ENVIRONMENTAL STATEMENT – (VOLUME III)

Appendix 18.2 Summary of Effects

HyNet Carbon Dioxide Pipeline DCO

Planning Act 2008

The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 – Regulations 5(2)(a)

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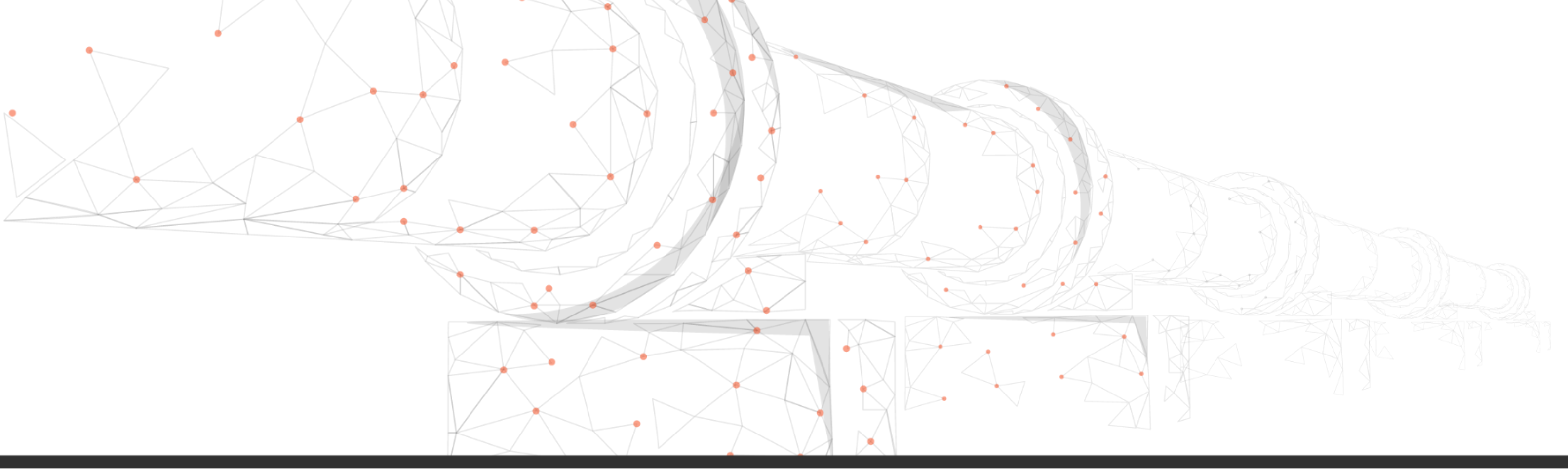

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1. SUMMARY OF EFFECTS

1.1. INTRODUCTION

1.1.1. This appendix presents the assessment of potential effects of the DCO Proposed Development on the water environment and flood risk during the construction, operation and decommissioning stages. This document supports **Chapter 18 – Water Environment and Flood Risk (Volume II)** of the Environmental Statement (ES) provided for the DCO Application.

1.1.2. The assessment of effects utilises **Tables 18.3**, **18.4** and **18.5** of **Chapter 18 – Water Environment and Flood Risk (Volume II)** to define whether a potential impact is likely to be significant. The assessment of likely effects is discussed in **Section 2** and summarised within **Tables 4.1 to 4.19** in **Section 4.**

1.1.3. The assessment presented within this appendix also considers the secondary mitigation for the construction, operation and decommissioning phases in order to determine the residual effects, should this mitigation be implemented. These residual effects are discussed in **Section 3** and summarised in **Section 4** of this appendix, and **Section 18.11** of **Chapter 18 – Water Environment and Flood Risk (Volume II)** of the ES**.**

1.2. RECEPTORS

1.2.1. A full list of receptors scoped into this assessment is presented in **Section 18.4** of **Chapter 18 – Water Environment and Flood Risk (Volume II)** of the ES. Error! Reference source not found. sets out the sensitivities of each of these r eceptors. For the purpose of this appendix, the list of receptors is presented below in Error! Reference source not found.**,** grouped based on sensitivity and t he activities of the DCO Proposed Development which have potential to impact these receptors.

Table 1.1 - Sensitivity of receptors associated with activities for the DCO Proposed Development

Sensitivity	Receptors
Very High	Protected Areas: Dee Estuary Special Protection Area, Mersey Estuary Site of Special Scientific Interest (including Shellfish Water and Cockle Regulating Order)
	Trenchless crossing Shropshire Union Canal, River Dee

Sensitivity	Receptors
	Downstream of watercourse receiving drainage and open cut crossing Manchester Ship Canal
	Residents and users of the surrounding land
High	Trenchless crossing: River Gowy, Railway Ditch 2, Railway Ditch 1, Broughton Brook, Northop Brook, Principal aquifer, GWDTE
	Open cut crossing Stanney Mill Brook, Seahill Tributary 2, Seahill Drain, Sandycroft Drain, Chester Road Drain North, Mancot Brook, Chester Road Brook Tributary 2, Willow Park Brook, New Inn Brook, Alltami Brook, Wepre Brook, Principal aquifer, GWDTE.
	Outfalls: Wepre Brook
	Embedded pipe bridge option: Alltami Brook
	Crossed using temporary crossing: Chester Road Drain North
Medium	Trenchless crossing: Sandycroft Drain, Secondary A and Secondary (undifferentiated) aquifers, private, unlicenced abstractions.
	Open cut crossing: East Central Drain, West Central Drain, Hapsford Brook, Gale Brook, Thornton Uplands, Stanney Main Drain, Gowy Tributary 2, Rake Lane Brook, Backford Brook, Friars Park Ditch, Finchetts Gutter Tributary, Sealand Main Drain, Secondary A and Secondary (undifferentiated) aquifers, private, unlicenced abstractions.
	Outfalls: ~~East Central Drain,~~ Gale Brook, Little Lead Brook, Nant-y-Fflint
	Within Newbuild Infrastructure Boundary:

Sensitivity	Receptors
	Western Boundary Drain
	Crossed using temporary crossings: Hawarden Brook
	Construction Workers
Low	Trenchless crossing: Elton Lane South Ditch, Elton Marsh 1, Elton Brook Tributary 1, Wervin Hall Ditch Tributary
	Trenched crossing: Elton Lane Ditch 1, Elton Lane Ditch 4, Elton Marsh 2, Elton Marsh 13, Hall Green Lane Brook, Thornton Ditch 1, Thornton Ditch 2, Collinge Wood Brook, Grove Road Ditch, Gypsy Lane Brook, Mancot Brook Tributary, Oakfield Ditch 3, Northop Brook Tributary 2, Northop Brook Tributary 1, Canal Ditch.
	Within the Newbuild Infrastructure Boundary which could be subject to trenched crossing measures: Elton Marshes West, Elton Marsh 12, Elton Marsh 11, Thornton Ditch 4, Thornton Ditch 5, Thornton Ditch 5, Thornton Ditch 6, Thornton Ditch 3, Oakfield Ditch 1
	Outfalls: Canal Ditch, Overwood Ditch, Aston Hill Brook Tributary, Wepre Brook Tributary 1, Elton Lane Ditch 1
	Within Newbuild Infrastructure Boundary: Goldfinch Meadow Drain, Marsh Lane Drain, Elton Lane Ditch 2, Elton Lane Ditch 6, Glass Factory Ditch, Elton Marsh 3 Elton Marsh 10, Gowy Tributary 2

1.3. IMPACT TYPES

1.3.1. The following potential impacts during the Construction stage are listed in **Table 1.2** which were identified for the receptors listed in **Table 1.1**.

Table 1.2 - Directness, Duration and Reversibility of Each Potential Impact during the Construction Stage

Construction Impacts	Direct/ Indirect	Short/ Medium/ Long	Temporary/ Permanent
Impact to water quality and hydromorphology from entrainment of material	Direct	Short	Temporary
Impact to water quality from pollution spillages and tempory drainage systems	Direct	Short	Temporary
Impact to hydrological and hydromorphological processes from temporary crossing of watercourses for access	Direct	Short	Temporary
Impact to hydrological and hyromorphological processes from open cut crossings of watercourses	Direct	Short	Temporary
Impact to water quality and hydromorphology due to works in the channel for the culvert replacement and extension	Direct	Short	Temporary
Impact to hydrological and hydromorphological processes from dewatering discharges	Direct	Short	Temporary
Quantitative impacts to Principal ~~and~~ , Secondary A and Secondary (undifferentiated) aquifers	Direct	Short	Temporary
Quantitative impacts to groundwater abstractions,	Indirect	Short	Temporary

Construction Impacts	Direct/ Indirect	Short/ Medium/ Long	Temporary/ Permanent
GWDTE and surface watercourse baseflow			
Pollution of Principal and Secondary A and Secondary (undifferentiated) aquifers	Direct	Short	Temporary
Pollution of groundwater abstractions and GWDTE	Indirect	Short	Temporary
Impact to flood risk	Direct	Short	Temporary

1.3.2. The following potential impacts during the Operation stage are listed in **Table 1.3** which were identified for the receptors listed in **Table 1.1.**

Table 1.3 - Directness, Duration and Reversibility of each Potential Impact during the Operation Stage

Operation Impacts	Direct/ Indirect	Short/ Medium/ Long	Temporary/ Permanent
Impacts associated with loss of riparian vegetation along watercourses	Direct	Long	Permanent
Impacts to hydromorphological forms and processes due to channel and bank reinstatement following open cut crossings	Direct	Long	Permanent
Impacts associated with culvert replacement and extension	Direct	Long	Permanent

Operation Impacts	**Direct/ Indirect**	**Short/ Medium/ Long**	**Temporary/ Permanent**
Impacts associated with the Newbuild Carbon Dioxide Pipeline buried beneath watercourses	Direct	Long	Permanent
Impacts associated with installation of permanent artificial features within the channel or on the bank face of watercourse	Direct	Long	Permanent
Impacts to surface water associated with the new above ground features	Direct	Long	Permanent
Impacts to groundwater flood risk	Direct	Long	Permanent
Impact to flood risk	Direct	Long	Permanent
Impacts associated with an embedded pipe bridge option crossing a watercourse	Direct	Long	Temporary

1.3.3. Potential impacts during the Decommissioning Stage are expected to be similar to those experienced during the Construction Stage.

2. ASSESSMENT OF LIKELY IMPACTS AND EFFECTS

2.1. CONSTRUCTION STAGE

2.1.1. The following potential impacts and effects have been considered in this assessment of likely significant effects. Proposed mitigation for these potential effects is also provided along with further information on mitigation in **Section 3.** The full assessment of impacts and significance of effects is presented in **Table 4.1** to **Table 4.19** in **Section 4.**

IMPACT TO WATER QUALITY AND HYDROMORPHOLOGY FROM ENTRAINMENT OF MATERIAL

Potential Effects

2.1.2. The entrainment of loose sediment either exposed through excavation or stockpiled on site could make its way to sensitive surface water bodies. This can increase the turbidity within the watercourse and have detrimental impacts to both water quality and aquatic ecology. If fine sediment is deposited, it can smother aquatic habitats and impact the oxygen levels in the water body. It can also impact the hydromorphological processes by altering bedforms within the watercourse through sediment deposition and consequently altering the cross-sectional profile and variation. Changes to the sediment dynamics could also potentially alter prevailing erosion and deposition processes operating. The potential for fine sediment accumulations could also result in a change in marginal and in-channel vegetation. This could trigger a feedback loop resulting in further morphological adjustment of the watercourse at the reach-scale.

2.1.3. Temporary drainage systems will be installed at the temporary compounds to manage and reduce the risk of entrainment of material stored at the temporary compounds. Wherever possible, runoff will be collected in containment areas in order that silts (other pollutants) can be captured, and outlets flows can be controlled to agreed rates of discharge.

2.1.4. Potential receptors include all watercourses within close proximity to AGIs, BVSs, new outfalls, temporary compounds and open cut watercourse crossings. As the discharge location for temporary drainage systems is not determined, as a precautionary measure, all watercourses scoped in are considered in the assessment of this impact.

Proposed Mitigation

2.1.5. Adoption and implementation of measures and controls within the **Outline Construction Environment Management Plan (Document reference: D.6.5.4)** to reduce entrainment of loose material.

2.1.6. Turbidity monitoring will be undertaken by an Ecological Clerk of Works (ECoW) during the Construction Stage where deemed required by the Construction

Contractor's Environmental Manager due to the sensitivity of aquatic species receptors. The need and frequency of turbidity monitoring would be determined by the regulatory authority and detailed in any required permits for undertaking work within or near watercourses (**D-WR-044** of the **REAC, Document number: D.6.5.1**).

IMPACT TO WATER QUALITY FROM POLLUTION SPILLAGES AND TEMPORARY DRAINAGE SYSTEMS

Potential Effects

2.1.7. Poor management of harmful chemicals (such as fuels and lubricants) can result in a spillage or leakage of contaminants that could impact the water quality of nearby watercourses and water bodies. Hydrocarbons form a film on the surface of the water body and deplete oxygen levels. Where a spilled liquid is sufficiently toxic above certain concentrations it can result in the death of organisms over a relatively short period of time.

2.1.8. The most common source of pollution is from leaks and spillages of hydrocarbons from mechanical plant or storage vessels. Concrete and cement products can also pose a significant risk to the water environment and are highly alkaline and corrosive. Fish may be physically damaged, and their gills blocked, and both vegetation and the bed of the receiving water body may be smothered. Generally, it is only when large quantities of hazardous substances are spilled, or the spillage is directly into the water body, that a significant risk of acute toxicity would arise in the receiving water.

2.1.9. Centralised Compounds will be served by filter drains which divert water to an area suitable for infiltration. During substantial rainfall, the drainage system will collect runoff from the compound and pass it through tanks with weirs, so that entrained sediment can settle prior to discharge to a nearby watercourse or tankered away.

2.1.10. Potential receptors include all watercourses within close proximity to AGIs, BVSs, temporary compounds and open cut watercourse crossings. As the discharge location for temporary drainage systems associated with the Centralised Compounds is not determined, as a precautionary measure, all watercourses scoped in are considered in the assessment of this impact.

Proposed Mitigation

2.1.11. Adoption and implementation of controls and measures within the **OCEMP (Document reference: D.6.5.4)** to reduce the risk of spillage reaching nearby receptors.

IMPACT TO HYDROLOGICAL AND HYDROMORPHOLOGICAL PROCESSES FROM TEMPORARY CROSSINGS OF WATERCOURSE FOR ACCESS

Potential Effects

2.1.12. Where temporary crossings of watercourses are required for access, it is proposed to temporarily culvert the watercourse with a plastic or concrete pipe and surround with fill material. Once the Construction Stage has completed, these temporary watercourse crossings will be removed, and the watercourse returned to baseline conditions. The location of temporary crossings has not been determined for this Basic Design but will be determined by the Construction Contractor during Detailed Design.

2.1.13. As part of these works, vegetation will need to be removed. It is proposed that riparian vegetation is replanted post-construction however it will take time to return to current maturity depending on the complexity and species richness of the existing baseline condition. Where mature tree vegetation is present, this would lead to a loss of river habitat in the short- to medium-term due to the time to recover.

2.1.14. The installation of a pipe and backfill will temporarily disturb the bed and banks of the watercourse. This could result in a change in geomorphic processes within the watercourse both upstream and downstream of the temporary crossing. For example, the smoothness of the channel will increase through the culvert and therefore velocity will increase and subsequently increase the likelihood of scour occurring at the downstream end of the temporary crossing. In times of high flow, the temporary culvert may not have sufficient capacity to convey flows, resulting in water backing up upstream of the culvert and likely depositing any suspended materials.

2.1.15. There is also risk that backfill material may be loosened by the flows within the channel and increase sediment loading within the watercourse. This sediment loading will be unnatural materials for the watercourse. There could be a deposit of these materials further downstream.

2.1.16. Compaction of the channel bed could also arise due to the temporary crossing of heavy machinery. This could alter exchanges within the hyporheic zone and damage the structure of the riverbed sediments and physical habitat for aquatic species.

2.1.17. Temporary culvert crossings will not be used be used on watercourses where a trenchless crossing method is proposed. Such watercourses will have single-sided access only from each bank.

2.1.18. At open cut crossing locations, temporary crossings will be used to enable passage of construction vehicles to both banks. The location of the temporary crossings at open cut locations will be determined during Detailed Design by the Construction Contractor.

Proposed Mitigation

2.1.19. Adoption and implementation of measures and controls within the **OCEMP (Document reference: D.6.5.4)** to reduce entrainment of loose material.

2.1.20. The relevant permits will be obtained for temporary discharges and in-stream works within ordinary watercourses or main rivers, from the lead local flood authorities, Natural Resources Wales or the Environment Agency (**D-WR-033** of the **REAC, Document reference: D.6.5.1**).

2.1.21. Biodegradable fibre-textile matting or similar will be used to stabilise the backfill material whilst in the channel in accordance with industry best practice guidance **(D-BD-059, D-BD-060** of the **REAC, Document reference: D.6.5.1)**. BioGeo-textiles will be used to stabilise the banks of the watercourse when reinstated, post-removal of the temporary culvert crossing **(D-WR-028** of the REAC, **Document reference: D.6.5.1)**.

2.1.22. The watercourse will be temporarily blocked and pumped over whilst the temporary crossing is constructed, if required **(D-WR-029** of the **REAC, Document reference: D.6.5.1)**.

2.1.21.2.1.23. A sediment boom will be used downstream of the temporary crossing to intercept any sediment artificially mobilised during the Construction Stage (**D-BD-060** of the **REAC, Document reference: D.6.5.1**).

2.1.22.2.1.24. Channel and banks will be reinstated to mimic baseline conditions as far as practicable to ensure more natural bank forms and in-channel features and morphological diversity. This includes reinstatement of an appropriate vegetation assemblage and structure within the riparian zone along with enhancements to the riparian zone to off-set impacts. Any tree loss will be compensated for in accordance with the site wide replanting strategyapproach (**D-BD-048** of the **REAC, Document reference: D.6.5.1**).

2.1.23.2.1.25. Temporary culverts and causeways/access routes will be removed as soon as practicable when no longer required (**D-BD-052** of the **REAC, Document reference: D.6.5.1**).

2.1.24.2.1.26. Turbidity monitoring will be undertaken by an Ecological Clerk of Works (ECoW) during the construction phase where deemed required by the Construction Contractor's Environmental Manager (**D-WR-044** of the **REAC, Document reference: D.6.5.1**). will be undertaken.

IMPACT TO HYDROLOGICAL AND HYDROMORPHOLOGICAL PROCESSES FROM OPEN CUT CROSSINGS OF WATERCOURSES

Potential Effects

~~2.1.25.~~2.1.27. It is proposed that most watercourses potentially impacted by the DCO Proposed Development are crossed by open cut methods. This method involves the watercourse being blocked upstream and downstream of the trench location. Water will be pumped from upstream to downstream whilst the watercourses is blocked to create a dry working area for excavation of the trench. The trench will be cut and the pipe buried before the watercourse cross section is reinstated and vegetation replanted. The temporary blockages will then be removed.

~~2.1.26.~~2.1.28. In some watercourses, there could be a build-up of sediment at the upstream extent of the open cut trench. This could lead to changes in bedforms within the channel resulting in potential alteration of the cross-sectional profile, channel boundary conditions and physical habitat within the channel.

~~2.1.27.~~2.1.29. Open cut crossings will also require the removal of vegetation along the riparian zone and alteration of the exposed bank faces to enable the excavation of a trench and installation of a temporary crossing location for heavy machinery at the open cut location. A working width of up to 32m may be required for these construction activities at open cut crossing locations.

~~2.1.28.~~2.1.30. At the Alltami Brook, it will be necessary to cut through sections of bedrock. The watercourse may be temporarily contained within a pipe culvert whilst the excavation is carried out. The diversion of the watercourse through a pipe could cause mobilisation of sediments downstream due to flow constriction through the temporary pipe, which could result in increased deposition further downstream. This could alter the sediment dynamics and features within the channel. The open cut crossing could remove or disturb existing depositional features such as gravel bars within the watercourse.

~~2.1.29.~~2.1.31. In addition, mature woodland vegetation removal within the working width will be required as part of the enabling works to install an open cut crossing on the Alltami Brook as well as the reprofiling of naturalised steep bank forms.

~~2.1.30.~~2.1.32. Open cut on the Finchetts Gutter Tributary will remove natural bank profiles, complex and mature riparian vegetation on the bank faces, and remove habitat features such as pools and point bars that were observed within a sinuous channel as part of the enabling works and construction activities.

~~2.1.31.~~2.1.33. Open cut crossing on Backford Brook has the potential to remove complex large wood and trees habitat both within the riparian zone and in-channel as part of the enabling works and construction activities. Large wood presently forms complex in-channel habitat diversity in the form of log jams and step-pools. The loss of these habitat features will result in deterioration in river habitat condition at a localised scale.

~~2.1.32.~~2.1.34. Open cut crossing on Friars Park Ditch will remove mature vegetation and large wood/tree habitat as part of the enabling works and construction activities. The removal of these features will result in deterioration in river habitat condition at a localised scale.

~~2.1.33.~~2.1.35. The open cut method may temporarily affect the following hydromorphological processes: flow dynamics, sediment transport, cross-sectional area, longitudinal connectivity, structure and substrate of the watercourse bed, hyporheic connectivity, structure of the riparian zone and erosion and deposition processes operating within the reach. A change to geomorphic processes can alter habitats and impact the ecological receptors within the watercourses as well.

~~2.1.34.~~2.1.36. As flow and connectivity is reinstated, localised erosion of the reinstated bed and banks could occur along with slumping of the banks due to the wetting process.

~~2.1.35.~~2.1.37. Bank reprofiling for both the enabling and reinstatement works will result in engineered bank profiles along the impacted reach of the watercourse. The excavation of the channel bed may also result in an engineered channel form localised to the excavation zone. These impacts could have longer-term impacts to the fluvial form and function of the watercourse.

~~2.1.36.~~2.1.38. As part of these works, vegetation will need to be removed. It is proposed that riparian vegetation is replanted post-construction however it will take time to return to current maturity. Vegetation on some watercourses, namely Friars Park Ditch, Backford Brook, Finchetts Gutter Tributary and Alltami Brook, is not likely to recover within two years of the completion of the Construction Stage.

Proposed Mitigation

~~2.1.37.~~2.1.39. Adoption and implementation of measures and controls within the **OCEMP (Document reference: D.6.5.4)** to reduce entrainment of loose material.

~~2.1.38.~~2.1.40. **D-BD-048, D-BD-060, D-WR-033, D-WR-044** of the **REAC, Document reference: D.6.5.1** will be undertaken.

~~2.1.39.~~2.1.41. A minimal working width will be adopted as far as practicable to minimise the potential impacts of open cut watercourse crossings (**D-BD-018** of the **REAC, Document reference: D.6.5.1**). At Alltami Brook the working width in the channel will ~~be at most~~not exceed 16m within the riparian zone, with only 4m of the brook subject to the open cut trench (**D-WR-063** of the **REAC, Document reference: D.6.5.1**).

~~2.1.40.~~2.1.42. Where practicable, the detailed alignment of the Newbuild Carbon Dioxide Pipeline within the Newbuild Infrastructure Boundary will be explored to minimise potential environmental impacts during Detailed Design (**D-WR-050** of the **REAC, Document reference: D.6.5.1**).

~~2.1.41.~~2.1.43. Where practicable, any habitats that have been removed will be reinstated, such as riffles, pools, point bars, berms, large wood, log jams, cross-sectional and planform variation. Any reinstatement will be ensured to not cause other potential impacts, such as increased flood risk (**D-BD-049** of the **REAC, Document reference: D.6.5.1**).

~~2.1.42.~~2.1.44. A pre-works crossing point survey will be carried out to record channel and bank morphology and features, riparian zone structure, and collect photographic records, so that reinstatement is as close to baseline as practicable. Re-instatement works should be supervised by an appropriately qualified ECoW (**D-WR-052** of the **REAC, Document reference: D.6.5.1**).

~~2.1.43.~~2.1.45. There will be riparian planting along Friars Park Ditch, Backford Brook and Finchetts Gutter Tributary, which is additional to the vegetation which would be reinstated from open cut crossings. This should be a mix of riparian trees and shrub species where practicable (**D-WR-062** of the **REAC, Document reference: D.6.5.1**).

IMPACT TO WATER QUALITY AND HYDROMORPHOLOGY DUE TO WORKS IN THE CHANNEL FOR THE CULVERT REPLACEMENT AND EXTENSION

Potential Effects

~~2.1.44.~~2.1.46. The entrainment of loose sediment exposed through the removal and installation of the new permanent culvert could impact the water quality and hydromorphology of the Elton Lane Ditch 1. If entrained sediment is deposited it can smother aquatic habitats and impact the oxygen levels in the water body. Localised impacts to the hydromorphological processes such as alteration of bedforms within the watercourse through sediment deposition and consequently alteration of the cross-sectional profile and variation. However, this is a low-value receptor for hydromorphology due to it being a low-energy ditch with no perceptible flow.

~~2.1.45.~~2.1.47. Construction works directly in the channel to replace the culvert will increase the likelihood of a spillage of pollutants within the watercourse.

Proposed Mitigation

~~2.1.46.~~2.1.48. Best-practice sediment management controls will be implemented as outlined in the **OCEMP (Document reference: D.6.5.4)**.

~~2.1.47.~~2.1.49. All relevant consents will be sought from the Environment Agency and/or Natural Resources Wales for temporary discharges and in-stream works affecting Main Rivers (**D-WR-033** of the **REAC, Document reference: D.6.5.1**). ~~will be undertaken.~~

IMPACT TO HYDROLOGICAL AND HYDROMORPHOLOGICAL PROCESSES FROM DEWATERING AND HYDROSTATIC TESTING DISCHARGES

Potential Impact

~~2.1.48.~~2.1.50. Dewatering of excavations is likely to be required at the Ince Marshes, Elton Marshes and Thornton Marshes. It is likely that water extracted from the ground will be discharged to nearby watercourses, namely the West Central Drain and River Gowy.

~~2.1.49.~~2.1.51. Hydrostatic testing will be carried out on the Carbon Dioxide Pipeline prior to the Operation Stage. The water used for the testing will either be discharged to a watercourse, public sewer or tankered away. The final method will be determined prior to construction. If discharged to a watercourse the following potential impacts may occur.

~~2.1.50.~~2.1.52. Discharging to watercourses will also temporarily increase flow within the channel. This could lead to localised scour, and subsequently increased sediment transport and deposition downstream. Increased deposition of sediments can damage aquatic habitat.

~~2.1.51.~~2.1.53. Also, there is a risk that discharge of water extracted from excavations could increase turbidity within the watercourse and increase sediment supply, which subsequently will increase deposition of sediments downstream and potentially smothering aquatic habitats. It is proposed that extracted water is put through a sedimentation system prior to discharge to watercourses to minimise this impact.

Proposed Mitigation

~~2.1.52.~~2.1.54. Temporary discharges and in-stream works will comply with the requirements for permits on Main Rivers from the Environment Agency and NRW, ~~as well for ordinary watercourse consent from LLFAs, both regarding acceptable discharge volumes and water quality~~ (**D-WR-033** of the **REAC, Document reference: D.6.5.1**).

~~2.1.53.~~2.1.55. Where ~~reasonably~~ practicable, ~~open trench activities~~construction works will be programmed for the summer months, when groundwater levels are lower, in order to reduce potential impact of local dewatering volumes on local watercourses (**D-WR-030** of the **REAC, Document reference: D.6.5.1**).

QUANTITATIVE IMPACTS TO GROUNDWATER RECEPTORS

~~2.1.54.~~2.1.56. There are multiple areas within the Newbuild Infrastructure Boundary where groundwater levels are shallow and expected to be above the base elevation of the open trenches ~~and/or entry and exit pits~~ of the trenchless crossings. At these locations it is likely that dewatering will be required during the Construction Stage. A quantitative assessment was undertaken to calculate the radius of influence (ROI) for each open trench section ~~and the entry and exit pits~~ of the trenchless crossings to identify any groundwater receptors located within the calculated ROI and which could potentially be impacted by dewatering. The anticipated dewatering rates were also calculated. Given that the Newbuild Carbon Dioxide Pipeline and trenchless crossing pits can be constructed anywhere within the Newbuild Infrastructure Boundary, the calculated ROIs (shown on **Figure 18.3 Sheets 1 to 7 Radii of Influence, Volume IV**) are shown as being measured from the edge of the Newbuild Infrastructure Boundary.

Dewatering Calculation Methodology

~~2.1.55.~~2.1.57. The ROI is defined as the distance from a well or a system of wells to the point at which drawdown is equal to zero (**Ref. 1**). For this assessment, the ROI was calculated from a pit or trench excavation, which represents the point of maximum drawdown. This has been calculated using Sichardt's Equation. The calculation method requires various input parameters, which are presented in **Table 2.1.**

Table 2.1 - Dewatering calculation input parameters

Input Parameter	Source of information
Trench / Pit Depths (m)	This depth has been calculated based on the depth of the Carbon Dioxide. The depth for all open trench sections has been assumed to be the 3 mbgl. It is assumed that any trenchless crossing method could be utilised at the crossing locations and therefore, a typical depth of 9.5 m ~~for the entry and exit pits~~ has been assumed for the calculations.
Lengths (m)	The final dimensions ~~of the entry and exit pits~~ will be dictated by a variety of factors and will be confirmed by the Construction Contractor(s). Note,

Input Parameter	Source of information
	a “worst case” i.e., most impactful method (auger-boring is considered most impactful) has been assumed, for the purpose of the EIA. ~~Note, a “worst case” i.e., most impactful method has been assumed, for the purpose of the EIA, which includes the following entry/exit pit dimensions (for auger-boring as considered most impactful):~~ • ~~entry pits: 8 x 4 m~~ • ~~exit pits: 4 x 4 m~~ A maximum length of 200 m meters has been assumed for all calculations where the open trench is likely to encounter groundwater. However, in reality the length of trench open at any given time will vary dependent on the ground conditions and dewatering required, amongst other factors.
Trench Widths	The trenches will vary in width depending on shoring method and depth of trench, i.e., typically 3 m wide for shored trenches and 3 m plus the depth to bottom of trench for sloped trenches.
Ground Level Elevation (mAOD)	The elevation value used for each pit or trench calculation is based on topographical survey points. The topographical elevation varies across the length of the pits. The elevations used are based on the centre point of the pit. Where the topographical survey didn't record elevations at certain points, information contained on preliminary design drawings has been used to infer the elevations. For areas where the Newbuild Carbon Dioxide Pipeline trench will likely require dewatering, the ground elevation changes along pipe length and therefore, the calculation is based on the elevation at the centre point.
Existing groundwater level (mAOD)	Inferred from continuous groundwater monitoring data (highest levels used), or otherwise spot measurements from GI boreholes, spot measurements, or historical data recorded on BGS borehole logs, Hydrogeological Map etc.

Input Parameter	Source of information
Aquifer Base Elevation (mAOD)	The expected depth of the aquifer has been estimated using nearby relevant BGS borehole records or the GI data, where the full depth of the formation has been encountered.
Permeability (m/s)	BGS records in the first section that recorded permeabilities for the peat deposits. Where GI soakaways not present (or data does not record perm), textbook values have been used. Where there were particle size distribution permeability tests undertaken during the GI, these results have been used to assign permeabilities.

~~2.1.56.~~2.1.58. The equation utilised to calculate potential discharge from an excavation is based on an expansion of the Sichardt equation which incorporated volumetric flow and the length of the excavation (all sides). The equation is given as:

$Q = (0.73 + (0.27 * P / H)) * (k * x * ((H^2) – (h^2))) / L$

Where:

P = Penetration below original water table (m)

H = Initial piezometric level (H)

k = Assigned permeability based on GI and BGS info (m/s)

x = Linear length (of excavation)

H = Initial piezometric level (mAOD)

h = Piezometric level (drawn down) (mAOD)

L = Distance of influence (m, derived using Sichardt equation, with an empirical calibration factor of 2000)

Assumptions and Limitations

~~2.1.57.~~2.1.59. Note, the following assumptions apply to the Sichardt equation:

- That the aquifer is unconfined;
- That the aquifer has an infinite areal extent, and
- That the aquifer is homogenous, isotrophic and of uniform thickness.

~~2.1.58.~~2.1.60. The following assumptions/limitations apply to the equation used to determine dewatering volume:

- That the aquifer is unconfined;
- That the initial water table is horizontal;

- That the aquifer is homogenous, isotropic and of uniform thickness;
- Lo is obtained using the Sichardt formula, taking C as between 1500 - 2000, the default value for C used in this spreadsheet is 2000. However, in high permeability soils where very large values of Lo are calculated, caution is needed. Chapman's equations were developed for ratios L0/H of <5 and may not be suitable for application where Lo is very large; flow rates may be significantly underestimated;
- That the excavations are only partial penetrating the unconfined aquifer below the original water table;
- The calculation assumes the excavation area is completely dewatered;
- That the recorded groundwater level (for a GI location) is assumed to be the original water table;
- The equation assumes that the impact from dewatering affects the full aquifer thickness. In reality a minor excavation (i.e. 5m into a 30m thick aquifer) is unlikely to impact the full aquifer depth beneath the base of the excavation. In a deep or thick aquifer and for anisotropic conditions where Kv<Kh the influence of partial penetration on the yield of a well (or excavation) is likely to be significantly diminished. This is not considered in the equation adopted, and
- Permeability may vary along the length of the excavation i.e. variable lithologies and variations in measured values may occur and there may not be fully represented by available GI data or the simplified approach to estimate discharge. This is overcome by comparing measured permeabilities or infiltration rates with approximate permeability values derived using the Hazen method based on PSD data. Where appropriate, discretised analyses could be performed to represent some variations along the length of the excavation as applies here.

~~2.1.59.~~2.1.61. As the Newbuild Carbon Dioxide Pipeline can be situated anywhere within the Newbuild Infrastructure Boundary and the trenchless crossing method is not confirmed at time of writing, the calculated ROI (and dewatering rate) has been assumed to start from the edges of the Newbuild Infrastructure Boundary. Where groundwater levels were below 10 mbgl (deepest excavation), no ROI has been calculated as no quantitative impact from the DCO Proposed Development would be expected. **Figure 18.3 Sheets 1 to 7 Radii of Influence (Volume IV)** show the receptors with the potential to be impacted relative to the ROI for the trenched sections and trenchless crossings.

~~2.1.60.~~2.1.62. At the locations of AGIs and BVSs the expected excavation depth was compared to the groundwater level to determine if dewatering will be required. The highest likelihood of dewatering was assessed to be at the Cornist Lane BVS due to the proposed 4m of excavation and uncertainty in groundwater levels. Data from the GI at the Rock Bank, Pentre Halkyn and Babell BVS did not record any groundwater levels. At these locations the GI only included trial pits with no groundwater monitoring present, therefore a risk of dewatering could not be ruled out. At the remaining AGIs and BVSs there was a low likelihood of dewatering due to deeper groundwater levels or limited excavation. ROI and flow rates were not calculated for the AGI and BVS locations due to the likelihood of dewatering being low and if dewatering was required, the volumes will be insignificant.

Flow Discharge Calculation Results

~~2.1.61.~~2.1.63. The results of the flow discharge calculations for the trenchless crossings are shown below in **Table 2.2.** Note, any trenchless crossings which are not shown in the table were considered not likely to intercept groundwater and therefore would not lead to any groundwater discharge.

Table 2.2 - Results of flow discharge calculations for trenchless crossing excavations ~~(entry and exit pits)~~ during Construction stage

Crossing	Calculated Maximum* ROI (m)	Calculated Flow Rate (combined**) (m^3/d)	Calculated Flow Rate (l/s)
TRS-01	6	0	0.2
TRS-02	57	34	0.4
TRS-04	6	94	1.1
TRS-05	18	264	3
TRS-06	19	264	3
TRS-07	19	264	3
TRS-08	19	264	3
TRS-09	9	6	<0.1
TRS-10	3	3	<0.1
TRS-17	42	19	0.2
TRS-18	10	1345	16
TRS-19	24	3	<0.1
TRS-22	3.1	6	<0.1
TRS-23	3.3	6	<0.1
TRS-24	3.4	6	<0.1
TRS-26	35	40	0.5
TRS-27	27	31	0.4
TRS-28	8	173	2.0
TRS-29	105	328	3.8

Crossing	Calculated Maximum* ROI (m)	Calculated Flow Rate (combined**) (m^3/d)	Calculated Flow Rate (l/s)
TRS-30	2	7	0.1
TRS-31	19	64	0.7
TRS-32	19	59	0.7
TRS-33	5	6	0.1
TRS-34	3	32	0.4
TRS-35	3	32	0.4
TRS-36	51	51	0.6
TRS-37	48	32	0.4
TRS-38	48	32	0.4
TRS-39	4	2	<0.1
TRS-40	8	5	0.1
RDX-35	28	4	<0.1
TRS-41	168	24	0.3
TRS-43	69	3	<0.1

* The maximum ROI is shown from calculations undertaken ~~for entry and exit pits~~ (whichever is highest)

**Discharge estimates were calculated for individual excavations ~~(entry and exit pits),~~ however have been combined to show totals for trenchless crossings

~~2.1.62.~~2.1.64. The results of the flow discharge calculations for the open trench excavations are shown below in **Table 2.3.**

Table 2.3 - Results of Flow Discharge Calculations for Open Trench Section Excavations during Construction Stage

Section	Open trench location description	Calculated ROI (m)	Calculated inflow rate* (m^3/d)	Calculated inflow rate (l/s)
1	From Ince AGI to TRS-01	1.9	406	4.7
1	Situated between TRS-01 and TRS-02	1.1	131	1.5
2	Situated between TRS-08 and GI borehole BH08	28	572	6.6

Section	Open trench location description	Calculated ROI (m)	Calculated inflow rate* (m^3/d)	Calculated inflow rate (l/s)
2	Situated between previous section and TRS-09	39	1287	14.9
2	Situated between TRS-09 and TRS-10	2.3	76	0.9
2	Situated between TRS-17 and TRS-18	6.4	38	0.4
3	Situated between TRS-26 and TRS-27	21	428	5.0
4	Situated between TRS-28 and TRS-29	32	3357	38.9
4	Situated between TRS-29 and TRS-30	32	3357	38.9
4	Situated between TRS-30 and GI borehole BH51	0.4	204	2.4
4	Situated adjacent to GI borehole BH51	0.4	16	0.2
4	Situated between previous section and TRS-31	0.4	120	1.4
4	Situated between previous section and TRS-32	0.4	16	0.2
4	Situated between previous section and TRS-33	0.4	262	3.0
4	Situated between TRS-33 and end of section 4	1.2	264	3.1

Crossing	Maximum ROI (m)	Flow Rate (combined) (m^3/d)	Flow Rate (l/s)
TRS-01	6	0	0.2

TRS-02	57	34	0.4
TRS-04	6	94	1.1
TRS-05	18	264	3
TRS-06	19	264	3
TRS-07	19	264	3
TRS-08	19	264	3
TRS-09	9	6	<0.1
TRS-10	3	3	<0.1
TRS-17	42	19	0.2
TRS-18	10	1345	16
TRS-19	24	3	<0.1
TRS-22	3.1	6	<0.1
TRS-23	3.3	6	<0.1
TRS-24	3.4	6	<0.1
TRS-26	35	40	0.5
TRS-27	27	31	0.4
TRS-28	8	173	2.0
TRS-29	105	328	3.8
TRS-30	2	7	0.1
TRS-31	19	64	0.7
TRS-32	19	59	0.7
TRS-33	5	6	0.1
TRS-34	3	32	0.4
TRS-35	3	32	0.4
TRS-36	51	51	0.6
TRS-37	48	32	0.4
TRS-38	48	32	0.4
TRS-39	4	2	<0.1
TRS-40	8	5	0.1
RDX-35	28	4	<0.1
TRS-41	168	24	0.3
TRS-43	69	3	<0.1

QUANTITATIVE IMPACTS TO PRINCIPAL AQUIFERS

Sherwood Sandstone Group

~~2.1.63.~~2.1.65. The Sherwood Sandstone Group (SSG) Principal aquifer underlies the Newbuild Carbon Dioxide Pipeline from Stanlow AGI to the River Dee. Construction will require dewatering of the Principal aquifer at several sections of the DCO Proposed Development, associated with open trench and trenchless crossings for the pipe installation.

~~2.1.64.~~2.1.66. To the south of Stanlow AGI, at Thornton le Moors and north of the Shropshire Union Canal west of the A41, the SSG is at shallow depth below ground, with the base of the trenchless crossings expected to be within the SSG. This will likely mean that dewatering of part of the SSG will be required. The dewatering calculations have indicated that a maximum combined inflow rate at the trenchless crossing pits will be approximately 1150 m^3/day (13 l/s), while the calculated maximum ROI within the SSG aquifer is approximately 19 m from the edge of the excavation (**Figure 18.3 Radius of Influence Sheet 1, Volume IV**). Sheet piling on pit walls and the temporary nature of the works and subsequent dewatering will limit the influx of water ~~to the entry and exit pits~~ and limit the total volume of water to be discharged. The use of sheet piling will likely result in a temporary, limited change to groundwater levels and flows within the SSG and mean that the calculated ROI will most likely be higher than what it will be in reality (as the calculation method used doesn't consider the presence of sheet piling).

~~2.1.65.~~2.1.67. The proposed excavation works for the Ince AGI will be entirely within the overlying glacial till, therefore no dewatering risk is expected to the underlying SSG aquifer at this location. No excavations are proposed at Stanlow AGI, and so no dewatering is expected to be required. GI at the Rock Bank and Mollington BVSs has indicated that glacial till is present to the maximum proposed excavation depths, therefore no quantitative impact risk is expected to the SSG aquifer from the proposed works at these locations.

Clwyd Limestone Group

~~2.1.66.~~2.1.68. Alteration of groundwater flows or groundwater levels in the Clwyd Limestone Group (CLG) from excavation and potential minor dewatering at the BVSs are expected to be minimal due to the shallow excavation depths and thickness of superficial deposits overlying the Principal aquifer, as it is unlikely there will be any physical interaction with the Clwyd Limestone Group Principal aquifer.

Quantitative impacts to the (superficial deposits) Secondary A and Secondary (undifferentiated) aquifers

~~2.1.67.~~2.1.69. Blown sand deposits underlie the indicative Stanlow AGI to Flint AGI Pipeline route to the east of the River Gowy. Excavation works within the blown sand deposits will likely require dewatering of the Secondary A aquifer, associated with open trench and trenchless crossings. The dewatering calculations have indicated that a maximum inflow rate from a 200 m open trench section in the blown sand deposits will be approximately 1,300 m^3/day (15 l/s), while the calculated ROI is approximately 39 m. This calculated flow rate is based on a 200 m long trench excavation.

~~2.1.68.~~2.1.70. The glaciofluvial deposits underlie the indicative Stanlow AGI to Flint AGI Pipeline route to the west of Mancot, at Old Aston Hill. Excavation works within the glaciofluvial deposits will likely require dewatering of the glaciofluvial deposit Secondary A aquifer, associated with trenchless crossings. The dewatering calculations have indicated that the maximum inflow rate at a trenchless crossing pit in the glaciofluvial deposits will be approximately 31 m^3/day (0.4 l/s), and the calculated ROI is approximately 50 m. Sheet piling of pit walls and the temporary nature of dewatering will limit further influx of water~~ to the entry and exit pits~~.

~~2.1.69.~~2.1.71. The Aston Hill, Pentre Halkyn and Babell BVSs will be constructed where the glaciofluvial deposits outcrop. The Aston Hill BVS is proposed to be predominantly above the current ground surface and is not expected to require dewatering. The Pentre Halkyn and Babell BVSs are likely to require an excavation depth equivalent to the open trenching depth (approx. 3 mbgl), as shallow groundwater may be present, the requirement for dewatering cannot be fully ruled out at these locations. If present, shallow groundwater volumes would be only very minor.

~~2.1.70.~~2.1.72. Much of the Stanlow AGI to Flint AGI Pipeline route passes over glacial Devensian till, tidal flat deposits and peat which are all categorised as secondary (undifferentiated) aquifers. Excavation works within these deposits will likely require dewatering, associated with open trench and trenchless crossings. The calculated inflow rates for excavations within these formations is generally low (<1 l/s), except for some of the open trench and trenchless crossing excavation in Section 4 where the GI indicated a higher permeability in the tidal flat deposits (due to increased sand content). In these areas a maximum flow rate of 3360 m^3/d (39.9 l/s) was calculated (in reality flow rates will be significantly lower due to implementation of sheet piling or other impermeable structures within the excavations).

Quantitative impacts to the (bedrock) Secondary A and Secondary (undifferentiated) aquifers

Pennine Coal Measures Group

~~2.1.71.~~2.1.73. The Pennine Coal Measures Group (PCMG) (Secondary A aquifer) is found at outcrop along the indicative Stanlow AGI to Flint AGI Pipeline route from Deeside to the Flint AGI. Excavation works for the trenchless crossings will likely be below groundwater level and therefore dewatering of the Secondary A aquifer will be required.

~~2.1.72.~~2.1.74. At Pentre Halkyn and south of Northop Hall the superficial deposits are thin and the PCMG near surface, with the base of the trenchless crossings within the saturated part of the aquifer. This means dewatering of the PCMG, to the base level of the excavation will be required. The dewatering calculations have indicated that the maximum flow rate from a trenchless crossing pit in the PCMG will be approximately 19 m^3/day (0.2 l/s), while the ROI from the pit excavations is approximately 2.7 m. Sheet piling within pit excavations and the temporary nature of dewatering will further limit the influx of water ~~to the entry and exit pits~~ and limit the total volume of water to be discharged.

~~2.1.73.~~2.1.75. The Aston Hill BVS, Northop Hall AGI and Flint AGI will be constructed within the superficial deposits and therefore there will be no impact the bedrock PCMG at these locations.

Millstone Grit Group

2.1.76. The Millstone Grit Group (MGG) Secondary A aquifer is present along the indicative Stanlow AGI to Flint AGI Pipeline route from Deeside to the Flint AGI and at Cornist Lane BVS, where it outcrops. Excavation works at the Cornist Lane BVS are unlikely to require dewatering of the MGG. Trial pits excavated to a depth of 2.7 mBGL did not reach the bedrock and did not encounter any groundwater. ~~Additionally, the majority of the BVS Site is situated on the low permeability Bowland Shale Formation, with only a small section to the east of the BVS overlying the MGG aquifer~~.

2.1.77. Bowland Shale Formation

~~2.1.74.~~ The majority of the Cornist Lane BVS Site is situated on the low permeability Bowland Shale Formation, however no interaction with groundwater is anticipated. No quantitative impact to the Bowland Shale Formation Secondary (undifferentiated) aquifer is anticipated for the entire proposed Scheme (note, there are no Secondary B bedrock aquifers present).

Quantitative groundwater impacts to the Groundwater Dependant Terrestrial Ecosystems (GWDTE)

~~2.1.75.~~2.1.78. To the south of the Ince AGI and the River Gowy (**Figure 18.3 Sheets 1 to 5 Radii of Influence, Volume IV**) the DCO Proposed Development crosses through areas of shallow groundwater which contain GWDTEs, described in **Section 18.6** of **Chapter 18 – Water Resources and Flood Risk (Volume II)** of the Environmental Statement. During the Construction Stage dewatering will occur in these areas associated with open trenching, trenchless crossings, and the construction of the Ince AGI.

~~2.1.76.~~2.1.79. The GI has indicated that groundwater levels in the area to the south of the Ince AGI are shallow (<1 mBGL). The dewatering calculations have indicated that the reasonable worst-case scenario maximum flow rate from a 200 m open trench section in the superficial deposits south of the Ince AGI will be ~406 m^3/day (4.7 l/s), while the calculated ROI is approximately 1.9 m. South of the railway line an exit pit of the trenchless crossing and an open trench section will dewater an area designated as MG9 GWDTE. The MG9, whilst classified as being moderately groundwater-dependent, is considered to be more dependent on surface water sources and rainfall (due to presence of artificial drains) as opposed to groundwater. Furthermore, the abstracted water will be discharged into the nearby surface watercourses of which the MG9 are more reliant on.

~~2.1.77.~~2.1.80. The GI data has indicated that groundwater levels at and in the vicinity of the River Gowy are shallow (<1 mBGL). The dewatering calculations have indicated a flow rate from a 200 m open trench section in the superficial deposits within the area will be ~1,300 m^3/day (15 l/s), and the ROI is approximately 39 m. To the south of woodland strip on the eastern side of the River Gowy MG9, MG10, S5, S12 and S28 GWDTEs are present. If the Carbon Dioxide Pipeline runs along the northern side of the woodland strip the GWDTE will be over 45 m away and out with the ROI for any dewatering. However, if the Newbuild Carbon Dioxide Pipeline runs along the southern side of the woodland, then the ROI of the excavation works could dewater the GWDTE. The identified GWDTE, whilst classified as being moderately groundwater-dependent, are considered to be more dependent on surface water sources and rainfall (due to presence of artificial drains) as opposed to groundwater. Furthermore, the abstracted water will be discharged into the nearby surface watercourses of which the GWDTE are more reliant on.

Quantitative impacts to groundwater abstractions

~~2.1.78.~~2.1.81. There are a number of licenced abstractions and private water supplies within 1 km of the Newbuild Infrastructure Boundary which are outlined in **Table 18.6** of **Chapter 18 – Water Environment and Flood Risk (Volume II)** of the ES. The dewatering assessment has indicated that no identified abstractions are situated within any of the calculated ROIs for the excavations proposed for the Construction Stage. The abstraction point closest to the DCO Proposed Development is the Croughton Road, Caughall abstraction at the Shropshire Union Canal which is down gradient of a trenchless crossing and Centralised Compound (approx. 90 m away). It remains a possibility that dewatering could reduce the yield of the private abstractions however this would be a temporary effect.

Quantitative impacts to surface watercourses with a baseflow component

~~2.1.79.~~2.1.82. There are a number of watercourses located along the Newbuild Infrastructure Boundary which may be in hydraulic connection with shallow groundwater; with groundwater providing a baseflow component to the overall flow of the watercourse. A number of these locations require dewatering during the Construction Stage for open trench and trenchless crossings. The dewatering calculations have identified the following watercourses as potentially being potentially affected:

- Small watercourses to the south of the Ince AGI;
- Gale Brook;
- Thornton Uplands watercourse;
- Thornton Main Drain
- River Gowy;
- Shropshire Union Canal; and
- Broughton Brook

~~2.1.80.~~2.1.83. The dewatering calculations have indicated that the largest flow rate will be 1,300 m^3/day (15 l/s) for the excavation of a 200 m open trench section at the Thornton Main Drain; this flow rate could be reduced by reducing the trench length (130 m^3/day for 20 m trench length). The other watercourses are all within a ROI that has a calculated flow rate of below 150 m^3/day (2 l/s). The watercourses are all within the low permeability glacial till or tidal flat deposits with the exception of the watercourse west of Thornton Green Lane and the Shropshire Union Canal, which are found within the blown sand and alluvium deposits respectively. The low permeability deposits will limit the potential hydraulic connection between groundwater and the watercourses, while the Shropshire Union Canal is a manmade feature and will likely be lined. Therefore, the baseflow component from the blown sands deposit to the Thornton Uplands watercourse is the most at risk of being impacted by dewatering. Abstracted water will be discharged directly into the nearby watercourses, therefore the effect of dewatering on the watercourses mentioned above will not change their overall water balance.

Proposed mitigation

~~2.1.81.~~2.1.84. Adoption and implementation of measures and controls within the **REAC**, contained in ~~Annex A of~~ the **OCEMP (Document reference: D.6.5.4)**, Dewatering Management Plan (DMP) (**D-WR-035** ~~i~~of the **REAC, Document reference: D.6.5.1**) and Groundwater Management and Monitoring Plan (GWMMP) will reduce the potential impacts from dewatering activities (**D-WR-034** of the **REAC, Document reference: D.6.5.1**).

~~2.1.82.~~2.1.85. Dewatering activities (as part of construction works) will be programmed for the summer months, wherever reasonably practicable, when groundwater levels are lower, in order to reduce potential impact of local dewatering volumes (**D-WR-030** of the **REAC, Document reference: D.6.5.1**). Temporary abstractions will comply with the requirements and regulations, including the need for an abstraction license on from the Environment Agency and Natural Resources Wales (NRW). To ensure minimal loss of groundwater quantity from the water environment, water recycling practices such as the re-use of the hydrotest water will be considered as far as practicable (**D-WR-037** of the **REAC, Document reference: D.6.5.1**).

~~2.1.83.~~2.1.86. In areas where shallow groundwater is present, sheet piling and caisson shafts are proposed for the open trench sections and also the trenchless crossing excavations during the Construction Stage (**D-WR-036** of the **REAC, Document reference: D.6.5.1**). The sheet piling and caisson shafts will significantly reduce the rate of groundwater flow into the excavations.

~~2.1.84.~~2.1.87. At the Croughton Road, Caughall abstraction, an existing overhead power line (which will not be moved) will act as a constraint on the final positioning of the pipeline within the Newbuild Infrastructure Boundary, preventing the expected radius of influence of any dewatering from reaching the abstraction and therefore preventing an impact. This is considered an embedded mitigation. The entry and exit pits will be situated at a sufficient distance from the abstraction with the aim of avoiding an impact (**D-WR-038** of the **REAC, Document reference:D.6.5.1**).

~~2.1.85.~~2.1.88. At the GWDTE at the River Gowy, the GWDTE is situated to the south of the NVC vegetation area which the pipeline will not encroach into. As the expected radius of influence from the dewatering does not extend into this area of GWDTE, there is no impact to it anticipated. This is also considered an embedded mitigation. During detailed design, the final alignment will seek to avoid any impact on the GWDTE as far as reasonably practicable. This is expected to be achieved by the final alignment being situated north of the NVC vegetation area. ~~The entry and exit pits will be situated at a sufficient distance from the GWDTE with the aim of avoiding an impact~~ (**D-WR-067** of the **REAC, Document reference:D.6.5.1**).

GROUNDWATER QUALITY IMPACTS

~~2.1.86.~~2.1.89. Across the Newbuild Infrastructure Boundary, trenching techniques used along the Newbuild Carbon Dioxide Pipeline will involve earthworks in which excavated material will be temporarily stored on-site and reused as padding and backfill on completion of the works. Therefore, alongside the working sections of open trenches and trenchless crossings~~ entry/exit pits~~, loose excavated material will be stored above groundwater receptors. At the AGIs, BVSs and compounds it is expected that stripping of topsoil and excavation may be required, which will generate excavated material and exposed ground. Surface runoff from loose excavated material has the potential to increase turbidity in groundwater, resulting in polluting of groundwater receptors.

~~2.1.87.~~2.1.90. Due to the construction activities outlined above, harmful substances will be used and stored across the Newbuild Infrastructure Boundary. Centralised Compounds and Localised Compounds will store harmful substances such as oils and fuels for heavy construction equipment and trucks, and at Trenchless Crossing Compounds, drilling fluids will be present. The construction of the AGIs and BVSs will use and store harmful substances at each location such as vehicle fuels, oils and lubricants. Accidental spillages of these harmful substances could infiltrate to groundwater, polluting groundwater receptors. At the Ince AGI, piling is expected and in areas of shallow groundwater sheet piling is likely. Piling has the potential to create a preferential pathway for contaminants to pollute groundwater receptors. The pollution risk to each groundwater receptor has been assessed below.

Groundwater quality impacts to Principal aquifers

Sherwood Sandstone Group

~~2.1.88.~~2.1.91. Construction works above the SSG will involve open trench and trenchless crossings for the pipe installation and the construction of Ince AGI, Stanlow AGI, Rock Bank BVS, Mollington BVS.

~~2.1.89.~~2.1.92. To the south of Elton westwards along the indicative Newbuild Carbon Dioxide Pipeline route to Thornton Green Lane, GI data has indicated that the SSG is at relatively shallow depth at less than 10 mbgl. While at the Construction Compound alongside the Shropshire Canal the SSG is potentially outcropping. At these locations pollution of the SSG aquifer is at a higher risk due to the lack of superficial cover and the potential of sheet piling to penetrate the SSG aquifer. Across the remainder of the indicative Newbuild Carbon Dioxide Pipeline route where the SSG is present, superficial deposits are from 10 – 50 m thick. The majority of superficial cover is from the glacial till, which will act as an aquitard reducing the pollution risk to bedrock, however there are small regions in which more permeable superficial cover may be in hydraulic continuity with the Principal aquifer.

~~2.1.90.~~2.1.93. As described in **paragraph 2.1.78** trenching in the superficial deposits above the SSG will generate loose material through the excavation works, temporary stockpiles of material and exposed ground which may increase turbidity. While harmful substances will be used above the SSG which could leak from vehicles and construction plant during the trenching and construction of the AGIs and BVSs. Both will increase the risk of pollution to the SSG during the Construction Stage. Where the SSG is in hydraulic continuity with the overlying deposits, major spills of pollutants (e.g. fuels or oils) could migrate through the topsoil and superficial deposits into the SSG polluting the Principal aquifer. Furthermore, at the Ince AGI piling is expected and across areas of shallow groundwater sheet piling is expected above the SSG, this could create a preferential pathway for contaminants to pollute the aquifer.

Clwyd Limestone Group

~~2.1.91.~~2.1.94. The Clwyd Limestone Group (CLG) Principal aquifer underlies the existing Flint Connection to PoA Terminal Pipeline below the superficial deposits. Proposed construction works along the existing Carbon Dioxide Pipeline route will involve excavations, as will the installation of the Pentre Halkyn and Babell BVSs. The depth of block valves will depend on site-specific conditions, however the typical depth of the pipe is assumed to be 3 mbgl, which is shallower than the proven depth of the superficial deposits.

~~2.1.92.~~2.1.95. The construction of the BVSs will generate temporary stockpiles of loose material through the excavation works, temporary stockpiles of material and exposed ground which may increase turbidity within the CLG aquifer. The construction of the BVSs will use harmful substances increasing the potential risks to the CLG Principal aquifer from spillage of pollutants. The Principal aquifer is overlain with superficial cover which will offer protection from pollution. Where the CLG is in hydraulic continuity with the overlying deposits, major spills of pollutants (e.g., fuels or oils) could migrate through the topsoil and superficial deposits into the CLG polluting the Principal aquifer. Fracturing in the limestone could enhance contaminant travel through the aquifer via preferential flow pathways. Where the Principal aquifer is overlain by more impermeable superficial deposits (glacial till) the risk of pollution is low/insignificant.

Groundwater quality impacts to (superficial) Secondary A and Secondary (undifferentiated) aquifers

~~2.1.93.~~2.1.96. The alluvium Secondary A aquifer underlies the Newbuild Infrastructure Boundary at two locations. Alluvium is present at outcrop at the location of the proposed connection to the Stanlow AGI. Alluvium is present at outcrop at the proposed trenchless crossing location of the Shropshire Union Canal. Excavation works within the alluvium at the Stanlow AGI and Shropshire Union Canal will involve open trenched and trenchless crossings.

~~2.1.94.~~2.1.97. The glaciofluvial deposit Secondary A aquifer underlies the area of the Newbuild Infrastructure Boundary at multiple locations. Southeast of the Shropshire Union Canal where the indicative Newbuild Carbon Dioxide Pipeline route crosses the A41 road and surrounding Old Aston Hill Road the glaciofluvial deposits are at outcrop. Construction on the glaciofluvial deposits will involve open trenching, trenchless crossings, Centralised and Localised Compounds, laydown areas and the Aston Hill BVS.

~~2.1.95.~~2.1.98. The blown sand deposits Secondary A aquifer underlies the indicative Newbuild Carbon Dioxide Pipeline where it crosses the M56, 350 m east of the River Gowy. Construction on the blown sand deposits will involve open trenching and a Localised Compound.

2.1.99. The head deposit Secondary A aquifer is found along the indicative Newbuild Carbon Dioxide Pipeline route at locations to the southeast of the A494 and to the northeast of Holywell Road. Construction Stage activities on the head deposits will involve, open trenching, trenchless crossings, laydown areas, Localised Compounds and sections of the Centralised Compound at Holywell Road.

~~2.1.96.~~2.1.100. Much of the indicative Newbuild Carbon Dioxide Pipeline route is over secondary (undifferentiated) aquifers (Devensian till, tidal flat deposits and peat) where construction works will include open trenching and trenchless crossings.

~~2.1.97.~~2.1.101. These construction methods have the potential to generate turbidity. There is a potential for the spillage from construction site machinery of pollutants such as oils, fuels and drilling fluids. This has the potential contaminate the superficial Secondary A and Secondary (undifferentiated) aquifers. Sheet piling may also be required (where shallow groundwater is encountered) which has the potential to create preferential pathways for pollutants to reach the aquifer.

Groundwater quality impacts to (bedrock) Secondary A aquifers

Pennine Coal Measures Group

~~2.1.98.~~2.1.102. The Pennine Coal Measures Group (PCMG) Secondary A aquifer underlies proposed indicative Newbuild Carbon Dioxide Pipeline and the existing Flint Connection to PoA Terminal Pipeline. The GI and BGS borehole records (**Ref. 2**) have indicated that at Chester Road the PCMG is below the superficial deposits at approximately 50 mbgl. It is then found at a relatively shallow depth of 5 -10 mbgl at between Pentre Halkyn BVS and Northop Hall AGI. Westwards from Northop Hall AGI to the Flint AGI the PCMG deepens below the superficial deposits again to approximately 50 mbgl below the superficial deposits. Construction on the PCMG will involve open trench and trenchless crossings for the installation of the Newbuild Carbon Dioxide Pipeline and the construction of Northop Hall AGI, Flint AGI and Aston Hill BVS.

As described in **paragraph 2.1.78** the trenching above the PCMG in the superficial deposits will generate temporary stockpiles of loose material through the excavation works, temporary stockpiles of material and exposed ground which may increase turbidity. While harmful substances will be used above the PCMG for the trenching and construction of the AGIs and BVSs. At the shallower depths between Pentre and Northop Hall the PCMG is more at risk from pollution as the superficial cover is thinner (5 – 10 mbgl) and sheet piles could penetrate bedrock; especially in regions of more permeable superficial deposits (glaciofluvial and head deposits) where greater infiltration rates would be expected. In areas in which trenchless crossing pits could be in direct contact with the PCMG, groundwater abstraction (during dewatering) would form a gradient towards the dewatering point reducing the likelihood of pollution reaching the PCMG aquifer. Regions of the PCMG overlain by thicker glacial till and tidal flat deposits will be at less risk from pollution as the deposits will act as an aquitard. Millstone Grit Group

~~2.1.99.~~2.1.103. The Millstone Grit Group (MGG) Secondary A aquifer underlies the Newbuild Infrastructure Boundary and the existing Flint Connection to PoA Terminal Pipeline. Construction above the MGG will involve open trench and trenchless crossings for the pipe installation and the construction of the Aston Hill BVS and Cornist Lane BVS.

~~2.1.100.~~2.1.104. As described in **paragraph 2.178** trenching above the MGG in the superficial deposits will generate temporary stockpiles of loose material through the excavation works, temporary stockpiles of material and exposed ground which may increase turbidity. While harmful substances will be used above the MGG for the trenching and construction of the Cornist Lane BVS. Both will increase the risk of pollution to the MGG during the Construction Stage. Sheet piling may be required where shallow groundwater is encountered which has the potential to create preferential pathways through the superficial deposits into bedrock.

~~2.1.101.~~2.1.105. The GI and BGS borehole records (**Ref. 2**) have indicated that at Aston Hill the MGG is overlain by 12 m of glaciofluvial deposits, which may offer protection from contamination however infiltration through the permeable deposit to bedrock is possible. At the Cornist Lane BVS, BGS mapping suggests that no superficial deposits are present, however GI data has proven 2.7 m of glacial till across the BVS Site. Excavation at the Cornist Lane BVS may remove the superficial cover and pollution may be directly on to the MGG. However, it is assumed that an unsaturated zone will exist between the surface and groundwater (as no groundwater was encountered in the GI trial pits) which would act as a buffer between any pollutant spillages on the surface and groundwater. Across the rest of the DCO Proposed Development the MGG is overlain by glacial till which will likely act as an aquitard.

Groundwater quality impacts to Groundwater Dependant Terrestrial Ecosystems (GWDTEs)

~~2.1.102.~~2.1.106. To the south of the Ince AGI (**Figure 18.3 Sheets 1 to 5 Radii of Influence, Volume IV**)) the Newbuild Infrastructure Boundary crosses through areas of shallow groundwater which contain GWDTEs. To the south of the Ince AGI, and at the River Gowy, proposed construction activities include open trench excavations and excavations for trenchless crossings. Excavation works for trenching within these GWDTE areas will use vehicles and plant which contain harmful substances that could pollute the receptor. To the south of the Ince AGI the trenching works will occur directly within an area of MG9 therefore direct spillage onto the GWDTE could occur, increasing the risk of pollution to GWDTE during the Construction Stage. The identified GWDTE at both the area south of the Ince AGI and the River Gowy, whilst classified as being moderately groundwater-dependent, are considered to be more dependent on surface water sources and rainfall (due to presence of artificial drains). Therefore, pollution of groundwater will have a lower impact on the GWDTE compared to a community with a higher groundwater dependency.

Groundwater quality impacts to groundwater abstractions

~~2.1.103.~~2.1.107. There are a number of groundwater abstractions within 1 km of the Newbuild Infrastructure Boundary as described in **paragraph 2.1.78.** Pollution would occur indirectly due to abstraction from an aquifer which had been polluted due to turbidity increases or pollution spillages during the Construction Stage. The majority of the abstractions are located in areas where the abstraction and Newbuild Carbon Dioxide Pipeline are underlain by glacial till or tidal flat deposits. Therefore, the risk of pollution is expected to be low due to the deposits acting as an aquitard, protecting the aquifer, and indirectly the abstractions.

~~2.1.104.~~2.1.108. The Bickely Hall Farm abstraction is located 200 m north of the Newbuild Infrastructure Boundary, adjacent to the River Gowy. Pollution risk to the abstraction is low due to the low hydraulic conductivity of tidal flat deposits, glacial till and peat within Newbuild Infrastructure Boundary at the River Gowy. The low hydraulic conductivity of these deposits will reduce the risk of pollution transfer into the underlying aquifer units which are likely to supply the abstraction point. The Croughton Road Caughall abstraction alongside the Shropshire Union Canal is found within alluvium, which is likely to be in hydraulic connection with the underlying SSG and is down gradient of a trenchless crossing and Centralised Compound (approx. 90 m away). Therefore, the abstraction is at a greater risk when compared to areas in which the DCO Proposed Development is within impermeable deposits (glacial till or tidal flat deposits).

Proposed Mitigation

~~2.1.105.~~2.1.109. Adoption and implementation of pollution prevention measures and controls within the **REAC**, **OCEMP (Document reference: D.6.5.4)**, DMP and GWMMP (**Section 18.10** of **Chapter 18 – Water Environment and Flood Risk, Volume II)** of the Environmental Statement). This includes control measures to reduce the potential of increased turbidity and pollution from the spillage of harmful substances:

- Temporary cut-off drains will be used uphill and downhill of the Construction Compounds ~~working areas~~ to prevent clean runoff entering and dirty water leaving the working area without appropriate treatment (**D-WR-007** of the **REAC, Document reference:D.6.5.1**);
- Surface water run-off and excavation dewatering will be captured and settled out prior to disposal ~~to sewer as appropriate~~where practicable. The Construction Contractor will ensure that ~~A~~any contaminants are to be suitably removed prior to disposal; (**D-WR-021** of the **REAC, Document refence: D.6.5.1**).
- The use of silt fences, silt traps, filter bunds, settlement basins and/or proprietary units to treat sediment laden water generated on-site before discharge (**D-WR-024** of the **REAC, Document reference: D.6.5.1**);
- Areas with a great risk of spillage (for example, vehicle maintenance and storage areas for hazardous materials) will be carefully sited (for example, away from drains or areas where surface waters may pond) and on an impermeable surface (**D-WR-010** of the **REAC, Document reference: D.6.5.1**);
- Emergency response plans will be developed, and spill kits made available on-site (**D-WR-011** of the **REAC, Document reference: D.6.5.1**);
- Measures to be put in place to prevent pollution from construction plant including refuelling and lubricating in designated areas, over an impermeable surface, with appropriate cut-off drainage located away from watercourses; plant to be maintained in a good condition with wheel washing in place, and all refuelling would be supervised and carried out in a designated area. In the event of plant breakdown, drip trays would be used during any emergency maintenance and spill kits would be available on-site. (**D-WR-012** of the **REAC, Document reference: D.6.5.1**);
- Construction plant will be checked regularly for oil and fuel leaks, particularly when construction works are undertaken in or near the existing waterbodies (**D-WR-014** of the **REAC, Document reference: D.6.5.1**);
- ~~Refuelling areas would be limited to central compounds and located within sealed bunds.~~ Fuel, oils and other vehicle fluids/lubricants will be stored in sealed bunds that have areas with external cut-off drainage; fuel would be stored in double skinned tanks with 110% capacity (**D-WR-013** of the **REAC, Document reference: D.6.5.1**); and
- Waste fuels and other fluid contaminants will be collected in leak-proof containers prior to removal from the construction area~~Site~~ to an approved recycling processing facility (**D-WR-015** of **the REAC, Document reference: D.6.5.1**).

IMPACTS TO FLOOD RISK

Potential Impact

~~2.1.106.~~2.1.110. Flood risk to residents and users of land surrounding the DCO Proposed Development can be impacted by the following activities:

- Change in surface water runoff due to the creation of temporary impermeable surfaces as part of the works
- Change in surface water flooding likelihood/magnitude/location from site works affecting local topography or existing overland flow routes
- Increase in fluvial flood risk from works within watercourses or the floodplain, or increased runoff to watercourses

~~2.1.107.~~2.1.111. Changes to flood risk might also impact construction workers:

- Working within the floodplain
- Working in close proximity to blocked watercourses

~~2.1.108.~~2.1.112. In relation to the above, an increase in impermeable surface can lead to an increase in surface water runoff as the potential for infiltration is reduced. Increased surface water runoff can in turn increase flow in receiving watercourses or cause ponding in local depressions causing localised flooding. During the Construction Stage it is proposed that Construction Compounds will be served by a temporary drainage system which will collect site runoff and direct it towards an area suitable for infiltration or a nearby watercourse.

~~2.1.109.~~2.1.113. All Centralised Compounds have been sought to be located in the most appropriate place considering space, distance and other receptors, including fluvial and coastal flood risk. A surface water flow route is identified through the Centralised Compound at Chorlton Lane, and Stanlow and Shotton Lane compounds have a small area of high risk of surface water flooding (**Ref. 3** and **Ref. 4**).

~~2.1.110.~~2.1.114. During construction, temporary blockage of watercourses, such as for temporary crossings of open cut crossings, could modify conveyance and potentially increase flood risk in the surrounding area. During the temporary blockage of watercourses, the flows in the blocked watercourses will be maintained using a pump. This would be effective for normal flows however there is a possibility of pump failure or extreme flows in the watercourse which cannot be effectively transferred. The likelihood of these events is very low. For temporary crossings, flow will be maintained within the watercourses via the temporary culvert.

~~2.1.111.~~2.1.115. Extracted water from de-watered excavations is expected to be discharged to the River Gowy and West Central Drain. Temporary discharges would increase current flow rates and potentially increase flood risk downstream.

~~2.1.112.~~2.1.116. Centralised Compounds will have large volumes of material stored. All Centralised Compounds are located outside of the tidal and fluvial floodplain so there is no loss of flood plain storage during the Construction Stage.

~~2.1.113.~~2.1.117. Most construction works are located within areas of low fluvial flood risk or where the land is benefitting from flood defences. Construction works are located in the undefended tidal and/or fluvial floodplain at the following locations:

- Elton Marshes;
- Gale Brook;
- River Gowy and Thornton Marshes;
- Backford Brook;
- Chester Road;
- Wepre Brook.

~~2.1.114.~~2.1.118. Construction workers might be at risk of flooding whilst working in these areas.

~~2.1.115.~~2.1.119. Temporary storage of materials and equipment will be required at Elton Marshes and Thornton Marshes whilst the Newbuild Carbon Dioxide Pipeline is laid through this area. Excavated material from the open trench would be temporarily stored within the working width, whilst material won from trenchless crossings would be stored in the trenchless crossing compounds. However, the volume of floodplain lost from these activities is deemed to be insignificant to the flood storage volume of the whole area and the duration of the works is short term. Therefore, a negligible change to flood risk to surrounding land is expected.

~~2.1.116.~~2.1.120. The floodplain at Backford Brook is narrow and there will be no temporary storage of materials within the fluvial floodplain.

~~2.1.117.~~2.1.121. At Wepre Brook all of the temporary storage areas will be located on higher ground and out of the floodplain. Only construction workers within the channel would be at risk of flooding at this location.

Proposed Mitigation

~~2.1.118.~~2.1.122. Adoption and implementation of measures and controls within the **REAC**, contained in ~~Annex A of~~ the **OCEMP (Document reference: D.6.5.4)** to reduce flood risk to construction workers and nearby residents and land users. We summarise below some of the key measures that will be implemented.

~~2.1.119.~~2.1.123. A Construction Flood Action Plan will be implemented. This will include controls such as:

- The Construction Contractor will sign up for flood warnings and check online warnings regularly when appropriate i.e. following periods of heavy rainfall (.

- The Construction Contractor will monitor weather forecasts so to avoid working in peak flows or at times when flooding is possible;
- If a flood warning is received from the Environment Agency / NRW, all machinery and equipment will be out of the floodplain, where practicable and in advance of potential flooding. If this cannot be completed safely, secure equipment to prevent it being washed away; and
- Avoid works in the floodplain or watercourse during high flow events, intense rainfall events or when a flood warning is issued.

These controls are listed within **D-WR-041** of the **REAC (Document reference:D.6.5.1)**

~~2.1.120.~~2.1.124. Construction works will avoid the positioning of temporary stockpiles and arisings near to watercourses and will ensure material stockpiles and arisings are located outside of the flood zone (where not benefitting from flood defences) where practicable. Welfare faciliti8es and stored equipment and materials to be located within the compounds so that areas of high flood risk are avoided~~Where applicable the layout of the Construction Compounds will be arranged so that materials and welfare facilities are located in an area of lesser surface water flood risk~~ (**D-WR-001** of the **REAC, Document reference: D.6.5.1**).

~~2.1.121.~~2.1.125. A strategy for exceedance flows during pumping will be implemented during peak flows or pump malfunction (**D-WR-054** of the **REAC, Document reference: D.6.5.1**).

~~2.1.122.~~2.1.126. Where reasonably practicable, dewatering activities will be programmed for the summer months, when groundwater levels are lower, in order to reduce potential impact of local dewatering volumes on local watercourses. Therefore, flows in the receiving watercourses should not be peak flows and should not increase fluvial flood risk to a significant level which overwhelms the existing fluvial defences/pumping regime (**D-BD-046** and **D-WR-054** of the **REAC, Document reference: D.6.5.1**).

~~2.1.123.~~2.1.127. **All relevant consents will be sought from the Environment Agency and/or NRW for temporary discharges and in-stream works affecting Main Rivers (D-WR-033** of the **REAC**,~~-~~ (**Document reference: D.6.5.1**)~~ will be undertaken~~.

2.2. OPERATIONAL STAGE

2.2.1. The following potential effects have been considered in this assessment of likely significant effects. Proposed mitigation for these potential effects is also provided along with further mitigation presented in **Section 4**. The full assessment of impacts and significance of effects is presented in **Table 4.1** to **Table 4.19**, **Section 4**.

IMPACTS ASSOCIATED WITH LOSS OF RIPARIAN VEGETATION ALONG WATERCOURSES

Potential Effect

2.2.2. Where vegetation clearance is required near watercourses, mostly at open cut crossings and temporary watercourse crossings, there will be an adverse impact to the riparian zone. Vegetation will be reinstated post-construction, however it will take time for the vegetation to mature to the current conditions in some cases, such as where complex mature woodland is present. This will therefore represent a loss of habitat under the BNG Rivers metric (see **Biodiversity Net Gain Report, Document reference: D.6.5.12).**

2.2.3. Loss of riparian vegetation would leave the material on the bed and banks exposed and vulnerable to erosion or bank failure. Sediment from the bed and banks loosened by geomorphic processes can be deposited further downstream and smother aquatic habitats.

2.2.4. These potential impacts are expected to occur at all watercourses where an open cut crossing and/or a temporary watercourse crossing is proposed. The anticipated impacts would be of larger magnitude at watercourses with existing mature riparian zones (namely, Friars Park Ditch, Backford Brook, Finchetts Gutter Tributary and Alltami Brook). There is also the potential for impacts to sediment processes to affect downstream receiving watercourses.

2.2.5. Degradation of river habitat and encroachment of the bed and banks, through loss of vegetation, is recognised through the biodiversity metric. As the DCO Proposed Development is targeted to deliver 1% net gain on priority habitats, these potential losses are offset by the enhancements proposed elsewhere within the Newbuild Infrastructure Boundary, for priority habitats only.

Proposed Mitigation

2.2.6. **D-BD-052, D-WR-062, D-BD-049, D-BD-060 and D-BD-018** of the **REAC (Document reference: D.6.5.1)** will be undertaken.

IMPACTS TO HYDROMORPHOLOGICAL FORMS AND PROCESSES DUE TO CHANNEL AND BANK REINSTATEMENT FOLLOWING OPEN CUT CROSSINGS

Potential Effects

2.2.7. Following installation of the Newbuild Carbon Dioxide Pipeline, open cut crossings of the channel and banks will be reinstated with backfill. The reinstatement zone could span up to 32m of watercourse channel and banks. The reinstatement of the bed and banks could result in the loss of morphological features observed under baseline conditions, such as riffles, pools, point and side bars, berms and channel sinuosity. Reinstated channels and banks could have straight planforms and uniform bank profiles resulting in a loss of morphological diversity, loss of physical habitat and potential alteration to fluvial processes operating within the reach.

Proposed Mitigation

2.2.8. **D-BD-048, D-WR-052, D-BD-018 and D-WR-063** of the **REAC** (**Document reference:D.6.5.1**) will be undertaken.

IMPACTS ASSOCIATED WITH CULVERT REPLACEMENT AND EXTENSION

Potential Effects

2.2.9. There is one permanent culvert extension proposed as part of the DCO Proposed Development. This is an extension of the existing vehicle crossing at Elton Lane Ditch 1. This is a narrow ditch between a field boundary and an access track. The ditch is likely to be ephemeral and serves the main process of local land drainage of Ince Marshes. This ditch is considered to be of Poor condition within the biodiversity metric.

2.2.10. There is already a culvert at this location, and it is proposed to replace it with a 10m culvert, which is longer than the existing culvert. The existing culvert was not visible during the site visit likely due to vegetation cover, siltation or a small orifice. Replacing the culvert could allow for improving the existing connection through the ditch given the condition of the existing feature. Furthermore, the extension of the culvert is insignificant compared to the length of the ditch. The ditch is already shaded and heavily vegetated at this location so the extended culvert is not expected to cause a significant change to the current conditions.

2.2.11. Riparian planting is proposed to offset the potential effects of this replacement culvert. This riparian planting is proposed approximately 100m away on a neighbouring watercourse within the same catchment. Refer to the replanting approach outlined in the ~~**REAC (**Appendix A of the~~ **OCEMP**~~,~~ **(Document reference: D.6.5.4).**

Proposed Mitigation

2.2.12. There is no additional mitigation required for this potential impact.

IMPACTS ASSOCIATED WITH A CARBON DIOXIDE PIPELINE BURIED BENEATH WATERCOURSES

Potential Effect

2.2.13. The Newbuild Carbon Dioxide Pipeline once in situ could be exposed during its lifetime by fluvial processes of erosion. This could be in the form of channel incision or lateral migration. However, the watercourses potentially impacted are currently in a general state of deposition and therefore erosion of the bed is not anticipated.

2.2.14. High groundwater levels within some zones could cause buoyancy of the pipeline and potentially cause disturbance and interactions with watercourses.

2.2.15. The Newbuild Carbon Dioxide Pipeline will be buried at least 1.2m below the bed level of all watercourses. In some cases, a concrete slab will be placed above the Newbuild Carbon Dioxide Pipeline to prevent scour of the pipeline, should the above watercourses incise. The proposed concrete slab will mitigate the potential risk of buoyancy of the Newbuild Carbon Dioxide Pipeline. At all proposed crossing locations, the watercourses are in a state of deposition and therefore erosion of the bed is not anticipated. Therefore, the Newbuild Carbon Dioxide Pipeline should not be exposed over its lifetime and beyond, therefore not interfering with the baseline geomorphological processes and features of the crossed watercourses.

2.2.16. There are proposals for the re-naturalisation of watercourses within the Newbuild Infrastructure Boundary. This could result in the exposure of the Newbuild Carbon Dioxide Pipeline if appropriate consideration of the future baseline is not given when designing the placement of the asset.

2.2.17. At the River Gowy, it is the aim of the Environment Agency to set the flood embankments further back to allow for increased floodplain connectivity and to reinstate the natural sinuous planform of the channel (**Appendix 18.6 - Record of Engagement, Volume III**). The setting back of the embankments to allow reinstatement of a natural planform is set out in a WFD Mitigation Measure set for this water body to aid the achievement of WFD objectives. The DCO Proposed Development cannot prevent the achievement of this WFD Mitigation Measure in order to secure WFD compliance.

2.2.18. The Alltami Brook historically had a more sinuous planform and may laterally migrate during the lifespan of the Newbuild Carbon Dioxide Pipeline. In addition, there may be aspirations to re-naturalise the planform and fluvial form and processes of the Alltami Brook within the next 25 years.

Proposed Mitigation

2.2.19. The Construction Contractor will undertake further engagement with the Environment Agency Planning and Geomorphology Technical Specialists during the Detailed Design stage to determine the required floodplain extent for pipeline burial depth below the existing riverbed level of the River Gowy. This will determine the potential distance for setting back of the embankments (to a maximum distance of 100m) along the River Gowy to allow for the WFD Mitigation Measure to be achieved (refer to **Appendix 18.3: WFD Assessment (Volume III)** for more information). This mitigation is required to enable the re-naturalisation of a sinuous planform of the River Gowy, as depicted in historical mapping records, without the risk of the Newbuild Carbon Dioxide Pipeline becoming exposed **(D-WR-055** of the **REAC, Document reference: D.6.5.1**).

2.2.20. The Construction Contractor will undertake further consultation with NRW and the Lead Local Flood Authority Planning and Geomorphology Technical Specialists to determine the appropriate depth, type and extent of the Newbuild Carbon Dioxide Pipeline placement so as not to prevent the future re-naturalisation of the Alltami Brook to a sinuous planform (**D-WR-056** of the **REAC, Document reference: D.6.5.1**). For WFD compliance, the DCO Proposed Development cannot prevent the future achievement of WFD status objectives or mitigation measures set for the water body or cause any hydromorphological harm to watercourses.

IMPACTS ASSOCIATED WITH INSTALLATION OF PERMANENT ARTIFICIAL FEATURES WITHIN THE CHANNEL OR ON THE BANK FACE OF WATERCOURSES

Potential Effects

2.2.21. In the **Outline Surface Water Strategy Report (Document reference: D.6.5.13)**, there are new outfalls proposed to be installed at ~~East Central Drain~~ Elton Lane Ditch 1, Canal Ditch, Overwood Ditch, Aston Hill Brook Tributary, Wepre Brook, Little Lead Brook and Nant-y-Fflint, to discharge surface water runoff from AGIs and BVSs. These outfalls will introduce new modifications to the bank and additional flow to the receiving watercourse. The discharge from the outfalls could also introduce fine sediment and pollutants into the receiving watercourses.

2.2.22. The **Outline Surface Water Strategy Report (Document reference: D.6.5.13)** states that outfall discharge rates will be restricted to 2l/s as this is the lowest rate (closest to greenfield rate) practicable to prevent regular blockage. There will also be appropriate treatment trains in place to remove pollutants and sediments from the discharged water. Further details on the drainage strategy is provided in the **Outline Surface Water Strategy Report (Document reference: D.6.5.13)** for the DCO Proposed Development.

2.2.23. There are no headwalls proposed on receiving watercourses. The **Outline Surface Water Strategy Report (Document reference: D.6.5.13)** proposes to discharge to receiving watercourses via an open channel. This design avoids concrete structures within the channel and reduce the risk of scour at the bed and banks.

2.2.24. At Alltami Brook, open cut crossing methodology is proposed which will result in the excavation of bedrock. As bedrock cannot be replaced, the bed and banks of the watercourse will be reinstated with a likely mixture of artificial and natural material. This would result in a permanent loss of a natural bed feature and may induce geomorphic change within the river over time. For example, if the natural bed erodes at a different rate to the concrete bed, this could create knick-points in the channel which can migrate upstream and destabilise banks of the river.

Furthermore, these changes could alter the watercourse so that fish passage is impacted.

2.2.25. The reinstated channel bed will introduce artificial substrate and bed reinforcement to the channel, thus reducing the river condition status and introducing further modification to the channel form and physical habitat. The concrete bed may also cause localised alteration to stream power and shear stress properties within the channel. This could result in increased potential for the entrainment of channel substrate and the transport of sediment. It is anticipated that these impacts would be highly localised should they occur.

Proposed Mitigation

2.2.26. For the Alltami Brook crossing, aA bespoke geomorphological assessment will be carried out by the Construction Contractor (**D-WR-064** of the **REAC, Document reference: D.6.5.1**) to inform:

- micro-siting the crossing location of the pipe so that the least sensitive section of riverbed is permanently impacted, where practicable,
- the detailed design of the permanent works installed as part of the reinstatement of the watercourse after pipe is laid

2.2.27. Further engagement with Natural Resources Wales and the Lead Local Flood Authority Planning would be undertaken to inform the methodology of this bespoke geomorphological assessment.

2.2.28. The width within which the works for the Alltami Brook crossing will be contained will not exceed 16m within the riparian zone. Maximum width of bedrock channel permanently impacted from removal of bedrock will be no more than 4m. The depth of cut would be at least 2.5m below bed level, but the depth would be confirmed during detailed design and with further consultation with NRW (**D-WR-063** of the **REAC**, (**Document reference: D.6.5.1**). will be undertaken.

2.2.29. Geomorphological and ecological monitoring of the permanent works would be carried out, post construction, to identify any potential failure of the permanent works which could lead to a significant impact to the water environment and aquatic habitat. Type, duration and frequency of monitoring is to be determined through the development of the geomorphological assessment and detailed design, and in consultation with NRW and FCC LLFA. Adaptive mitigation would be implemented to prevent deterioration from occurring (**D-WR-065** of the **REAC, Document reference: D.6.5.1**).

IMPACTS TO SURFACE WATER ASSOCIATED WITH THE NEW ABOVE GROUND FEATURES

Potential Effects

2.2.30. There will be four new AGIs and six new BVSs installed as part of the DCO Proposed Development. Each will have an area of impermeable surface and a gravelled area. There is potential for a change in sediment processes associated with overland flow or increased flow within watercourses receiving runoff from the new impermeable surfaces. If flow to watercourses increases significantly, this could lead to scour at the location of the outfall, increased transportation of sediment and increased deposition further downstream. Cathodic Protection transformer rectifier cabinets and pipeline marker posts are small above ground infrastructure which would not have a significant impact on surface water processes.

2.2.31. Water quality of watercourses receiving runoff from AGIs and BVSs could be impacted by entrainment of sediments deposited in hardstanding areas, or from a spillage on these areas flowing overland.

2.2.32. The DCO Proposed Development has a drainage strategy, **Outline Surface Water Strategy Report (Document reference: D.6.5.13),** which includes a treatment train to reduce the likelihood of the AGIs and BVSs contributing to a reduction in water quality. Firstly, filter drains and attenuation ponds should allow sediments to be captured and settled prior to water being discharged to watercourses. Next, runoff will be passed through a vortex or petrol separator to remove additional pollutants and sediments, prior to discharge to watercourse or ground via infiltration.

2.2.33. The drainage strategy for these AGIs and BVSs involves collecting runoff and attenuating it so that it is discharged to receiving watercourses at 2l/s greenfield flow rates or discharge to ground via infiltration. This is the smallest practicable flow restriction so as not to cause blockages. Discharging at low rates will not fully mimic the existing situation, however the volume of runoff from the AGIs and BVSs is small and still restricted to a low flow, therefore no significant change to sediment processes within the watercourses is anticipated.

2.2.34. The collection of runoff will prevent sediment which may be entrained in the runoff being deposited in watercourses, as this will be largely removed through filter drains, attenuation ponds and vortex separators.

2.2.35. Regarding spillages, no chemicals will be stored at the AGIs or BVSs. The AGIs and BVSs are only anticipated to be visited once a month by a couple of vehicles. The likelihood of spillage is so small that the potential impact is insignificant.

2.2.36. The Alltami Brook embedded pipe bridge option will be capped but will not be fully impervious. Surface water from precipitation will runoff from the sides of the structure into the Alltami Brook, along with discharging to ground from drainage holes within the structure. Surface water will then flow overland to Alltami Brook. There will be no formal outfall structure in the Alltami Brook channel. No drainage treatment is required and the drainage arrangement will be similar to existing regarding quantity of flow due to its proximity to Alltami Brook. No further mitigation is required.

Proposed Mitigation

2.2.37. <u>Maintenance </u>~~Visiting~~ vehicles will <u>be equipped with </u>~~take~~ a spill kit in case of emergency and spill kits will be stored in the ~~Electrical and Instrumentation~~ kiosks at AGIs and BVSs (**D-WR-057** of the **REAC, Document reference: D.6.5.1**).

IMPACTS TO GROUNDWATER LEVELS AND FLOWS

Principal aquifers

2.2.38. During the Operational Stage the risk to the SSG and CLG Principal aquifers are confined to areas in which the aquifer units are shallow (thin superficial cover) and the permanent infrastructure extends below the groundwater table acting as an impermeable barrier to shallow groundwater flow.

2.2.39. The Newbuild Carbon Dioxide Pipeline will create an impermeable structure of approximately 0.5 - 1 m in diameter with a minimum depth of cover above the pipework of 1.2 metres. This could cause a barrier effect, backing up groundwater on one side of the pipeline or diverting groundwater flows, creating a local groundwater flood risk. The shallowest part the SSG has been recorded by the GI is 3 - 4 mbgl. This will limit the potential interaction of the pipe and SSG unit, with the pipeline primarily situated within the superficial deposits. The Newbuild Carbon Dioxide Pipeline will not extend over the CLG aquifer (existing pipeline present). The pipeline will have a sand bedding and surround in most locations. be padded and backfilled with a sand material. The sand will be of a sufficient permeability hydraulic conductivity that will allow groundwater to flow around the pipeline reducing the impact on groundwater movement.

2.2.40. Therefore, the barrier effect on groundwater flow within the Principal aquifers from the pipeline is considered negligible.

2.2.41. The AGIs and BVSs with associated drainage infrastructure may create impermeable barriers to groundwater flow due to lined SUDs features and building foundations. However, only the Stanlow AGI and Rock Bank BVS have a shallow superficial cover (<5 m thick) above the Principal aquifers, in these locations groundwater levels will be below the expected depth of any impermeable barriers, negating the risk to groundwater flows.

2.2.42. Recharge to the Principal aquifers could be reduced due to the increased impermeable area as a result of the AGIs and BVSs, impacting groundwater levels. The combined impermeable area for all AGIs and BVSs is less than 16,500 m^2 across the DCO Proposed Development. With the majority of the Newbuild Infrastructure Boundary covered by superficial deposits with a low infiltration rate (glacial till and tidal flat deposits), the impact of the AGIs and BVSs on groundwater recharge will be negligible.

(Superficial) Secondary A and Secondary (undifferentiated) aquifers

2.2.43. During the Operational Stage the risk to the (Superficial) Secondary A and Secondary (undifferentiated) aquifers are confined to the area in which the permanent infrastructure extends below the groundwater table acting as an impermeable barrier to shallow groundwater flow.

2.2.44. The Newbuild Carbon Dioxide Pipeline will create an impermeable structure of approximately 0.5 - 1 m in diameter with a minimum depth of cover above the pipework of 1.2 metres. Areas in which groundwater levels within the (Superficial) Secondary A aquifers are shallow (< 3 mbgl) the barrier effect could cause groundwater to back up on one side of the pipe or divert groundwater flows creating a local groundwater flood risk. This is most likely to be in the blown sand deposits to the east of the River Gowy and in the glaciofluvial deposits east of Aston Hill BVS, as groundwater levels are <2 mbgl. The pipeline will have a sand bedding and surround in most locations. The sand will be of a sufficient hydraulic conductivity that will allow groundwater to flow around the pipeline reducing the impact on groundwater movement.

2.2.45. The AGIs and BVSs with associated drainage infrastructure may create impermeable barriers to groundwater flow due to lined SUDs features and building foundations. The Aston Hill, Pentre Halkyn and Babell BVSs are constructed on (Superficial) Secondary A aquifers. Groundwater levels at the Pentre Halkyn and Babell BVSs are likely to be below the expected depth of any impermeable barriers, negating the potential risk. The Aston Hill BVS is located in an area of shallow groundwater on the glaciofluvial deposits, therefore the BVS and impermeable liners of the SUDs could restrict groundwater flow increasing the risk of groundwater flooding if groundwater flow paths are blocked. The design of the SUDs features will include a permeable drainage layer below any impermeable liners to increase groundwater flow, reducing the impact of impermeable barriers.

2.2.46. Reduction in groundwater recharge to the Secondary A and Secondary (undifferentiated) aquifers from the increased impermeable area will be negligible due to the relatively small size of the infrastructure when compared to the low infiltration superficial deposits.

(Bedrock) Secondary A aquifers

2.2.47. During the Operational Stage the risk to the PCMG and MGG Secondary A aquifers are confined to an area in which the aquifers are shallow (where there is thin superficial cover) and the permanent infrastructure extends below the groundwater table acting as an impermeable barrier to shallow groundwater flow.

2.2.48. The Newbuild Carbon Dioxide Pipeline will create an impermeable structure of approximately 0.5 - 1 m in diameter with a minimum depth of cover above the pipework of 1.2 metres. This could cause a barrier effect, backing up groundwater on one side of the pipe or diverting groundwater flows creating a local groundwater flood risk. Both the PCMG and MGG are overlain by more than 5 m of superficial deposits where the Newbuild Carbon Dioxide Pipeline is present, therefore the barrier effect from the pipeline is negligible on the (Bedrock) Secondary A aquifers.

2.2.49. The AGIs and BVSs with associated drainage infrastructure may create impermeable barriers to groundwater flow due to lined SUDs features and building foundations. The majority of the AGIs and BVS will be constructed on thick superficial deposits above the (Bedrock) Secondary A aquifers. The exception is the Cornist Lane BVS which may be excavated and constructed directly on the MGG. At the Cornist Lane BVS groundwater levels were not encountered during the GI and it has been assumed that an unsaturated zone will exist between the BVSs and groundwater. Furthermore, the design of the SUDs features will include a permeable drainage layer below any impermeable liners to increase groundwater flow, reducing the impact of impermeable barriers.

2.2.50. Reduction in groundwater recharge to the Secondary A aquifers from the increased impermeable area will be negligible due to the relatively small size of the infrastructure when compared to the low infiltration superficial deposits.

GWDTE

2.2.51. During the Operational Stage the risk to the GWDEs are confined to area in which permanent infrastructure extends below the groundwater table acting as an impermeable barrier to shallow groundwater flow towards the GWDTE.

2.2.52. The Newbuild Carbon Dioxide Pipeline will create an impermeable structure of approximately 0.5 - 1 m in diameter with a minimum depth of cover above the pipework of 1.2 metres. To the south of the Ince AGI and at the east of the River Gowy groundwater levels are shallow with the Newbuild Carbon Dioxide Pipeline either passing though or within close proximity to identified GWDTE (**Chapter 18 – Water Environment and Flood Risk, Volume II), paragraph 18.6.10**). This could cause a barrier effect backing up groundwater on one side of the pipe, reducing groundwater levels at the GWDTEs, or diverting groundwater flows which GWDTE are reliant on. Whilst being classified as moderately groundwater-dependent, the GWDTE are considered to be more dependent on surface water sources and rainfall (due to presence of artificial drains) as opposed to groundwater. Furthermore, design of the pipeline will be padded and backfilled with a sand material. The sand will be of a sufficient permeability that will allow groundwater to flow around the pipeline reducing the impact on groundwater flow.

2.2.53. No AGIs or BVSs are located within 1 km of the identified GWDTE, therefore the groundwater level and flow impacts associated with the AGIs and BVSs will not impact the identified GWDTE.

Groundwater Abstractions

2.2.54. During the Operational Stage the risk to the groundwater abstractions is confined to the areas in which permanent infrastructure extends below the groundwater table acting as an impermeable barrier to shallow groundwater flow towards the abstractions.

2.2.55. The Newbuild Carbon Dioxide Pipeline will create an impermeable structure of approximately 0.5 - 1 m in diameter with a minimum depth of cover above the pipework of 1.2 metres. The abstractions which could potentially be impacted by changes to groundwater flows from the pipeline are the Bickley Hall Farm and Croughton Road Caughall abstractions as they are within 250 m downgradient of the Newbuild Infrastructure Boundary. The abstractions are expected to be targeting the underlying bedrock aquifers, rather than the superficial deposits which the pipeline excavations will not fully penetrate in these locations. Additionally, as the impact from the Newbuild Carbon Dioxide Pipeline on the bedrock aquifers is considered negligible, this assessment rating would also apply to the abstractions which target the same aquifers.

2.2.56. No AGIs or BVSs are located within 500 m of groundwater abstractions, therefore the groundwater level and flow impacts associated with the AGIs and BVSs are unlikely to cause a significant impact the groundwater abstractions.

Proposed Mitigation

2.2.57. Trench breakers (clay plugs) will be placed at regular intervals along the Carbon Dioxide Pipeline trench where required to avoid preferential flow pathways being created which could impact groundwater flows to receptors (**D-WR-039** of the **REAC**, (**Document reference: D.6.5.1)**. ~~will be undertaken.~~

GROUNDWATER QUALITY IMPACTS TO GROUNDWATER RECEPTORS

Principal Aquifer

2.2.58. During the Operational Stage the pollution risk to the Principal aquifers comes from leakage of the Newbuild Carbon Dioxide Pipeline and spillage of pollutants (such as vehicle fluids) during the operational works at the AGIs and BVSs.

2.2.59. The Newbuild Carbon Dioxide Pipeline is expected to be within the superficial deposits and not directly within the Principal aquifers at any point within the

Newbuild Infrastructure Boundary. The superficial deposits will reduce the risk of infiltration from a leak on the pipe reaching the Principal aquifers by acting as a buffer (especially where superficial deposits have low permeability). Furthermore, the pipeline will be transporting low solubility gas, therefore any leakage from the pipe will have no significant adverse impact on the Principal aquifers.

2.2.60. The Stanlow AGI and Rock Bank BVS have a shallow superficial cover (<5 m thick) above the Principal aquifers, therefore they have a higher likelihood of pollution relative to the remaining BVSs and AGIs which have a substantial superficial cover offering protection from infiltrating pollutants. At the AGIs and BVSs the drainage design includes permeable pavements, vortex separators, detention ponds and vegetated banks as part of the SUDs to reduce and remove pollutants from runoff before they can infiltrate to groundwater (Please refer to the Outline Surface Water Strategy Report (Document reference D.6.5.13). Therefore, the risk to Principal aquifers from pollution at the AGIs and BVSs is negligible.

(Superficial) Secondary A and Secondary (undifferentiated) Aquifers

2.2.61. During the Operational Stage the pollution risk to the (Superficial) Secondary ~~(~~A ~~)~~ and Secondary (undifferentiated) aquifers comes from leakage of the Newbuild Carbon Dioxide Pipeline and spillage of pollutants (such as vehicle fluids) during the operational works at the AGIs and BVSs.

2.2.62. The Newbuild Carbon Dioxide Pipeline is expected to be within the (Superficial) Secondary (A) and Secondary (undifferentiated) ~~-~~aquifers at multiple points along the Newbuild Infrastructure Boundary (outlined in **paragraph 2.1.61**, however as the pipeline will be transporting low solubility gas any leakage from the pipe will have no significant impact on the (Superficial) Secondary ~~(~~A ~~)~~ and Secondary (undifferentiated) aquifers.

2.2.63. The Aston Hill, Pentre Halkyn and Babell BVSs are proposed to be constructed on (Superficial) Secondary A aquifers. At the Pentre Halkyn and Babell BVSs, groundwater levels are deeper and an unsaturated zone will exist which would act as a buffer between any pollutant spillages on the surface and groundwater. At the Aston Hill BVS, groundwater levels are expected to be shallow and any runoff from the BVSs, could infiltrate the glaciofluvial deposit, increasing pollution risk. At the BVSs the drainage design includes permeable pavements, vortex separators, detention ponds and vegetated banks as part of the SUDs to reduce and remove pollutants from runoff before they can infiltrate to groundwater. This will significantly reduce the risk of pollution to the (Superficial) Secondary A and Secondary (undifferentiated) ~~-~~aquifers.

(Bedrock) Secondary A Aquifer

2.2.64. During the Operational Stage the pollution risk to the (Bedrock) Secondary A aquifers comes from leakage of the Newbuild Carbon Dioxide Pipeline and spillage of pollutants (such as vehicle fluids) during the operational works at the AGIs and BVSs.

2.2.65. The Newbuild Carbon Dioxide Pipeline is expected to be situated within the superficial deposits and not directly within the (Bedrock) Secondary A aquifers at any point within the Newbuild Infrastructure Boundary. The superficial deposits will reduce the risk of infiltration from a leak on the pipe reaching the (Bedrock) Secondary A aquifers by acting as a buffer (especially where superficial deposits have low permeability). Furthermore, the pipeline will be transporting low solubility gas, therefore any leakage from the pipe will have no significant impact on the (Bedrock) Secondary A aquifers. The majority of the AGIs and BVSs will constructed on thick superficial deposits above the (Bedrock) Secondary A aquifers. The exception is the Cornist Lane BVS which may be excavated and constructed directly on the MGG. Therefore, the Cornist Lane BVS will have a higher likelihood of pollution relative to the other BVSs and AGIs as it does not have a substantial superficial cover offering protection from infiltrating pollutants. However, it has been assumed that an unsaturated zone will exist between the Cornist Lane BVS and the MGG aquifer, which would act as a buffer between any pollutant spillages on the surface and groundwater. At the AGIs and BVSs the drainage design includes permeable pavements, vortex separators, detention ponds and vegetated banks as part of the proposed SUDs to reduce and remove pollutants from runoff before they can infiltrate to groundwater. This will significantly reduce the risk of pollution to the (Bedrock) Secondary A aquifers.

GWDTE

2.2.66. During the Operational Stage the pollution risk to the (Bedrock) Secondary A aquifers come from leakage of the Newbuild Carbon Dioxide Pipeline and spillage of pollutants (such as vehicle fluids) during the operational works at the AGIs and BVSs.

2.2.67. To the south of the Ince AGI and at the east of the River Gowy groundwater levels are shallow with the Newbuild Carbon Dioxide Pipeline either passing though or within close proximity to identified GWDTE **Section 18.6** of **Chapter 18 – Water Environment and Flood Risk (Volume II).** Therefore, the GWDTE could be in hydraulic connection with any polluted groundwater from the Newbuild Carbon Dioxide Pipeline. However, the pipeline will be transporting low solubility gas, therefore any leakage from the pipe will have no significant impact on the GWDTE receptors.

2.2.68. No AGIs or BVSs are located within 1 km of the identified GWDTE, therefore the pollution risk associated with the AGIs and BVSs will not impact the identified GWDTE.

Groundwater Abstractions

2.2.69. During the Operational Stage the pollution risk to the groundwater abstractions comes from leakage of the Carbon Dioxide Pipeline and spillage of pollutants (such as vehicle fluids) during the operational works at the AGIs and BVSs.

2.2.70. To the south of the Ince AGI and at the east of the River Gowy groundwater levels are shallow, with the Newbuild Carbon Dioxide Pipeline either passing though or within close proximity to an identified GWDTE (**Section 18.6 of Chapter 18 – Water Environment and Flood Risk, Volume II**). Therefore, the GWDTE could be in hydraulic connection with any polluted groundwater from the Newbuild Carbon Dioxide Pipeline. However, the pipeline will be transporting low solubility gas (carbon dioxide), therefore any leakage from the pipe will have no significant impact on the GWDTE receptors.

2.2.71. The abstractions which could potentially be impacted by pollution from the Newbuild Carbon Dioxide Pipeline are the Bickley Hall Farm and Croughton Road Caughall abstractions. These abstractions are within 250 m hydraulically downgradient of the Newbuild Infrastructure Boundary. However, the abstractions are expected to be reliant on the underlying bedrock aquifers. With the pollution risk to the bedrock aquifers assessed as negligible, the impact to abstractions drawing from bedrock would also be negligible.

2.2.72. No AGIs or BVSs are located within 500 m of groundwater abstractions, therefore the pollution risk associated with the AGIs and BVSs are unlikely to cause a significant impact the groundwater abstractions.

Proposed Mitigation

~~2.2.73. **D-WR-57** and **D-WR-39** of the **REAC (Document reference: D.6.5.1**) will be undertaken.~~

~~2.2.74.~~2.2.73. ~~Visiting~~ Maintenance vehicles will take a spill kit in case of emergency and spill kits will be stored in the ~~Electrical and Information~~ Kiosks at AGIs and BVSs (**D-WR-57** of the **REAC, Document reference: D.6.5.1)**. Trench breakers (clay plugs) will be placed at regular intervals along the Newbuild Carbon Dioxide Pipeline trench as required, to avoid preferential flow pathways for contaminant travel (**D-WR-39** of the **REAC, Document reference: D.6.5.1**)~~l~~. Pressure control systems of pipeline will identify any leakages.

IMPACTS TO FLOOD RISK

Potential Effects

~~2.2.75.~~2.2.74. Flood risk to residents and users of land surrounding the DCO Proposed Development could be impacted by the following:

- Increase in surface water runoff and flood risk associated with new impermeable surfaces as part of the DCO Proposed Development
- Increase in fluvial flood risk associated with changes to watercourses, surface water flow routes or floodplains as a consequence of the DCO Proposed Development.

~~2.2.76.~~2.2.75. The potential flood risk associated with the DCO Proposed Development is assessed and mitigated for in the accompanying **Flood Risk Assessment (Appendix 18.4, Volume III)** and **Flood Consequences Assessment (Appendix 18.5, Volume III)** required to support the DCO Application in line with NPPF (England) (**Ref. 5**) and TAN15 (Wales) (**Ref. 6**).

~~2.2.77.~~2.2.76. Ince and Stanlow AGIs are located within the fluvial / tidal floodplain which is controlled by the existing flood defences and the associated standard of protection available in the area. Finished floor levels at Ince AGI are proposed to be raised above the surrounding (existing) land elevation. This helps mitigate against any residual risk, including that associated with the high groundwater level present in the area. At time of writing, the proposal for Stanlow AGI is for the final floor elevation to remain approximately the same as current, as from a flood risk perspective there is not a requirement to raise the floor level.

~~2.2.78.~~2.2.77. Rock Bank BVS and Mollington BVS are located in Flood Zone 1 (land assessed as having a less than 0.1% chance of flooding any given year from rivers or sea). Aston Hill BVS, Northop Hall AGI and Flint AGI are all located in Zone A (considered to be at little or no risk of fluvial or coastal flooding). Therefore, these above ground features cannot affect fluvial or coastal flood risk to nearby land or residents/users.

~~2.2.79.~~2.2.78. Some limited encroachment in the existing surface water flow routes at Rock Bank BVS and Flint AGI would not cause significant effects. The proposed drainage strategy, described in the **Outline Surface Water Drainage Strategy (Document reference: D.6.5.13)**, at the AGI and BVS locations will control this runoff and discharge it at 2l/s as this is the lowest rate (closest to greenfield rate) practicable to prevent regular blockage, therefore mimicking existing conditions as much as possible.

~~2.2.80.~~2.2.79. There will be no permanent changes to the watercourses which would alter fluvial flood risk. Watercourses crossed by open cut methods will be returned to their current cross-section. The only watercourse with permanent changes is the Alltami Brook where the natural bed of the watercourse will likely be replaced with concrete or another artificial material after the open cut crossing is complete.

~~2.2.81.~~2.2.80. The Alltami Brook embedded pipe bridge option was assessed for its impact to coastal, fluvial, pluvial, groundwater, sewer and drainage infrastructure and artificial sources.

~~2.2.82.~~2.2.81. The embedded pipe bridge will be designed to prevent any increase in fluvial flood risk to Alltami Brook or elsewhere. The embedded pipe bridge will be designed in a way so as not to disrupt the flow of Alltami Brook. Therefore, during operational stage the pipeline is unlikely to impact or be impacted itself by fluvial flooding.

~~2.2.83.~~2.2.82. The embedded pipe bridge will include integral surface water drainage that would discharge surface water runoff from the edge of the pipe bridge to Alltami Brook. Therefore, it is deemed unlikely to increase pluvial flood risk elsewhere.

Proposed Mitigation

~~2.2.84.~~2.2.83. Inclusion of emergency procedures within the site management and operation plans for BVSs and AGIs for when a flood warning is received.

~~2.2.85.~~2.2.84. Groundwater monitoring will be carried out to inform detailed design and identify associated groundwater flood risk.

2.3. DECOMMISSIONING STAGE

2.3.1. The decommissioning stage will involve the removal of the AGIs, BVSs and the Alltami Brook embedded pipe bridge option, and their associated drainage features. The Carbon Dioxide Pipeline will be left in situ, where it is below ground, and therefore no new trenches across watercourses are anticipated.

2.3.2. Impacts to water quality during the decommissioning of the embedded pipe bridge, AGIs and BVSs are likely to be similar to those expected during the Construction stage. There is potential for sediment supply to watercourses to be increased during this phase due to works in close proximity to watercourses to remove outfalls and works in the channel to remove the embedded pipe bridge. Similarly, if spillage were to occur during these activities, these could reach the nearby watercourses. Please refer to the impact described in **Section 2.1** and **Table 4.1** and **Table 4.2** for the assessment of these impacts.

2.3.3. The embedded pipe bridge is located in an area at risk of flooding and therefore the impacts are likely to be similar to those anticipated during the construction phase. Please refer to the impact described in **Section 2.1** and **Table 4.9** for the assessment of this impact.

2.3.4. All AGIs and BVSs are located in areas at low risk of flooding and therefore decommissioning works within this area are likely to have a negligible impact on surrounding land and workers (**Table 4.19**).

2.3.5. Please refer to the potential impacts described in the Construction stage in **Section 2.1**. These effects do not consider the implementation of measures within a Demolition Environment Management Plan (DEMP) or the GWMMP which will be a requirement during decommissioning. The implementation of measures within the DEMP is listed as required mitigation and is included in the assessment of residual effects.

3. ASSESSMENT OF RESIDUAL EFFECTS

3.1.1. Mitigation is proposed to be adopted during the construction, operation and decommissioning stages of the DCO Proposed Development. When adopted, the magnitude of potential impacts can be reduced, resulting in a reduced significance of effect.

3.1.2. The mitigation to be adopted to reduce the magnitude of each impact is explained in **Section 2**. This mitigation is captured in **Register of Environmental Actions and Commitments (REAC)** which forms an appendix to the **OCEMP (Document reference: D.6.5.4)**.

3.1.3. The residual effects associated with implementation of the measures listed in **Section 2** are presented in **Table 4.1** to **Table 4.19.**

4. SUMMARY OF ASSESSMENT OF EFFECTS

4.1. CONSTRUCTION STAGE

Table 4.1 - Assessment of impacts to water quality and hydromorphology by entrainment of materials

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
Shropshire Union Canal, River Dee	Very high	Watercourses will be crossed using trenchless methods therefore no works will take place within the channel. No works will take place within the flood defences of the River Dee or River Gowy. The canal is raised above surrounding land. Therefore no hydrological connection from nearby working areas. Some particles within the air may deposited within these water bodies. The River Dee is downstream of watercourses crossed by open cut methods. There is potential for sediment supply to increase to these watercourses, however	Minor Adverse	***Moderate Adverse (Significant)***	Implementation of measures outlined in the **OCEMP (Document reference: D.6.5.4)**	*Slight Adverse (Not Significant)*

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
		they have sufficient flow to transport sediment further to where impacts are negligible.				
River Gowy	High	Watercourse will be crossed using trenchless methods therefore no works will take place within the channel. No works will take place within the flood defences of the River Gowy. Therefore there will be no hydrological connection from adjacent working areas. There is a Centralised Compound, where stockpiles are located, which is hydrologically connected to the Gowy via tributaries. Some particles within the air may deposited within these waterbodies. The Gowy is downstream of watercourses crossed by open cut methods. There is potential for sediment supply to increase	Minor Adverse	*Slight Adverse (Not Significant*)	Implementation of measures outlined in the **OCEMP (Document reference: D.6.5.4)** Turbidity monitoring	*Slight Adverse (Not Significant)*

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
		to these watercourses, however they have sufficient flow to transport sediment further to where impacts are negligible.				
Watercourses which are crossed by open cut methods with a Q95<1m^3/s. Monitored under WFD and provide habitat for a protected species.	High	Watercourses will be crossed by open cut methods which could result in potential impacts to channel geomorphology from increased fine sediment suppory, in-channel construction and vegetation clearance.	Moderate Adverse	***Moderate Adverse (Significant)***	Implementation of measures outlined in the **OCEMP (Document reference: D.6.5.4)** Turbidity monitoring	*Slight Adverse (not significant)*
Watercourses which are crossed by open cut methods with Q95>0.001m^3/s not monitored under WFD	Medium	Watercourses will be crossed by open cut methods, which could result in potential impacts to channel geomorphology from increased fine sediment suppory, in-channel construction and vegetation clearance.	Moderate Adverse	***Moderate Adverse (Significant)***	Implementation of measures outlined in the **OCEMP (Document reference: D.6.5.4)** Turbidity monitoring	*Neutral (not significant)*
Watercourses which are not crossed by open trench methods with Q95>0.001m^3/s	Medium	Watercourses downstream of other watercourses which are crossed via open cut techniques. Potential impacts to channel	Minor Adverse	*Slight Adverse (Not Significant)*	Implementation of measures outlined in the **OCEMP**	*Neutral (not significant)*

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
not monitored under WFD		geomorphology and water quality due to increased sediment supply from upstream watercourses.			**(Document reference: D.6.5.4)**	
Watercourses which are crossed by open cut methods with Q95<0.001m^3/s not monitored under WFD	Low	Watercourses which are crossed by open cut methods could result in potential impacts to channel geomorphology from increased fine sediment suppory, in-channel construction and vegetation clearance.	Moderate Adverse	*Slight Adverse (Not Significant)*	Implementation of measures outlined in the **OCEMP (Document reference: D.6.5.4)** Turbidity monitoring	*Neutral (Not Significant)*
Watercourses which are not crossed by open trench methods with Q95<0.001m^3/s not monitored under WFD	Low	Watercourses downstream of other watercourses which are crossed via open cut techniques. Potential impacts to channel geomorphology and water quality due to increased sediment supply from upstream watercourses.	Minor Adverse	*Neutral (Not Significant)*	Implementation of measures outlined in the **OCEMP (Document reference: D.6.5.4)**	*Neutral (Not Significant)*
Dee Estuary Special Protection Area and Mersey Estuary Site of	Very High	There are no direct works in or adjacent to these protected areas. There are some	Minor Adverse	***Moderate Adverse (Significant)***	Implementation of measures outlined in the **OCEMP**	*Slight Adverse*

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
Special Scientific Interest (including Shellfish Water and cockle Regulating Order)		watercourses upstream of these protected areas which are crossed by open cut methods. There is potential for increased sediment supply to reach these protected areas.			**(Document reference: D.6.5.4)**	*(not significant)*
Alltami Brook	High	The embedded pipe bridge option will include construction work being undertaken adjacent to and over the watercourse. These works have the potential impact to channel geomorphology from increased fine sediment supply, removal of riparian zone vegetation and potential reprofiling of valley sides adjacent to the riverbanks.	Moderate Adverse	***Moderate Adverse (Significant)***	Implementation of measures outlined in the **OCEMP** **(Document reference: D.6.5.4)** **[REP2-021]**	*Slight Adverse (not significant)*

Table 4.2 - Assessment of impacts to water quality by spillage of pollutants

<table>
<tr><th>Receptor</th><th>Sensitivity of receptor</th><th>Potential impact</th><th>Magnitude of impact</th><th>Signficance of effect</th><th>Mitigation</th><th>Residual effect</th></tr>
<tr><td>Shropshire Union Canal</td><td>Very High</td><td>Crossed using trenchless methods therefore no works within the channel. The canal is raised above surrounding land. Therefore no hydrological connection from nearby working areas where spillages may occur.</td><td>No Change</td><td>Neutral (not significant)</td><td>Implementation of measures outlined in the OCEMP (Document reference: D.6.5.4)</td><td>Neutral (not significant)</td></tr>
<tr><td>River Dee</td><td>Very High</td><td rowspan="2">Crossed using trenchless methods therefore no works within the channel. No works would take place within the flood defences of the River Dee or River Gowy. Therefore no hydrological connection from nearby working areas where spillages may occur.

The River Gowy and River Dee are downstream of watercourses crossed by open cut methods. There is</td><td>Minor Adverse</td><td>Moderate Adverse (Significant)</td><td>Implementation of measures outlined in the OCEMP (Document reference: D.6.5.4)</td><td>Slight Adverse (not significant)</td></tr>
<tr><td>River Gowy</td><td>High</td><td>Minor Adverse</td><td>Slight Adverse (Not Significant)</td><td>Implementation of measures outlined in the OCEMP (Document</td><td>Slight Adverse (not Significant)</td></tr>
</table>

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
		potential for a spillage to reach these watercourses, however they have higher flows to provide more dilution			**reference: D.6.5.4)**	
Watercourses which are crossed by open cut methods with a $Q95<1m^3/s$. Monitored under WFD and provide habitat for a protected species.	High	Watercourses crossed by open cut methods. There is potential for spillages to occur within or adjacent to the channel.	Moderate Adverse	***Moderate Adverse (Significant)***	Implementation of measures outlined in the **OCEMP (Document reference: D.6.5.4)**	*Slight Adverse (not significant)*
Watercourses which are crossed by open cut methods with $Q95>0.001m^3/s$ not monitored under WFD	Medium	Watercourses crossed by open cut methods. There is potential for spillages to occur within or adjacent to the channel.	Moderate Adverse	***Moderate Adverse (Significant)***	Implementation of measures outlined in the **OCEMP (Document reference: D.6.5.4)**	*Neutral (not significant)*

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
Watercourses which are not crossed by open trench methods with Q95>0.001m^3/s not monitored under WFD	Medium	Watercourses downstream of other watercourses which are crossed via open cut techniques. There is potential for spillages to occur within or adjacent to the channel. From upstream watercourses.	Minor Adverse	*Slight Adverse (Not Significant)*	Implementation of measures outlined in the **OCEMP (Document reference: D.6.5.4)**	*Neutral (not significant)*
Watercourses which are crossed by open cut methods with Q95<0.001m^3/s not monitored under WFD	Low	Watercourses crossed by open cut methods. There is potential for spillages to occur within or adjacent to the channel.	Moderate Adverse	*Slight Adverse (Not significant)*	Implementation of measures outlined in the **OCEMP (Document reference: D.6.5.4)**	*Neutral (not significant)*
Watercourses which are not crossed by open cut methods with Q95<0.001m^3/s not monitored under WFD	Low	Watercourses downstream of other watercourses which are crossed via open cut techniques. There is potential for spillages to occur within or adjacent to	Minor Adverse	*Neutral (Not Significant)*	Implementation of measures outlined in the **OCEMP (Document reference: D.6.5.4)**	*Neutral (not significant)*

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
		the channel from an upsteam watercourse.				
Dee Estuary Special Protection Area and Mersey Estuary Site of Special Scientific Interest (inlcuding Shellfish Water and cockle Regulating Order)	Very High	There are no works proposed within the protected areas. The protected areas are downstream of watercourses crossed by open cut methods. There is potential for a spillage to reach these areas, however the potential impact is reduced by dilution within large water bodies and the time for a spillage to reach these receptors is long and allows for interception and remediation before the effect occurs.	Moderate Adverse	***Large Adverse (Significant)***	Implementation of measures outlined in the **OCEMP (Document reference: D.6.5.4)**	*Slight Adverse (not significant)*
Western Boundary Drain	Medium	The watercourses would be crossed by an existing road which will be used for access to the construction	Negligible	*Neutral (not significant)*	Implementation of measures outlined in the **OCEMP**	*Neutral (not significant*

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
		sites. There will be no physical change to the watercourse. There would be a temporary increase in traffic volume on the existing road, but there would be no additional traffic route or any works with machinery close to this watercourse.			**(Document reference: D.6.5.4).**	
Alltami Brook	High	The embedded pipe bridge will include construction work being undertaken adjacent to and over the watercourse. There is potential for spillage of pollutants from machinery and construction activities to occur within or adjacent to the channel.	Moderate Adverse	*Moderate Adverse (Significant)*	Implementation of measures outlined in the **OCEMP** **(Document reference: D.6.5.4)** ~~**[REP2-021]**~~	*Slight Adverse (not significant)*

Table 4.3 - Assessment of impacts to hydrological and hydromorphological processes from temporary crossings of watercourses for access

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
Shropshire Union Canal, River Dee	Very High	No temporary crossings expected.	No Change	*Neutral (not significant)*	None required.	*Neutral (Not Significant)*
River Gowy	High	No temporary crossing expected, however downstream of tributaries which would be termporarily crossed.	Minor Adverse	*Slight Adverse (Not Significant)*	Use of bio-textiles to stabilise fill material (D-BD-059 of the REAC, document reference: D.6.5.1)~~.~~ Temporary blockage of watercourse during construction and use of sediment boom (D-BD-060 of the REAC, document	*Slight Adverse (Not Significant)*
Watercourses crossed by temporary crossings which are: Monitored under WFD; have Q95<1m^3/s, and/or provide habitat for a protected species.	High	Introduction of material and temporary culverting within the watercourse could impact aquatic habitat and affect hydrological and hydromoprhological processes within the watercourse as explained above.	Moderate Adverse	***Moderate Adverse (Significant)***		*Slight Adverse (not significant)*
Watercourses crossed by temporary crossings which are: Not monitored under WFD; have	Medium		Moderate Adverse	***Moderate Adverse (Significant)***		*Neutral (not significant)*

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
Q95>0.001m^3/s, and do not provide habitat for a protected species.					reference: D.6.5.1). Turbidity monitoring (D-WR-044 of the REAC, document reference: D.6.5.1)	
Watercourses crossed by temporary crossings which are: Not monitored under WFD; have Q95<0.001m^3/s, and do not provide habitat for a protected species.	Low		Moderate Adverse	*Slight Adverse (Not significant)*		*Neutral (not significant)*
Dee Estuary Special Protection Area and Mersey Estuary Site of Special Scientific Interest (including Shellfish Water and cockle Regulated Order)	Very High	There are no temporary crossings of these protected areas. There are a some watercourses upstream of these protected areas which are crossed by temporary crossings however the hydrological and hydromorphological processes within the protected areas are	Negligible	*Slight Adverse (Not significant)*	None required	*Slight Adverse (Not significant)*

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
		significantly larger than those in tributaries so the effects from the temporary crossings would have negligible effect on the protected areas.				

Table 4.4 - Assessment of Impacts to Hydrological and Hydromorphological Processes from Open cut Crossings of Watercourses

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
Shropshire Union Canal, River Dee	Very high	Both of these water bodies are crossed using trenchless methods. The Dee is downstream of watercourses crossed by open cut methods. However the hydrological and hydromorphological processes within the Dee are significantly larger than those in tributaries so the effects from the tributaries would have negligible effect on the Dee.	No Change	*Neutral (not significant)*	None required.	*Neutral (Not Significant)*
River Gowy	High	Watercourse crossed using trenchless methods. The Gowy is downstream of watercourses crossed by open cut methods. There is potential for impacts to hydrology and hydromoprhology on the	Minor Adverse	*Slight Adverse (not significant)*	Use of biotextiles to stabilise bank material after the watercourses are reinstated (D-BD-059 of the REAC,	*Slight Adverse (not significant)*

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
		Gowy's tributaries to affect the Gowy.			Document reference: D.6.5.1)~~.~~	
Alltami Brook	High	Open cut method on this watercourse will involve excavating bedrock. Vibration from the excavation may disturb bed and bank material elsewhere within the watercourse, close to the open cut. The flow of the watercourse will be maintained using a temporary culvert.	Moderate Adverse	***Moderate Adverse (significant)***	Relevant permits to be obtained for work on ~~ordinary watercourses and~~ main rivers (D-WR-033 of the REAC, Document reference: D.6.5.1).	***Moderate Adverse (significant)***
Watercourse with Q95<1m^3/s. Monitored under WFD and provide habitat for a protected species	High	Open cut method will temporarily disturb the banks and bed of the watercourse and potentially increase sediment supply to downstream reaches. Hydrological connection will be maintained during the	Moderate Adverse	***Moderate Adverse (Significant)***	Channel and banks to be reinstated to mimic the baseline conditions. This includes reinstatement of an appropriate	*Slight Adverse (not significant)*

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
Watercourses with Q95>0.001m^3/s not monitored under WFD	Medium	open cut crossing however there is potential for scour of bed material at the outfall of the pump.	Moderate Adverse	***Moderate Adverse (Significant)***	vegetation assemblage (D-BD-048 of the REAC, Document reference: D.6.5.1). Turbidity monitoring (D-WR-044). Minimal working width to be adopted as far as practicable. 16m maximum working width within the Alltami Brook. Detailed design alignment of the pipeline to be determined to minimise	*Slight Adverse (not significant)*
Watercourses with Q95<0.001m^3/s not monitored under WFD	Low		Moderate Adverse	*Slight Adverse (Not significant)*		*Neutral (not significant)*
Watercourses downstream of those crossed by open cut method, with Q95>0.001m^3/s not monitored under WFD	Medium	Upstream tibutaries of these watercourses crossed using open cut methods may affect the hydromoprhological processes within these watercourses.	Minor Adverse	*Slight Adverse (Not significant)*		*Neutral (not significant)*
Watercourses downstream of those crossed by open cut	Low		Minor Adverse	*Neutral (not significant)*		*Neutral (not significant)*

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
method, with Q95<0.001m^3/s not monitored under WFD					potential impacts. Where practicable, removed habitats to be replaced.	
Dee Estuary Special Protection Area and Mersey Estuary Site of Special Scientific Interest (including Shellfish Water and cockle Regulated Order)	Very High	There are no open cut crossings of the protected areas. Hydrological and hydromorphological processes within the protected areas are significantly larger than those in tributaries where open cut crossings are occuring, so the effects from the tributaries will have negligible effect on the protected areas.	Negligible	*Slight Adverse (Not significant)*	None required	*Slight Adverse (Not significant)*

Table 4.5 - Assessment of impacts to water quality and hydromorphology due to works in the channel for the culvert replacement and extension

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
Elton Lane Ditch 1	Low	Direct works in the channel to remove the existing culvert and lay the new longer culvert would potentially result in sediment being disturbed and transported downstream. Works within the channel would also increase the likelihood of a spillage event occuring.	Moderate Adverse	*Slight (Not Significant)*	Implementation of measures outlined in the **OCEMP (Document reference: D.6.5.4)**	*Neutral (Not Significant)*

Table 4.6 - Assessment of Impacts to Hydrological and Hydromorphological Processes of Surface Water Bodies from Dewatering Activities and Hydrostatic Testing Discharges

Receptor	Sensitivity of Receptor	Potential Impact	Magnitude of Impact	Signficance of Effect	Mitigation	Residual Effect
Watercourse with Q95<1m^3/s. Monitored under WFD and provide habitat for a protected species	High	Temporary increase to flows may alter the hydromorphological regime in the receiving watercourses. Extracted water will be treated on site prior to discharge to watercourse to reduce impact to water quality and turbidity.	Minor Adverse	*Slight Adverse (Not significant)*	Where reasonably practicable, ~~open trench~~construction activities will be programmed for the summer months, when groundwater levels are lower, in order to reduce potential impact of local dewatering volumes on local watercourses (D-WR-030 of the REAC, Document reference: D.6.5.1). Temporary discharges will comply with the requirements for permits on Main Rivers from the Environment Agency and/or Natural Resources Wales, ~~and ordinary watercourses from the LLFA,~~ both regarding acceptable discharge volumes and water quality (D-WR-033 of the REAC, Document Reference: D.6.5.1).	*Slight Adverse (Not significant)*
Watercourses with Q95>0.001m^3/s not monitored under WFD	Medium		Minor Adverse	*Slight Adverse (Not significant)*		*Neutral (not significant)*
Watercourses with Q95<0.001m^3/s not monitored under WFD	Low		Minor Adverse	*Neutral (Not significant)*		*Neutral (Not significant)*

Table 4.7 - Quantitative Impacts to Groundwater Receptors

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
Principal aquifers	High	Alteration of groundwater flow paths or lowering of groundwater levels due to dewatering and sheet piling	Minor	*Slight Adverse (Not Significant)*	Implementation of measures in the **OCEMP (Document reference: D.6.5.4)**, GWMMP and DMP (D-WR-034 and D-CR-010). Sheet piling to limit ingress of water to excavations (D-WR-036 of the REAC, Document reference: D.6.5.1). Permitting requirements which regulate dewatering potential	*Slight Adverse (Not Significant)*
(Superfical) Secondary A and Secondary (undifferentiated) aquifers	Medium		Moderate	***Moderate Adverse (Significant)***		*Slight Adverse (Not Significant)*
(Bedrock) Secondary A aquifers (PCMG, MGG)	Medium		Moderate	***Moderate Adverse (Significant)***		*Slight Adverse (Not Significant)*
	Medium		Minor	*Slight Adverse (Not Significant)*		*Slight Adverse (Not Significant)*
GWDTE	High		Moderate	***Moderate Adverse (Significant)***		*Slight Adverse (Not Significant)*
Groundwater abstractions	Medium		Moderate	***Moderate Adverse (Significant)***		*Slight Adverse (Not Significant)*

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
Suface watercourse baseflow	Medium	Reduction in groundwater flow to surface watercourses which are dependant on baseflow due to dewatering	Minor	*Slight Adverse (not significant)*		*Neutral (not significant)*

Table 4.8 - Groundwater Quality Impacts

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
Principal aquifers (SSG, CLG)	High	Pollution from spillages of harmful substances and suspended soilds	Moderate	***Moderate Adverse (Significant)***	Implementation of measures in the **OCEMP (Document reference: D.6.5.4)**. Compliance with standard pollution prevention measures	*Slight Adverse (not significant)*
			Minor	*Slight Adverse (not significant)*		*Slight Adverse (not significant)*
(Superficial) Secondary A and Secondary (undifferentiated) aquifers	Medium		Moderate	***Moderate Adverse (Significant)***		*Slight Adverse (not significant)*
(Bedrock) Secondary A aquifers	Medium		Minor	*Slight Adverse (not significant)*		*Slight Adverse (not significant)*
GWDTE	High		Moderate	***Moderate Adverse (Significant)***		*Slight Adverse (not significant)*
Groundwater abstractions	Medium		Moderate	***Moderate Adverse (Significant)***		*Slight Adverse (not significant)*

Table 4.9 - Impact to Flood Risk

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
Residents and Users of the surrounding land	Very High	Potential impact as a consequence of potential changes in the surface and groundwater regime caused by the construction works	Minor Adverse	***Moderate adverse (significant)***	Implementation of measures outlined in the **OCEMP (Document reference: D.6.5.4)**. e.g. implementation of a Construction Flood Action Plan and signing up for flood warnings (D-WR-032 and D-WR-041). Layout of the compounds arranged so materials and welfare facilities in area of lesser flood risk (D-WR-001). Where reasonably practicable, dewatering activities will be programmed for the summer months, when groundwater levels are lower (D-WR-030 of the	*Slight adverse (not significant)*
Construction workers	Medium	Potential impact as a consequence of the risk associated to working in the floodplain, in proximity to blocked watercourses or in areas	Moderate Adverse	***Moderate Adverse (significant)***		*Neutral (not significant)*

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
		potentially affected by other forms of flooding			REAC, Document reference: D.6.5.1).	

4.2. OPERATION STAGE

Table 4.10 - Assessment of Impacts Associated with Loss of Riparian Vegetation Along Watercourses

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
Alltami Brook (open cut)	High	The vegetation at the proposed crossing location is mature woodland which will need to be removed to complete the open cut crossing. The mature trees and the ecosystem they support would not be replaced within the short term.	Moderate Adverse	***Moderate Adverse (Significant)***	Placement of bio-textile matting to reduce risk of scour of bed and banks whilst vegetation is maturing. Vegetation reinstatement should comprise an appropriate species mix and structure within the riparian	*Slight adverse (not significant)*
Backford Brook, Finchetts Gutter	Medium		Moderate Adverse	***Moderate Adverse (Significant)***		*Slight adverse (not significant)*
Friars Park Ditch	Low		Moderate Adverse	*Slight Adverse (Not Significant)*		*Neutral (not significant)*

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
		This could result in bank instability and increased deposition of eroded sediments downstream.			zone along with enhancements to the existing riparian vegetation to off-set impacts. (D-BD-060 of the REAC, Document reference: D.6.5.1). Any tree loss will be compensated for in accordance with the site wide replanting approach (D-BD-048 of the outlined in the **REAC** (~~Appendix A of the OCEMP,~~(**Document reference: D.6.5.14**). Additional riparian planting on Friars Park Ditch,	
Watercourse with Q95<1m^3/s. Monitored under WFD and provide habitat for a protected species	High	The vegetation at the crossing of these watercourses is less mature and anticipated to recover within two years of reinstatment. Therefore operational phase impacts are deemed negligible.	Minor Adverse	*Slight Adverse (Not significant)*		*Slight adverse (not significant)*
Watercourses with Q95>0.001m^3/s not monitored under WFD	Medium		Minor Adverse	*Slight Adverse (Not significant)*		*Neutral (not significant)*
Watercourses with Q95<0.001m^3/s not monitored under WFD	Low	There could be short term bank instability and increased deposition of eroded sediments downstream whilst vegetation recovers.	Minor Adverse	*Neutral (Not significant)*		*Neutral (not significant)*

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
					Backford Brook and Finchetts Gutter Tributary, where practicable. Any removed habitat to be replaced where practicable (D-WR-062 of the REAC, Document reference: D.6.5.1).	
Alltami Brook (embedded pipe bridge crossing option)	High	The vegation at the proposed crossing location is mature woodland on the left bank and mature trees lining the right bank which will need to be removed to complete the construction of the embedded pipe bridge option. Whilst it is expected that most of	Moderate Adverse	***Moderate Adverse (Significant)***	Placement of bio-textile matting to reduce risk of scour of bed and banks whilst vegetation is maturing (D-BD-059). Vegetation reinstatement should comprise an appropriate species mix and structure	*Slight adverse (not significant)*

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
		the vegation would recover, it is likely that the embedded pipe bridge would result in permanent localised loss of riparian vegetation within the footprint of the embedded pipe bridge structure.			within the riparian zone along with enhancements to the existing riparian vegetation to off-set impacts. Any tree loss will be compensated for in accordance with the site wide replanting approach (D-BD-049 of the ~~outlined in the~~ **REAC, document reference: [D.6.5.1) ~~REP2-017]~~.** Additional riparian planting on Friars Park Ditch, Backford Brook and Finchetts Gutter Tributary, where practicable.	

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
					Any removed habitat to be replaced where practicable (D-WR-062).	

Table 4.11 - Assessment of impacts to hydromorphological forms and processes due to channel and bank reinstatement following open cut crossings

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
Alltami Brook	High	If bed and banks not reinstated as current conditions, the hydromorphic processes in the watercourse could change. This could result in additional scour or deposition elsewhere in the watercourse.	Moderate Adverse	***Moderate Adverse (significant)***	Reinstatment of existing bed and bank profiles. Reinstatement of in-channel morphological features. Use of biotextiles to stabilise bank material after the	*Slight Adverse (not significant)*
Watercourse with Q95<1m^3/s. Monitored under WFD and provide habitat for a protected species	High		Moderate Adverse	***Moderate Adverse (Significant)***		*Slight Adverse (not significant)*

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
Watercourses with Q95>0.001m^3/s not monitored under WFD	Medium	At Alltami Brook it is proposed to install the Newbuild Carbon Dioxide Pipeline via open cut methods. This would involve cutting through bedrock and replacing with artificial bed material. Therefore the impact is greater at this watercourse.	Moderate Adverse	***Moderate Adverse (Significant)***	watercourses are reinstated (D-BD-059 of the REAC, Document reference: D.6.5.1). Vegetation reinstatement should comprise an appropriate species mix and structure within the riparian zone along with enhancements to the existing riparian vegetation to off-set impacts. Any tree loss would be compensated for in accordance with the site wide replanting (D-BD-	*Slight Adverse (not significant)*
Watercourses with Q95<0.001m^3/s not monitored under WFD	Low		Moderate Adverse	*Slight Adverse (Not significant)*		*Neutral (not significant)*
Watercourses downstream of those crossed by open cut method, with Q95>0.001m^3/s not monitored under WFD	Medium	If bed and banks not reinstated as per current conditions of upstream watercourses, this could instigate geomorphic change which impacts downstream water bodies.	Minor Adverse	*Slight Adverse (Not significant)*		*Neutral (not significant)*
Watercourses downstream of those crossed by open cut	Low		Minor Adverse	*Neutral (not significant)*		*Neutral (not significant)*

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
method, with Q95<0.001m^3/s not monitored under WFD					049 of the REAC, approach outlined in the **REAC (Appendix A of the OCEMP,** (**Document reference: D.6.5.14**). For the Alltami Brook, a bespoke geomorphological assessment will be carried out by the Construction Contractor to inform: micro-siting the crossing location of the pipe so that the least sensitive section of river bed is permanently impacted, where	

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
					practicable; and the detailed design of the permanent works installed as part of the reinstatement of the watercourse after pipe is laid. At most a length of 4m of the bed of the Alltami Brook will be removed and replaced with artificial material. Geomorphological and ecological monitoring of the permanent works would be carried out, post construction, to identify any potential failure of	

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
					the permanent works which could lead to a significant impact to the water environment and aquatic habitat (D-WR-065 of the REAC, Document reference: D.6.5.1). Adaptive mitigation would be implemented to prevent deterioration from occurring.	

Table 4.12 - Assessment of impacts associated with culvert replacement and extension

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
Elton Lane Ditch 1	Low	Permanent loss of ditch habitat with	Negligible	*Neutral (Not Significant)*	None	*Neutral (Not Significant)*

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
		permanent shading and loss of bed material. Impacts are negligible when compared with length and quality of watercourse. Riparian planting proposed on nearby watercourse to offset this impacts.				

Table 4.13 - Assessment of Impacts Associated with the Newbuild Carbon Dioxide Pipeline Buried Beneath Watercourses

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
River Gowy	High	As the flood defences for the River Gowy are moved back as part of WFD mitigation works, there is potential for the river to move laterally between to the embankments. This could potentially result in the pipe being exposed at bed level and instigating geomorphic change within the river.	Moderate Adverse	***Moderate Adverse (Significant)***	The Construction Contractor will undertake further engagement with the Environment Agency Planning and Geomorphology Technical Specialists during the detailed design process to determine the required floodplain extent required for pipeline burial depth below the existing river bed level to allow for this WFD Mitigation Measure to be achieved (D-WR-055 of the REAC, Document reference: D.6.5.1).	*Neutral (Not Significant)*
Alltami Brook	High	There is a requirement to ensure that the Alltami Brook cannot be prevented to returning to its more	Minor Adverse	*Slight Adverse (Not Significant)*	The Construction Contractor will undertake further consultation with Natural Resources Wales and the	*Neutral (Not Significant)*

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
		sinuous planform in the future. If the watercourse is returned to its planform, the buried pipe is at risk of being exposed at bed level and potentially instigating geomorphic change within the river.			Lead Local Flood Authority Planning and Geomorphology Technical Specialists to determine the appropriate depth and extent of the pipeline placement so as not to prevent the future re-naturalisation of the Alltami Brook to a sinuous planform (D-WR-056 of the REAC, Document reference: D.6.5.1).	
Watercourses crossed by the pipeline which are: Monitored under WFD; have Q95>1m^3/s; and/or provide habitat for a protected species.	Very High	The pipeline is buried at least 1.2m below bed level of all watercourses. These watercourses are not expected to migrate laterally due to confinement within flood defences or due to the watercourses having	No Change	*Neutral (Not Significant)*	No Mitigation required	*Neutral (Not Signficiant)*

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
		deposition as a dominant geomorphic process.				
Watercourses crossed by the pipeline which are: Monitored under WFD; have Q95<1m^3/s; and/or provide habitat for a protected species.	High	The pipeline is buried at least 1.2m below bed level of all watercourses. These watercourses are not expected to migrate laterally due to confinement within flood defences or due to the watercourses having deposition as a dominant geomorphic process.	No Change	*Neutral (Not Significant)*	No Mitigation required	*Neutral (Not Significant)*
Watercourses crossed by the pipeline which are: Not monitored under WFD; have Q95>0.001m^3/s, and do not provide habitat for a protected species.	Medium		No Change	*Neutral (Not Significant)*	No Mitigation required	*Neutral (Not Significant)*
Watercourses crossed by the pipeline which are:	Low		No Change	*Neutral (Not Significant)*	No Mitigation required	*Neutral (Not Significant)*

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
Not monitored under WFD; have Q95<0.001m^3/s, and do not provide habitat for a protected species.						

Table 4.14 - Assessment of Impacts Associated with Installation of Permanent Artificial Features within the Channel of Watercourses

Receptor	Sensitivity of Receptor	Potential Impact	Magnitude of Impact	Signficance of Effect	Mitigation	Residual Effect
Alltami Brook (open cut)	High	There will be a permanent loss of bed material due to excavation of bedrock and replacement with concrete. Changes to the bed could instigate geomophic change within the reach. This could alter aquatic	Moderate Adverse	***Moderate adverse (significant)***	A bespoke geomorphological assessment will be carried out by the Construction Contractor to inform: • micro-siting the crossing location of the pipe so that the least sensitive section of river bed is permanently impacted, where practicable, • the detailed design of the permanent works installed as part of the reinstatement of the watercourse after pipe is laid	*Slight adverse (not signficant)*

Receptor	Sensitivity of Receptor	Potential Impact	Magnitude of Impact	Signficance of Effect	Mitigation	Residual Effect
		habitats and prevent fish migration.			Further engagement with Natural Resources Wales and the Lead Local Flood Authority Planning would be undertaken to inform the methodology of this bespoke geomorphological assessment (D-WR-054 of the REAC, Document reference: D.6.5.1). At most a length of 4m of the bed of the Alltami Brook will be removed and replaced with artificial material. Geomorphological and ecological monitoring of the permanent works would be carried out, post construction, to identify any potential failure of the permanent works which could lead to a significant impact to the water environment and aquatic habitat. Type, duration and frequency of monitoring is to be determined through the development of the geomorphological assessment and detailed design, and in consultation with NRW and FCC LLFA. Adaptive mitigation would be implemented to	

Receptor	Sensitivity of Receptor	Potential Impact	Magnitude of Impact	Signficance of Effect	Mitigation	Residual Effect
					prevent deterioration from occurring (D-WR-065 of the REAC, Document reference: D.6.5.1).	
~~East Central Drain,~~ Nant-y-Fflint	Medium	A new open channel will connect to these watercourses to discharge runoff from the new above ground features.	Minor adverse	*Slight adverse (not signficant)*		*Slight adverse (not signficant)*
Canal Ditch, Overwood Ditch, Aston Hill Brook Tributary, Little Lead Brook, Wepre Brook Tributary 1, Elton Lane Ditch 1	Low		Minor adverse	*Neutral (not significant)*		*Neutral (not significant)*
Alltami Brook (embedded pipe bridge crossing option)	High	There will be a permanent structure located on the banks / valley sides of Alltami Brook. This could potentially have	Minor Adverse	*Slight Adverse (not siginficant)*	No mitigation required	*Slight adverse (not signficant)*

Receptor	Sensitivity of Receptor	Potential Impact	Magnitude of Impact	Signficance of Effect	Mitigation	Residual Effect
		a localised impact the channel width and the river continuity.				

Table 4.15 - Assessment of Impacts to Surface Water Associated with the New above Ground Features

Receptor	Sensitivity of Receptor	Potential Impact	Magnitude of impact	Signficance of Effect	Mitigation	Residual Effect
~~East Central Drain,~~ Nant-y-Fflint	Medium	Impact to hydrological processes in receiving and downstream watercourses is minimised by the control of surface water at the AGIs and BVSs and discharging at greenfield rates. Impact to the sediment regime is minimised by treatment of runoff and settlement of entrained sediments through filter drains and attenuation ponds. No changes to the sediment regime of receiving watercourses is antipcated due to the controlled surface water runoff.	Negligible	*Neutral (not significant)*		*Neutral (not significant)*
Canal Ditch, Overwood Ditch, Aston Hill Brook Tribuatry, Little Lead Brook, Wepre Brook Tributary 1, Elton Lane Ditch 1	Low		Negligible	*Neutral (not significant)*		*Neutral (not significant)*

Receptor	Sensitivity of Receptor	Potential Impact	Magnitude of impact	Signficance of Effect	Mitigation	Residual Effect
		Impact to water quality from routine runoff is minimised by the treatment measures embedded within the drainage strategy. Risk of spillage is very low and sufficient treatment measures to slow spread of spillages to watercourses to allow for interception				

Table 4.16 - Assessment of impacts to groundwater levels and flows

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
Principal aquifer	High	Impact to groundwater levels and flows by the Newbuild Carbon Dioxide Pipeline acting as an impermeable barrier backing up groundwater and diverting flows. Impacts to groundwater levels and flows from the AGIs and BVSs	Negligible	*Slight adverse (not significant)*	None required.	*Slight adverse (not significant)*
(Superfical) Secondary A and Secondary (undifferentiated) aquifers	Medium		Minor	*Slight adverse (not significant)*	None required.	*Slight adverse (not significant)*

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
(Bedrock) Secondary A aquifer	Medium	acting as an impermeabive barrier and limiting groundwater recharge	Negligible	*Neutral (not significant)*	None required.	*Neutral (not significant)*
GWDTE	High		Negligible	*Slight adverse (not significant)*	None required.	*Slight adverse (not significant)*
Groundwater abstracitons	Medium		Negligible	*Neutral (not significant)*	None required.	*Neutral (not significant)*
(Bedrock) Secondary A aquifer	Medium	Impact to groundwater levels and flow from the embedded pipe bridge option support abutments and any associated piling at Alltami Brook.	Minor Adverse	*Slight Adverse (Not significant)*	None required.	*Slight adverse (not significant)*

Table 4.17 - Assessment of impacts to groundwater quality

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
Principal aquifer	High	Pollution from leakage of the Carbon Dioxide Pipeline and spillages of harmful substances at the AGIs and BVSs	Negligible	*Slight adverse (not significant)*	None required.	*Slight adverse (not significant)*
(Superficial) Secondary A and Secondary (undifferentiated) aquifers	Medium		Minor	*Slight adverse (not significant)*	None required.	*Slight adverse (not significant)*
(Bedrock) Secondary A aquifer	Medium		Negligible	*Neutral (not significant)*	None required.	*Neutral (not significant)*
GWDTE	High		Negligible	*Slight adverse (not significant)*	None required.	*Slight adverse (not significant)*
Groundwater abstractions	Medium		Negligible	*Neutral (not significant)*	None required.	*Neutral (not significant)*

Table 4.18 - Assessment of impacts to flood risk

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
Residents and users of the surrounding land	Very High	There are no changes to watercourses or the floodplain which would increase fluvial flood risk to surrounding land. Drainage from AGIs and BVSs would be restricted to greenfield rates so that surface water flood risk does not increase.	No change	*Neutral (not significant)*	None required.	*Neutral (not significant)*
Operational workers	Medium	AGIs and BVSs are located in areas of low flood risk and therefore operational workers are not anticipated to be significantly impacted	Negligible	*Neutral (not significant)*	None required.	*Neutral (not significant)*

4.3. DECOMMISSIONING PHASE

Table 4.19 - Assessment of impact to flood risk during the decommissioning phase

Receptor	Sensitivity of receptor	Potential impact	Magnitude of impact	Signficance of effect	Mitigation	Residual effect
Residents and Users of the surrounding land	Very High	No works carried out within the active floodplain.	No change	*Neutral (not significant)*	Implementation of measures outlined in a DEMP. ~~Including~~ I~~i~~mplementation of a flood action plan (D-WR-041) and signing up for flood warnings (D-WR-032 of the REAC, Document reference: D.6.5.1).	*Neutral (not significant)*
Decommissioning workers	Medium		No change	*Neutral (not significant)*		*Neutral (not significant)*

5. REFERENCES

- **Ref.1:** Preene, M., Roberts, T., & Powrie, W. (2016). Groundwater control: design and practice, second edition. London: Ciria.
- **Ref. 2:** British Geological Survey. (2022a). *BGS GeoIndex*. Avaliable online: https://mapapps2.bgs.ac.uk/geoindex/home.htm
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- **Ref. 5:** HM Government. (2019). *National Planning Policy Framework*. Available online: https://www.gov.uk/government/publications/national-planning-policy-framework--2
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