the Minor significance, mitigation measures are not considered necessary for this potential effect.	MINOR
			Reduction in infiltration caused by increased hardstanding cover or compaction of soils, resulting in impacts on groundwater	Medium	Low	MINOR		Considering the limited hardstanding cover and small footprint of the works relative to the catchment size, if this effect were to occur it is considered likely that it would result in a detectable but localised and non-material change and so a Low magnitude is considered appropriate.	Considering the Minor significance, mitigation measures are not considered necessary for this potential effect.	MINOR
		CONTAMINATION	Potential contamination of water environment by increased mobilisation of existing contamination (e.g. through deep excavations or dewatering of excavations)	Medium	Medium	MODERATE	Considering the limited use of the hydrogeological resource as a public or private water supply and the scale of the catchment area, the water environment within the study area is considered to be of Medium sensitivity to the potential increased mobilisation of contamination.	If this effect were to occur, it is considered likely that it would result in a short to medium term change to the quality of the groundwater body underlying the study area.	The primary source of the contamination within the former gas works will be removed to address potential risks to human health, which will also reduce any risks to the water environment, as detailed in the remediation strategy.	MINOR
			Potential contamination of water environment by leachable contamination from imported fill materials	Medium	High	MODERATE			Considering the medium sensitivity of the groundwater body underlying the study area and the potential long term change a Moderate Significance is considered appropriate. Mitigation measures are likely to comprise chemical analysis and assessment of any site-won or imported fill materials to ensure their suitability for reuse.	MINOR
			Human exposure to contamination (including ground gas) by users of the Scheme, and by maintenance workers on proposed structures.	Very High	Moderate	MODERATE	Considering the potential for human receptors a Very High sensitivity has been applied to this possible effect.	Moderate risk from contamination and Low risk from ground gas was identified at the former Gasworks and so a moderate significance has been assigned to this potential effect.	Considering the very high sensitivity of human health, but the relatively low risks identified associated with contamination, a Moderate Significance is considered appropriate and mitigation methods are required, especially for the former gas works. These are detailed in the Remediation Strategy and include excavation and removal of 1m depth of made ground and placement of a geotextile membrane to act as a demarcation layer to any residual contaminated soils at depth, with placement of clean cover soils above to a depth of 0.4m.	MINOR
			Potential for human exposure to contamination in adjacent areas (including redirection of ground gas caused by Scheme structures)	Very High	Moderate	MODERATE				MINOR