Cambridge Waste Water Treatment Plant Relocation Project
Anglian Water Services Limited

Flood Risk Assessment

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Summary

The Proposed Development involves the construction of a new waste water treatment plant (WWTP) and sludge treatment centre (STC), together with the associated waste water transfer infrastructure comprising waste water transfer tunnel, sewer rising main diversions and a treated effluent transfer with an outfall to the River Cam. The Proposed Development also includes a transfer pipeline corridor from Waterbeach Water Recycling Centre (WRC). The proposed WWTP would be above ground, but associated tunnels and pipelines which connect to proposed or existing infrastructure will be below ground.

The Environment Agency Flood Map for Planning demonstrates that the 'Less Vulnerable' proposed WWTP would be located entirely within Flood Zone 1. 'Water compatible' infrastructure (outfall, pipelines and tunnel) which are located in Flood Zones 2 and 3 would not be considered to be at high risk from fluvial flooding, assuming the application of best practice construction methodology.

Fluvial modelling, which includes climate change allowance, indicates that the increased discharge from the proposed outfall would have a negligible effect on River Cam water levels, flows and flood extents.

A cofferdam will be used to maintain dry conditions during construction of the outfall. The cofferdam is expected to be constructed in two sections: a land section and a river section. Construction behind the land section of the cofferdam is expected to take up to four months. The river section of the cofferdam will be in place for a limited period of approximately eight weeks to minimise river constriction impacts. The river section of the cofferdam may reduce the cross-sectional area of the River Cam which may result in temporary locally increased water-levels and/or velocities within the vicinity of the constriction. The risk to fluvial flood risk elsewhere may slightly increase during the limited time (approximately eight weeks) that the river section of the cofferdam is in place.

Monitored groundwater levels (2021-2022) at the proposed WWTP are relatively close to existing ground level. The proposed WWTP will be situated in an excavated area and, at times of year when groundwater levels are high, the unmitigated risk of groundwater flooding within the proposed WWTP is considered medium to high. Emergent groundwater within the proposed WWTP site will however be managed by the Drainage Strategy (Appendix 20.12, Application Document Reference 5.4.20.12), in combination with surface water runoff.

The surface water (pluvial) flood risk at the site required for the construction of the proposed WWTP is considered very low. However, the proposed WWTP would be located in an excavated area which lies slightly below external ground level and may therefore be at increased risk of surface water (pluvial) ponding. Surface water runoff within the proposed WWTP and access roads will be managed by the Drainage Strategy (Appendix 20.12, App Doc Ref 5.4.20.12).

The Drainage Strategy (Appendix 20.12, App Doc Ref 5.4.20.12) includes dedicated drainage for areas of the proposed WWTP which present a contamination risk. Potentially contaminated surface water runoff will be returned to the head of the works for treatment. Runoff from uncontaminated areas and emergent groundwater, if present, will be directed to an attenuation pond located within the land required for the landscape masterplan. Outflow from the attenuation pond will be restricted to greenfield runoff rates and discharged to a drain linked to Black Ditch.

1 Proposed Development setting

1.1 Commission

1.1.1 The Cambridge Waste Water Treatment Plant Relocation (CWWTPR) project is a Nationally Significant Infrastructure Project (NSIP) (Department for Environment, Food & Rural Affairs, 2012), as defined in the Planning Act Section 29 (Planning Act, 2008) and requires a Development Consent Order (DCO).

1.1.2 This Flood Risk Assessment (FRA) has been prepared to the support the DCO application.

1.1.3 The aim of this FRA is to assess the flood risk to the Proposed Development and its potential impact on flood risk. Operational and construction flood risks are considered.

1.2 Setting and topography

1.2.1 The Proposed Development (Appendix B Figure 1) involves the construction of a waste water treatment plant (WWTP) and a sludge treatment centre (STC), together with associated waste water transfer infrastructure, comprising a waste water transfer tunnel, treated effluent transfer and stormwater pipelines with an outfall to the River Cam. The Proposed Development also includes a transfer pipeline corridor from Waterbeach Water Recycling Centre (WRC). The proposed WWTP would be above ground, but associated tunnels and pipelines which connect to proposed or existing infrastructure, will be below ground. The Proposed Development includes the provision of a bridleway extension along a 1km stretch of disused railway.

1.2.2 The current Scheme Order Limits (Appendix B Figure 1) cover an area of approximately 250Ha.

1.2.3 The proposed WWTP will replace the existing Cambridge WWTP, both of which are shown in Appendix B Figure 1. The Proposed Development will include below-ground pipelines and tunnels connecting to existing and proposed infrastructure.

1.2.4 The land required for the construction of the proposed WWTP is located approximately 1.5km south-east of the existing Cambridge WWTP. The site is approximately 22Ha in size, located within a wider 95ha development area of land which is required for the landscape masterplan.

1.2.5 The Proposed Development is located in an area that is currently predominantly greenfield. The land required for the landscape masterplan is currently used for arable farming and sown with crops such as barley and wheat.

1.2.6 Within the land required for construction of the proposed WWTP, topographic elevations vary between 7.1mAOD and 11.4mAOD (2m LiDAR data), sloping to the east/north-east. The footprint of the proposed WWTP will be adjusted (excavation and partial fill) to a ground level of between 8.5mAOD to 9.5mAOD.

1.2.7 Topographic elevations within the land required for the landscape masterplan vary between approximately 3mAOD and 16mAOD (2m LiDAR data). Lowest topographic elevations are observed in the vicinity of the River Cam with the highest elevations associated with the A14 (Appendix B Figure 2).

1.3 Geology

1.3.1 The Geology of Britain Viewer (British Geological Survey, 2022) indicates that the bedrock underlying the Scheme Order Limits consists of the West Melbury Marly Chalk Formation and the Gault Formation (Appendix B Figure 3).

1.3.2 The West Melbury Marly Chalk Formation, comprising soft, marly chalk and hard grey limestone, is part of the Grey Chalk sub-group. The land required for the construction of the proposed WWTP is located on the West Melbury Marly Chalk Formation.

1.3.3 The underlying Gault Formation comprises clay and mudstone. The Gault Formation is present along the west of the Scheme Order Limits, for example underlying the existing WWTP.

1.3.4 Superficial deposits underlying the Proposed Development are River Terrace Deposits (sand and gravel), Alluvium (clay, silt, sand and gravel) and some Peat (British Geological Survey, 2022). Superficial deposits are absent within the land required for the construction of the proposed WWTP, according to BGS 1:50,000 mapping (Appendix B Figure 3) and confirmed by ground investigation works.

1.4 Watercourses

1.4.1 Watercourses present within the vicinity of the Proposed Development are shown in Appendix B Figure 4.

1.4.2 The River Cam, which is classified as an Environment Agency main river, is approximately 1km west of the land required for the construction of the proposed WWTP (Appendix B Figure 4). The river will be crossed by below-ground infrastructure (tunnel and pipelines) of the Proposed Development.

1.4.3 Quy Water, which is classified as an Environment Agency main river, is located approximately 1km east of the land required for the construction of the proposed WWTP. Quy Water discharges to Bottisham Lode (also which is classified as an Environment Agency main river), which in turn discharges to the River Cam (Appendix B Figure 4). Numerous drains and ditches are present within and close to the Scheme Order Limits. Drainage channels on the eastern side of the proposed WWTP discharge to Black Ditch. Black Ditch flows to the north to Bottisham Lode, which then discharges to the River Cam near Waterbeach.

1.4.4 The drainage catchments are managed by Swaffham Internal Drainage Board (IDB) and Waterbeach Level Internal Drainage Board (The Drainage Office, 2022).

1.5 Vulnerability classification

1.5.1 The Scheme Order Limits incorporates both the existing Cambridge WWTP and greenfield areas. The DCO application includes the Waterbeach waste water transfer pipeline, but does not include the pumping station or associated infrastructure at the existing Waterbeach WRC, located at the north of the Scheme Order Limits.

1.5.2 According to National Planning Policy Framework (NPPF) (Department for Levelling Up, Housing and Communities, 2021) and Planning Practice Guidance flood risk vulnerability classification (Department for Levelling Up, Housing and Communities, 2022) the proposed WWTP and associated infrastructure could be classified under various vulnerability criteria (shown in Table 1-1).

1.5.3 The Scheme Order Limits include greenfield areas, which are unclassified according to the NPPF flood risk vulnerability guidelines. Post-development, the greenfield areas within the Scheme Order Limits will generally increase in vulnerability to Less Vulnerable/Water Compatible.

Table 1-1: Flood Risk Vulnerability classification with respect to the Proposed Development

Vulnerability Classification	Description	Post-development
Water Compatible	Water/sewage transmission infrastructure and pumping stations. Amenity open space, nature conservation and biodiversity, outdoor sports and recreation.	• Transfer tunnel • Final Effluent & stormwater pipelines • Outfall • Waterbeach pipeline • Proposed bridleway extension
Less Vulnerable	Sewage treatment works, if adequate measures to control pollution and manage sewage during flooding events are in place.	• proposed WWTP

Source: Environment Agency/NPPF guidelines

1.6 Flood zones

1.6.1 The Environment Agency Flood Map for Planning (Appendix B Figure 5) demonstrates that the Proposed Development is located within Flood Zones 1, 2 and 3, which have a low, medium and high probability of flooding respectively. Flood risk associated with the flood zones is described in full in Table 1-2, but can be summarised for river flooding as follows:

- Flood Zone 1 has a less than 1 in 1000 year (0.1%) annual probability of river flooding

- Flood Zone 2 has a 1 in 1000 year to 1 in 100 year (0.1% to 1%) annual probability of river flooding
- Flood Zone 3 has a greater than 1 in 100 year (1%) annual probability of river flooding.

1.6.2 The Environment Agency Flood Zone mapping withing the vicinity of the Scheme Order Limits is based on fluvial modelling only, indicating that tidal flooding is not a significant risk in this area.

1.6.3 The Environment Agency Flood Map for Planning shows only the potential floodplain. The mitigating effects of any flood defences currently in place are not considered.

1.6.4 The land required for the construction of the proposed WWTP is sequentially located entirely within Flood Zone 1 which has a low probability of flooding from rivers or sea in any year (Table 1-2).

1.6.5 Below-ground pipelines and tunnels will however pass through Flood Zones 2 and 3 of the River Cam, which have a medium to high probability of flooding from rivers or sea in any year.

1.6.6 The land required for the bridleway designation is in Flood Zones 2 and 3 of Black Ditch (Appendix B Figure 5).

Table 1-2 Definition of the NPPF Flood Zones.

Flood Zone	Description
1	Low Probability. This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%).
2	Medium Probability. This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% – 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% – 0.1%) in any year.
3a	High Probability. This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.
3b	The Functional Floodplain. This zone comprises land where water has to flow or be stored in times of flood. SFRA's should identify this Flood Zone (land which would flood with an annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in an extreme (0.1%) flood, or at another probability to be agreed between the LPA and the EA, including water conveyance routes).

1.7 Sequential Test/Exception Test

1.7.1 The National Policy Statement (NPS) on Wastewater, Paragraph 4.4.14 (Department for Environment, Food & Rural Affairs, 2012) and the 2022 update of the Flood risk and Coastal Change section of the Planning Practice Guidance (Department for

Levelling Up, Housing and Communities, 2022) require that new planning applications undergo a Sequential Test. The Sequential Test requires the location of new development to an area of lowest flood risk. Where there are no reasonable alternatives, sites in areas of higher flood risk may be considered, depending on the flood risk vulnerability of the proposed development, and an Exception Test may need to be passed.

1.7.2 The flood risk vulnerability and flood zone compatibility table from the 2022 update of the Flood risk and Coastal Change section of the Planning Practice Guidance (Department for Levelling Up, Housing and Communities, 2022) is shown in Table 1-3, with highlighted cells indicating elements of the Proposed Development. Flood risk vulnerability with respect to the Proposed Development is defined inTable 1-1.

1.7.3 The 'Less Vulnerable' proposed WWTP would be sequentially located within Flood Zone 1 and therefore passes the Sequential Test.

1.7.4 'Water Compatible' elements of the Proposed Development are deemed appropriate development within Flood Zones 1, 2, and 3a in accordance with the flood zone compatibility table (Table 1-3). However, additional considerations (indicated in Table 1-3 as ✓*) are required for Water Compatible development in Flood Zone 3b[1] (the functional floodplain), where development should be designed and constructed to:

- remain operational and safe for users in times of flood,
- result in no net loss of floodplain storage,
- not impede water flows and not increase flood risk elsewhere.

1.7.5 Below ground pipelines and tunnel elements of the Proposed Development located in Flood Zone 3b would remain operational during flood conditions and would have a negligible impact on floodplain storage, surface water flows or flood risk elsewhere. The 'Water Compatible' elements of the Proposed Development in Flood Zone 3b, may therefore be considered appropriate development according to Table 1-3.

[1] Flood Zone 3b designations are shown in Greater Cambridge Strategic Flood Risk Assessment (SFRA) Appendix D6

Table 1-3: Sequential Test. Flood Risk Vulnerability and Flood Zone 'Compatibility' Table.

Flood Risk Vulnerability Classification	Essential Infra-structure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
Flood Zone 1	✓	✓	✓	✓ Proposed WWTP	✓ • Transfer tunnel • Final Effluent & stormwater pipelines • Waterbeach pipeline • Proposed bridleway extension
Flood Zone 2	✓	Exception Test Required	✓	✓	✓ • Transfer tunnel • Final Effluent & stormwater pipelines • Waterbeach pipeline • Proposed bridleway extension
Flood Zone 3a	Exception Test Required	×	Exception Test Required	✓	✓ • Transfer tunnel • Final Effluent & stormwater pipelines • Waterbeach pipeline • Proposed bridleway extension • Outfall
Flood Zone 3b	Exception Test Required	×	×	×	✓* • Transfer tunnel • Final Effluent & stormwater pipelines • Waterbeach pipeline • Proposed bridleway extension • Outfall

*✓development is appropriate; ×the development should not be permitted; ✓*further considerations required; highlighted cells (pink) indicate elements of the Proposed Development.*

2 Flood Risk to the Proposed Development

2.1 Fluvial flooding

Flood defences

2.1.1 The fluvial flood defences (Appendix B Figure 6) along the River Cam generally consist of high ground, to a 1 in 10 year (10%) standard of protection.

2.1.2 In the Waterbeach area, the standard of protection of the embankments on the River Cam is 1 in 100 year (1%). The area downstream area of Waterbeach is therefore considered to 'benefit from defences' (to a 1 in a 100 year standard of protection) as indicated in Appendix B Figure 5.

2.1.3 Pipeline and tunnel crossings below the flood defences of the River Cam may require an Environment Agency Flood Risk Activity Permit for work within 8m of EA flood defences, or for excavation within 16m of flood defences.

2.1.4 The outfall structure, which will be located on the east bank of the River Cam, will require an Environment Agency Flood Risk Activity Permit for work within 8m of EA flood defences.

2.1.5 Along Quy Water (Appendix B Figure 4), flood defences in the form of high ground and embankments are not assigned a standard of protection by the Environment Agency (Appendix B Figure 6). It is assumed that the standard of protection of the flood defences in this area is low.

2.1.6 Bottisham Lode (Appendix B Figure 4) also has flood defences that alternate between high ground and embankments. The flood defence standard of protection (Appendix B Figure 6) varies along Bottisham Load between 1 in 50 year (2%) and 1 in 100 year (1%).

Existing fluvial flood risk

2.1.7 Flood Zones in relation to the Proposed Development are discussed in Section 1.6.3

2.1.8 Fluvial modelling has been undertaken (Appendix 20.5, App Doc Ref 5.4.20.5: Fluvial model report) based on the River Cam Urban model[2] (Halcrow, 2012). The fluvial modelling includes additional inflow locations for the existing and proposed outfall discharges, which were not explicitly represented in the River Cam Urban model. The modelled flood outlines include the mitigating effects of existing flood defences.

2.1.9 Modelled flood outlines (Appendix B Figure 7) demonstrate that the land required for the construction of the proposed WWTP would not be at risk in any fluvial flood event from the 1 in 2 year to the 1 in 1000 year event. Fluvial flood risk would largely be confined to the immediate vicinity of the River Cam.

[2] The River Cam Urban model is currently being updated by the Environment Agency. However the updates have not been finalised and therefore the 2012 model (Halcrow, 2012) remains the best available data.

2.1.10 Stage level and flow data for nodes along the River Cam have been provided in the Fluvial Model Report (Appendix 20.5, App Doc Ref 5.4.20.5). Node CA17720 is upstream of the Proposed Development (Appendix B Figure 8). In a 1%AEP event, the modelled stage level at this node is 5.22mAOD, and in a 0.1%AEP event the modelled stage level is 5.67mAOD. As the topographic elevation within proposed WWTP would be at least 8.50mAOD, it will be at least 2.8m above the modelled 0.1% AEP peak flood level.

2.1.11 The risk of fluvial flooding in all events, up to and including the 0.1%AEP, may be considered low for the land required for the construction of the proposed WWTP, and medium to high in the vicinity of the River Cam. Water compatible infrastructure (outfall, pipelines and tunnel) in the vicinity or the River Cam would not be considered to be at high risk from fluvial flooding, assuming the application of best practice construction methodology.

Climate change: fluvial

2.1.12 Climate change is likely to mean changes in future weather patterns, with warmer temperatures, sea level rise, seasonal rainfall changes and more extreme events. The Proposed Development is likely to be at more risk of flooding in the future.

2.1.13 A summary of the Environment Agency peak river flow allowances for climate change is shown in Table 2-1 (Environment Agency , 2021), where highlighted cells are those relevant to the Proposed Development. Peak river flow allowances are based on percentiles:

- the central allowance is based on the 50th percentile;
- the higher central allowance is based on the 70th percentile;
- the upper end allowance is based on the 90th percentile.

2.1.14 In Flood Zones 2 and 3, the Central climate change allowance is applicable to 'Water Compatible' developments as shown in Table 2-1. For definitions of vulnerability, see Table 1-1.

Table 2-1: Development vulnerability, flood zones and peak river flow allowances.

Flood Zone	Essential Infrastructure	Highly vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
2	Higher central	Central	Central	Central	Central
3a	Higher central	Central (development not permitted)	Central	Central	Central
3b	Higher central	Development should not be permitted	Development should not be permitted	Development should not be permitted	Central

Source: Summarised from (Environment Agency , 2021). Highlighted cells (pink) indicate Proposed Development.

2.1.15 Environment Agency guidance for flood risk assessments states that Nationally Significant Infrastructure Projects (NSIPs) may need to assess the flood risk from a

credible maximum climate change scenario. Where it is appropriate to apply a credible maximum scenario, the upper end allowance should be used, in accordance with the relevant national policy statement.

2.1.16 The National Policy Statement on Wastewater, Paragraph 3.6.10 (Department for Environment, Food & Rural Affairs, 2012) states:

> *'The decision maker should be satisfied that there are not critical features of the design of new waste water infrastructure which may be seriously affected by more radical changes to the climate beyond that projected in the latest set of UK climate projections, taking account of the latest credible scientific evidence on, for example, sea level rise (e.g. by referring to additional maximum credible scenarios – i.e. from the Intergovernmental Panel on Climate Change or the Environment Agency) and that necessary action can be taken to ensure the operation of the infrastructure over its estimated lifetime'.*

2.1.17 The proposed WWTP is sequentially located in Flood Zone 1. Only the outfall and short sections of below-ground transmission infrastructure, such as the tunnel and pipelines, will be located with Flood Zones 2 and 3. Consideration of the credible maximum scenario and use of the upper end allowance would be considered overly conservative for the elements of 'Water Compatible' infrastructure located in Flood Zones 2 and 3.

2.1.18 Based on the peak river flow allowance categories identified in Table 2-1 and in consideration of the life-time of the development to the 2080s epoch, it is considered that the Central (9%) peak river flow allowance is applicable, as shown in Table 2-2 (Environment Agency, 2021).

Table 2-2: Peak river flow allowance Cam and Ely Ouse Catchment

River basin district	Allowance category	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Cam and Ely Ouse	Upper end	21%	22%	45%
	Higher central	7%	5%	19%
	Central	2%	-2%	9%

Source: Environment Agency. Highlighted cell (pink) indicates Proposed Development.

2.1.19 Flood modelling reported within the Fluvial Model Report (Appendix 20.5, App Doc Ref 5.4.20.5), which is based on the River Cam Urban model (Halcrow, 2012), incorporates a 20% climate change allowance (1%AEP + 20%CC).

2.1.20 It is understood that the River Cam Urban model (Halcrow, 2012) is being updated to include current climate change allowances (Table 2-2). However, updates have not been finalised at the time of this report and therefore the 2012 model remains the best available. The blanket 20% climate change allowance may be considered conservative with respect to the Central allowance of 9% (for the 2080s epoch).

2.1.21 Flood outlines for the 1%AEP & 20%CC (Appendix B Figure 9) demonstrate that the land required for the construction of the proposed WWTP would not be at risk in this event. Flooding in this event would largely be confined to the immediate vicinity of the River Cam between the existing and proposed WWTP. Stage level and flow data for nodes along the River Cam have been provided in the fluvial modelling report (Appendix 20.5, App Doc Ref 5.4.20.5: Fluvial model report). Node CA17720 is upstream of the proposed development (Appendix B Figure 8). In a 1%AEP + 20%CC event, the modelled stage level at this node is 5.31mAOD. As the average topographic elevation within the proposed WWTP will be at least 8.5mAOD, the proposed WWTP will be at least 3m above the modelled 1%AEP + 20%CC peak flood level.

2.1.22 The risk of fluvial flooding in the 1%AEP + 20%CC event may be considered **low** in the land required for the construction of the proposed WWTP, and along the majority of the Waterbeach pipeline route. Fluvial flood risk may be considered **medium to high** in the vicinity of the outfall and pipeline and tunnel crossings of the River Cam.

2.2 Surface water (pluvial) flooding

Existing surface water flood risk

2.2.1 Cambridgeshire Local Flood Risk Management Strategy (Cambridgeshire County Council, 2022) lists 275 surface water 'wet spots', based on flood risk to properties over the time period 2015-2020. The Proposed Development is located in a greenfield location however, in an area that has not been specifically assessed as part of Cambridgeshire LFRMS wet spot analysis.

2.2.2 The Environment Agency Extent of Flooding from Surface Water map (Appendix B Figure 10) shows that the Proposed Development will be predominantly located in an area considered to be at very low risk (less than 0.1% chance of flooding annually) from surface water flooding.

2.2.3 There is an area at low risk of surface water ponding, to the north of the Waterbeach pipeline, in the vicinity of Bannold Road. This may be due to entrapment by the railway track and ignores the effect of any existing mitigating drainage, if present.

2.2.4 The proposed WWTP will be located in an excavated area slightly below external ground level. Areas of low topographic elevation within the proposed WWTP may therefore be at **increased risk** of surface water (pluvial) ponding. As the earth banks surrounding the proposed WWTP will not be continuous, there is also a further minor risk of runoff from external areas into the excavation.

2.2.5 Surface water runoff from site will be managed through a Drainage Strategy (Appendix 20.12, App Doc Ref 5.4.20.12), which considers the Environment Agency climate change allowances for peak rainfall intensity.

2.2.6 The Drainage Strategy (Appendix 20.12, App Doc Ref 5.4.20.12) includes dedicated drainage for areas of the proposed WWTP which present a contamination risk.

Potentially contaminated runoff will be returned to the head of the works for treatment.

2.2.7 Runoff from uncontaminated hard surfaces will be attenuated by the drainage system and directed to an attenuation pond within the land required for the landscape masterplan. Outflow from the pond will be restricted to greenfield runoff rate and discharged to a drain linked to Black Ditch.

Climate change: surface water

2.2.8 Climate change will increase peak rainfall intensity in small and urban catchments. The Proposed Development will be at more risk of surface water flooding in the future. The Environment Agency climate change allowances for peak rainfall intensity are shown in Table 2-3.

2.2.9 The Drainage Strategy (Appendix 20.12, App Doc Ref 5.4.20.12) includes provision for 40% climate change with respect to surface water runoff within the proposed WWTP and associated hard surfaces.

Table 2-3: Peak rainfall intensity allowance in small and urban catchments

	3% AEP		1%AEP	
Allowance	**2050s epoch**	**2070s epoch**	**2050s epoch**	**2070s epoch**
Central	20%	20%	20%	25%
Upper End	35%	35%	40%	40%

Source Environment Agency, updated May 2022

2.3 Groundwater flooding

2.3.1 The British Geological Survey (BGS) Geology of Britain Viewer demonstrates that the bedrock underlying the Scheme Order Limits consists of the West Melbury Marly Chalk Formation (Grey Chalk Sub-group) and the Gault Formation (Appendix B Figure 3).

2.3.2 The Grey Chalk sub-group is considered to be a Principal aquifer (Department for Environment, Food & Rural Affairs, 2022). A Principal aquifer is highly permeable, supporting water supplies and/or river base flow at a strategic scale.

2.3.3 The Gault Formation is classified as an Unproductive aquifer (Department for Environment, Food & Rural Affairs, 2022).

2.3.4 The Geology of Britain Viewer (British Geological Survey, 2022) indicates that the superficial deposits, where present, are River Terrace Deposits (sand and gravel), Alluvium (clay, silt, sand and gravel) and some Peat. Superficial deposits are absent within the land required for the construction of the proposed WWTP according to BGS 1:50,000 mapping and ground investigation works.

2.3.5 River Terrace Deposits and Alluvium are classified as Secondary A aquifers (Department for Environment, Food & Rural Affairs, 2022). A Secondary A aquifer is permeable, supporting water supplies at a local scale and may contribute to base flow of rivers.

2.3.6 The Proposed Development will not be located within an Environment Agency groundwater Source Protection Zone (SPZ) (Department for Environment, Food & Rural Affairs, 2022). The closest groundwater SPZ is approximately 2.5km south-east of the Proposed Development.

2.3.7 The Greater Cambridge Strategic Flood Risk Assessment (SFRA) Appendix D10 susceptibility to groundwater flooding (Stantec on behalf of Greater Cambridge Shared Planning, 2021) indicates that the proposed WWTP will be located in an area where there is potential for groundwater flooding either at the surface or for structures below ground level.

2.3.8 Susceptibility to groundwater flooding maps identify areas where geological conditions and available groundwater level data indicate that a rise in groundwater could occur under certain circumstances. A high susceptibility to groundwater flooding does not mean that groundwater flooding has occurred in the past or will in the future. Susceptibility to groundwater flooding mapping, coupled with site specific hydrogeological data, is used to identify a potential risk and to plan for such a risk.

2.3.9 Below-ground water-compatible transmission infrastructure elements (pipelines and tunnel) and below-ground deep foundations and shafts of the Proposed Development would not be considered at risk of groundwater flooding or inflow, assuming best practice construction methodology.

2.3.10 Groundwater level monitoring locations at, and in close vicinity to the proposed WWTP, ranged between approximately 0.5m and 5m below ground level between August 2021 and May 2022

2.3.11 The proposed WWTP will be located in an excavated area slightly below external ground level. Excavated areas within the proposed WWTP may be at increased risk of groundwater flooding. Shallowest observed groundwater levels over the monitoring period were in March 2022, when they were approximately 1m below indicative finished ground level in areas within the proposed WWTP.

2.3.12 Groundwater levels may locally rise upgradient of below-ground structures, possibly slightly exacerbating the groundwater flood risk within the excavated proposed WWTP.

2.3.13 The unmitigated risk of groundwater flooding to the proposed WWTP may therefore be considered **medium to high**.

2.3.14 The risk of emergent groundwater at ground level would be managed by the following measures;

- Design measures i.e., gravity drainage as set out in the drainage strategy, to remove groundwater (combined with any surface water) for temporary storage within an attenuation pond located within the land required for the landscape masterplan.
- Continued monitoring of groundwater levels within the area of land required for the proposed WWTP and use of these data by the appointed

contractor to prepare detailed design of surface water drainage and finished ground levels within the proposed WWTP.

2.3.15 The Drainage Strategy (Appendix 20.12,App Doc Ref 5.4.20.12) is considered the most vital element of flood risk management within the proposed WWTP and, in combination with the flood warning service and flood evacuation plan, in effect performs the role of an operational flood risk management strategy.

2.3.16 The impact of the Proposed Development on groundwater flooding elsewhere is considered in Section 4.3 of this report.

2.4 Sewer flooding

2.4.1 The Greater Cambridge SFRA Appendix D11 sewer flooding map (Stantec on behalf of Greater Cambridge Shared Planning, 2021), includes a list of sewer flooding incidents by postcode.

2.4.2 The proposed WWTP is located in a postcode area CB5 where a total of one sewer flooding incident has been recorded. The existing WWTP is located in postcode CB24 where there have been twelve recorded sewer flooding incidents. Pipeline and tunnel elements of the Proposed Development are distributed between postcodes CB5, CB25 and CB24.

2.4.3 The Proposed WWTP will be located in a greenfield setting for which there is no evidence of historic sewer flooding. The risk of sewer flooding to the Proposed Development is considered to be **low.** This risk of sewer flooding resulting from the Proposed Development is considered in Section 4.4

2.5 Historic flooding

2.5.1 The Environment Agency holds records of fluvial flooding within the district. The closest recorded fluvial flooding events occurred in 1947 and 2001 in the reach of the River Cam adjacent to the existing Cambridge WWTP and were associated with exceedance of channel capacity (no raised defences) of the River Cam (Appendix B, Figure 6: Environment Agency Flood Defences Standard of Protection in years (Return Period).).

2.5.2 The Greater Cambridge SFRA Appendix 7 historic flooding map (Stantec on behalf of Greater Cambridge Shared Planning, 2021), indicates no additional reported flooding incidents from groundwater or surface water sources withing the Scheme Order Limits.

3 Residual Risk to Proposed Development

3.1 Identification of residual risk

3.1.1 Residual risks are those remaining after applying the sequential approach to the location of development and taking mitigating actions. Examples of residual flood risk include:

- the failure of flood management infrastructure such as a breach of a raised flood defence, blockage of a surface water conveyance system, overtopping of an upstream storage area, or failure of a pumped drainage system;
- failure of a reservoir, or;
- a severe flood event that exceeds a flood management design standard, such as a flood that overtops a raised flood defence, or an intense rainfall event which the drainage system cannot cope with.

3.1.2 The residual risk assessed in this section is based on the risk matrix in Appendix 0, which is based on UK Water Industry Specification guidelines (UK Water Industry, 2018).

3.2 Defence breach

3.2.1 The majority of the Scheme Order Limits area does not 'benefit from defences' to a 1 in 100-year standard of protection.

3.2.2 The northern 1.3km of the Waterbeach pipeline will be located within an area that 'benefits from defences' to a 1 in 100 year standard of protection as shown in Appendix B Figure 5. However, the pipeline will be located below-ground and would not be at risk from fluvial flooding in the event of a breach of flood defences.

3.2.3 Defence breach hazard mapping from Appendix D2 of Cambridge and South Cambridgeshire SFRA (Cambridge City Council and South Cambridgeshire District Council, 2010)[3], classifies the flood hazard to people in a defence breach event according to flood depth and velocity. In a 'worst case' 1 in 1000 year defence breach event, the majority of the Scheme Order Limits is located in a Very Low Hazard area (Appendix B, Figure 13: Defence breach hazard 1 in 1000 years). Only the pipeline and tunnel elements of the scheme which cross below the River Cam are located in Medium or High Hazard areas.

3.2.4 As the likelihood of a defence breach is low and the consequence to the Proposed development is very low, the residual risk to the operational area of the Proposed Development in the event of defence-breach may be considered **very low**.

[3] Defence breach modelling was not undertaken as part of the Greater Cambridge SFRA (Stantec on behalf of Greater Cambridge Shared Planning, 2021) and therefore that from the 2010 Cambridge SFRA remains the best available information.

3.3 Reservoir failure

3.3.1 The Environment Agency Flood Risk from Reservoir Map (Environment Agency , 2021) (Appendix B Figure 14) demonstrates the extent of an uncontrolled release of water if a dam or reservoir failed. The map shows reservoir flooding extents when river levels are within their normal range ('dry day') and also when rivers have overflowed their banks ('wet day').

3.3.2 Reservoirs in the UK are strictly regulated and subject to mandatory inspections (Department for Environment, Food and Rural Affairs, 2015). The Environment Agency is responsible for managing, implementing and enforcing reservoir safety regulations in England. Reservoir safety is regulated through the Reservoirs Act 1975, as amended by the Flood and Water Management Act 2010. England has an excellent reservoir safety record, and there have been no dam breaches resulting in the loss of life since reservoir safety legislation was first introduced in 1930 (Department for Environment, Food and Rural Affairs, 2015).

3.3.3 In a 'dry day' scenario when river levels are normal, no area of the Proposed Development would be at risk from reservoir flood waters.

3.3.4 In a 'wet day' scenario when river levels have overflowed their banks, the area of the River Cam between the existing and proposed WWTP may be at risk. The proposed WWTP would not be at risk in this event. The northern-most 1.3km of the Waterbeach pipeline will be located in an area that may be at risk from 'wet day' reservoir flooding. However, as the pipeline will be below ground, it would not be at risk in this event.

3.3.5 As the likelihood of reservoir flooding is very low and the consequence to the Proposed Development is low, even in the worst case 'wet day' scenario, the residual risk of reservoir flooding to the Proposed Development may be considered **very low**.

3.4 Drainage exceedance

3.4.1 In extreme rainfall events, failure or blockage of the drainage system may result in flooding within the Proposed Development. The direction of runoff flow will be topographically controlled in the event of drainage system failure.

3.4.2 Topographic levels from 2m LiDAR suggest that runoff from the land required for the construction of the proposed WWTP would at present be directed north-east towards Black Ditch/Quy Water.

3.4.3 However, the proposed WWTP will be located in an excavated area, slightly below external ground level and will be surrounded by a system of earth banks. Therefore, it is expected that runoff flow in a drainage exceedance event will be contained within the perimeter of the proposed WWTP.

3.5 IDB pumping station failure

3.5.1 The Proposed Development is located within the catchment boundary of Swaffam and Waterbeach Level Internal Drainage Boards. The catchments are reliant on the IDBs for maintenance of surface water levels through the operation of pumping stations and management of the drainage network.

3.5.2 Waterbeach Level IDB operates Bottisham Lock Pumping Station, which is in the vicinity of the northern extent of the Waterbeach pipeline. In the event of pumping station failure, Waterbeach Level IDB has advised[4] that the catchment would quickly flood. Emergency pumps would be required as soon as possible to prevent catchment flooding. Flooding due to pumping station failure at Bottisham Lock would not impact the adjacent Waterbeach pipeline, which is below-ground. Pumping station failure at Bottisham Lock is unlikely to impact the proposed WWTP, which is 4km upstream of the pumping station, and is at approximately 5m higher topographic elevation than the pumping station.

3.5.3 Swaffam IDB operates Upware Pumping Station, which is 5.5km north-east of the northernmost extent of the Proposed Development. Due to its distance from all elements of the Proposed Development, failure of Upware Pumping Station is considered unlikely to impact the proposed WWTP.

3.5.4 As the likelihood of IDB pumping station failure is low, and the consequence to the Proposed Development is very low, the residual risk of flooding from pumping station failure to the Proposed Development may be considered **very low**.

[4] Consultation meeting 11/02/2022

4 Flood Risk from Proposed Development

4.1 Fluvial flooding

4.1.1 The Proposed Development will discharge treated effluent (final effluent plus stormwater discharge) to the River Cam. Fluvial modelling has been undertaken and is reported in the Fluvial Model Report (Appendix 20.5, App Doc Ref 5.4.20.5)to determine the impact of the proposed outfall to fluvial flood risk downstream on the River Cam. Modelled flood outlines (Appendix B Figure 15) demonstrate that the land required for the construction of the proposed WWTP would not be at risk in any fluvial flood event from the 1 in 2 year to the 1 in 1000 year event, inclusive of treated effluent discharge from the proposed WWTP. Flood outlines inclusive of treated effluent from the proposed outfall (Appendix B Figure 15) are almost identical to those which include treated effluent from the existing outfall (Appendix B Figure 7).

4.1.2 The fluvial flood model results reported in the Fluvial Model Report (Appendix 20.5, App Doc Ref 5.4.20.5) indicate a 4mm (0.004m) increase in stage level at Baits Bite Lock (approximately 500m downstream of the proposed outfall) for a 61 hour storm in the 1%AEP event. In a 1%AEP + 20%CC event, the stage level rise would be 7mm (0.007m). At other node locations for this event, the increases are even smaller. The water level convergence tolerance for the model was 10mm and therefore changes in water level of less than 10mm are not considered significant.

4.1.3 The fluvial flood model outputs reported in the Fluvial Model Report (Appendix 20.5, App Doc Refence 5.4.20.5) indicate stage level increases of up to 22mm (0.022m) at Baits Bite Lock for lower magnitude events (e.g. 1 in 2 year event). This is due to WWTP discharge making up a larger proportion of the total River Cam flow in lower magnitude events. In the 1 in 2 year event, the stage level would not exceed the normal retention level (3.88mAOD) at Baits Bite Lock.

4.1.4 The impact of the treated effluent on flood risk of the River Cam may therefore be considered negligible.

4.1.5 The finished platform level of the proposed outfall will match the existing bank height and therefore will have a negligible impact on flood risk.

4.1.6 Above ground development within the proposed WWTP will be located entirely within Flood Zone 1 and therefore would not impact fluvial flood risk elsewhere.

4.1.7 The Proposed Development would therefore have a **very low** impact on fluvial flood risk elsewhere

4.2 Surface water flooding

4.2.1 The proposed WWTP will be located in an excavated area, slightly below external ground level, and will be surrounded by a system of earth banks. Therefore, it is expected that surface water runoff will be contained within the perimeter of the

proposed WWTP, where it will be managed by the Drainage Strategy (Appendix 20.12, App Doc Ref 5.4.20.12).

4.2.2 The drainage strategy includes dedicated drainage for areas of the proposed WWTP which present a contamination risk. Potentially contaminated surface water runoff will be returned to the head of the works for treatment.

4.2.3 Runoff from uncontaminated areas will be directed to an attenuation pond located within the land required for the landscape masterplan. Outflow from the pond will be restricted to greenfield runoff rate and discharged to a drain linked to Black Ditch.

4.2.4 The Proposed Development is therefore unlikely to increase surface water flood risk elsewhere. The impact of the Proposed Development to surface water flood risk elsewhere is considered **very low**.

4.3 Groundwater flooding

4.3.1 The Proposed Development includes deep below-ground foundations, shafts and tunnels which may impact groundwater flows and levels. These deep structures may intercept groundwater within the Gault Formation and West Melbury Marly Chalk Formation.

4.3.2 Groundwater levels may locally rise upgradient of below-ground structures, potentially increasing groundwater flood risk to the proposed WWTP (as discussed in Section 2.3). However, groundwater is expected to flow around these structures and the impact at aquifer scale is considered negligible.

4.3.3 The risk of groundwater flooding elsewhere as a result of the Proposed Development is therefore considered **low**.

4.4 Sewer flooding

4.4.1 The Proposed Development includes provision for population growth and includes improved storm water management as indicated within the Storm Model Report (Appendix 20.10, App Doc Ref 5.4.20.10). This will reduce the likelihood of storm spills in the future compared to the existing situation.

4.4.2 Mitigation measures in operation are embedded through design in accordance with National Policy Statement for Waste Water (Department for Environment, Food & Rural Affairs, 2012) allowing future flexibility and the ability to adapt. Environmental management plans and regulatory permits will govern operational use.

4.4.3 The risk of sewer flooding from the Proposed Development is considered **low**.

5 Flood Risk in Construction

5.1 Flood risk from construction

Cofferdam

5.1.1 The outfall and rip-rap riverbed protection will be built within a sheet pile cofferdam, to provide dry conditions for construction. The cofferdam will be designed to maintain the flood protection levels currently provided by the river bank.

5.1.2 The cofferdam will temporarily reduce the cross-sectional area of the river, which may cause an increase in water levels and/or an increase in water velocity within the zone where the constriction occurs. There may be a backwater impact due to an increase in water levels (mounding) slightly upstream of the constriction.

5.1.3 The cofferdam is expected to be approximately 35m long and will extend up to 5m into the river. The River Cam is approximately 24m wide at the location of the proposed outfall and therefore the cofferdam may reduce the river width by 21%.

5.1.4 It is anticipated that the cofferdam will be constructed during a dry time of year (e.g., summer/autumn months) when stage levels are not above average. The cofferdam is expected to be constructed in two sections: a land section and a river section. The river section of the cofferdam will be in place for a limited period of approximately eight weeks, to minimise river constriction impacts. Construction behind the land section of the cofferdam is expected to take up to four months.

5.1.5 Changes in water level and velocity as a result of the cofferdam are likely to dissipate downstream and are expected to be eliminated at Baits Bite Lock.

5.1.6 The river section of the cofferdam may locally affect flows and levels of the River Cam. However, as the river section of the cofferdam will be in place during a dry time of year and for a short period of time, the impact to flood risk elsewhere is considered **low**. However, in a fluvial flood event, the cofferdam will increase flood risk.

FE and storm pipelines

5.1.7 Excavation work for FE and storm pipelines to the outfall is not expected to significantly impact flood risk elsewhere, assuming that mitigation measures and best practice will be applied prior to and during construction to protect hydrological receptors as outlined in the Code of Construction Plan (CoCP) Part A and B (App Doc Ref 5.2.2.1 and 5.2.2.2). and implemented in the Construction Water Quality Plan and the Construction Environmental Management Plan (CEMP).

Waterbeach pipeline

5.1.8 The Waterbeach pipeline will be installed below the River Cam at two crossing points and will be constructed using directional drilling techniques to a depth of 5.5m below the river bed. There would be negligible construction or disturbance to water levels, flows or flood defences within the River Cam using these techniques.

5.1.9 Numerous ditches and drains are present within the vicinity of the Proposed Development, which are managed by Swaffam and Waterbeach Level IDBs (see maps in Appendix 0). The ditches convey surface water through the IDB drainage network.

5.1.10 During construction, shallow ditches along the route of the Waterbeach pipeline, will be blocked and over-pumped during excavation and laying of the pipe section below the base of the ditch. Once the pipe section has been laid, ditches will be reinstated promptly.

5.1.11 Micro-tunnelling techniques will be used on larger ditches to install the pipelines below the base of the ditch. There will be little disturbance to water levels or flows within ditches using this technique.

5.1.12 The northern extent of the Waterbeach pipeline to the area just south of the crossing of the Cam is within Flood Zones 2 and 3 (see Figure 5). Laydown areas will be required along the route approximately every 1km used to store sections of the pipeline whilst the construction takes place. Each laydown area is expected to be a maximum of 20m x 80m. As a reasonable worst case scenario, it has been assumed that each will require the topsoil to be stripped, a barrier laid (i.e. terram) and the area covered with temporary hardstanding. The hardstanding will be removed, and the topsoil reinstated when the use of the laydown area ceases. Due to the limited size of the hardstanding areas and their temporary nature, the impact to fluvial and surface water flood risk elsewhere is considered very low.

Transfer tunnel

5.1.13 The transfer tunnel will cross below the River Cam between the existing and proposed WWTP and will be constructed in sections using a pipe-jacking technique. The crown of the tunnel will be at least 10m below the riverbed. There will be negligible construction or disturbance to water levels, flows or flood defences within the River Cam using these techniques.

Dewatering discharge

5.1.14 Dewatering may be required during construction of shafts, pipelines and the outfall.

5.1.15 Dewatering discharge rates and locations of discharge points will be agreed with the Environment Agency or other relevant body as required.

5.1.16 A Construction Water Quality Management Plan will be prepared, which sets out requirements to protect watercourses from sediment release during dewatering activities.

5.2 Flood risk to construction

Outfall construction

5.2.1 The outfall will be built within a sheet pile cofferdam to provide dry conditions for construction. The cofferdam will be designed to maintain the flood protection levels

currently provided by the river bank, and is expected to include a freeboard of approximately 1m to prevent overtopping in a higher magnitude flood event.

Transfer tunnel and intermediate shafts

5.2.2 The transfer tunnel crosses below the River Cam between the existing Cambridge WWTP and proposed WWTP and will be constructed in sections using a pipe-jacking technique.

5.2.3 The transfer tunnel would only be affected by flooding if an intermediate shaft floods. All six intermediate shafts for the tunnel will be located within Flood Zone 1 and therefore the risk of fluvial flooding is **very low**.

5.3 Flood risk during commissioning and decommissioning

5.3.1 During the wet commissioning period for the proposed WWTP, which is expected to be of approximately 6 months duration, final effluent will be gradually transferred from the existing WWTP to the proposed WWTP. There will be a gradual reduction in final effluent discharge from the existing WWTP outfall and a corresponding increase in discharge from the proposed WWTP outfall. As the same quanta of discharge will in effect gradually change from the existing outfall to the proposed outfall over the commissioning period, the impact to flood risk over the commissioning period is considered negligible.

5.3.2 Discharge from the existing outfall will eventually cease entirely, as part of the decommissioning of the existing WWTP. Flow in the approximately 90m reach of the river between the existing and proposed outfall will be impacted (reduced) by the reduction in discharge from the existing WWTP outfall, thereby reducing fluvial flood risk over this reach. The reduction in flow over the 90m reach of river between the existing and proposed outfall is considered not of significance at WFD waterbody scale as reported within the Water Framework Directive Assessment Report (Appendix 20.3, App Doc Ref 5.4.20.3).

5.3.3 Flood risk relating to discharges from the proposed outfall are discussed in Section 4.1 Fluvial flooding.

6 Flood Risk Management Measures

6.1 Permits and policies

6.1.1 The proposed WWTP will be sequentially located in Flood Zone 1.

6.1.2 Elements of the Proposed Development which cross, or are adjacent to the River Cam, are located either wholly or partially within Environment Agency Flood Zones 2 and 3. These include the outfall, Final Effluent (FE) and storm pipelines, Waterbeach pipeline, and the transfer tunnel.

6.1.3 Any development within 8m of an Environment Agency main river may require an Environment Permit (Flood Risk Activities) from the Environment Agency.

6.1.4 Pipeline and tunnel crossings below flood defences of the River Cam may require an Environment Agency Flood Risk Activity Permit for works involving temporary or permanent structure in, over or under a main river, dredging/ removing any material from a main river, any activity within 8 metres of the bank of a main river or any activity within 8 metres of any flood defence structure or culvert on a main river.

6.1.5 Internal Drainage Board (IDB) consent will be required for all activity in, under, or within 9m of IDB managed watercourses.

6.1.6 An Environment Agency Permit to Pump (Water Discharge Activity Permit) will be required for dewatering discharge to watercourses that do not meet the criteria of the Environment Agency Regulatory Position Statement (RPS) 261 'Temporary dewatering from excavations to surface water' (Environment Agency, 2023).

6.1.7 The National Policy Statement for Waste Water (Department for Environment, Food & Rural Affairs, 2012) requires flood resilience measures within flood risk areas (Paragraph 4.4.10), and for the drainage system to comply with the Flood and Water Management Act (2010), with priority given to SuDS (Paragraph 4.4.11)).

6.1.8 Updated flood risk planning practice guidance (Department for Levelling Up, Housing and Communities, 2022)reinforces the policy position on flood risk introduced in the updates to the NPPF in 2018 and 2021.This includes guidance relating to new development reducing the causes and impacts of flooding, through the use of natural flood management techniques wherever they would be effective (Paragraph: 062 Reference ID: 7-062-20220825). The landscape masterplan within the Landscape Ecology and Recreation Management Plan (LERMP)(Appendix 8.14, App Doc Ref 5.4.8.14) and the Drainage Strategy (Appendix 20.12, App Doc Ref 5.4.20.12) collective include provision for an integrated solution to surface water management including green infrastructure features for the management of surface water. Flood risk and coastal change sections of Planning Practice Guidance (Department for Levelling Up, Housing and Communities, 2022) covers flood resistance and flood resilience particularly in relation to development within the flood plain. The proposed WWTP will be located in Flood Zone 1. Below-ground pipelines and tunnel elements of the Proposed Development located in Flood Zones 2 and 3 are flood

resilient, remaining operational during flood conditions and would have a negligible impact on floodplain storage, surface water flows or flood risk elsewhere.

6.2 Flood warning service

6.2.1 The Environment Agency operate a free 24-hour Flood Alert and Warning service (GOV.UK, 2022). Flood warnings are sent by email, text or phone call for:

- current flood warnings or alerts
- river, sea, groundwater and rainfall levels
- flood risk in the next 5 days

6.2.2 Elements of the Proposed Development which cross the River Cam are located with an Environment Agency Flood Alert area for 'Lower River Cam in Cambridgeshire'. The land required for the bridleway extension is located within an Environment Agency Flood Alert area for 'Ely Ouse in Cambridgeshire, Suffolk and Norfolk'. The CoCP Part A and B (Appendix 2.1 & 2.2 App Doc Refs 5.4.2.1 & 5.4.2.2) will require Site Managers to subscribe to the Environment Agency Flood Alert service. Maintenance of infrastructure in, or adjacent to, Flood Zones 2 and 3 should be avoided if a Flood Alert or Warning is in place. Construction flood risk is further considered in Section 6.4.

6.3 Flood evacuation plan

6.3.1 The proposed WWTP is located in Flood Zone 1 and safe refuge will be available on site in a flood event.

6.3.2 Should staff and visitors leave the safe refuge of the proposed WWTP during a flood event, flooding may have already occurred in adjacent watercourses such as the River Cam or Quy Water. If flooding has commenced and flood depths along roads or public footpaths/bridleways exceed 25cm, staff and visitors are advised to remain on site, or seek refuge within adjacent Flood Zone 1 areas, until flood waters recede.

6.3.3 The CoCP Part A and B (Appendix 2.1 & 2.2, App Doc Refs 5.4.2.1 & 5.4.2.2) requires that the Principal Contractor(s) consult with the Environment Agency, Lead Local Flood Authority and any other relevant risk management authorities in respect of the flood risks in the preparation of the Emergency Preparedness Plan for construction work in areas at risk of flooding.

6.4 Construction flood risk mitigation

6.4.1 Elements of the Proposed Development which cross, or are adjacent to the River Cam, will be located either wholly or partially within Environment Agency Flood Zones 2 and 3. These include the outfall, Final Effluent (FE) and storm pipelines, Waterbeach pipeline, and the transfer tunnel.

6.4.2 Measures within the CoCP Part A and B (Appendix 2.1 & 2.2 App Doc Refs 5.4.2.1 &5.4.2. 2) will be implemented through a Construction Environmental Management Plan (CEMP). The CoCP outlines that all construction activities will be undertaken to avoid any significant increase of flood risk.

6.4.3 The CEMP will require that procedures are put in place to deal with potential flood events, as is relevant to the flood risk at each working area. This will include a requirement to sign up to the Environment Agency flood warnings, and identification of emergency evacuation routes and potential refuge areas in the event of a flood.

6.4.4 During construction of the outfall, the river section of the cofferdam may locally affect flows and levels of the River Cam. The risk to flood risk elsewhere will be mitigated by works within the cofferdam occurring at a dry time of year when stage levels are not above average, and efficient construction practices reducing the duration in which the river section of the cofferdam is in place, expected to be approximately eight weeks.

6.4.5 Works affecting the water course (main river) would require a separate Environmental Permit (flood risk activities). The works would be carried out in accordance with the conditions of the Environment Permit, and these are expected to include specific flood risk management measures to be agreed with the Environment Agency.

6.4.6 Additional construction mitigation measures within the CoCP Part B (Appendix 2.2, App Doc Ref 5.4.2.2) are:

- A requirement to locate construction compounds t in Flood Zone 1 where possible;
- A requirement for loose items within laydown or storage areas within Flood Zones 2 and 3 to be secured to prevent them becoming a debris hazard in a flood event; and
- A requirement for any material with contaminant potential to be stored e in Flood Zone 1 if possible, otherwise above design flood levels.

Table **6-1** sets out how and when mitigation would be secured.

Table 6-1: Securing flood risk mitigation in construction

Works area and activity	Flood risk related mitigation	Secured by	Timing
Waterbeach pipeline construction- water course crossings	Implementation of works to accord with the requirements of the Environmental Permit (Flood Risk Activities) and or Land Drainage Consent. Approved CEMP incorporating requirements within	Requirement within Schedule 2 of the DCO to implement CoCP Compliance with permit under the Environmental Permitting Regulations Compliance with consents under the Land Drainage Act	Approved CEMP and associated sub plans prior to commencement of works between Waterbeach and the proposed WWTP Obtaining licences and consents prior to start of works

Works area and activity	Flood risk related mitigation	Secured by	Timing
	Environmental Permit (Flood Risk Activities) and appended water quality management plan, flood management plan, and emergency response plan		
Waterbeach pipeline construction - main compound and temporary laydown areas	Implementation of works to accord with the requirements of the Environmental Permit (Flood Risk Activities) and or Land Drainage Consent. Approved CEMP incorporating requirements within Environmental Permit (Flood Risk Activities) and appended water quality management plan, flood management plan, and emergency response plan	Requirement within Schedule 2 of the DCO to implement CoCP Compliance with permit under the Environmental Permitting Regulations Compliance with consents under the Land Drainage Act	Approved CEMP and associated plans prior to commencement of works between Waterbeach and the proposed WWTP Obtaining licences and consents prior to start of works
Construction of the outfall	Approved outfall management plan required prior to the commencement of construction activities affecting the River Cam incorporating requirements within Environmental Permit (Flood Risk Activities) Environmental Permit (Discharge to surface water) and Land Drainage Consents	Requirement within Schedule 2 of the DCO to implement CoCP Compliance with permit under the Environmental Permitting Regulations Compliance with consents under the Land Drainage Act	Prior to construction of the outfall Obtaining licences and consents prior to start of works
Temporary compound within the adjacent field to the proposed outfall		Requirement within Schedule 2 of the DCO to implement CoCP Compliance with permit under the Environmental Permitting Regulations Compliance with consents under the Land Drainage Act	Prior to installation of the compound and accesses Obtaining licences and consents prior to start of works

Works area and activity	Flood risk related mitigation	Secured by	Timing

6.5 Operation flood risk mitigation

6.5.1 The risk of surface water ponding within the excavated area of the WWTP will be mitigated by the Drainage Strategy (Appendix 20.12, App Doc Ref 5.4.20.12), with uncontaminated runoff directed to an attenuation pond within the land required for the landscape masterplan, and subsequently discharged at greenfield rates to a drain linked to Black Ditch.

6.5.2 The risk of infrequent emergent groundwater at ground level will also be managed by the Drainage Strategy (Appendix 20.12, App Doc Ref 5.4.20.12). Emergent groundwater at ground level within the proposed WWTP will likewise be directed to the attenuation pond within the land required for the landscape masterplan.

6.5.3 Ongoing monitoring of groundwater levels will inform detailed drainage design, emergency attenuation storage volumes and finished ground levels.

6.5.4 Operational flood risk within the proposed WWTP from surface water and groundwater sources will be managed by the drainage strategy, which will in turn be informed by continuous monitoring of groundwater levels. The drainage strategy further allows for future expansion of attenuation storage capacity if required. The drainage strategy is therefore considered to be the most vital element of flood risk management within the proposed WWTP and, in combination with flood warning and evacuation measures outlined in Sections 6.2 and 6.3, in effect performs the role of an operational flood risk management strategy.

6.5.5 Within the land required for the landscape masterplan as described within the LERMP (Appendix 8.14, App Doc Ref 5.4.8.14) there will be retention of permeable surfaces in land outside of the earth bank with new planting. This new planting will create a more varied vegetation and habitats around the proposed WWTP which may have a secondary benefit of slowing surface water run-off during more extreme rainfall events. Further measures related to the management of surface water delivered during operation will be implemented through the long term application of the LERMP (Appendix 8.14, App Doc Ref 5.4.8.14) which requires that the operator prepare a detailed management and maintenance plan (secured through requirements in the DCO), based on the LERMP which will be agreed with key stakeholders. Since the LERMP integrates aspects of the Drainage Strategy (Appendix 20.1 App Doc Ref 5.4.20.1) the detailed surface water drainage design shall be prepared to account for the detailed management of the LERMP.

7 Conclusion

7.1.1 The Proposed Development involves the construction of a new waste water treatment plant (WWTP) and sludge treatment centre (STC), together with the associated waste water transfer infrastructure comprising waste water transfer tunnel, sewer rising main diversions and a treated effluent transfer with an outfall to the River Cam. The Proposed Development also includes a transfer pipeline corridor from a new pumping station constructed close to the existing Waterbeach Water Recycling Centre (WRC). The proposed WWTP would be above ground, but associated tunnels and pipelines which connect to proposed or existing infrastructure, are below ground.

7.1.2 The Environment Agency Flood Map for Planning demonstrates that the 'Less Vulnerable' proposed WWTP will be sequentially located entirely within Flood Zone 1. 'Water compatible' infrastructure (outfall, pipelines and tunnel) which would be located in Flood Zones 2 and 3 would not be considered to be at high risk from fluvial flooding, assuming the application of best practice construction methodology.

7.1.3 Fluvial modelling (Appendix 20.5, App Doc Ref 5.4.20.5), which includes an allowance for climate change, indicates that increased discharge from the proposed outfall will have a negligible effect on River Cam water levels, flows and flood extents.

7.1.4 During construction of the outfall, a cofferdam will be used to maintain dry conditions. The cofferdam is expected to be constructed in two sections: a land section and a river section. The river section of the cofferdam will be in place for a limited period of approximately eight weeks in order to minimise river constriction impacts. Construction behind the land section of the cofferdam is expected to take up to four months. The river section of the cofferdam may reduce the cross-sectional area of the River Cam which may result in temporary locally increased water-levels and/or velocities within the vicinity of the constriction. The risk to fluvial flood risk elsewhere may slightly increase during the approximate eight week period when the river section of the cofferdam is in place.

7.1.5 Monitored groundwater levels (2021-2022) at the proposed WWTP are relatively close to existing ground level. The proposed WWTP will be situated in an excavated area and, at times of year when groundwater levels are high, the unmitigated risk of groundwater flooding within the proposed WWTP is considered medium to high. The risk of emergent groundwater occurring within the proposed WWTP will be managed by the Drainage Strategy (Appendix 20.1App Doc Ref 5.4.20.1), which will also serve to manage surface water runoff.

7.1.6 The Drainage Strategy (Appendix 20.1, App Doc Ref 5.4.20.1) includes dedicated drainage for areas of the proposed WWTP which present a contamination risk. Potentially contaminated surface water runoff will be returned to the head of the works for treatment. Runoff from uncontaminated areas and emergent groundwater, if present, will be directed to an attenuation pond located within the land required for the landscape masterplan. Outflow from the pond will be restricted to greenfield runoff rates and discharged to a drain linked to Black Ditch.

7.1.7 The surface water (pluvial) flood risk for the land required for the construction of the proposed WWTP is considered very low. However, the proposed WWTP will be located in an excavated area slightly below external ground level and may therefore be at increased risk of surface water (pluvial) ponding within the perimeter of the proposed WWTP. Surface water runoff within the proposed WWTP and access roads will be managed by through the requirement to prepare a detailed drainage design informed by the Drainage Strategy (Appendix 20.1, App Doc Ref 5.4.20.1).

7.1.8 Detailed surface water drainage design informed by Drainage Strategy (Appendix 20.12, App Doc Ref 5.4.20.12) and associated operational management actions are considered to be the most vital element of flood risk management within the proposed WWTP and, in combination with flood warning and evacuation measures, in effect performs the role of an operational flood risk management strategy.

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Appendices

Appendix A - Residual Risk Matrix

Based on UK Water Industry Specification WIS 4-01-04 Appendix D guidelines (UK Water Industry, 2018).

Table 2 Residual Risk Likelihood Consequence table

		Consequence			
		High	**Medium**	**Low**	**Very Low**
Likelihood	**High**	Very high risk	High risk	Moderate risk	Moderate/low risk
	Medium	High risk	Moderate risk	Moderate/low risk	Low risk
	Low	Moderate risk	Moderate/low risk	Low risk	Very low risk
	Very Low	Moderate/low risk	Low risk	Very low risk	Very low risk

Table 3 Residual Risk Definitions

	Likelihood	Consequence
High	Likely to occur under most/all circumstances	Increased flood risk to essential infrastructure, highly or more vulnerable developments
Medium	Fairly likely to occur, under a reasonably wide range of conditions	Increased flood risk to less vulnerable developments
Low	Fairly likely to occur, under a reasonably wide range of conditions	Increased flood risk to water compatible development
Very Low	May occur in exceptional circumstances	Negligible change to flood risk

Appendix B – Figures

Figure 1 Location of Proposed Development

Scheme Order Limits
Proposed WWTP
Proposed earth works
Existing Cambridge WWTP
Final effluent pipeline
Proposed transfer tunnel

Data Sources
Scheme Order Limits, scheme elements: Anglian Water Services @One, 2022
Basemapping: © Crown copyright and database rights 2021 OS 100022432

Metres
0 500 1,000 1,500

MOTT MACDONALD
22 Station Road
Cambridge CB1 2JD
United Kingdom

T +44 (0)20 8774 2000
F +44 (0)20 8681 5706
W mottmac.com

Client: love every drop anglianwater

Rev	Date	Drawn	Description	Ch'k'd	App'd
P1	24/10/22	KL	First Draft	MC	CS

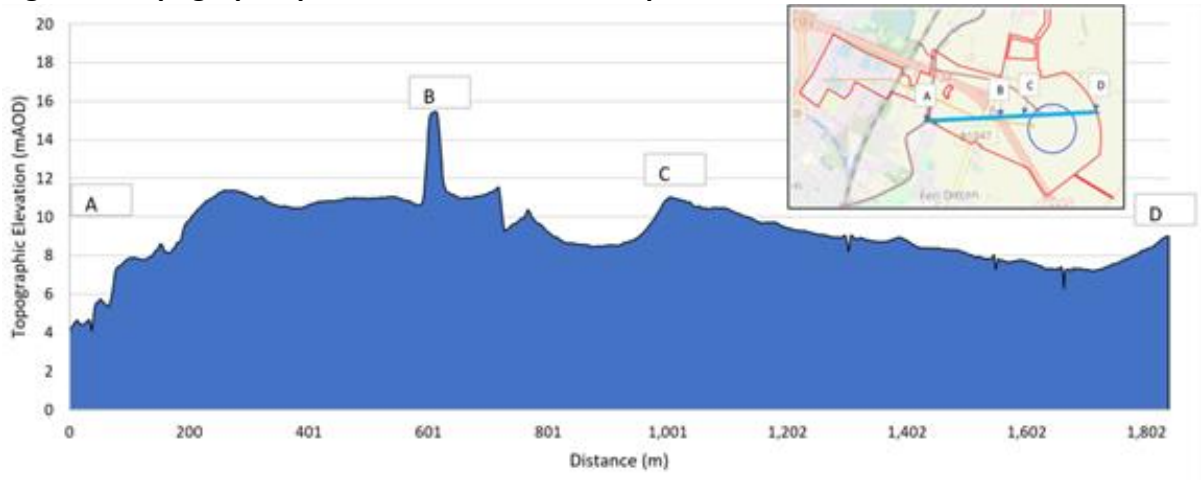
Title
Cambridge Waste Water Treatment Plant
Relocation Project
Flood Risk Assessment
Location overview

Drawn	KL
Checked	MC
Approved	CS
Scale at A3	1:20,000

Drawing Number: WW01003-CAMEST-MOT-05-XX-DR-X-0702

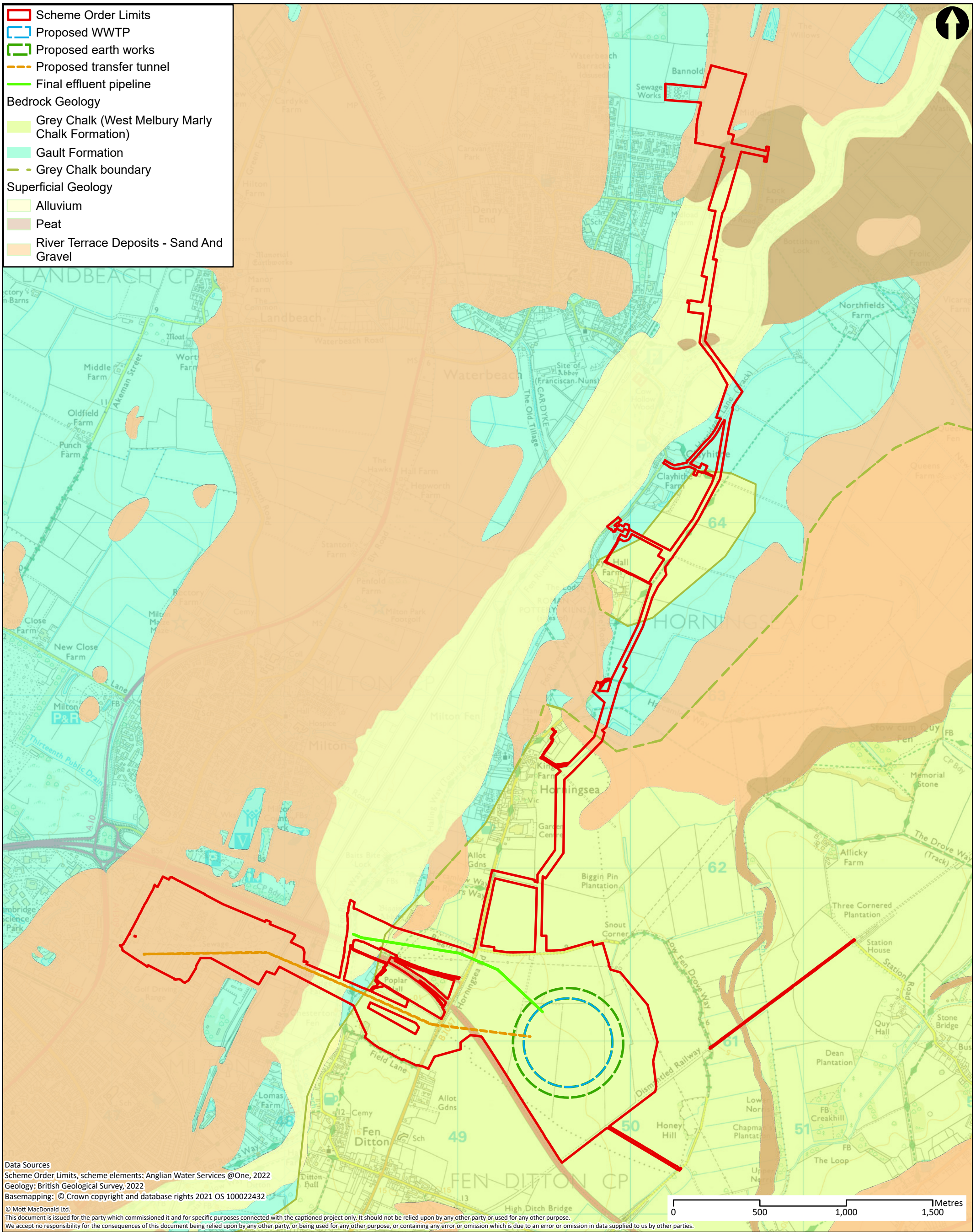
Security	Status	Rev
STD	PRE	P1

Figure 2: Topographic profile ABCD. Inset shows position of transect



Source: 2m LiDAR data

Figure 3 Superficial and bedrock geology



Data Sources
Scheme Order Limits, scheme elements: Anglian Water Services @One, 2022
Geology: British Geological Survey, 2022
Basemapping: © Crown copyright and database rights 2021 OS 100022432

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Cambridge CB1 2JD
United Kingdom
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Title
Cambridge Waste Water Treatment Plant Relocation Project
Flood Risk Assessment
Bedrock and superficial geology

Drawn	KL
Checked	MC
Approved	CS
Scale at A3	1:20,000

Drawing Number: WW01003-CAMEST-MOT-05-XX-DR-X-0703

Security	Status	Rev
STD	PRE	P1

Figure 4: Environment Agency main rivers and ordinary watercourses

Scheme Order Limits
Proposed WWTP
Proposed earth works
Final effluent pipeline
Proposed transfer tunnel
Main river (Environment Agency)
Watercourse
Ditch/Drain

Data Sources
Scheme Order Limits, scheme elements: Anglian Water Services @One, 2022
Watercourses: Environment Agency, 2022 and OS Open Data, 2022
Basemapping: © Crown copyright and database rights 2021 OS 100022432

Metres
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22 Station Road
Cambridge CB1 2JD
United Kingdom

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F +44 (0)20 8681 5706
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Rev	Date	Drawn	Description	Ch'k'd	App'd
P1	24/10/22	KL	First Draft	MC	CS

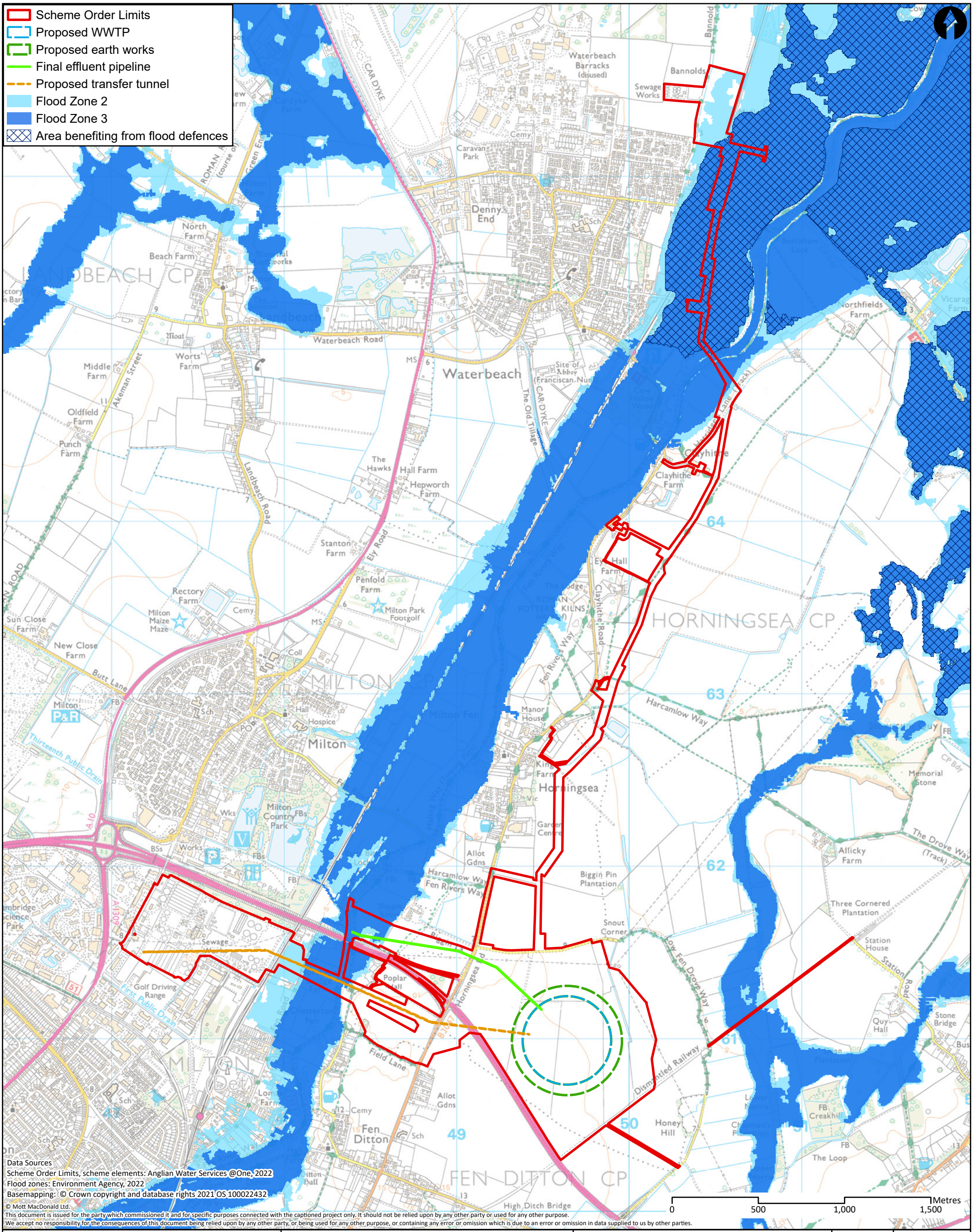
Title
Cambridge Waste Water Treatment Plant Relocation Project
Flood Risk Assessment
Environment Agency main rivers and ordinary watercourses

Drawn	KL
Checked	MC
Approved	CS
Scale at A3	1:40,000

Drawing Number: WW01003-CAMEST-MOT-05-XX-DR-X-0704

Security	Status	Rev
STD	PRE	P1

Figure 5: Flood Zones



Data Sources
Scheme Order Limits, scheme elements: Anglian Water Services @One, 2022
Flood zones: Environment Agency, 2022
Basemapping: © Crown copyright and database rights 2021 OS 100022432

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22 Station Road
Cambridge CB1 2JD
United Kingdom
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F +44 (0)20 8681 5706
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Title
Cambridge Waste Water Treatment Plant Relocation Project
Flood Risk Assessment
Flood zones

Drawn	KL
Checked	MC
Approved	CS
Scale at A3	1:20,000

Drawing Number: WW01003-CAMEST-MOT-05-XX-DR-X-0705

Security	Status	Rev
STD	PRE	P1

Figure 6: Environment Agency Flood Defences Standard of Protection in years (Return Period).

Scheme Order Limits
Proposed WWTP
Proposed earth works
Final effluent pipeline
Proposed transfer tunnel

Flood defence
Embankment
High ground
Wall

Data Sources
Scheme Order Limits, scheme elements: Anglian Water Services @One, 2022
Flood zones: Environment Agency, 2022
Basemapping: © Crown copyright and database rights 2021 OS 100022432

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Title
Cambridge Waste Water Treatment Plant Relocation Project
Flood Risk assessment
Environment Agency flood defences standard of protection in years

Drawn	KL
Checked	MC
Approved	CS
Scale at A3	1:40,000

Drawing Number
WW01003-CAMEST-MOT-05-XX-DR-X-0706

Security	Status	Rev
STD	PRE	P1

Figure 7: Flood outlines inclusive of treated effluent discharge from existing WWTP

Scheme Order Limits
Proposed WWTP
Proposed earth works
Final effluent pipeline
Proposed transfer tunnel

Fluvial model - existing

1 in 2 years
1 in 10 years
1 in 20 years
1 in 30 years
1 in 50 years
1 in 75 years
1 in 100 years
1 in 200 years
1 in 1000 years

Data Sources
Scheme Order Limits, scheme elements: Anglian Water Services @One, 2022
Flood outlines: Binnies, 2022
Basemapping: © Crown copyright and database rights 2021 OS 100022432

Metres
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Cambridge CB1 2JD
United Kingdom

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P1	24/10/22	KL	First Draft	MC	CS

Title
Cambridge Waste Water Treatment Plant Relocation Project
Flood Risk Assessment
Flood outlines inclusive of treated effluent discharge from existing WWTP

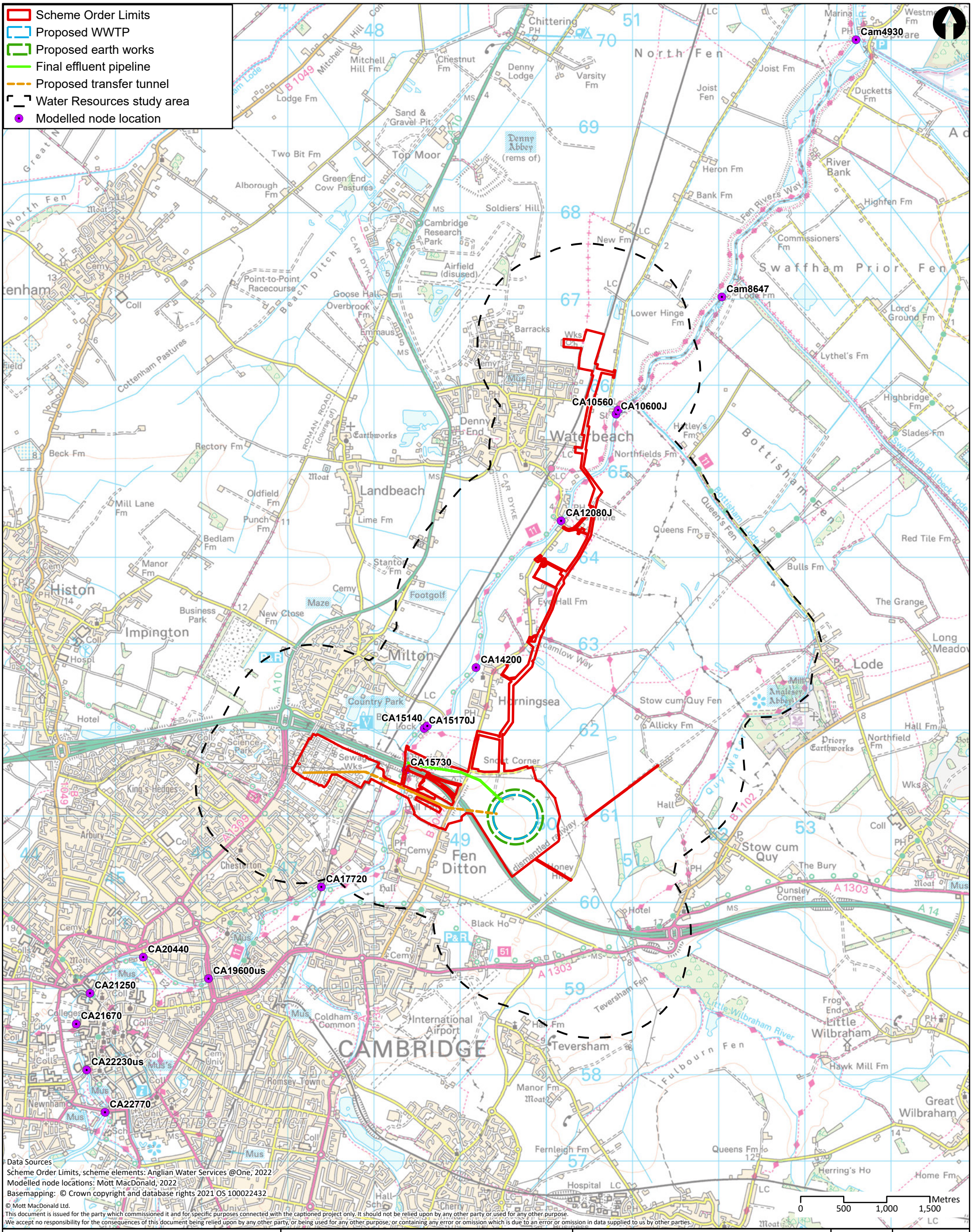
Drawn	KL
Checked	MC
Approved	CS

Scale at A3: 1:20,000

Drawing Number: WW01003-CAMEST-MOT-05-XX-DR-X-0707

Security	Status	Rev
STD	PRE	P1

Figure 8: Modelled node locations in relation to the Proposed Development



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22 Station Road
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United Kingdom

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F +44 (0)20 8681 5706
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P1	24/10/22	KL	First Draft	MC	CS

Title
Cambridge Waste Water Treatment Plant Relocation Project
Flood Risk Assessment
Modelled notes in relation to the proposed development

Drawn	KL
Checked	MC
Approved	CS

Scale at A3
1:40,000

Drawing Number
WW01003-CAMEST-MOT-05-XX-DR-X-0708

Security	Status	Rev
STD	PRE	P1

Figure 9: Climate change flood outline for 1%AEP + 20%CC

Scheme Order Limits
Proposed WWTP
Proposed earth works
Final effluent pipeline
Proposed transfer tunnel
Climate change flood outline for 1%AEP + 20%CC

LANDBEACH CP
MILTON CP
HORNINGSEA CP
FEN DITTON CP

Data Sources
Scheme Order Limits, scheme elements: Anglian Water Services @One, 2022
Climate change flood outline : Binnies, 2022 from Halcrow, 2012
Basemapping: © Crown copyright and database rights 2021 OS 100022432

0 500 1,000 1,500 Metres

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P1	24/10/22	KL	First Draft	MC	CS

Title
Cambridge Waste Water Treatment Plant Relocation Project
Flood Risk Assessment
Climate change flood outline for 1%AEP + 20%CC

Drawing Number
WW01003-CAMEST-MOT-05-XX-DR-X-0709

Drawn	KL
Checked	MC
Approved	CS
Scale at A3	1:20,000

Security	Status	Rev
STD	PRE	P1

Figure 10: Extent of Flooding from Surface Water (source: Environment Agency)

Scheme Order Limits
Proposed WWTP
Proposed earth works
Final effluent pipeline
Proposed transfer tunnel

Extent of flooding from surface water (Risk)
Low
Medium
High

Data Sources
Scheme Order Limits, scheme elements: Anglian Water Services @One, 2022
Flooding extent: Environment Agency, 2022
Basemapping: © Crown copyright and database rights 2021 OS 100022432

0 500 1,000 1,500 Metres

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United Kingdom

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Rev	Date	Drawn	Description	Ch'k'd	App'd
P1	24/10/22	KL	First Draft	MC	CS

Title
Cambridge Waste Water Treatment Plant Relocation Project
Flood Risk Assessment
Extent of flooding from surface water

Drawn	KL
Checked	MC
Approved	CS
Scale at A3	1:20,000

Drawing Number: WW01003-CAMEST-MOT-05-XX-DR-X-0710

Security	Status	Rev
STD	PRE	P1

Figure 11: Sewer Flooding incidents by postcode

Postcode	Number of Sewer Flooding Incidents		
	Internal	External	Total
CB1	3	0	3
CB10	n/a	n/a	0
CB11	n/a	n/a	0
CB2	n/a	n/a	0
CB21	0	8	8
CB22	2	4	6
CB23	2	19	21
CB24	2	10	12
CB25	1	7	8
CB3	1	2	3
CB4	0	3	3
CB5	0	1	1
CB6	n/a	n/a	0
CB7	n/a	n/a	0
CB8	n/a	n/a	0
CB9	n/a	n/a	0

Source: Greater Cambridge SFRA (2021), based on Anglian Water DG5 register.

Figure 12: Historic Fluvial Flood Outlines

Scheme Order Limits
Proposed WWTP
Proposed earth works
Final effluent pipeline
Proposed transfer tunnel
Recorded flood outline
March 1947
October 2001

Data Sources
Scheme Order Limits, scheme elements: Anglian Water Services @One, 2022
Historic flood outline: Environment Agency, 2022
Basemapping: © Crown copyright and database rights 2021 OS 100022432

Metres
0 500 1,000 1,500

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22 Station Road
Cambridge CB1 2JD
United Kingdom

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F +44 (0)20 8681 5706
W mottmac.com

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Title
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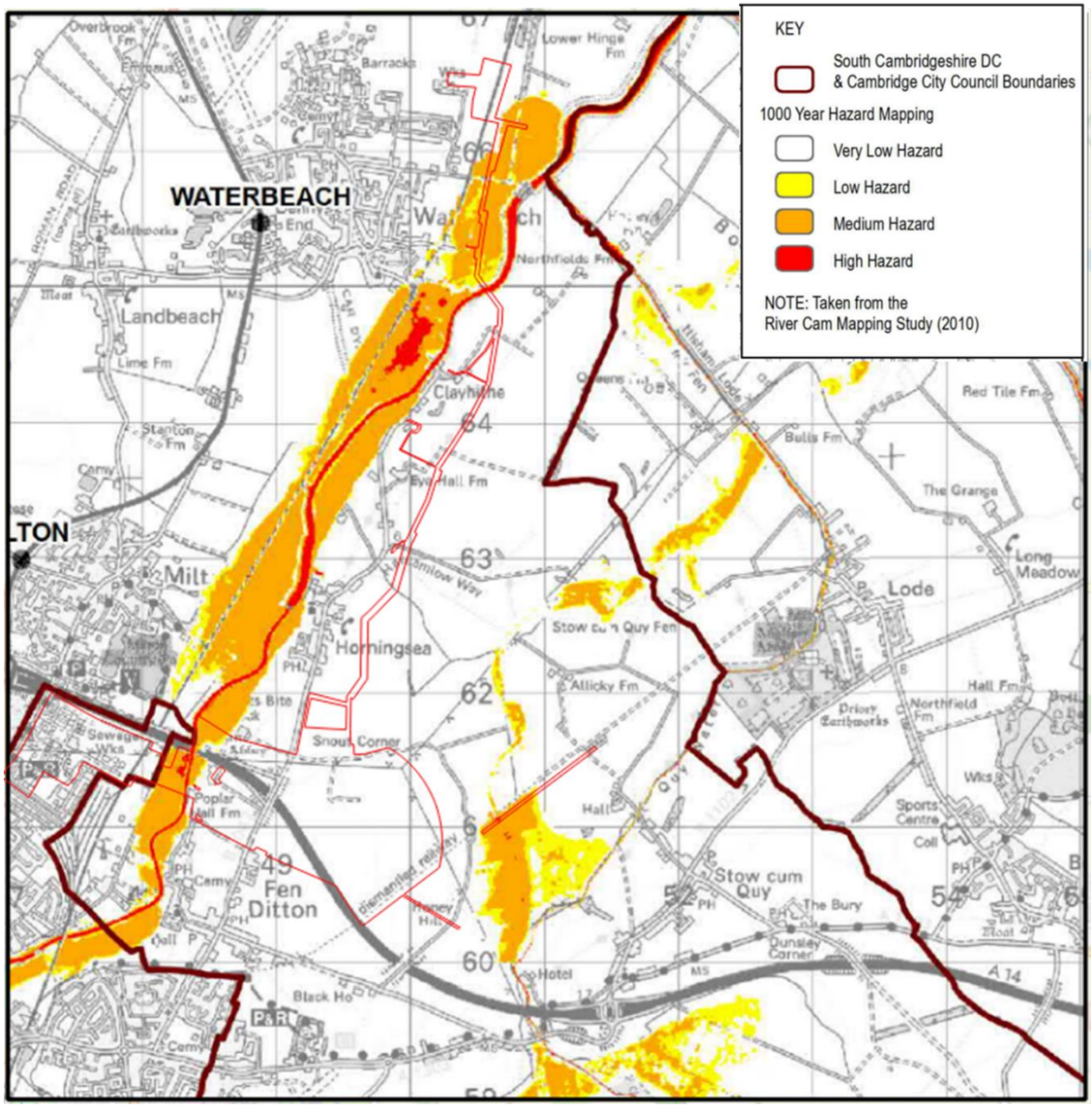
Flood Risk Assessment
Historic fluvial flood outline

Drawn	KL
Checked	MC
Approved	CS
Scale at A3	1:20,000

Drawing Number: WW01003-CAMEST-MOT-05-XX-DR-X-0711

Security	Status	Rev
STD	PRE	P1

Figure 13: Defence breach hazard 1 in 1000 years



Source: Cambridge and South Cambridgeshire SFRA, 2010

Figure 14: Reservoir flood extents for 'wet day' and 'dry day' scenarios

Scheme Order Limits
Proposed WWTP
Proposed earth works
Final effluent pipeline
Proposed transfer tunnel
Reservoir flood extent
Dry day
Wet day

Data Sources
Scheme Order Limits, scheme elements: Anglian Water Services @One, 2022
Reservoir flood extent: Environment Agency, 2022
Basemapping: © Crown copyright and database rights 2021 OS 100022432

0 500 1,000 1,500 Metres

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22 Station Road
Cambridge CB1 2JD
United Kingdom

T +44 (0)20 8774 2000
F +44 (0)20 8681 5706
W mottmac.com

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P1	24/10/22	KL	First Draft	MC	CS

Title
Cambridge Waste Water Treatment Plant Relocation Project
Flood Risk Assessment
Reservoir flood extents for 'wet day' and 'dry day' scenario

Drawn	KL
Checked	MC
Approved	CS
Scale at A3	1:40,000

Drawing Number: WW01003-CAMEST-MOT-05-XX-DR-X-0712

Security	Status	Rev
STD	PRE	P1

Figure 15: Flood outlines inclusive of treated effluent discharge from proposed WWTP

Scheme Order Limits
Proposed WWTP
Proposed earth works
Final effluent pipeline
Proposed transfer tunnel

Fluvial model - proposed development

1 in 2 years
1 in 10 years
1 in 20 years
1 in 30 years
1 in 50 years
1 in 75 years
1 in 100 years
1 in 200 years
1 in 1000 years

Data Sources
Scheme Order Limits, scheme elements: Anglian Water Services @One, 2022
Flood outlines: Mott MacDonald, 2022
Basemapping: © Crown copyright and database rights 2021 OS 100022432

Metres
0 500 1,000 1,500

MOTT MACDONALD
22 Station Road
Cambridge CB1 2JD
United Kingdom

T +44 (0)20 8774 2000
F +44 (0)20 8681 5706
W mottmac.com

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Rev	Date	Drawn	Description	Ch'k'd	App'd
P1	24/10/22	KL	First Draft	MC	CS

Title
Cambridge Waste Water Treatment Plant Relocation Project
Flood Risk Assessment
Flood outlines inclusive of treated effluent discharge from proposed WWTP

Drawing Number
WW01003-CAMEST-MOT-05-XX-DR-X-0713

Drawn	KL
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Approved	CS
Scale at A3	1:20,000

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You can contact us by:

Emailing at **info@cwwtpr.com**

Calling our Freephone information line on **0808 196 1661**

Writing to us at **Freepost: CWWTPR**

Visiting our website at [redacted]

You can view all our DCO application documents and updates on the application on The Planning Inspectorate website:

https://infrastructure.planninginspectorate.gov.uk/projects/eastern/cambridge-waste-water-treatment-plant-relocation/