Oath to Burrowbridge Dredging and Associated Activities

Volume 3: Appendices Part 8 Section1

APPENDIX 7C: WATER FRAMEWORK DIRECTIVE REGULATORY COMPLIANCE ASSESSMENT

Stathe to Burrowbridge Dredging Proposals
Water Framework Directive Assessment

STEP 1 – BACKGROUND AND SCREENING

Introduction

The WFD Assessment for the proposed dredging operation from Oath to Burrowbridge has been divided into the following sections:
Step 1 Background and Screening
Step 2 Scoping
Step 3 Baseline Assessment
Step 4 WFD Compliance Assessment
Step 5 In-combination Assessment
Step 6: WFD Environmental Mitigation Plan

This document forms Step 1 Background and Screening.

Description of Works

Dredging along 2.2km of the River Parrett transitional water body is proposed from downstream of Stathe Bridge on the River Parrett to the confluence with the River Tone at Burrowbridge for the purpose of flood protection. The full description of the works, justification and options assessment has been included in the Environmental Impact Assessment (EIA) and Environmental Statement (ES) for the project.

The dredge location map and works area , proposed river profile design and the method statement for works have provided in Appendix 1 to the WFD Assessment submission.

Excavator dredging of silt accumulations at locations on both sides of the bank, retaining certain areas (especially on the left hand side of the bank), above the lower flow channel, is proposed. This will be achieved using excavators with access from the right hand bank. The dredged material will be deposited on the rear slope of the right bank in one mechanical movement. The material will not be spread to agricultural land or removed from site. It is anticipated that the dredge equipment will be land based excavators on the banks of the river. The dredging operation is anticipated to take between 8 - 12 weeks with mobilisation commencing mid-August and the main works scheduled to commence from September 2019. Ecological mitigation, restoration and enhancement works will occur from August 2019 and extend through this and post completion of the dredging works, supported by monitoring and a dynamic management plan. The need for localised and limited maintenance of the restored cross-section will be based on a programme of monitoring, and is likely to comprise the use of small excavators or a small water injection dredge system being deployed e.g. every 5 years.

The baseline data from which to base the assessment of potential WFD impacts have been sourced from:

(1) the EA Catchment Data Explorer data for RBMP WFD classifications

(2) 2018/19 ecological surveys of the river environment from Oath Lock to Burrowbridge during spring/summer as part of the environmental assessments during project planning

(3) historic data/reports/surveys from other operations within the water body e.g. ongoing environmental monitoring of annual maintenance dredging downstream

(4) expert knowledge from staff within the Environment Agency, Somerset Drainage Boards Consortium, Engineering and Environmental Consultants and Natural England.

All data used is sources within the relevant sections of the WFD detailed assessment.

In-combination effects are to be considered within the WFD assessment and those projects scoped in to the assessment are listed in Step 2 Scoping.

A separate EIA and HRA process have been carried out for this project and the WFD assessment is to be reviewed alongside these two assessments.

Table 1: Stage 1 Screening Low Risk Activity A scoping assessment is not required if the activity is listed as low risk according to the activities listed below.		
	Low risk activity that can be screened out	Relevance to proposed works
1	a self-service marine licence activity or an accelerated marine licence activity that meets specific conditions	Not relevant to dredging proposal.
2	maintaining pumps at pumping stations – if you do it regularly, avoid low dissolved oxygen levels during maintenance and minimise silt movement when restarting the pumps	Not relevant to dredging proposal.
3	removing blockages or obstacles like litter or debris within 10m of an existing structure to maintain flow	Not relevant to dredging proposal.
4	replacing or removing existing pipes, cables or services crossing over a water body – but not including any new structure or supports, or new bed or bank reinforcement	Not relevant to dredging proposal.
5	'over water' replacement or repairs to, for example bridge, pier and jetty surfaces – if you minimise bank or bed disturbance	Not relevant to dredging proposal.
Conclusion: The activity cannot be screened out as low risk and the assessment must continue to **Step 2 Scoping**		

Table 2: Screening WFD water bodies				
Water body Name	**A/ HMWB Designation**	**Current WFD status (2015)**	**Screen for WFD Assessment**	**Reasoning**
Parrett (Transitional) GB540805210900	Yes - HMWB	Moderate Overall. Moderate Ecological. Good Chemical.	**IN**	Capital dredging of 2.2km of water body, potential direct and indirect effects on biological quality elements and supporting elements and potential impact on delivery of WFD mitigation measures. Potential in combination effects with annual maintenance dredging of 4.25km of downstream water body.
Parrett (River) - R Yeo to West Sedgemoor Drain	Yes - HMWB	Moderate Overall. Moderate Ecological. Good Chemical.	**OUT**	Water body is located upstream of dredging location, outside the tidally influenced area and extends up to Langport. Water levels are penned in the summer months at Oath Lock (upstream of the proposed dredging location). The water body is classified as HMWB and currently classified as Moderate potential, notably as a result of supporting quality elements and physico-chemical quality elements (e.g. poor status for Phosphate levels). Biological quality elements have a Good status, in particular macrophytes and phytobenthos are classified as

GB108052015470				High and invertebrates are classified as Good. There is no classification status listed for other biological supporting elements such as fish in the 2016 WFD data. However, a number of fish species are known to be present and include migratory fish listed under the Severn Estuary SAC as well as glass Eels populations that migrate up the Parrett. The water body is heavily embanked (for flood risk purposes) and there are a number of controlled offtakes and spillways which connect the channel to the adjacent moors (i.e. West Sedgemoor and Aller Moor). Hydraulic modelling shows that dredging the downstream river will, during high flow events, reduce the frequency of overtopping along the water body into the adjacent moors. Dredging is not envisaged to significantly affect water levels on the moors as these can be controlled by alternative water level management measures; this risk is included in the Habitat Regulation Assessment for the dredging proposals. River water levels are not considered to be significantly affected such that they could cause long term significant direct or indirect impacts on hydromorph or phys-chem quality elements. Upstream fish and eel migration through the dredged reach in the Parrett TraC water body may indirectly affect fish populations upstream within this water body, eels in particular. The indirect effects on biological quality elements in terms of influencing migration, or loss of some population by mortality, is covered in the assessment for the Parrett TraC water body. It is considered that impacts on WFD status in this water body in terms of risk to biological quality elements is likely to be insignificant and does not require direct assessment for this water body.
Tone DS Taunton (River) GB108052015482	Yes - HMWB	Moderate Overall. Moderate Ecological. Good Chemical.	**OUT**	This water body is part of the River Tone, outside the tidally influenced area and extending upstream through Taunton. The water body is classified as HMWB and is managed for flood risk and environmental purposes (to support habitat within the internationally important SPA/Ramsar sites). The river is heavily embanked and there are a number of controlled offtakes and spillways which connect the channel to the adjacent moors i.e. Curry & Hay Moor SPA/Ramsar. The impact of the proposed dredging on water levels on the moors adjacent to the Tone has been assessed within the HRA and EIA. As the proposed dredging is upstream of the confluence of the Tone and Parrett, it is considered that any impacts from the Stathe to Burrowbridge dredge on DO, hydromorphological, physico-chemical and biological will be indirect and negligible. Any effects as a result of changes to flow regime (increased flow

				capacity in the Parrett with the potential for backing up/high water in the lower Tone) are not considered to significantly affect WFD elements in the River Tone upstream of the tidal limit. The effect on biological quality elements (specifically fish) in terms of influencing migration, or loss of some population by mortality, will be considered in the detailed assessment for the Parrett (Transitional) waterbody. It is considered that impacts on WFD status in this water body in terms of risk to biological quality elements is likely to be insignificant and does not require direct assessment for this water body
Kings Sedgemoor Drain (River) GB108052021120	Yes - Artificial	Moderate Overall. Moderate Ecological. Good Chemical.	**OUT**	The water body extends east off the Parrett (river) water body outside of the tidally influenced area. The River Sowy Flood Relief Channel connects the River Parrett to King Sedgemoor Drain. The River Sowy is incorporated into the same water body. The proposed dredging may result in a reduction in the use of the Sowy Flood Relief Channel during times of high flow and flooding, therefore affecting water levels in the adjacent moors (and to a lesser extent there is a potential for impacts on the moors further downstream adjacent to King Sedgemoor Drain). This impact can be managed via existing water level management control structures and the impacts have been assessed as part of the EIA and HRA for the proposed dredging. There are no hydromorph or phys-chem impacts predicted on this water body as a result of the dredging and any effects as a result of changes to flow regime through increased flow capacity in the Parrett are not considered to significantly affect WFD elements in the King Sedgemoor Drain water body. Likewise, no significant effects on biological quality elements (e.g. fish) are identified as a result of the proposed dredging. This water body is therefore screened out from further WFD assessment.
Petherton Stream (River) GB108052015500	Yes - Artificial	Poor Overall. Poor Ecological. Good Chemical.	**OUT**	Discharges into the tidally influenced section of the Parrett (within the area to be dredged) through an outfall structure near Fordgate. Tidal flow at the offtake will continue to influence discharge from the Petherton Stream. Reasons for not achieving good status relate to biological quality elements as a result of sewage discharge and ecological discontinuity (physical barriers to fish). Negligible change in downstream water levels at the location of Petherton Stream is expected from the proposed dredging, therefore this water body is screened out from further assessment.

West Sedgemoor Main Drain (River) GB108052015450	Yes - Artificial	Moderate Overall. Moderate Ecological. Good Chemical.	**OUT**	Inflow into the channel is controlled through an offtake from the River Parrett and is pumped back into the a pumping station near Stathe. There are no hydromorph or phys-chem impacts predicted on this water body as a result of the dredging and any effects as a result of changes to flow regime through increased flow capacity in the Parrett are not considered to significantly affect WFD elements in the water body. Likewise, no significant effects on biological quality elements (e.g. fish) are identified as a result of the proposed dredging. Predicted changes in water level within the moor/rhyne resulting from the dredge operation relate to flooding conditions. The water levels can be managed via adaptations to the water level management structures to ensure water levels are maintained as required for WFD elements. This is covered further in the EIA and HRA for the proposed dredging. This water body is therefore screened out from further WFD assessment.
Bridgwater and Taunton Canal (AWB) GB708100069	Yes - Artificial (canal)	Moderate Overall. Moderate Ecological. Good Chemical.	**OUT**	The Bridgwater and Taunton Canal joins the Parrett (Transitional) in Bridgwater downstream from the proposed dredged area. No effect from proposed scheme is anticipated therefore this water body has been screened out from further assessment.
North Moor Main Drain (River) GB108052015500	Yes - Artificial	Moderate Overall. Moderate Ecological. Good Chemical.	**OUT**	Linked to WLMP for North Moor/Curry Moor. Water is fed into North Moor through a controlled offtake from the R.Parrett and spillways (e.g. Athelney Spillway) from Curry Moor, which receive flow from the R.Tone. Dredging within the Parrett (transitional) water body will reduce the frequency of flooding during high flow events. Dredging is not envisaged to significantly effect water levels on the moors because water levels are controlled by water level management measures. This is covered further in the EIA and HRA for the proposed dredging. This water body is therefore screened out from further assessment.
Tone and Somerset Streams (Groundwater body) GB40802GB06400	N/A	Poor Overall. Good Ecological. Poor Chemical.	**OUT**	This groundwater body has been classified as being at Poor Overall Status, Good Quantitative and Poor Chemical Status in 2016. Underlies area. Limited borehole logs confirm expected geology. Bedrock is Mercia Mudstone (Keuper Marl) which is not an aquifer. At the Curry Moor pumping station the depth to bedrock is about 15m, about 9m below OD. Above OD the sequence is soft alluvial clays and silts overlying a well-defined peat layer at about OD. Below the OD peat boreholes indicate a firm alluvial clay over the Marl. None of these materials can be considered aquifers. In some parts of the Levels, the lower part of the alluvial sequence is a silty sand with some gravel at the base. Even where the sands occur (mainly to the north and west of the area) they are

				unlikely to be any more than a very minor aquifer. Just south of the Tone in the area of Stoke Gregory and to the north around East Lyng there are some pockets of terrace gravel but these are above the level of the alluvial floodplain. There is also a small outcrop of Sherwood Sandstone in this area. This can be an aquifer and there are records of old farm wells into the sandstone. However, there is a good aquiclude of clay between the river and the sandstone. The Mercia Mudstone also occasionally outcrops as little hillocks. Hydrogeology is unlikely to be at risk based on lack of predicted connectivity between the Parrett river bed and aquifers within the zone of influence of the dredging operations. For this reason it is screened out of further assessment.
Bridgwater Bay (Coastal) GB670807410000	No	Moderate Overall. Moderate Ecological. Good Chemical.	**OUT**	Risk of sediment loss to wider system (Bristol Channel) but considered to be negligible based on understanding of sediment cell in Bridgwater Bay from ongoing silt flux monitoring since 2014. Loss of sediment is within the scale of natural variation. Water body screened out from further assessment.

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STEP 2 – SCOPING

Introduction

The WFD Assessment for the proposed dredging operation from Stathe to Burrowbridge has been divided into the following sections:
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Step 6: WFD Environmental Mitigation Plan

This document forms Step 2 Scoping.

The WFD Stage 2 Scoping exercise completed here has utilised the template provided in the Environment Agency Guidance document for carrying out WFD assessments in estuarine and coastal waters: Clearing the Waters for All 2017.

Contents

1. Description of Activity

Your activity	Description, notes or more information
Applicant name	Somerset Drainage Boards Consortium
Application reference number (where applicable)	Not relevant
Name of activity	Dredging silt accumulations from the river banks, in a transitional water body.
Brief description of activity	• Capital dredge of 2.2km of River Parrett between Beazleys Spillway/Stathe Bridge and confluence with the River Tone to remove accumulated silt deposits from the banks. Dredging does not include the lower flow thalweg (main channel) and removal of dredged arisings will all taken place above the low water channel. • Method involves use of long reach excavators from the river banks to remove silt and deposit on the backs of the bank in one mechanical movement. • The dredging will focus on the right hand bank, however this is not continuous (as seen on dredge design plans) with the majority of the banks on the left hand side being retained in their current condition with no disturbance. • The dredged material will be from the river bank above the typical water line (dry) and depending on the water levels at the time some will be below water level. • A terraced and varied cross section will be created, with a retained lower vegetated bank reed edge (1-2m width) in most locations to ensure that the critical marginal vegetation zone is maintained and enhanced. This will also ensure sufficient alternative key faunal habitat is present during the proposed works. Final dredge design profiles (agreed on site during the dredging by the Environmental Clerk of Works) will include a wide range morphological diversity (e.g. raised and lowered areas, scrapes and embayments/backwaters) to ensure vegetation zones and fish habitat are maintained. At no point will there be a trapezoidal channel with limited morphological diversity.. Cattle will be excluded from the right hand bank for a period of 12 months to allow re-seeded grassland to establish. See dredging plan in Appendix 1.
Location of activity (central point XY coordinates or national grid reference)	Upstream extent – 337,554 129,422 metres Downstream extent – 335,864 130,166 metres
Footprint of activity (ha)	2.1km length of river. Approx maximum area of channel affected (not taking into account retained areas) = 1.725 Ha. Approx maximum area of channel and banks affected (not taking into account retained areas) = 5.5 Ha
Timings of activity (including start and finish dates)	Enabling and advanced ecological works from August 2019, Commencement of right hand bank and limited left hand bank dredging and ecological mitigation 2019 Autumn – From Sept

	Ongoing dredging phase ecological mitigation during winter 2020 and during 2021 (8 - 12 weeks of dredging work) Post dredging monitoring and habitat management
Extent of activity (for example size, scale frequency, expected volumes of output or discharge)	Maximum of 22,000 m^3 of deposited silt to be removed (left and right bank) within approx. 2.2km. See dredging plan in Appendix 1.
Use or release of chemicals (state which ones)	• No release of chemicals. • Biodegradable oil used in excavator machinery on banks. • Relevant pollution prevention control procedures included in contract documents and site operations.

2. Description of Water Body

Water body[1]	Description, notes or more information
WFD water body name	Parrett Transitional Water Body (Parrett TraC)
Water body ID	GB540805210900
River basin district name	South West TraC
Water body type (estuarine or coastal)	Transitional Water
Water body total area (ha)	7083.536 Ha Length 40km.
Overall water body status (2015)	Moderate
Ecological status	Moderate
Chemical status	Good
Target water body status and deadline	Good 2027
Hydromorphology status of water body	Supports Good
Heavily modified water body and for what use	Yes, flood protection. Not for coastal protection or navigation, ports and harbours.
Higher sensitivity habitats present	Yes, within overall water body area:

Chalk reef (ha)	Clam, cockle and oyster beds (ha)	Intertidal seagrass (ha)	Maerl (ha)	Mussel beds, including blue and horse mussel (ha)	Polychaete reef (ha)	Saltmarsh (ha)	Subtidal kelp beds (ha)	Subtidal seagrass (ha)
-	-	-	-	-	83.37	232.02	-	-

No highly sensitive habitats are present within the area of proposed works.

<table>
<tr><td></td><td></td></tr>
<tr><td>Lower sensitivity habitats present</td><td>Yes, within overall water body area:
<table>
<tr><th>Cobbles, gravel and shingle (ha)</th><th>Intertidal soft sediment (ha)</th><th>Rocky shore (ha)</th><th>Subtidal boulder fields (ha)</th><th>Subtidal rocky reef (ha)</th><th>Subtidal soft sediments (ha)</th></tr>
<tr><td>14.08</td><td>5725.31</td><td>109.62</td><td>-</td><td>-</td><td>750.38</td></tr>
</table>
Within area of proposed works, the relevant low sensitivity habitat is mostly inter-tidal soft sediment and subtidal soft sediment.</td></tr>
<tr><td>Phytoplankton status</td><td>No classification status given.</td></tr>
<tr><td>History of harmful algae</td><td>Not monitored.</td></tr>
<tr><td>Designated sites for habitat importance</td><td>There are a number of designated sites in the nearby area. The location is provided in the environmental designation maps in Appendix 2. Details are provided below:
<u>EU Designated Habitats</u>
<table>
<tr><td>Severn Estuary</td><td>UK9015022</td><td>Conservation of Wild Birds Directive</td><td>SPA</td><td>Natural England</td></tr>
<tr><td>Severn Estuary</td><td>UK0013030</td><td>Habitats and Species Directive</td><td>SAC</td><td>Natural England</td></tr>
<tr><td>Somerset Levels & Moors</td><td>UK9010031</td><td>Conservation of Wild Birds Directive</td><td>SPA</td><td>Natural England</td></tr>
</table>
<u>Somerset Levels and Moors SPA</u> is designated primarily for the wintering wildfowl populations inhabiting the moors during winter months. These rely on specific wetland conditions. Nearest areas included in the SLM SPA are: Southlake Moor (adjacent to the right bank of the dredging location), West Sedgemoor (approx. 500m upstream of dredging location on the River Parrett) and Curry Moor (approx. 2km from dredging, upstream of the Parrett/Tone confluence on the River Tone).

<u>Severn Estuary SAC and SPA</u> designation extends as far upstream as Dunball Sluice (approx. 15km downstream from dredging location). The Somerset Levels and Moors SPA and Ramsar sites are ecologically linked to the Severn Estuary SPA and Ramsar sites. This is because the Severn Estuary populations of wintering waterfowl use the Somerset Levels and Moors as an alternative wintering site. However, the Severn Estuary Ramsar site also includes designations for migratory fish species. These migratory species may be</td></tr>
</table>

present and rely upon the habitat of the River Parrett Transitional Water Body (outside of the designation extent of the Severn Estuary SPA).

National Designations

SSSI**:** There are a number of SSSI designations nearby to the site, for the most part these are also designated within the Somerset Levels and Moors SPA area. The nearest moor that is designated a SSSI but is not designated within the SPA area is:

North Moor SSSI	Located approx. 300m from the downstream extent of the dredging location. Designated for grassland and rhyne system inhabited by an array of flora and fauna. Utilised by wintering bird populations, similar to the SLM SPA.

National Nature Reserve: Southlake Moor is also designation a National Nature Reserve as are small areas within Sedgemoor SSSI.

Locally Designated Habitats

The River Parrett, Middle Moor to Screech Owl Site of Nature Conservation Importance (SNCI)	The designation covers the entire works area. Designated as a LWS as it is a catchment seen to be in regular use by otter, and supports Red Data Book invertebrate species and other notable species. The river and its habitat also support water vole *Arvicola amphibius*, and is one of only three recent localities in the UK for the hairy click beetle *Synaptus filiformis*, whose larvae live in waterlogged soil and whose adults live in emergent vegetation, particularly reed canary-grass *Phalaris arundinacea*. In addition, the river supports a large number of coarse fish species as well as supporting a run of eel *Anguilla Anguilla*, Atlantic salmon *Salmo salar*, and sea trout *Salmo trutta*.
The River Tone and Tributaries SNCI	Located immediately to the west of Burrowbridge. This site has been designated as it is considered to be the best example in the county of a whole river from source to saline limit of each river type; comprise a section of river with a minimum of modification to bed and water level and a high proportion of semi-natural habitats on both banks; have high biological quality; and show regular recent use by otter, including all bankside wetland, scrub and woodland.

WFD protected areas within 2km	*NB - definition of WFD protected areas: Member States are required by the Directive to register as 'Protected Areas' all areas lying within each River Basin District which have been designated as requiring special protection under specific European Community legislation for the conservation of habitats and species directly depending on water. This register shall include all Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) where the maintenance or improvement of the status of water is an important factor in their protection.* See above for all relevant designations (all of the above designations rely on water for their designations).

3. Specific Risk Information

Below the potential risks of the activity have been considered for each of the receptors: hydromorphology, biology (habitats and fish), water quality, protected areas and invasive non-native species (INNS).

3.1. Hydromorphology

Consider if your activity:	Yes	No	Hydromorphology risk issue(s)
Could impact on the hydromorphology (for example morphology or tidal patterns) of a water body at high status		**Impact assessment not required**	Water body not at high status.
Could significantly impact the hydromorphology of any water body	**Impact assessment required**		Potential for significant hydromorphological impacts as a result of dredging, if not mitigated. In particular this relates to: • Morphological diversity of channel. A significant impact could result if channel diversity is consistently lost over the length of the dredging reach (and the dredge cross section is maintained in the future, such that the impacts are long term). • In combination impacts with maintenance dredging operations downstream along the Parrett and Tone.
Is in a water body that is heavily modified for the same use as your activity	**Impact assessment required**		The water body is classified as heavily modified for flood protection as a result of historic flood protection works (artificial embankments and diversions). Immediately downstream of the dredging area, the 1960's design profiles are maintained via regular dredging operations for the purpose of flood protection. The proposed dredging from Stathe to the confluence with the River Tone constitutes a similar flood protection measure as the actions carried out downstream. I.e. maintenance of the design profiles to enhance flow conveyance for flood protection. Consequently, the potential in-combination effects need to be considered further.

3.2. Biology

3.2.1. Coastal Habitat

Higher sensitivity habitats [1]	Lower sensitivity habitats [2]
chalk reef	cobbles, gravel and shingle
clam, cockle and oyster beds	intertidal soft sediments like sand and mud
intertidal seagrass	rocky shore
maerl	subtidal boulder fields
mussel beds, including blue and horse mussel	subtidal rocky reef
polychaete reef	subtidal soft sediments like sand and mud
saltmarsh	
subtidal kelp beds	
subtidal seagrass	

[1] *Higher sensitivity habitats have a low resistance to, and recovery rate, from human pressures.*

[2] *Lower sensitivity habitats have a medium to high resistance to, and recovery rate from, human pressures.*

Consider if the footprint[3] of your activity is:	Yes	No	Biology habitats risk issue(s)
0.5km^2 or larger		**No to all – does not require impact assessment.**	No – 0.055km^2 (channel and bank habitat combined)
1% or more of the water body's area			No – maximum of 0.08% of water body directly affected by works. Dredge footprint (1.5x the dredge area) = 0.12% of water body affected
Within 500m of any higher sensitivity habitat			No - The proposed activity is adjacent to protected (terrestrial) habitat but no highly sensitive transitional/estuarine habitats. Somerset Levels and Moors SPA (designated for wetland wintering birds) is located within 500m of proposed dredging. The potential impacts as a result of the operation is being assessed separately via a Habitat Regulation Assessment and Environmental Impact Assessment.
1% or more of any lower sensitivity habitat			No – Lower sensitivity habitat within the water body mostly relates to intertidal soft sediments like sand and mud, with a total water body area of 5725.31 ha.

			The entire working area (plus 1.5x for dredge footprint) is 0.15% of the water body intertidal soft sediment area. Further to this the entire working area of 5.5ha also includes the main channel (which would not be dredged) and the upper banks (which do not include intertidal soft sediment) and as such is an over-estimate.

[3]*Note that a footprint may also be a temperature or sediment plume. For dredging activity, a footprint is 1.5 times the dredge area.*

3.2.2. Riparian Habitat and Aquatic Flora

This section has been added as an additional to the requirements of the EA template for transitional water bodies. Although the water body is classified as estuarine, the purpose of this section is to include freshwater riverine habitat elements that are present in the upper extent of the waterbody (and location of proposed dredging). Further to this, existing knowledge of the location and wider Somerset Levels and Moors habitat sensitivities has been applied to generate the list below.

Aquatic flora relate to: Angiosperms (riparian flowering plants), Macrophytes (benthic growing) and Phytobenthos (on features in the watercourse).

Higher sensitivity	**Lower sensitivity habitats**
Riparian trees.	Marginal riparian vegetation stands (reed canary grass)
Macrophytes.	Semi-improved wetland grassland habitat.

Consider if the footprint[4] of your activity is:	**Yes**	**No**	**Biology habitats risk issue(s)**
0.5km^2 or larger		**No impact assessment not required**	No – 0.055km^2 (channel and bank habitat combined)
1% or more of the water body's area		**No impact assessment not required**	No – maximum of 0.08% of water body directly affected by works. Dredge footprint (1.5x the dredge area) = 0.12% of water body affected
Directly remove any higher sensitivity habitat.		**No impact assessment not required**	A Phase 1 river habitat and vegetation survey of the proposed dredging location was carried out in May 2018. The survey confirmed that the riparian vegetation was of abundant and common species (no rare species were identified). The riparian habitat is not tree lined.

1% or more of any lower sensitivity habitat.	**Impact assessment required.**		Lower sensitivity habitat within the water body mostly relates to intertidal vegetation (e.g. reed canary grass). The total coverage of reed canary grass habitat along the banks of the Parrett transitional body is unknown. However, based on expert knowledge and experience working on the River Parrett (e.g. through management of maintenance dredging) it can be assumed that over 1% of the reed canary grass habitat will be affected by the proposed works, at least on a temporary basis. Even if canary reed grass was present along all 80km of bank along the watercourse length, the proposed dredging would be impacting 2.1km of this (2.6%).

3.2.3. Invertebrates

This section has been added as an additional to the requirements of the EA template for transitional water bodies. Although the water body is classified as estuarine, the purpose of this section is to include freshwater riverine species that are present in the upper extent of the waterbody (and location of proposed dredging). Further to this, existing knowledge of the location and wider Somerset Levels and Moors habitat sensitivities has been applied to generate the list below.

Consider if your activity:	Yes	No	risk issue(s)
Could impact on normal invertebrate behaviour like movement, spawning (for example reducing available habitat, creating noise, chemical change or a change in depth or change in flow)	**Requires impact assessment**		Dredging operations have the potential to cause damage to invertebrate populations through direct kill and loss of habitat and deterioration of water quality during and for a limited period after dredging operations.
Could have a negative impact on protected species?	**Requires impact assessment**		Hairy Click Beetle (marginal terrestrial invertebrate) is known on the silt accumulations proposed for dredging, with the potential to negatively affect the population. Ramsar invertebrates may also be present in the river habitat environment.

3.2.4. Fish

Consider if your activity:	Yes	No	Biology fish risk issue(s)
Is in an estuary and could affect fish in the estuary, outside the estuary but could delay or prevent fish entering it or could affect fish migrating through the estuary	Continue with questions		Yes. See below.
Could impact on normal fish behaviour like movement, migration or spawning (for example creating a physical barrier, noise, chemical change or a change in depth or flow)	**Requires impact assessment**		Dredging operations could have a temporary effect on fish migration during dredging operations (sediment, temperature, dissolved oxygen). Impacts on river morphology could have an effect on fish spawning if fish habitat diversity is significantly reduced.
Could cause entrainment or impingement of fish		**Impact assessment not required**	Dredging operations are temporary and unlikely to significantly affect fish through the physical action of the excavators. No physical structure will permanently be in place that could cause entrainment or impingement.

3.2.5. Other Riverine Protected Species

The proposed dredging has the potential to impact protected species that use the river environment (Water Voles, Otter Kingfisher and Schedule 1 bird species). The potential impact to protected species has been assessed and managed via the Environmental Impact Assessment.

3.3. Water quality

Consider if your activity:	Yes	No	Water quality risk issue(s)
Could affect water clarity, temperature, salinity, oxygen levels, nutrients or microbial patterns continuously for longer than a spring neap tidal cycle (about 14 days)	**Requires impact assessment**		Water clarity, temperature, salinity, oxygen levels, nutrients could all be affected temporarily during the dredging operations.

Is in a water body with a phytoplankton status of moderate, poor or bad		**Impact assessment not required**	No information available. Expert knowledge and experience of the water body suggests that an impact assessment is not required.
Is in a water body with a history of harmful algae		**Impact assessment not required**	No information available. Expert knowledge and experience of the water body suggests that there is no history of harmful algae.
If your activity uses or releases chemicals (for example through sediment disturbance or building works) consider if:	**Yes**	**No**	**Water quality risk issue(s)**
The chemicals are on the Environmental Quality Standards Directive (EQSD) list		**Impact assessment not required**	No use or release of chemicals on the EQSD list.
It disturbs sediment with contaminants above Cefas Action Level 1		**Impact assessment not required**	Sediment sampling, analysis and reporting has been carried out along the proposed stretch of river (see references). The results of which suggest that no harmful contaminants are present.
If your activity has a mixing zone (like a discharge pipeline or outfall) consider if:	**Yes**	**No**	**Water quality risk issue(s)**
The chemicals released are on the Environmental Quality Standards Directive (EQSD) list		**Impact assessment not required**	No use or release of chemicals on the EQSD list.

3.4. WFD protected areas

Consider if WFD protected areas are at risk from your activity. These include:

- special areas of conservation (SAC)
- special protection areas (SPA)
- shellfish waters
- bathing waters
- nutrient sensitive areas

Consider if your activity is:	Yes	No	Protected areas risk issue(s)				
Within 2km of any WFD protected area	**Impact assessment required**		Somerset Levels & Moors	UK9010031	Conservation of Wild Birds Directive	SPA	Natural England

Severn Estuary	UK9015022	Conservation of Wild Birds Directive	SPA	Natural England
Severn Estuary	UK0013030	Habitats and Species Directive	SAC	Natural England
Berrow North of Unity Farm	UK35500	Bathing Water Directive		Bathing water
Burnham Jetty North	UK35300	Bathing Water Directive		Bathing water
Brean	UK35600	Bathing Water Directive		Bathing water

- See 2 Description of Water Body above for more details.
- The Somerset Levels and Moors SPA area is immediately adjacent to the right banks of the proposed dredging area (Southlake Moor).
- Severn Estuary SAC and SPA designation extends as far upstream as Dunball Sluice (approx. 15km downstream from dredging location).
- The nearest nutrient sensitive area is the Petherton Stream NVZ over 4km to the North West, the River Parrett at the proposed dredging location does not feed into this water body.
- The River Parrett discharges at Bridgwater Bay where there are six designated Bathing Waters in neighbouring catchments, including the 'Burnham Jetty North' (Burnham-on-Sea) Bathing Water Quality Area. Burnham-on-Sea is a designated beach for bathing and is tested by the Environment Agency regularly under the EU Bathing Water Directive (2006/7/EC). Burnham-on-Sea is located approximately 3km downstream of the confluence of the River Parrett with the Severn Estuary. The confluence is approximately 30km from the downstream extent of the dredging area.

The risks to the following designations will be covered by the assessment in the Environmental Impact Assessment and Habitat Regulations Assessment for the proposed dredging operations:

- Somerset Levels & Moors SPA
- Severn Estuary SPA
- Severn Estuary SAC

Risks to the Bathing Water protected areas should be assessed in relation to the risk of pollution from pollutants in the sediments being disturbed/released during the dredging operation. Sediment sampling, analysis and reporting has been carried out along the proposed stretch of river (see references). The results of which suggest that no harmful contaminants are present.

3.5. Invasive non-native species (INNS)

Consider if your activity could:	Yes	No	INNS risk issue(s)
Introduce or spread INNS	**Requires impact assessment**		A river habitat and vegetation survey was completed in May 2018 for the proposed dredging location (see references). The habitat survey highlights the presence of invasive non-native species, in particular Himalayan Balsam. As such, this has been included for further impact assessment.

4. Summary of WFD Elements for Assessment

Receptor	Potential risk to receptor?	WFD classification element for impact assessment
Hydromorphology	Yes	Hydromorphological supporting elements: depth variation, quantity and structure of bed and structure of the intertidal zone.
Riparian habitats	Yes	Hydro-morphological supporting element: structure of the intertidal zone Biological quality element: Aquatic Flora.
Invertebrates	Yes	Biological quality element: Invertebrates.
Fish	Yes	Biological quality element: Fish fauna.
Water quality and protected areas.	Yes	Physico-chemical supporting elements: temperature, salinity, turbidity, dissolved oxygen, pollutant risk to Bathing Waters.
Invasive non-native species	Yes	Biological quality element: invasive species.

5. Scoping In-Combination Projects for Assessment

The table below includes a list of all projects considered via communication with the Environmental Regulators regarding in combination effects. The bold projects were those scoped into the assessment.

Projects	Scoped in/out	Explanation
River Parrett and Tone maintenance dredging	IN	Phase 1 and 2 capital dredge on 8km of the Rivers Parrett and Tone was completed in 2014. This was followed by annual maintenance dredging targeted at locations of maximum re-siltation (approx. 4.25km length of the water body). Dredging did not include dredging of both sides of the bank. The 2015 maintenance dredge was completed using bank side excavators, the 2016, 2017 and 2018 dredge were completed using Water Injection Dredging (WID) on bed sediment. Further maintenance dredging is planned. Each dredge has been accompanied by EIA and HRA environmental assessments. Maintenance dredging is managed by the SRA and a 5 year maintenance dredging permit has been issued. This will take account of the in-combination effects of annual episodes of maintenance dredging on the water body. However the permit does not include the in-combination effect of any new areas of capital dredging alongside the annual maintenance dredging (such as the Stathe to Burrowbridge dredge). Consequently, the potential impacts of the maintenance dredging with the proposed capita dredge on WFD elements should be considered and has been included here.
Bridgwater Parrett Tidal Barrier	OUT	The in-combination impacts of the proposed Bridgwater Tidal Barrier with the Stathe to Burrowbridge dredge proposals has been scoped out of further consideration based on the information currently available about the planned operation of the barrier. The barrier is intended for use as a tidal surge barrier only, and therefore it is anticipated that the barrier will be used infrequently at times of spring tide and surge (weather) conditions where there is a risk of tide lock/flooding. As such, it is not anticipated that the operation of the barrier will interact with the increased flow capacity of the Parrett generated by the dredging. The construction of the barrier is not scheduled until post 2020 and consequently would not conflict with the planned time frames of the dredging operation.
Environment Agency NCPMS Projects	OUT	Ongoing communication with the Environment Agency over the proposed dredging project (in particular regarding works on a reservoir bank) has highlighted a potential NCPMS project planned for 2019/20 within the same stretch of river between Stathe and Burrowbridge. The project has been identified as necessary to maintain the left banks of the River adjacent to Southlake Moor where there are known low spots and erosion (the project aims to re-establish bank crest). Ongoing consultation is being carried out to identify potential cost savings, multiple benefits and avoid unnecessary project overlap. The NCPMS project is at an early stage and no project information or defined dates are available. The project will also focus on works on the bank, not within the watercourse itself. As such, this project has been scoped out of the in-combination assessment but will be considered as part of the environmental mitigation programme requirements for the project should more information become available.

Natural England Plans for SSSI improvements	OUT	Southlake Moor (Natural England ownership) is adjacent to the right bank of the River Parrett along the majority of the proposed dredging location. Natural England have informed SDBC that there are project plans within Southlake Moor to develop reed beds for nutrient stripping and environmental enhancement. The proposed dredge is not anticipated to effect the proposed project or create in-combination environmental impacts on Southlake Moor. Ongoing communication with Natural England on project development and plans is in place to ensure that the two projects are not compromised or create environmental risks. As such, this project has been ruled out of the in-combination assessment.
Sowy Scheme Increased Capacity	IN	Both projects being developed at the same time. However, the proposed dredging is scheduled prior to the construction of the enhanced Sowy. In-combination impacts resulting in significant impacts in the WFD status of the Parrett transitional water body are not anticipated. However, this project has been scoped in to the in-combination assessment and considered as part of the environmental mitigation programme requirements for the project.
Beer Wall - Ongoing	OUT	The recently completed works on Beer Wall has increased the capacity of flow through infrastructure at Beer Wall, which may alter the water regime on the adjacent moors. There is a potential for in-combination impacts with the Sowy Scheme and the reduction in flood frequency resulting from the proposed Stathe to Burrowbridge dredge. However these impacts are restricted to changes to flood frequency on the moors, which will be assessed as part of the EIA and HRA for both projects, and it is not anticipated that there would be any significant impact on WFD elements within the River Parrett transitional water body. For this reason, it has been ruled out of any further in-combination assessment.
NSIP such as Hinkley C	OUT	There are no known in-combination impacts between Hinkley C proposals and the proposed dredging project.
Somerset Eel Passage Programme	OUT	The proposed dredging will not result in any fixed barriers to Eel migration and there are no known Eel passage works being carried out in the vicinity of the dredge location. The proposed dredging is not considered to impact on any measures in place to improve Eel passage as part of the Somerset Eel Passage Programme. For this reason, in-combination impacts with Somerset Eel Passage Programme will not be considered further. However, in-combination effects on Eels as a result of maintenance dredging operations is considered (as discussed above).

Oath to Burrowbridge Dredging Proposals
Water Framework Directive Assessment

STEP 3 – WFD BASELINE ASSESSMENT

Introduction

The WFD Assessment for the proposed dredging operation from Stathe to Burrowbridge has been divided into the following sections:
Step 1 Background and Screening
Step 2 Scoping
Step 3 Baseline Assessment
Step 4 WFD Compliance Assessment
Step 5 In-combination Assessment
Step 6: WFD Environmental Mitigation Plan

This document forms Step 3 Baseline Assessment.

Scoping outcomes

Step 2 Scoping identified the following WFD elements for a more detailed impact assessment. The current condition and status of these elements has been reviewed within this Step 3 – Baseline Assessment.

Hydromorphology supporting element	Depth variation Quantity and structure of bed Structure of the intertidal zone
Physico- chemical supporting elements	Temperature Salinity Turbidity Dissolved oxygen Pollutant risk
Biological	Aquatic Flora Invertebrates Fish Invasive species Water vole and otter (nonWFD) Pollutants

Summary of body status 2015

Water body	Parrett Transitional	
ID	GB540805210900	
Length	40km	
Type	HMWB (Flood Protection)	
Ecological Potential	Moderate	
	Surface water supporting elements *Mitigation measures*	Moderate *Moderate or less*
	Biological quality elements	Good
	Hydro-morphological supporting elements	Supports Good
	Specific pollutants	High
Chemical Status	Good	
	Priority substances	Good
	Other Pollutants	Does not require assessment
	Priority hazardous substances	Good
Reason for not achieving Good	Physical modification. Flood protection use.	Sector under investigation

	Other (not listed)	

Baseline Assessment Tables

Four tables below include information on the transitional water body WFD classification status for each WFD element using RBMP2 2015 data from the EA catchment data explorer resource. Additional data/information from various reports, monitoring and studies has also been identified, reviewed and discussed for each classification element (to help characterise the baseline condition of these elements using all available information).

Table 1: WFD classification and status – hydro-morphological supporting conditions.

Table 2: Table 2: WFD Classification and Status - Physico-Chemical Supporting Elements

Table 3: WFD Classification and Status - Biological Quality Elements

Table 4: Table 4: WFD Classification and Status - HMWB Mitigation Measures

Key for classification status of WFD element in Table 1 - 4	
	No classification data
	Element classified at bad status
	Element classified at poor status
	Element classified at moderate status, or mitigation measure not 'in place'
	Element classified at good status, or mitigation measure 'in place'
	Element classified at high status

Figures

Figure 1 – 17 are located at the end of the document and referred to within the relevant section of text.

References and Appendices

References of data/reports used to carry out the baseline assessment are given in the right hand column for each quality element. The text also refers to original documents or supplementary information provided in the appendices of the WFD assessment. The content of the appendices are listed below.

Appendix 1: Dredge Design

- Dredge design drawings (cross sections).
- Map of dredge deposition.
- Contractors Specification (also containing construction environmental management, mitigation and monitoring measures).

Appendix 2: Environmental Survey Reports (relevant to the WFD Assessment)

- Phase 1 Habitat Survey (SDBC, Johns Associates 2018)
- Fish Habitat Survey (SDBC, Johns Associates 2018).
- Fixed Point Photography Report (Johns Associates, June 2018). Phase 1 Habitat Survey (SDBC, Johns Associates 2018).
- Oath to Burrowbridge Benthic Macroinvertebrate Study (Johns Associates, June 2018).
- Oath to Burrowbridge Ramsar Invertebrate Study (Johns Associates, June 2018).
- Results of a Survey for Hairy Click-Beetle Synaptus Filiformis on the River Parrett, Somerset. AEcol, July 2018.
- Loughborough University, Dr A Pledger, Dr Dapeng Yu, Prof. Paul Wood, Dr David Ryves. Interim report: Ecological Impacts of Water Injection Dredging, Somerset Levels.
- Loughborough University, Dr Andrew Pledger. Technical note: 2018 pre-dredge River Parrett fish surveys.
- River Parrett Oath to Burrowbridge Dredge. Soils Screening Report. On Behalf of Somerset Drainage Boards Consortium (Hydrogeo, July 2018).
- Particle Size Distribution Results: Sediment Samples Oath to Burrowbridge. June 2018.
- Parrett Dredging Trials Monitoring Report Ambios vFinal. 2017.

Appendix 2: Environmental Mitigation Programme (relevant to the WFD Assessment)

- WFD Water Quality, Morphology, Fish, Riparian Habitats, Hairy Click Beetle (and other invertebrates) Assessment and Mitigation Programme

Table 1: WFD Classification and Status – Hydro-morphological Supporting Conditions			
WFD Quality Elements	**2015 RBMP2 data**	**Additional baseline information***	**Sources**
Depth variation	**Supports Good**	**Parrett TraC Water Body** RBMP2 2015 classification for hydromorphological supporting elements is Supports Good, the predicated 2022 and 2027 status is also Good and the objective is Good. The status represents that this is a Heavily Modified Water Body (HMWB). **Characterisation** This water body is a tidal lowland channel, artificial in nature with a relatively uniform planform. Much of the riverbank is artificial levee. Rock armour reinforces outer bends, and dredging and other maintenance works ensure that the river does not laterally migrate out of the confining levees. The estuary channel between Burrowbridge to Moorland formed part of a Dredging Trial Monitoring Programme between November/December 2016 (including post dredging monitoring in February 2017), hereafter referred to as the Ambios Report. The Ambios Report describes the section downstream of Burrowbridge as a sinuous channel of simple cross section, the sinuosity taking the form of short and straight reaches separated by often sharp bends, reflecting its man-made origin. Some photographs that summarise the general character are provided in ***Figure 1-6*** at the end of this table. Within the section of the Parrett described in the Ambios report, the channel thalweg varies between +3 and +1.5m ODN and the bank crestline stays constant around 8m ODN. Through the monitoring zone the width between bank crests generally increases from 30 to ~45m, and the cross-section area from about 85 to 120m^2. There is however considerable variation in these dimensions through the zone, with narrower, smaller area profiles tending to occur on bends. The low water channel is a metre or so deep at times of very low river flow, with a zone of periodically inundated mud and vegetation extending upwards on either bank for some 5m vertically. This zone is invaded to some level by the tide for short periods over spring tides, but only reaches bankfull during severe river floods. The cross-sectional area of the channel does vary through time, being subject to natural seasonal and inter-annual fluctuations in bed level in response to alternating cycles of erosion and deposition. Bathymetric (pole) surveys undertaken at 6 monthly intervals from April 2015 to October 2016 (EA Parfac data referred to in the Ambios Report) show a clear pattern of deposition (reduction of the cross-sectional area) through the summer months and scour (enlargement of the cross-section) through the winter months. This was further supported by the February monitoring completed as part of the dredging trial also discussed in the Ambios Report. The channel was largely free of dredging activity during this later monitoring period. Evidence also suggests that more fluctuations in channel section occur in response to extreme events, as evidenced from comparison of the 2012 and 2013 cross sections, where the 2013 section, post flooding in 2012 was substantially larger.	• EA Environmental Statement Rivers Parrett and Tone Dredge, Feb 2014: Appendix B 2014 WFD Compliance Assessment. • River Parrett and Tone Channel Monitoring Project (B&V/EA report June 2009). • Dredging Trials Monitoring Report, Ambios, 2017. • Phase 1 Habitat Survey (SDBC, Johns Associates 2018) • Fish Habitat Survey (SDBC, Johns Associates 2018).

This description of the channel provided in the Ambios Report is fairly characteristics of the water body in general as it heads downstream toward Bridgwater. At Bridgwater there is a throttling effect from man-made flood defence structures. Downstream of Bridgwater, the channel widens considerably as it becomes more estuarine in nature.

Impact on dredging
The river is historically dredged and it is considered that dredging was carried out as a regular activity until the 1990's. Dredging tailed off in the late 1990's and 2000's; with one major dredge during 2003. Following the large scale and damaging flooding in 2012 and more significantly in 2013/2014 it was considered that this reduction in dredging had reduced the channel capacity and increased flood risk. A major capital dredge was completed in 2014 along 8km of the lower Tone and the Parrett to Moorland that led to a significant change in the channel cross sectional area in the 8km zone. Depth variation is therefore considered to have been artificially influenced by this dredging activity since 2014.

Annual maintenance dredging (since 2014) has been completed based on both topographic survey and bathymetry monitoring to identify areas of significant silt accretion. The dredging has taken different forms (bank-side excavator capital dredging 2015 and maintenance water injection dredging since 2016). All dredging activities have intended to maintain a channel berm and some depth variation in the cross section. Water Injection Dredging (WID) focuses on the bed only and does not affect the inter-tidal area of the channel. Therefore since 2015, the depth variation of the banks is maintained by natural processes. The location of dredging episodes from 2014 is provided in ***Figure 7*** at the end of this document.

Post dredging monitoring of topographic surveys and bathymetry data has shown that re-sedimentation occurs primarily on the inside of bends. More significant-siltation is noted to occur from Burrowbridge to Northmoor (4.25km) than any other section of previously dredged river. For these areas, surveys show that the channel fairly rapidly recovers back to its post-dredge planform and depth variation within a year. For other areas, such as the last few hundred metres of the River Tone, re-siltation is now only evident to a significant level 4 years after the 2014 capital dredge.

Depth variation data
Approximately 11km of the River Parrett and lower River Tone (in the vicinity of the EA 2015 dredge and immediately downstream of the current proposed dredging reach) has been monitored via both topographic surveys and bathymetry to develop a record of cross sectional and river depth profiles. Ten separate monitoring episodes (spring and autumn) have been completed since 2014. Consequently, there is a high level of accuracy in the characterisation of the depth variation and river cross sectional profiles in this section of the water body.

River Parrett: Stathe to Burrowbridge Section
The section of the River Parrett TraC is upstream of Burrowbridge and the confluence with the River Tone (extending towards the tidal limit at Oath lock). It is similar in nature to the lower Parrett sections described in detail above. In particular, regarding the artificial nature of the channel, having been heavily modified for flood protection and drainage and likely to have seen regular dredging in the past.

		The channel is upstream of the confluence with the River Tone, the volume of water conveyed is lower. The channel is narrower than the downstream sections with more consolidated silt deposits and vegetation establishment on the banks. This difference is likely to be a result of the absence of dredging at this location in the medium term and the smaller tidal influence (allowing vegetation colonisation). However, depth variation shows a similar general pattern to the downstream sections with a central thalweg channel, silt deposited berms and a steep upper bank constrained by the artificial flood defence banks. A Phase 1 vegetation and habitat survey was completed by Johns Associates in late May 2018 updated in June 2019 for the purpose of this dredging proposal. The survey report documents the channel with regards to river features and habitat. The report noted that the channel from Oath Lock to Burrowbridge has an approximate width of 8m, and an approximate depth of at least 2m within the centre of the channel to the toe of the resectioned upper bank (subject to tidal and flood water influence). The channel banksides are typically 5m height in total, at an approximate angle of 45 degrees. See **Figure 11- 14.** Topographic survey has been completed for this section of river in 2014 (EA Londig Browning survey) and in Spring 2018 (Somerset Drainage Boards). The 2018 survey cross sections are provided with the dredge design drawing in Appendix 1 of the WFD assessment submission. In general the width between top of the flood bank is the elevation of Beazleys spillway (flood spillway into the Sowy). At this elevation the banks are between 23-30m wide with some wider bermed sections up to 35m. The main river channel is approximately 8m wide with steep banks as described in the John's Associates report. The low flow thalweg channel is defined as the minimum flow observed from flow gauging data (4m AOD). This is generally between 5-6m in width. The 8m main channel width is marked by steep sided banks, above which a vegetated bench is observed that becomes inundated under high flow conditions. The gradient of the banks above this bench then becomes shallower towards the top of flood bank (elevation of Beazleys spillway). The current cross sectional profiles therefore display a range of depths under different river levels. Under lower flow and mid flow conditions there is little depth variation, the river flow remains within the 8m wide channel with steep banks. Under high flow/flood conditions depth variation is evidenced.	
Quantity, structure and substrate of the bed	**Supports Good**	**Parrett TraC Water Body** RBMP2 2015 classification for hydromorphological supporting elements is Supports Good, the predicated 2022 and 2027 status is also Good and the objective is Good. The status represents that this is a Heavily Modified Water Body (HMWB). Bridgwater Bay is a major sediment sink within the Severn Estuary and is considered to be a long term source of fine sediment for the bed within the Parrett transitional water body. **Particle Size** Within the River Parrett transitional water body the bed sediment is fine, with sandy and coarse silt and compositionally homogenous (i.e. bed sediment type does not vary significantly). The reach downstream of Burrowbridge is typically dominated by tidally deposited sediment which tends to be coarser than further upstream. Bed sediment is known to be very mobile and easily entrained during high flow events. Bed sampling and particle size analysis has been carried out by two recent studies in the location of the 2014 capital dredge, focusing on the stretch of the Parrett between Burrowbridge and Moorland. EA data was obtained in March and August 2016 (completed by Pardac, referenced in the Ambios Report). Further samples were taken in November 2016 - February 2017 as part of the dredging trials described	• EA Environmental Statement Rivers Parrett and Tone Dredge, Feb 2014: Appendix B 2014 WFD Compliance Assessment. • River Parrett and Tone Channel Monitoring Project (B&V/EA report June 2009). • Dredging Trials Monitoring Report, Ambios, 2017. • River Parrett Oath to Burrowbridge Dredge.

		in the Ambios Report. Both sets of data correspond well. The Nov 16-Feb 17 data was separated into a bank group and a channel group. It was found that there was no variability in the relative sand/mud composition between groups, however there was a large variation in the relative contribution to the mud, the bank group containing much higher coarse silt and lower clay. The EA data suggested both a longitudinal variation in the particle-size characteristics of the sediment, and a seasonal variation of those characteristics. The sand content of the bed increases landwards and during the winter. The Ambios Report (Nov sample) also noted that there was a very slight increase in coarse sediment at the landward end of the study zone (Burrowbridge to Moorland) and found that this was contrary to the estuary wide trend. The bed sediment survey undertaken as part of the Ambios Report clearly showed that a) cohesive sediment dynamics will dictate the sediment transport processes that occur in this area and b) once in motion, processes of sediment suspension (rather than bedload transport) will dominate. Some rolling of material along the bed (gravel particles, highly consolidated mud clasts/balls) may occur at times of highest flow velocities, but they are likely to play a minor role in the sedimentary regime. **Sediment Flux** From the information gathered during the dredging trial monitoring project (Ambios Report) several strong and independent lines of evidence have emerged demonstrating that a seasonal alternation of sedimentary processes is found in the estuary. Sediment influx from marine sources at times of high spring tides and low river discharge is replaced by effective seaward scouring of this material at times of higher river discharge. These two regimes can be summarised as follows. **Fluvial dominance**: Where sedimentary processes under the control of river flow prevail for most of the time. At times of low river flow, and when the Severn Estuary tidal range is less than about 8m (neap tides) there is no or little tidal effect in the monitored area of the upper Parrett estuary (Burrowbridge to Moorland). The water currents flow seaward all of the time, possibly slowing with a modest rise in water level on the late flood, and no saline water is seen. At higher river discharge levels the tide is even more excluded, and during the highest river floods even peak spring tides affect local river-flow conditions to a minor extent only. Under this fluvial regime, the suspended sediment concentration in the water is normally low (500 mg/l, TSS values) and in the reaches between Burrowbridge and Westonzoyland bed scour normally dominates (deduced from the observation that water turbidity generally steadily rises in concentration as the flow moves between these two sites). During river flood events scour is even more pronounced, and observed TSS values peak around 2 g/l (higher values are likely to be seen during the rising limb of the highest flood events). As a result there is little potential for sediments of (primary) fluvial origin to accumulate in these reaches, and during the winter both the channel floor and the lower side slopes of the channel are eroded, with 10-20 cm of scour being typically seen. During these periods of erosion the bed sediments tend to become sorted, with the finest particles (clays and fine silts) becoming dispersed seawards and coarse silt and sand remaining. **Marine dominance**. Much higher suspended sediment concentrations are seen in the upper Parrett estuary monitoring zone during the spring/summer/autumn months (when periods of low river flow prevail) at the times of highest spring tides. These effects are seen when the Severn estuary tidal range exceeds about 11m (seen for up to about ten tides in most lunar cycles). The phenomenon results from the combination of two factors: firstly the ability of the tide to penetrate upstream as a function of the high-tide water level and secondly the massive mobilisation of settled fluid mud deposits that occurs in the upper Severn Estuary over these periods of high tidal energy,	Soils Screening Report. On Behalf of Somerset Drainage Boards Consortium (Hydrogeo, July 2018).

		increasing the feed of highly concentrated mud suspensions into the Parrett. Mean TSS values reach about 1 g/l and maximum (near bed) values exceed 25 g/l. The distortion of the rising limb of the tide (due to the high tidal range and the long, narrow sinuous estuary morphology) creates a short (~2 hour) powerful flood (landward-going) current. In contrast the ebb is a much longer period of less energetic seaward going currents. A very strong peak of suspended solids concentrations is associated with the flood (up to ~10 g/l), and the protracted ebb also sees high turbidity, but generally lower than on the flood. Fine sediment deposits from the flood-source suspended sediment body over the short (~30 minute) high water stand, and although some of this deposit may be reworked during the ebb there is a net accumulation of mud over the tide. This process provides the primary supply of sediment to the upper estuary. The sediment is of (recent) marine origin and is dominated by clay and fine silt particles. The seasonal balance between the (scouring) fluvial/ebb influence and the less frequent spring flood tide supply of marine sediment (accumulation) dictates the net sedimentation situation. There may be significant inter-annual variability due principally to different peak river discharge conditions between the years. A natural equilibrium between these conflicting processes will prevail, with associated channel profile dimensions and shapes. Where dredging is used, these equilibria will be disrupted and net accretion will become the norm. Under natural conditions, accumulation may be expected to dominate on the estuary lower side slopes (inundated by the sediment-rich flood tides, dry for much of the ebb and low river discharge periods) and an equilibrium maintained on the channel floor (thalweg) where prolonged ebb currents can scour away accumulations. The deposits on the side slopes are periodically scoured by the severest winter river floods, to create a natural system where the cross-sectional area of the conduit changes seasonally. From a flood prevention stance, this causes a problem as the natural clearance of the channel section only takes place during and after the occurrence of overbank flooding. Vegetation may play an important role in trapping sediments on the higher bank slopes, affecting longer-term equilibria. The sediment bed of the upper estuary that forms as the net result of the temporal interlinking of these two very different (fluvial and marine) processes is a coarse silt, with a lesser fine silt and clay content, and typically <15% very fine sand. This material moves as suspended load once set in motion, although mass-failure of cohesive mud deposits can produce large clasts of mud that may temporarily roll as bedload until disintegrated. The frequent episodes of erosion and long intertidal drying times enhance mud consolidation, and the deposits are remarkably dense and strong compared to more typical estuarine muds. The cyclic nature of the deposition and erosion created a very layered sediment, which impacts on its geotechnical properties. **River Parrett: Stathe to Burrowbridge Section** **Particle Size** Particle size analysis was completed on sediment samples taken from between Oath and Burrowbridge on the River Parrett in May 2018. The content for each sample is represented in ***Figure 8*** and the location in ***Figure 9*** at the end of this table and the Particle Size Distribution graphs are available in Appendix 2 of the WFD Assessment. The results are consistent with the water body characteristics for sediment size as described above; predominantly silt and clay. However it is generally slightly finer in the section from Oath to Burrowbridge than downstream of Burrowbridge where there is a greater influence of tidal energy/deposition and fluvial scour (which results in a sorting of the deposited sediment, leaving the coarser fraction). The sand content between Oath and Burrowbridge is low (under 10% in all but 1 of the 21 samples). This is slightly lower than the average for further downstream (under 15%). The sample results	

		do not show a significant difference in sediment type between clay, silt and sand from the channel banks to the channel bed. However there may be a slight difference in silt composition (coarse/fine). **Sediment Flux** The seasonal alternation of sedimentary processes described for the Parrett TraC water body above also describe the process for the river reach from Stathe to Burrowbridge. However the process is markedly reduced upstream of Burrowbridge due to the limiting tidal influence and the lower flows (upstream of the confluence with the Tone). The exact sediment flux behaviour has not been studied and can only be summarised from existing knowledge of the whole water body system as described in the Ambios Report. In terms of sediment deposition, it is likely that the Parrett upstream of Burrowbridge behaves similarly to the Tone upstream of the confluence. Monitoring along the lower reaches of the Tone has shown that sediment deposition on the river bed following dredging has been considerably reduced compared to that downstream of the confluence (showing the lesser influence of tidal deposition this far up the river system).	
Structure of the intertidal zone	**Supports Good**	**Parrett TraC Water Body** RBMP2 2015 classification for hydromorphological supporting elements is Supports Good, the predicated 2022 and 2027 status is also Good and the objective is Good. The status represents that this is a Heavily Modified Water Body (HMWB). The narrow intertidal zone along the River Parrett is typically characterised by steep banks with extensive silted berms, which become exposed at low tide and during low fluvial flows. As mentioned above, bank sediment is typically coarse silt and the upper banks are vegetated, resulting in a very steep bank profile. Historically, there are local areas of bank instability and erosion (notably on the right bank at Burrowbridge). This action causes a localised sediment supply from slumping of unstable banks. This was supported by evidence from the Ambios Report, in which comparison of banks from November to February displayed an increase in inter-tidal bank erosion following the high flows of winter (see ***Figure 4-6*** at the end of this table). The vegetated margin is typically characterised by reeds (*Phragmites)*, whereas saltmarsh and coastal grazing marsh is more extensive downstream of Bridgwater within the outer estuary. There are no known / mapped saltmarsh areas upstream of Bridgwater. Flood embankments extend along the majority of the water body length, limiting the extent of the intertidal zone (especially upstream of Bridgwater). The River Parrett channel underwent capital dredging in 2014 in which inter-tidal habitat was removed using excavators. Comparison of post dredge surveys has shown that intertidal area (morphology and the ecology it supports) is able to recover fairly rapidly back to its pre-dredge condition. For the 8km dredge section, inter-tidal zone vegetation and silt has not been removed since 2015 as maintenance dredging now focuses on WID methods refined to the channel bed only. Consequently the intertidal zone has been able to reach a recovered equilibrium state over the last 3 years. **River Parrett: Stathe to Burrowbridge Section**	• EA Environmental Statement Rivers Parrett and Tone Dredge, Feb 2014: Appendix B 2014 WFD Compliance Assessment. • River Parrett and Tone Channel Monitoring Project (B&V/EA report June 2009). • Dredging Trials Monitoring Report, Ambios, 2017. • River Parrett Oath to Burrowbridge Dredge. Soils Screening Report. On Behalf of Somerset Drainage Boards Consortium (Hydrogeo, July 2018).

		The intertidal zone differs slightly in the upstream extent on the River Parrett, partially due to the more consolidated silt deposits that have developed into vegetated upper banks within this zone, the narrower channel and the limited tidal influence. A Phase 1 and River Habitat Survey was completed for the full 4km from Oath to Burrowbridge by Johns Associates in May 2018 (updated in June 2019) and characterises vegetation in the intertidal and maximum upper bank flood zone. This is complimented by a Fixed Point Photography Report (Johns Associates, June 2018) that show the location of vegetation types in the river cross sectional profiles throughout the length of the dredging zone for every 50m topographic survey section. A Fish Habitat Survey was also completed by John's Associates (May 2018). The Fish Habitat Report includes identification and characterisation of certain in-channel and inter-tidal bank habitat features. Representative photographs from the report were taken and provided in **Figure 11-14** below this table. Characteristics of the banks and intertidal zone are summarised below: • Normal low flow channel and banks (i.e. non-drought) with the dominance of bare clay lower (submerged) bank and bed with steep (45 degree) banks. This is in contrast with a large increase in wetted width and water depth/ volume and submerged vegetated upper banks forming a higher flow submerged bankface (artificial flood banks). • Some variation in lower bank stability as a result of weathering and erosional activities. These are typically more notable downstream of Stathe Bridge. Slab/cantilever and slump failures cause a more irregular bank form resulting in small backwaters or embayments (where collapsed sediment has been transported downstream). Narrower cross-sections or pinch points are present in the lower reaches, where bank failures have become stabilized and vegetated, which increase flow velocities under lower tidal states. • A near absence of submerged tree or shrubs including exposed roots in the intertidal banks. • Marginal vegetation occurs upon the base of channel banks to a height of approximately 1-2m from the water level at the time of survey. Vegetation at the margins of the River Parrett is species poor and predominantly consists of reed canary grass, which occurs abundantly. Stands of locally abundant common comfrey are also present in this zone, and species such as Himalayan balsam (invasive species). • Above the height of variation in water level within the river, marginal vegetation upon the upper flood banksides succeeds into tall ruderal vegetation, supporting common and competitive species which are typical of drier soils and nutrient enriched conditions.	• Fish Habitat Survey (SDBC, Johns Associates 2018). • Fixed Point Photography Report (Johns Associates, June 2018). Phase 1 Habitat Survey (SDBC, Johns Associates 2018).
Hydrological Regime **Tidal Regime - Freshwater flow**	**Supports Good**	**<u>Parrett TraC Water Body</u>** The Bristol Channel has a very large tide range, with 14m recorded between the highest and lowest tides. The tidal flow regime dominates the character of the lower sections of the Parrett Transitional water body. The upstream tidal limit along the River Parrett is at Oath Lock, and on the River Tone is at Newbridge Sluice. At the upstream end of the water body, fluvial flows tend to dominate during the winter months, influencing sediment transfer downstream. In the summer, tidal flows tend to dominate, which can result in a net transfer of sediment upstream, which is deposited along the bed and banks of the Rivers Parrett and Tone. There is a lag in the local time of High Water (HW) as the tide wave moves up the estuary, with a spring tide one hour difference between HW at Hinkley Point and HW at Northmoor, and a 2 hour lag between Hinkley HW and HW at the tidal limits (Stanmoor recorder on the Parrett and Currymoor recorder on the Tone). As the thalweg bed level at Northmoor is ~+2.5m ODN, and on low flows there is always at least 0.5m of water in the river (water surface at +3m ODN), neap tides (Table 3) are only just felt at this site, and hardly any semidiurnal effects at all are seen at Saltmoor where levels are ~0.5m higher. Low neap tide HW takes the form of a backing up of river flow rather	• EA Environmental Statement Rivers Parrett and Tone Dredge, Feb 2014: Appendix B 2014 WFD Compliance Assessment. • River Parrett and Tone Channel Monitoring Project (B&V/EA report June 2009). • Dredging Trials Monitoring Report, Ambios, 2017.

		than the passing of the landward-flowing front of the rising tide. When the tidal range at Hinkley is less than about 8m, the high water condition in the monitoring zone (between the Northmoor and Saltmoor sites) is one of backing up of river water, with the Saltmoor HW level greater than that at Northmoor. At higher tidal ranges the HW level at Northmoor is greater than that at Saltmoor, consistent with the passing of the crest of the tidal wave and some dissipation of its energy between the two sites. This model of the (low river discharge) tidal mechanism and lag times is summarised in ***Figure 10*** below this table. High river discharge modifies this model, increasing water levels relative to Hinkley and reducing lag times (to as low as ~30 minutes).The combination of high tidal range and a long narrow morphology strongly modifies the form of the tide as it progresses up the Parrett estuary. **River Parrett: Stathe to Burrowbridge Section** Saltmoor river level monitoring site (referenced above) is located immediately upstream of the proposed dredging location (approximately 800m). Therefore the tidal regime experienced at saltmoor as described above, is fairly representative of the proposer dredging reach from Stathe to Burrowbridge. The tidal influence is minor at this site and mostly reflects a backing up of water rather than a tidal incursion. River flow will mostly be fresh water at this site, with occasional brackish waters during Spring tides. Naturally the downstream section at Burrowbridge will be more influenced by the tide that 2.1km upstream at Stathe.	
Wave exposure	**Not assessed.** **No classification data**	**Parrett TraC Water Body** The downstream end of the water body (within Bridgwater Bay) is exposed to wave action generated by the dominant south-westerly winds that funnel up through the Severn Estuary. Further upstream and away from the coast wave exposure reduces, due to the sheltering effect of the estuary and Steart Peninsula. The water body can experience a tidal bore, which occurs a few times a year during a high spring tide. This can result in a 3ft standing wave which extends upstream at about 6 miles per hour (10 km/h). The Bore is known to extend up to Bridgwater but it is unlikely that it extends further upstream to a significant extent. The tidal wave is described in the section above with energy dissipation mostly observed downstream of Burrowbridge however this does not produce notable wave action. Consequently much of the water body is not exposed to any wave action. **River Parrett: Stathe to Burrowbridge Section** Wave exposure is not considered to influence the River Parrett at the reach from Stathe to Burrowbridge due to the inland and sheltered location. The tidal wave is described in the section above (with energy dissipation mostly observed downstream of Burrowbridge) will not produce notable wave action.	• Observation / local knowledge. • EA Environmental Statement Rivers Parrett and Tone Dredge, Feb 2014: Appendix B 2014 WFD Compliance Assessment.

Table 2: WFD Classification and Status - Physico-Chemical Supporting Elements

WFD Quality Elements	2015 RBMP2 data	Additional baseline information	Source
Transparency	**Not assessed.** **No classification data**	**Parrett TraC Water Body** The water body is highly turbid as a result of the strong tidal currents, with subsequent transport of suspended solids into the River Parrett system. This is less so at the upstream end of the water body due to the greater influence of freshwater flow (especially along the Tone). During the summer on the Tone the bed can been seen, but not along the Parrett where turbidity remains very high. The dredging monitoring trials detailed in the Ambios Report included turbidity monitoring before, during and after dredging operations. It was noted that the absolute DO value varied with temperature, but not obviously with turbidity, and this suggested that the latter (at natural concentrations in suspension) is not creating an oxygen demand. Therefore transparency/turbidity is not at environmentally limiting conditions. **River Parrett: Stathe to Burrowbridge Section** As detailed above, the upstream nature of the river from Stathe to Burrowbridge means that the river is fluvially dominated and this results in significantly reduced suspended silt compared to the rest of the water body. This results in generally good transparency. This finding is clarified by generally good visibility from site visits through 2018. The Phase 1 Habitat Survey also completed in May 2018 (updated in June 2019) by Johns Associates noted that the flowing water in the river has limited turbidity, although is thought to be eutrophic. The Fish Habitat Survey completed by Johns Associates in May 2018 noted that the transparency varied (with varying water depth/tidal influence). **Figure 14** of this report shows a low flow scenario where macrophytes are clearly visible in the low flow section of the channel. This gives a generally good level of visibility during low flows at the time of the survey. There is no formal data recording visibility levels under different conditions.	• Observation / Expert Judgement. • EA Environmental Statement Rivers Parrett and Tone Dredge, Feb 2014: Appendix B 2014 WFD Compliance Assessment. • Dredging Trials Monitoring Report, Ambios, 2017. • Phase 1 Habitat Survey (SDBC, Johns Associates 2018) • Fish Habitat Survey (SDBC, Johns Associates 2018).
Thermal conditions	**Not assessed.** **No classification data**	**Parrett TraC Water Body** Some data may be available based on previous summer flooding. Tidal inflow along the water body means that temperature is generally kept relatively low (however there is thought to be very little mixing of the tidal and freshwater flows at the upstream end of the water body). The upstream end of the water body is considered to be more vulnerable to high water temperatures during the summer months due to low fluvial flows (reduced water depths within the channel). The Parrett especially can experience algal blooms during high water temperatures and elevated nutrient conditions. **River Parrett: Stathe to Burrowbridge Section**	• Observation / Expert Judgement • EA Environmental Statement Rivers Parrett and Tone Dredge, Feb 2014: Appendix B 2014 WFD Compliance Assessment.

		As mentioned above, the water temperature is expected to be higher at this upstream location within the water body, especially in relatively low flows during summer months. The Fish Habitat Report completed by Johns Associates in May 2018 noted that the near absence of overhanging tree canopy resulting in virtually no shading or inputs of tree sourced organic detritus (e.g. leaf litter), with water volume/depth and transparency being the key regulator of water temperature in this section of river. It can be noted from the fish monitoring results obtained through surveys completed by Loughborough University during 2018 that a wide variety of fish species (predominantly fresh water species) have been identified within the section of river from Oath to Burrowbridge, indicating a generally healthy temperature range that suits a number of notable species characteristic of lowland coastal rivers. See fish species and corresponding temperature ranges listed in the Fish Habitat Report (Johns Associates, 2018) located in Appendix 2.	• Dredging Trials Monitoring Report, Ambios, 2017. • Loughborough University, Dr Andrew Pledger. Technical note: 2018 pre-dredge River Parrett fish surveys.
Oxygenation conditions	**Not assessed.** **No classification data**	**<u>Parrett TraC Water Body</u>** Previous Environment Agency WFD Assessments noted that the dissolved oxygen levels expected under normal conditions was over 70%. The Ambios Report carried out dissolved oxygen monitoring as part of the dredging monitoring trials between Burrowbridge and Moorland. In all the near-surface measurements the % DO in the water rarely dropped below 80%. Absolute values only fell below 8mg l-1 for very short periods of time, suggesting temporary clogging of the sensor head with organic matter. All the manual profiles recorded (outside of the dredging period) also showed similarly high DO levels (no reduction with depth) except one cast, during which DO dropped to 50% on reaching the bed rose to normal values again on moving back to the water surface. There was no high turbidity associated with this event, again likely to be a spurious reading. Consequently it can be concluded that oxygen conditions are generally healthy in the water body. **<u>River Parrett: Stathe to Burrowbridge Section</u>** Oxygen conditions are expected to be similar to those described above for the upstream section of the water body between Stathe and Burrowbridge. It has been noted that the Parrett can be subject to significant algal blooms during very low flow conditions which can influence oxygen levels. However this was not noted during site visits throughout early 2018 and in the fish monitoring or vegetation monitoring surveys in May/June 2018.	• EA Environmental Statement Rivers Parrett and Tone Dredge, Feb 2014: Appendix B 2014 WFD Compliance Assessment. • Dredging Trials Monitoring Report, Ambios, 2017. • Phase 1 Habitat Survey (SDBC, Johns Associates 2018). • Fish Habitat Survey (SDBC, Johns Associates 2018).
Salinity	**Not assessed.** **No classification data**	**<u>Parrett TraC Water Body</u>** Salinity was measured in 2008/2009 River Parrett and Tone Channel Monitoring Project and referenced in previous dredging WFD assessments (EA 2015). Salinity levels during the summer monitoring period of this project average around 0.41PSU (Parrett) and 0.37 PSU (Tone) (saltwater is typically around 35PSU). It was found that tides that reach Burrowbridge generally do not mix with freshwater flow. Salinity monitoring was also carried out during the dredging trials monitoring project from November to December 2016 and again in February 2017 (discussed in the Ambios Report). In November at the Westonzoyland sensor, the mean and median autonomous near-water-surface values were 0.50 and 0.47 respectively. The minimum salinity was <0.01 and was seen at the time of peak river discharge. Higher than the median salinity values were seen once the tidal range at Hinkley rose above about 11m, on high springs. The values rose through the flood, peaking at HW, with the greatest value (7.92) coinciding with the highest tide. Manned monitoring was undertaken the	• EA Environmental Statement Rivers Parrett and Tone Dredge, Feb 2014: Appendix B 2014 WFD Compliance Assessment. • River Parrett and Tone Channel Monitoring Project

		same day commencing exactly at HW in the centre of the experimental dredging zone. Values recorded were generally around 1.5, rising to 2.9 near the bed on one cast. At the Burrowbridge permanent sensor site the equivalent mean, median, maximum and minimum salinity values through November were 0.44, 0.47, 1.01 and <0.01 respectively. The salinity data collected during November and December (with low river flow for much of the period) indicated that these upper reaches of the Parrett estuary lie above the zone of saline water intrusion. No marked salinity stratification was observed, and maximum values were low (reaching 7 only at times of very low river flow and highest annual tide range). The Ambios Report also references the data collected during July and August 2008 (EA data) at Partrac sites 1-7 along the Parrett transitional water body, showing similar/lower salinity values. **River Parrett: Stathe to Burrowbridge Section** Salinity monitoring has not been carried out as part of the sediment sampling of the river carried out from Stathe to Burrowbridge in May 2018. It is considered that the data available for Burrowbridge in the Ambios Report provides adequate representation of the river salinity levels. Further upstream from Burrowbridge will see lower salinity levels again and fresh water dominance. No marked salinity stratification is expected in this reach. Salinity tests for chloride, sodium and fluoride were completed on sediment samples from the river bed and bank for the reach from Stathe to Burrowbridge. The average values were found to be well below the PTE and below the recorded levels further downstream at Hook Bridge to Raymonds Farm dredging (see Soils Screening Report, HydroGeo 2018).	(B&V/EA report June 2009). • Dredging Trials Monitoring Report, Ambios, 2017. • River Parrett Oath to Burrowbridge Dredge. Soils Screening Report. On Behalf of Somerset Drainage Boards Consortium (Hydrogeo, July 2018).
Nutrient conditions	**No classification data**	**Parrett TraC Water Body** Nutrient enrichment of watercourses is known to be a problem in the catchment caused by discharges from sewage treatment works and diffuse pollution from agriculture and other sources. There are a number of large sewage treatment works within the water body catchment at Bridgwater and also upstream at Creech St Michael (along the River Tone), which may elevate nutrient levels, along with runoff from arable and pasture. The Tone is not known to suffer algal blooms whereas the Parrett does. **River Parrett: Stathe to Burrowbridge Section** As mentioned above algal blooms are a risk for the River Parrett section from Stathe to Burrowbridge during low flow periods in summer. However, it is noted that the ecological surveying completed as part of the scoping survey for the proposed dredging were carried out during a prolonged dry/low flow period at the end of May 2018 and no algal blooms were noted (as demonstrated in **Figure 14**). However the Phase 1 Habitat Survey completed by Johns Associates in May 2018 (updated in June 2019) noted that the river flow was thought to be eutrophic (despite limited turbidity). Furthermore, the reach from Stathe to Burrowbridge is some distance upstream of the major sewage outfalls at Bridgwater and Creech St Michael. Consequently, nutrient enrichment as a result of these sources is unlikely to be significant at the dredging location. Sediment sampling from 21 samples taken on the bed and banks between Oath and Burrowbridge were tested for Phosphate, Nitrate and Potassium as a measure of nutrients. The recorded values for magnesium and potassium from sediment sampling are slightly below the levels reported in the annual soil survey for the Somerset Levels (completed by NRM laboratories collating results from multiple samples). Phosphate levels in the sampled sediment are higher than the values reported in the NRM survey for Somerset as a whole.	• EA Environmental Statement Rivers Parrett and Tone Dredge, Feb 2014: Appendix B 2014 WFD Compliance Assessment. • Expert Judgement. • River Parrett Oath to Burrowbridge Dredge. Soils Screening Report. On Behalf of Somerset Drainage Boards Consortium (Hydrogeo, July 2018).

Specific Pollutants **Priority Substances and Priority Hazardous Substances**	**High** **Good**	**<u>Parrett TraC Water Body</u>** The RBMP2 2015 classification for specific pollutants is High, the predicated 2022 and 2027 status is also High and the objective is High. The RBMP2 2015 classification for priority hazardous substances is Good, the predicated 2022 and 2027 status is also Good and the objective is Good. The EA WFD assessment for the 2014 dredge noted that there were a number of potential contamination sources present within the overall catchment (both point sources and diffuse sources) and historical data shows contamination of estuary sediments. To assess potential contamination some limited sampling of sediments within the Parrett and Tone, including bank sediments within the area to be dredged, was carried out in 2008 (Partrac, 2009) and laboratory testing of these samples was undertaken to look for heavy metals, cyanide, TBTs, petroleum hydrocarbons, PAHs and PCBs. This testing did not find grossly elevated levels of the tested for contaminants within the sediments. The spatial distribution was relatively uniform, indicating a point source outside of the sampling area (either upstream or from downstream). There are a number of large sewage treatment works within the water body at Bridgwater and also upstream at Creech St Michael (along Tone). Water quality considered to be at normal background levels. Burnham, Berrow Beach and Brean beaches are assessed for Bathing Water Quality. Burnham is considered to be potentially sensitive to elevated bacterial levels. **<u>River Parrett: Stathe to Burrowbridge Section</u>** Sediment sampling from 21 samples taken on the bed and banks between Oath and Burrowbridge during May 2018 were tested for a wide suite of potential contaminant metals and hydrocarbons. Five samples were also analysed for Semi Volatile Organic Compounds (SVOCs) and Poly Chlorinated Biphenyls (PCBs). The results showed that metal concentration was generally low and close to background concentration in nearby soils. Total Petroleum hydrocarbons screening shows an average C6 to C40 concentration of 171mg/kg, and a maximum concentration of 250mg/kg. A 'Public Open Space' end use the S4UL is 21,000mg/kg for C8 to C10 hydrocarbons. Consequently, these levels are considered low and unlikely to cause any risk to human health, further banded testing for mineral oils and fuels was not considered necessary. The recorded concentrations are likely to be due to natural organics present in the silt such as humus (which can be co-extracted in the TPH extraction), rather than anthropogenic contamination. Specific pollutant levels are therefore considered to be insignificant.	• EA Environmental Statement Rivers Parrett and Tone Dredge, Feb 2014: Appendix B 2014 WFD Compliance Assessment. • River Parrett and Tone Channel Monitoring Project (B&V/EA report June 2009). • River Parrett Oath to Burrowbridge Dredge. Soils Screening Report. On Behalf of Somerset Drainage Boards Consortium (Hydrogeo, July 2018).

Table 3: WFD Classsification and Status - Biological Quality Elements

WFD Quality Elements	2015 RBMP2 data	Additional baseline information	Source
Aquatic flora: Angiosperms, macroalgae and phytobenthos	**High**	**Parrett TraC Water Body** The RBMP2 data from Dec 2015 classifies macroalgae as High (2015) and predicted for High in 2022 and 2027 (the objective is Good). Opportunistic Macroalgae sub class is also classified as High. However the previous 2014 EA WFD assessment for dredging in this water body noted that the High classification data (in draft at the time) was based on data from downstream of Bridgwater. Upstream of Bridgwater there is greater freshwater influence. Reed (*Phragmities)* is common along both banks. There is no survey data available on which to base the assessment but Saltmarsh maps show no areas within or close to the previous dredging areas or upstream of moorland. **River Parrett: Stathe to Burrowbridge Section** A Phase 1 and River Habitat Survey was completed for the full 4km from Oath to Burrowbridge by Johns Associates in May 2018 (updated in June 2019) and characterises vegetation types in the intertidal zone. This is complimented by a Fixed Point Photography Report (Johns Associates, June 2018) that show the location of vegetation zones in the river cross sectional profiles throughout the length of the dredging zone for every 50m topographic survey section. A Fish Habitat Survey was also completed by Johns Associates (May 2018). The Fish Habitat Report includes identification and characterisation of certain in-channel aquatic plants. Angiosperms – The Phase 1 Habitat Survey notes that the angiosperms along the river banks are dominated by reed canary grass upon the base of channel banks to a height of approximately 1-2m from the water level at the time of surveying. Stands of locally abundant common comfrey are also present in this zone, and species such as Himalayan balsam (invasive species). Vegetation at the margins of the River Parrett is species poor. A detailed list of the species recorded in the river habitat survey, representative photographs and mapping are all provided in the Phase 1 Habitat Report in Appendix 2 to the WFD Assessment. Macrophytes - The Fish Habitat Report notes aquatic macrophytes growing submerged within running water (see **Figure 14****Figure 14**). These are limited in species diversity, with fennel pondweed *Potomogeton pectinatus* occurring abundantly at the edges of the channel in slower flowing water, in localised stands (see Plate 1). Additional macrophytes present, at occasional abundance, include unbranched bur-reed *Sparganium emersum* and sea club-rush *Bolboschoenus maritimus*, suggesting a brackish influence in the Site. Broken strands of Canadian pondweed *Elodea canadensis*, a WCA 1981 Schedule 9 invasive species were observed flowing downstream indicating this	• EA Environmental Statement Rivers Parrett and Tone Dredge, Feb 2014: Appendix B 2014 WFD Compliance Assessment. • Phase 1 Habitat Survey (SDBC, Johns Associates 2018) • Fish Habitat Survey (SDBC, Johns Associates 2018). • Fixed Point Photography Report (Johns Associates, June 2018). Phase 1 Habitat Survey (SDBC, Johns Associates 2018).

		plant could exist at a potentially rare abundance in areas of slower flowing water. Species present are listed in Table 1 of the report. See Appendix 2 of the WFD Assessment. Phytobenthos – No sampling and analysis has been completed for phytobenthos along this section of the River Parrett.	
Invertebrate fauna	**Good**	**<u>Parrett TraC Water Body</u>** RBMP2 classifies invertebrate status as Good, with a predicted level of Good for 2022 and 2027. The objective level for this element is good. The 2015 EA WFD Assessment noted that some monitoring data is available from within Bridgwater Bay but no data for Parrett/Tone, in order to classify this element at the water body scale. There are several UKBAP priority invertebrate species of importance in the area. The depressed river mussel (*Pseudanodonta complanata*) is a bivalve mussel inhabiting the beds of lowland rivers; it is known from other sites in the catchment and was found to be present in the annual maintenance dredging section downstream of Burrowbridge. Other notable freshwater species are associated with the smaller ditches and pools rather than the main river channels: the snails *Omphiscola glabra*, *Segmentina nitida* and *Valvata macrostoma*. Fish and invertebrate monitoring was carried out during 2016/2017 on the River Parrett/Tone (within the transitional water body) as part of mitigation measures during annual maintenance dredging operations using water injection dredging (Interim Report: Ecological Impacts of WID. Dr Pledger et al., Loughborough University, 2018). Benthic invertebrate samples from the main channel yielded low abundances where samples were taken from soft mobile fine sediments. However, in a few places where the sample was clearly collected from a more compacted/ stable bed, more individuals were observed. Diversity was low in the main channel compared to the margins primarily as a function of instability of the habitat in the main channel combined with the increased risk of predation due to limited refuge availability. It is reasonable to assume that due to low numbers of invertebrates within pre-management samples, dredging had limited effect on the abundance and diversity of the community for the pre- and post-dredging periods. Marginal macroinvertebrate samples were also taken and reported in the Loughborough University Interim Report. Communities were monitored on three occasions before (pre) and after (post) dredging at 6 sites. Two of these sites were located upstream (control) and within (treatment) the dredge reach. Only data collected from the two sites (control and treatment) were considered in the report. At the dredging site, the activity was found to be associated with significant changes in Simpson's and Berger Parker indices. At the control site, abundance was significantly lower in the post dredging period and reflects the trend observed at other sites. Data suggest changes in community structure (Simpson's Diversity and Berger Parker) were the result of dredging at the treatment site but the overall effect was limited on invertebrate abundance. Hairy Click Beetles are a marginal terrestrial invertebrates known to be present on the banks of the Parrett transitional water body. The UK population of the hairy click-beetle is considered 'Endangered' under pre-1994 criteria defined by the International Union for	• Observation / Expert Judgement. • Environment Agency Biodiversity Officer correspondence, Gemma Mahoney, 2018 (direct). • ABN Atlas website. • Wildscreen Archive website. • EA Environmental Statement Rivers Parrett and Tone Dredge, Feb 2014: Appendix B 2014 WFD Compliance Assessment. • Oath to Burrowbridge Benthic Macroinvertebrate Study (Johns Associates, June 2018). • Oath to Burrowbridge Ramsar Invertebrate Study (Johns Associates, June 2018). • Results of a Survey for Hairy Click-Beetle

		Conservation of Nature (IUCN). They are classified as Schedule 41 species in the NERC 2006 Regulations. Schedule 41 is a list of habitats and species which are of principal importance for the conservation of biodiversity in England, identified through consultation with Natural England. The S41 list is intended to be used to guide decision-makers such as public bodies, in implementing their duty under section 40 of the Natural Environment and Rural Communities Act 2006, to have regard to the conservation of biodiversity when carrying out their normal functions. All recent records in Britain are from the River Parrett between Burrow Bridge and Oath, in Somerset. Old records are from the Severn catchment between Bristol and Tewkesbury, and on islands in the Thames. It is also found in central and southern Europe 7 datasets have provided data to the ABN Atlas. All records of Hairy Click Beetle have been made in F2.1 – Swamp, marginal and inundation / Marginal and inundation / Marginal vegetation. However, within this broad habitat type the species is restricted to tall vegetation encompassing the probable larval food-plants, growing along rivers with brackish influence. All records of adult Hairy Click Beetle have been made in association with reed canary-grass *Phalaris arundinacea* and common reed *Phragmites australis*, which are present along the banks of the Parrett transitional water body (in particular at the landward end of the waterbody). Based on previous records, the potential range occupied by Hairy Click Beetle on the banks of the River Parrett extends over approximately 4.5 km between Oath (the upper tidal limit of the River Parrett) and Burrowbridge and the downstream section of the River Tone. **River Parrett: Stathe to Burrowbridge Section** As part of the baseline ecological surveys for the proposed dredging project, four aquatic macro invertebrate samples were taken in June 2018 using a combined approach of a repeated haul from a naturalists dredge, and times sweep sampling using a standard sampling net from all marginal, submerged and emergent vegetation, woody debris and other structures and bed of the channel. These samples were sorted and specimens identified to family and species level by a highly experienced entomologist, often engaged by the Environment Agency for this type of work. The rationale was to use the assessment of the macroinvertebrate assemblage present as a reliable indicator of the overall biological quality of the watercourse and to indicate the presence/absence of more sensitive and conservation notable species. The use of British Monitoring Working Party (BMWP) scores were given to highlight potential organic pollution within the aquatic system. The benthic survey concluded that there were no notable or rare species found in any of the samples and all were characteristic of lowland waterbody habitat at or around the tidal limit with low diversity. However, relatively high numbers of the brackish shrimp *Gammarus zaddachi* were recorded from all four samples, with a maximum count of 429 individuals from sample S3. BMWP scores were generally low, although sample S1 contained some higher-scoring taxa (including blackfly larvae, water beetles, alderfly larvae and the cased caddisfly larva *Anabolia nervosa*), which explains the higher score of 81. The samples indicated a similar assemblage across all four sites. Given the known presence of Hairy Click Beetle (as a NERC Schedule 41 species) on the banks of the water body in the vicinity of the proposed dredging operation, a further site specific and current survey of Hairy Click Beetle was required. This was carried out during the last week of May 2018 (when adults are active) by AEcol in-house entomologist, Dr James McGill, on three dates, 21st, 22nd and 23rd May 2018. Survey locations were agreed with the Environment Agency and Natural England prior to commissioning the survey. 26 adults were recorded from 21 locations along the River Parrett between 500m downstream of Oath Lock and 250 m downstream of Burrowbridge. The species was found to be associated with shallowly sloping tidal terraces, where dense stands of reed canary-grass are subject to flooding on the highest tides. Of an overall seven locations in which the species has historically occurred, it was recorded at	*Synaptus Filiformis* on the River Parrett, Somerset. AEcol, July 2018. • Loughborough University, Dr A Pledger, Dr Dapeng Yu, Prof. Paul Wood, Dr David Ryves. Interim report: Ecological Impacts of Water Injection Dredging, Somerset Levels

		three in 2018. Based on observations of habitat where hairy click beetles were recorded, and absent, it was possible to characterise typical habitat for adult hairy click beetle as gently sloping tidal terraces with dense, wide stands of reed canary-grass. The survey results are provided in the report entitled 'Results of a Survey for Hairy Click-Beetle *Synaptus Filiformis* on the River Parrett, Somerset (provided in Appendix 2 of the WFD Assessment submission).	
Fish fauna	**Not assessed.** **No classification data**	**<u>Parrett TraC Water Body</u>** No classification data is available for the water body from RBMP2 2015. Salmon and eel are the only known migratory species. Eel migration (and elver fishing season) starts Feb through to end May. There are known to be a wide range of freshwater and estuarine species within the water body. Upstream water bodies have some WFD classification data - the Tone d/s Taunton has a High classification (freshwater). The River Parrett has no formal WFD classification data except much further upstream. The Parrett is an Index river for Eels and is therefore monitored. The Parrett is included in the South West River Basin District (SWRBD) Eel Management Plan under the EC Eel Recovery Plan (Council Regulation No 1100/2007/EC). The SWRBD is currently regarded as failing to meet the 40% silver eel escapement management target stipulated by the regulations. Significant monitoring of fish has been undertaken at Hinkley Point B which is 0.5km outside of the Parrett transitional water body in the estuary. Fyke netting has been undertaken at Huntspill in the lower section of the Parrett during 2012 and 2013. Species recorded include conger, European eel, cod, Dover sole, sea bass, mullet and some freshwater species including perch and roach, indicative of significant freshwater flows and tidal flux at this location. All species are likely to be intermittently present depending upon tidal state and prevailing freshwater flow conditions. Twaite shad have been recorded at Hinkley Point B but not in the Parrett water body. Fish monitoring has also been carried out recently on the River Parrett/Tone (within the transitional water body) as part of the mitigation measures for the annual maintenance dredging operations in 2016 and 2017 using water injection dredging. The monitoring area focuses on the 4.25km of the River Parrett that undergoes dredging from Burrowbridge to Moorland. An interim report on the ecological impacts on fish mortality and health from WID dredging on the River Parrett has recently been completed by Loughborough University (2018) using the 2016 and 2017 data. The report also considers the pre- and immediate post-dredging effects on fish community composition, macroinvertebrate communities recorded at the channel margins and the benthic macroinvertebrate communities. The report is included in Appendix 2 of this WFD Assessment submission. The monitoring was carried out in December, during the period of dredging operations. Sampling occurred at an upstream site (control), within the managed area (treatment) and downstream of the dredge site (downstream) on three occasions before (pre) and after (post) dredging. During the pre-dredging survey, 179 and 92 individuals, corresponding to 12 and 7 species, were caught at the control and treatment sites respectively. Both fresh and marine water species were recorded. 236 fish were captured, representing 4 species during dredging operations. The majority of the marine fish captured were juveniles, highlighting the importance of the system as a nursery habitat.	• Observation / Expert Judgement. • EA Environmental Statement Rivers Parrett and Tone Dredge, Feb 2014: Appendix B 2014 WFD Compliance Assessment. • Phase 1 Habitat Survey (SDBC, Johns Associates 2018) • Fish Habitat Survey (SDBC, Johns Associates 2018). • Loughborough University, Dr Andrew Pledger. Technical note: 2018 pre-dredge River Parrett fish surveys. • Loughborough University, Dr A Pledger, Dr Dapeng Yu, Prof. Paul Wood, Dr David Ryves. Interim report: Ecological Impacts of Water Injection Dredging, Somerset Levels

There was a significant decrease in fish abundance following operations at the dredged site. Dredging did not have a statistically significant effect on species richness or biodiversity indices (Shannon Weiner, Simpson or Berger Parker). Post-dredging, fish abundances within the upstream (control) site were also significantly reduced, with mean values declining from around 30 to 11 individuals. No other parameters or biotic indices were significantly affected at the control site. It was considered within the report that the reductions in fish abundance within the managed area and at the control site (due to close proximity to the dredge reach) were likely due to fish avoidance of the dredging vessel.

The report concludes that dredging had an effect on some of the measured ecological parameters specifically, significant changes in fish abundance and invertebrate community structure characteristics were detected for the control and/or treatment sites. Importantly, no dead fish were caught during the dredging program suggesting either: 1) water physico-chemistry was suitable for fish life throughout the operation; or 2) fish were capable of avoiding the dredging vessel and associated sediment plume. Further analysis is required to better understand the causes of community changes; further monitoring/assessment is planned as part of the ongoing maintenance dredging environmental mitigation programme.

River Parrett: Stathe to Burrowbridge Section

As part of the ecological baseline surveying for the Stathe to Burrowbridge dredging proposals, Somerset Drainage Boards Consortium commissioned Johns Associates to complete a fish habitat survey from Oath to Burrowbridge on the River Parrett at the end of May 2018 (the report is enclosed within Appendix 2 of the WFD Assessment submission). The habitat survey included a review of habitat requirements of certain fish species identified as previously being present in the River Parrett (from fish monitoring completed downstream by Loughborough University in the preceeding years and through expert knowledge from the SDBC and Environment Agency. This was completed (using www.fishbase.org) to support the assessment of suitable promoting and limiting features present in the survey area. Further to this, a boat based visual inspection survey was completed for the characterisation of certain in channel habitat features influencing the distribution, behaviour and presence/absence of fish species. The River Habitat Survey method standard (EA, 2003) was applied as a structured approach to recording channel and bank physical habitat features.

The following features were recorded that influence fish habitat availability:

- Artificial channel with relatively simple planform and sinuosity resulting in a reduced physical habitat diversity in comparison with more semi-natural river systems (but recognising this is characteristic of many watercourses in the Somerset Levels and Moors).
- Tidal influence resulting in at least diurnal vertical changes in the extent of bank features submerged and accessible to fish (depending on tidal state and freshwater flows).
- Influence on tidal / freshwater conditions / flows and migration beyond the Oath Lock during summer periods.
- Influence of freshwater flows on the embanked cross section, notably the contrast between normal low flow conditions (i.e. non-drought) including lower tidal states and the dominance of bare clay dominated lower (submerged) steep banks and bed in contrast with a large increase in wetted width and water depth/ volume and submerged vegetated upper banks forming a higher flow submerged bankface.
- A near absence of overhanging tree canopy resulting in virtually no shading or inputs of tree sourced organic detritus (e.g. leaf litter), with water volume/depth and transparency being the key regulator of water temperature.
- A near absence of submerged tree or shrubs including exposed roots.

- A near absence of coarse woody debris, log jams or leaf litter.
- Generally, an extensive presence of tall vegetation on the embanked upper river bank (above typical high tide levels), providing habitat for certain life-stages of aquatic macroinvertebrates that could provide a food source for fish.
- Generally, an extensive presence of submerged fine-leaved macrophytes that can be fully submerged or more exposed depending on river flows/tidal state and that provide cover and a lower energy environment for certain fish/life-stages as well as a source of food (direct or as a habitat for prey invertebrates/fish). See **Figure 14**. These stands also influence flow character with a greater influence on lower water column flow velocities and restricting flows across the wetted width, concentrating velocities between stands. Presence of other rooted macrophytes.
- Some variation in lower bank stability as a result of weathering and erosional activities. These are typically more notable below Staithe Bridge. Slab/cantilever and slump failures cause a more irregular bank form resulting in small backwaters or embayments (where collapsed sediment has been transported downstream). Narrower cross-sections or pinch points are present in the lower reaches, where bank failures have become stabilized and vegetated, which increase flow velocities under lower tidal states. Some overhangs are present causing some limited areas of shading, and some submerged overhangs are present as well. See Figure ***Figure 15-16.***
- Small numbers of larger backwaters are present in the vicinity of flap valves/pumping stations. These tend to be shallower and warmer and are of high value to fry. The typically smooth surface of the submerged clay banks/bed result in reduced friction and more elevated velocities, potentially increasing the risk of smaller fish/fry being washed downstream where no suitable refuge habitat is present. See ***Figure 17***.

The fish habitat report concluded that the artificial, re-aligned and re-sectioned River Parrett between Oath Lock and Burrowbridge appears to present many consistent attributes in terms of limiting fish habitat along its length (see list above). However, additional fish habitat diversity has been introduced as a result of bank failure causing localised (but limited) backwaters, overhangs and submerged overhangs, and influences on cross-sectional velocity profiles associated with the lower flow channel area, caused by macrophyte stands and narrower channel cross sections. Habitat conditions are considered likely to continue to support the range of species previously identified by Loughborough University on the River Parrett transitional water body.

River and sea lamprey ammocoetes have previously been identified in the River Parrett. The fish habitat report notes that these species could use softer marginal sediments, (for example those associated with the limited backwaters/ embayments), as juvenile habitat but generally the banks are too steep and compact for this purpose. The species could navigate upstream unimpeded, although no suitable spawning habitat is present within the survey reach. The river is not designated for lamprey species and as such their habitat is not legally protected within this section of the River Parrett.

It was also noted that that despite its artificial and managed form, the River Parrett remains a dynamic system trying to revert to a state of equilibrium in terms of processes and energy/flow efficiency. As such, deposition and erosion (alongside weathering processes) will continue to occur, together with the growth/dieback of vegetation. As such, more naturalised smaller scale (and as such potentially key) fish habitat features will continue to develop and evolve over time as observed during the fish habitat boat survey.

Following the fish habitat survey completed at the end of May 2018, Loughborough University conducted quantitative fish surveys under baseflow conditions between July-September 2018 on the River Parrett between Oath and Burrowbridge. Sites were located 1)

		immediately upstream of the Tone/Parrett confluence, 2) approximately halfway between the Tone/Parrett confluence and West Sedgemoor pumping station and 3) adjacent to West Sedgemoor pumping station. Two three-pass electric fishing surveys were completed per site and prior to surveying on each occasion, a 100-m reach was isolated with stop nets. The results are provided in 'Technical note: 2018 pre-dredge River Parrett fish surveys, Dr Andrew Pledger, Loughborough University, October 2018', located in Appendix 2 of the WFD Assessment submission. A total of 766 fish, representing 13 species were captured. These included: Thin lipped Grey Mullet, Tench, Common Bleak, Roach, Gudgeon, Pike, Common Bream, Chub, Flounder, European Eel, Perch. Note, Lamprey were not recorded. As expected, the majority of captured individuals (757, representing 99% of the total catch) were freshwater rather than marine fish. Fish communities were similar between sites. On average, common Bleak, Roach, Gudgeon, Common Bream, Chub and European Eel were most prevalent, in terms of abundance. The European Eel was observed at each of the sites with the greatest mean abundance recorded near the confluence. The fish monitoring results show that the reach from Oath to Burrowbridge has a good fish assemblage and represents relatively good fish habitat within the overall water body reach.	

Table 4: WFD Classification and Status - HMWB Mitigation Measures

The following sources have been used to obtain baseline data on the WFD HMWB mitigation measures classification for the Parrett transitional Water Body:

- The EA Catchment Data Explorer has been used to identify mitigation HMWB mitigation measures – none are listed. However, mitigation measures are mention under 'Reason for Not Achieving Good Status' for the biological water quality as a result of 'surface water supporting element'.
- The Environment Agency enquiries service was used in April May 2015 to obtain all WFD and ecological data available for use in this WFD assessment – no HMWB mitigation measures were provided or listed with the data.
- The Environment Agency SW Biodiversity officer and Geomorphology officer were consulted in May 2018 for the latest WFD RBMP2 mitigation measures for the water body – a response was provided but no information was given on active mitigation measures in place within the water body.

The 2014 EA WFD that accompanied the Environmental Statement for the 8km capital dredging on the Parrett and Tone references **draft** measures that were to be included in RBMP2 (quoted as 'to be confirmed in July 2014). These are listed below, as it may be possible that these are intended as future HWMB mitigation measures that have not been made publicly available for RBMP2 2015 on the catchment data explorer.

It is also worth noting that the WFD Assessment that formed part of the EA Environmental Statement for the 8km of capital dredging on the Parrett and Tone stated "Proposed measures from within the next RBMP2 (to be confirmed in July 2014) have been sense-checked against existing 2009 SW RBMP for a degree of future-proofing. No measures listed were identified to be in conflict with the proposed works".

HMWB Mitigation Measures	**2015 RBMP2 draft data -** quoted in the EA 2014 WFD Assessment	**Additional comment**
Overall Mitigation Measures Assessment	Moderate	The mitigation measures is the reason for the overall Moderate status (relating to surface water supporting element and biological status). See introduction section.
Structures or other mechanisms in place and managed to enable fish to access waters upstream and downstream of the impounding works	Measure is 'in place'	Not relevant to proposed dredging from Stathe to Burrowbridge. Is likely to contribute towards the reason for not achieving good ecological status (e.g. penning structures prohibiting fish passage and water abstraction for summer penning).
Indirect / offsite mitigation (offsetting measures)	Measure is not 'in place'	Not clear what the mitigation measure is offsetting.
Manage disturbance	Measure is not 'in place'	There is a potential for a WFD impact on this mitigation measures as a result of the proposed dredging. See Step 4 WFD Assessment.

Sediment management	Measure is not 'in place'	
Preserve and where possible enhance ecological value of marginal aquatic habitat, banks and riparian zone	Measure is not 'in place'	
Managed realignment of flood defence	Measure is not 'in place'	

Figure 1

Visual observations downstream of the confluence of the Parrett and the Tone at Burrowbridge showing that reeds often come down to the water's edge at the more landward end of the water body, with steep bare sediment bays between reed zones.

Figure 2

Visual observations at Moorland (further downstream from the proposed dredging location) showing that reeds are rarely present along the LW mark at this seaward end, with wide shallow angled bare mud zones dominating.

Figure 3

Visual observations of intertidal bed features at Burrowbridge (lateral and longitudinal features, likely rain-wash rills).

Figure 4

Visual observations between Burrowbridge and Moorland on the intertidal mud surfaces, showing transverse ripple marks and micro-cliffing

Figure 5

Sedimentary features between Burrowbridge and Moorland. Intertidal sediment surfaces following strong erosion of inner bends with large slump features.

Figure 6

Sedimentary features between Burrowbridge and Moorland, straight reaches with wide scoured sediment surfaces, less prone to slumping.

Figure 7

Location and timing of Dredging Operations on the River Parrett and Tone from 2014

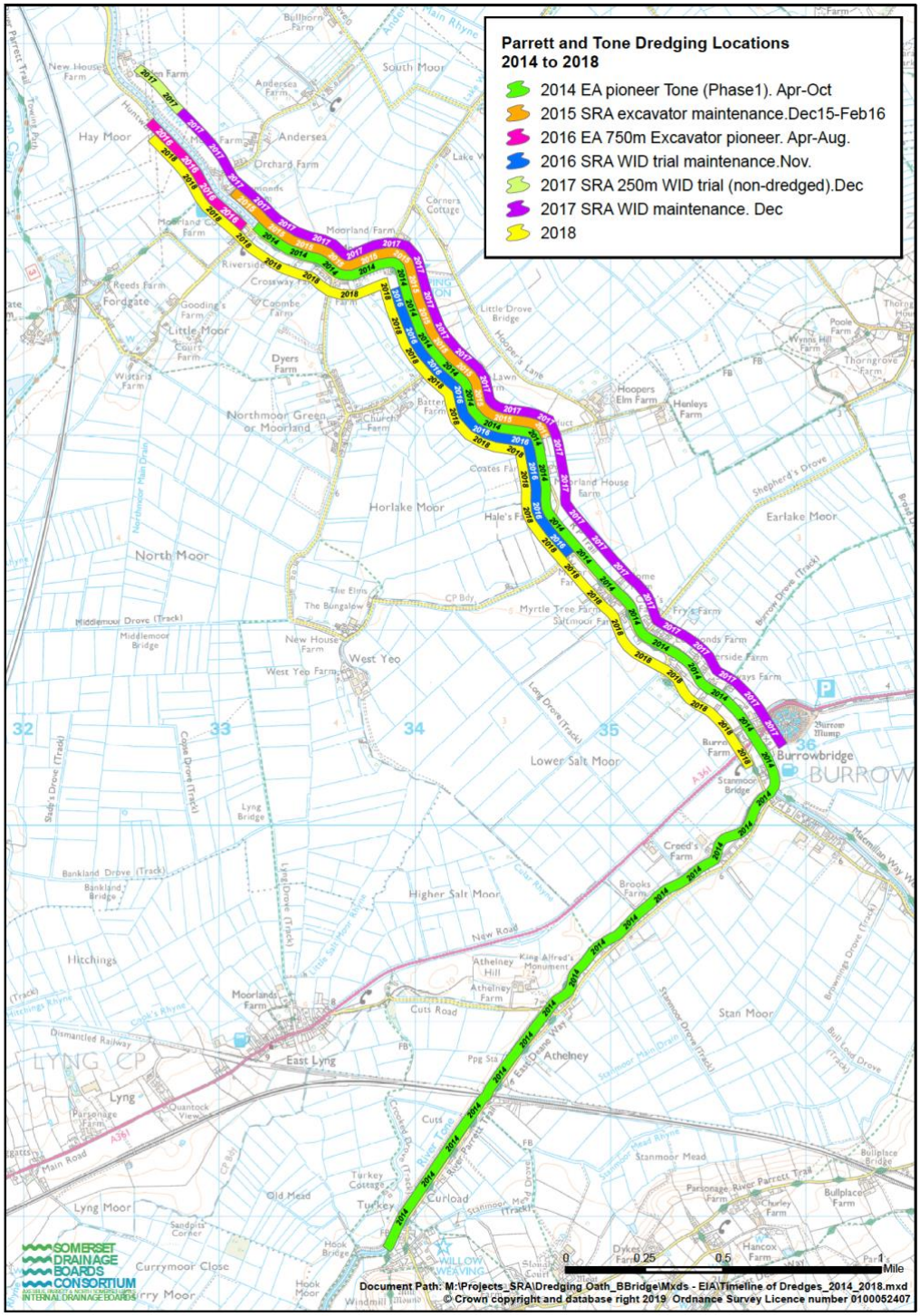


Figure 8 Particle Size Distribution for Samples in Proposed Dredging Location

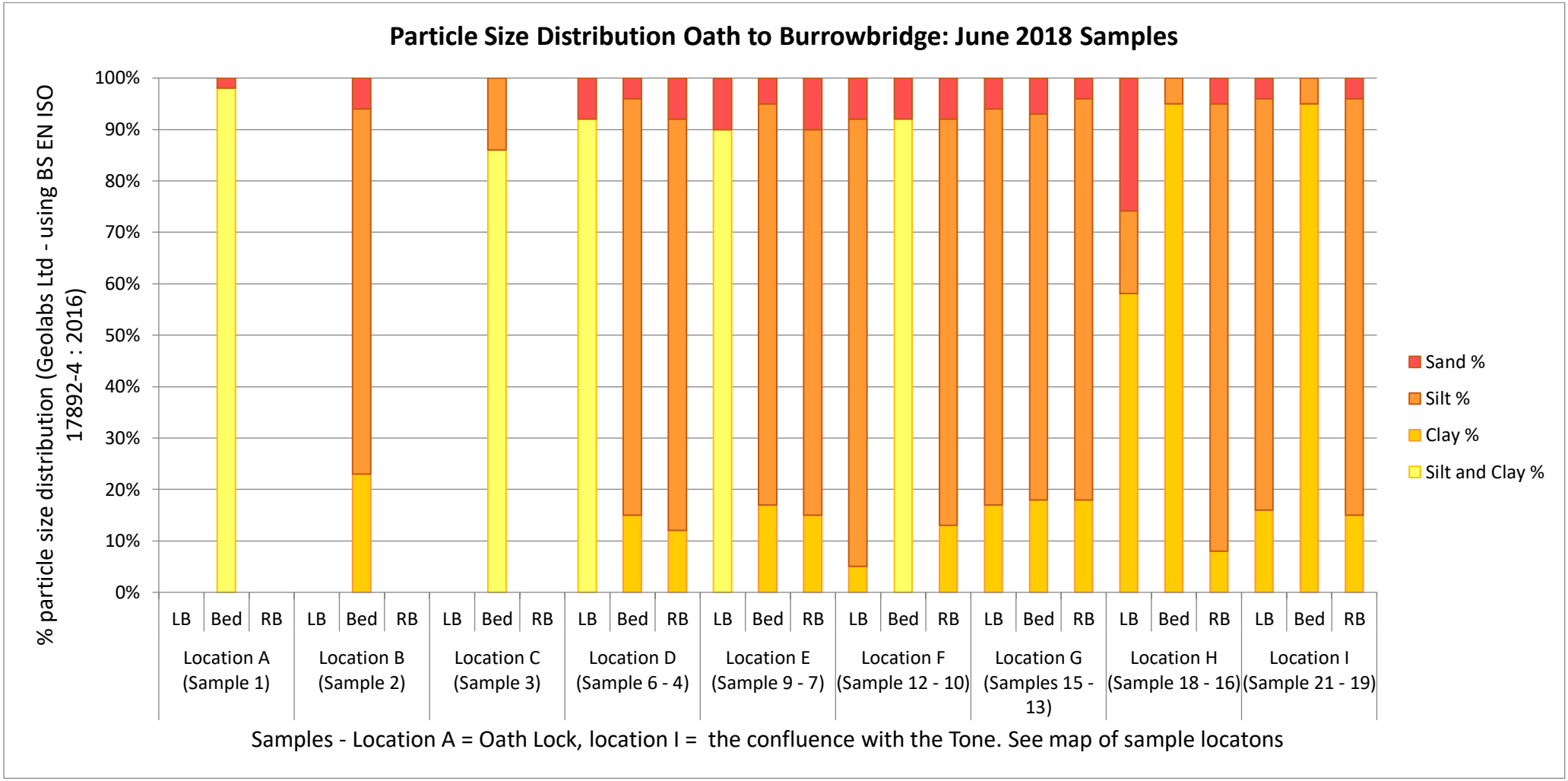


Figure 9 Sediment sample locations

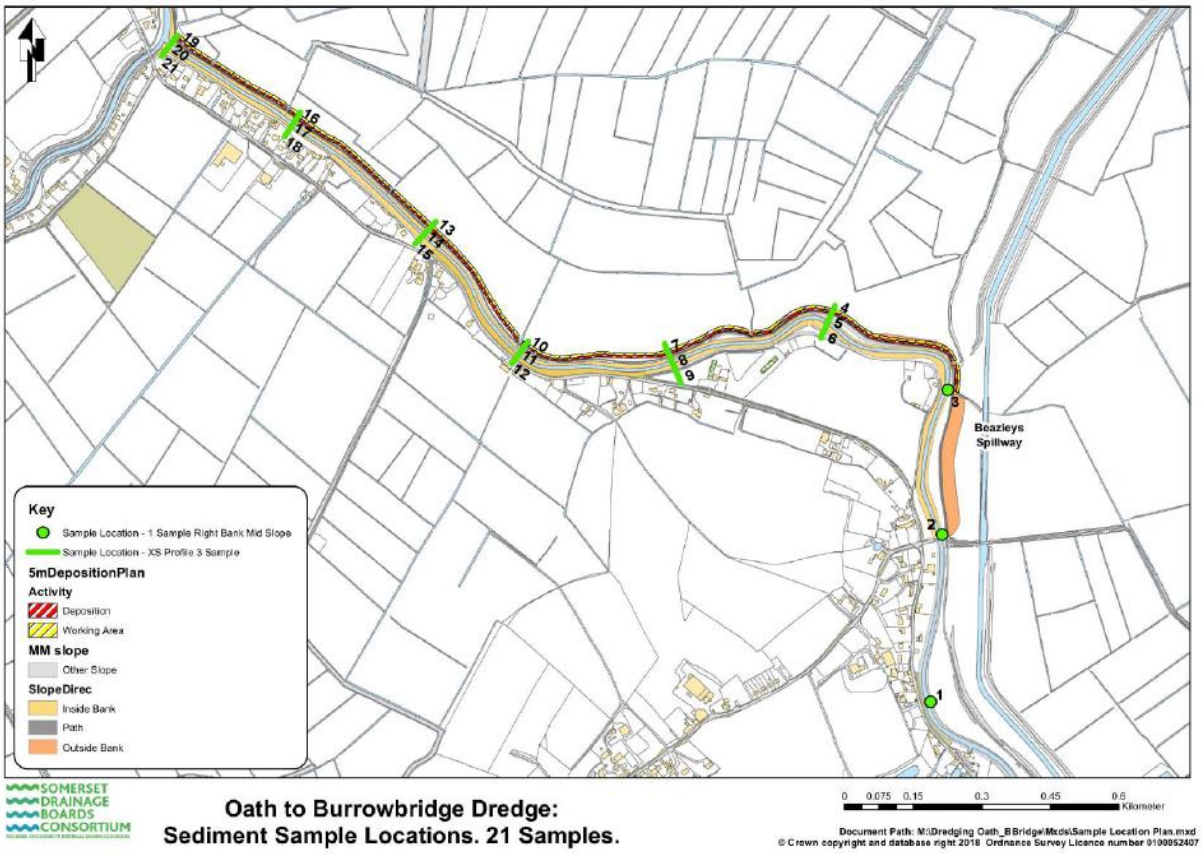


Figure 10 A model of high tide levels reached in the upper Parrett estuary compared to offshore tide levels, illustrating the changed drivers of water level elevation between spring and neap conditions.

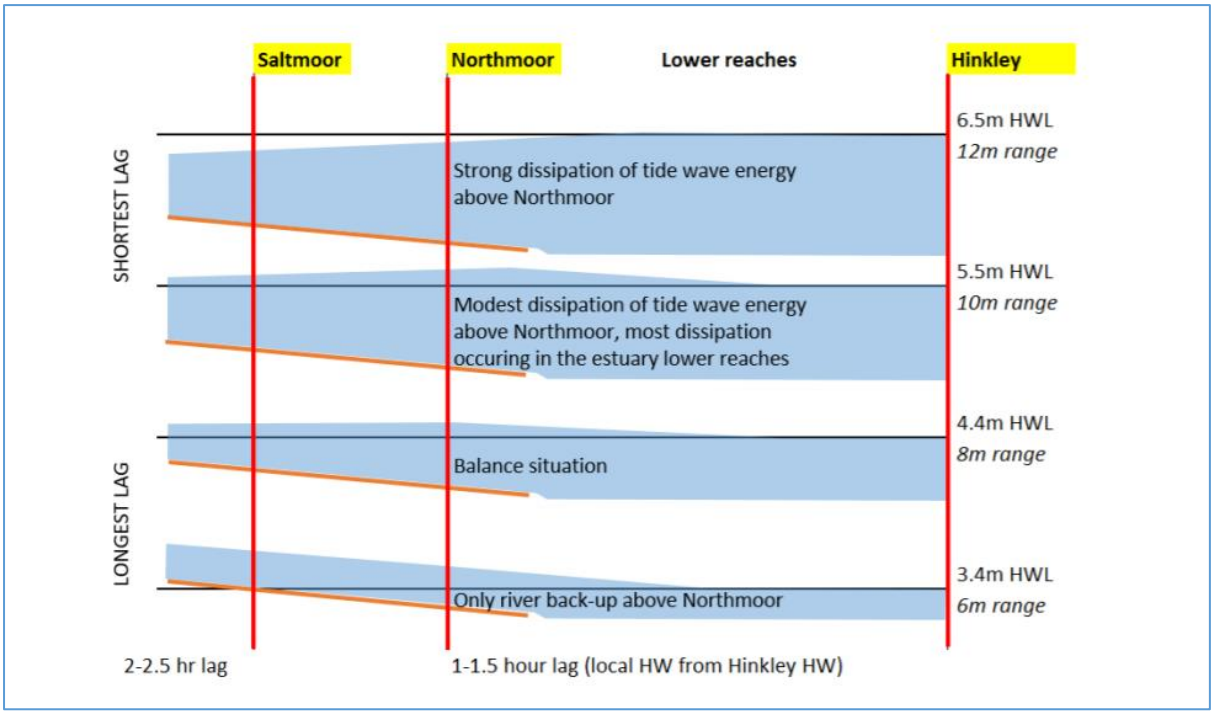


Figure 11
Typical view showing re-sectioned and re-aligned planform, influence of tide on water levels, smooth flow, no in-channel habitat/features from trees.

Figure 12

Typical view showing increased proximity to upper bank vegetation at higher/freshwater flow tidal states.

Figure 13

Typical view of gentle bend without typical meander geomorphology.

	**Figure 14** Typical appearance of submerged aquatic macrophyte bed at lower flows/tidal states, providing a dense submerged and lower energy habitat for fish and invertebrates with greater flow passing to the side.
	**Figure 15** Bank failure in progress resulting in the provision of fresh sediment in-channel (potential for localised depth reduction until transported) and small embayment/overhang that could develop further during higher energy flow events.

Figure 16

Stabilised and vegetated bank collapse creating shallow backwater/embayment at higher flow conditions and a narrowing/pinch point in the channel at lower flow conditions, locally increasing flow velocity.

Figure 17

Submerged lower energy feature caused by bank failure, adjacent to macrophyte bed.

Oath to Burrowbridge Dredging Proposals
Water Framework Directive Assessment

STEP 4 – WFD COMPLIANCE ASSESSMENT

Introduction

The WFD Assessment for the proposed dredging operation from Stathe to Burrowbridge has been divided into the following sections:
Step 1 Background and Screening
Step 2 Scoping
Step 3 Baseline Assessment
Step 4 WFD Compliance Assessment
Step 5 In-combination Assessment
Step 6: WFD Environmental Mitigation Plan

This document forms Step 4 WFD Compliance Assessment.

Scoping Outcomes

Step 2 Scoping identified the following WFD elements for a more detailed compliance assessment. All available information was reviewed to characterise the status and condition of these elements and provided in Step 3 Baseline Assessment.

Hydromorphology supporting element	Depth variation Quantity and structure of bed Structure of the intertidal zone
Physico- chemical supporting elements	Temperature Salinity Turbidity Dissolved oxygen Pollutant risk
Biological	Aquatic Flora Invertebrates Fish Invasive species Pollutants

WFD Compliance Assessment Tables

Four tables below provide an assessment of the potential impacts of the proposed dredging operation on the transitional water body WFD classification elements, with reference to their baseline condition (before dredging).

Table 1: Hydro-morphological supporting conditions

Table 2: Physico-Chemical Supporting Elements

Table 3: Biological Quality Elements

Table 4: HMWB Mitigation Measures

Key	
	No classification data
	Element classified at bad status
	Element classified at poor status
	Element classified at moderate status, or mitigation measure not 'in place'
	Element classified at good status, or mitigation measure 'in place'
	Element classified at high status

Figures

Figure 1 – 3 are located at the end of the document and referred to within the relevant section of text.

References and Appendices

References of data/reports used to establish the baseline from which to carry out the impact assessment are provided within that document. The text also refers to original documents or supplementary information provided in the appendices of the WFD assessment. The content of the appendices are listed below.

Appendix 1: Dredge Design

- Location map of dredging.
- Dredge design drawings (cross sections).
- Contractors Specification (also providing construction phase environmental management, mitigation and monitoring measures)

Appendix 2: Environmental Survey Reports (relevant to the WFD Assessment)

- Phase 1 Habitat Survey (SDBC, Johns Associates 2018)
- Fish Habitat Survey (SDBC, Johns Associates 2018).
- Fixed Point Photography Report (Johns Associates, June 2018). Phase 1 Habitat Survey (SDBC, Johns Associates 2018).
- Oath to Burrowbridge Benthic Macroinvertebrate Study (Johns Associates, June 2018).
- Oath to Burrowbridge Ramsar Invertebrate Study (Johns Associates, June 2018).
- Results of a Survey for Hairy Click-Beetle *Synaptus Filiformis* on the River Parrett, Somerset. AEcol, July 2018.
- Loughborough University, Dr A Pledger, Dr Dapeng Yu, Prof. Paul Wood, Dr David Ryves. Interim report: Ecological Impacts of Water Injection Dredging, Somerset Levels.
- Loughborough University, Dr Andrew Pledger. Technical note: 2018 pre-dredge River Parrett fish surveys.
- River Parrett Oath to Burrowbridge Dredge. Soils Screening Report. On Behalf of Somerset Drainage Boards Consortium (Hydrogeo, July 2018).
- Particle Size Distribution Results: Sediment Samples Oath to Burrowbridge. June 2018.

Appendix 3: Environmental Mitigation Programme (relevant to the WFD Assessment)

- WFD Hairy Click Beetle Assessment and Mitigation Programme
- Contractor Specification / CEMP – See Appendix 1 of this WFD Assessment
- Agreed Strategic Mitigation for the Somerset Levels and Moors SPA/Ramsar

Further references used in this report include:

- Common Implementation Strategy for the Water Framework Directive (2000/60/EC) Guidance document n.o 4 Identification and Designation of Heavily Modified and Artificial Water Bodies. https://circabc.europa.eu/sd/a/f9b057f4-4a91-46a3-b69a-e23b4cada8ef/Guidance%20No%204%20-%20heavily%20modified%20water%20bodies%20-%20HMWB%20(WG%202.2).pdf
- Development and Review of a TraC Hydromorphology Decision Support Tool for (a) screening proposed new or altered activities / structures for compliance with WFD water body status and (b) classifying TraC waters under the WFD TraC-MImAS.

Hydro-Morphological Supporting Element

Guidance and Description for the Assessment – UKTAG WFD

The WFD describes hydro-morphological elements as 'supporting the biological elements'. There are no environmental standards available to assess the ecological impacts of alterations to the morphology of lakes, estuaries and coastal waters. Where regulation occurs, decisions are based largely on expert judgement. Under the Water Framework Directive, the UK is required to manage morphological change to ensure that all surface water bodies aim to achieve good ecological status and that there is no deterioration in status. In terms of classification, the Directive specifies that morphological quality elements must be considered explicitly when classifying for high status. For other status boundaries, the Directive requires that morphological conditions are consistent with the achievement of the values required for the biological quality elements (WFD Directive, Annex V, 1.2). There is limited quantitative data describing the relationships between morphological conditions and ecological status.

The UKTAG Phase 2 Environmental Standards Guidance for WFD provides guidance on classifying impacts. The UKTAG proposals for defining risk to WFD elements for water flow, water level and morphology reflect that the science linking pressures to an impact on biology is limited. As such "condition limits" are proposed within the guidance documents (indirect standards). They indicate a risk that good status is *threatened* whereas "environmental standards" (for biological and chemical quality elements) indicate a risk that good status is *failed*. Morphological attributes that are listed for consideration for transitional water bodies include:

- Depth variation
- Quantity, structure and substrate of the bed
- Structure of the intertidal zone

A significant morphological pressure is defined a pressure that on its own or in combination with other pressures and in the absence of suitable measures, including existing controls, is liable to cause a failure to achieve one or more of the Directive's environmental objectives. In particular, significant pressures on surface water morphology include (a) any activity that causes a deterioration from high status [hydro]morphology to a lower status class, and (b) any activity that leads to [hydro]morphological conditions that prevent the achievement of good ecological status, or cause a decline in ecological status from one class to a lower one.

The list of specific pressures listed in UKTAG Guidance that are identified as affecting the morphology of transitional waters includes a listing for "Channel dredging: Removal or displacement of substratum by dredging or related techniques to create a new channel, to maintain navigation or flood conveyance, or for aggregate extraction". As such, the proposed dredging operation from Stathe to Burrowbridge has been considered a hydro-mophological pressure in the following assessment.

A risk assessment tool was developed by Royal Haskoning in 2012 to help determine whether changes to the morphology could pose a risk to ecology for estuaries and coastal waters (Transitional and Coastal (TraC) waters), the tool is called TraCMImAS. The tools have been developed to help regulators determine whether morphological alterations could: threaten the achievement of good ecological status; or result in a deterioration of ecological status. The principles underpinning them have been detailed in reports available on the UKTAG WFD web pages and have been followed and referred to in this WFD assessment. The tool has been used as a secondary screening process to qualify the scale and extent of the dredging operation against the national tools and thresholds defined by experts and peer reviewed. Exceeding a morphological condition limit using this tool would indicate a risk to the ecological status of a water body.

The tools employ a series of assumptions: the section of water under assessment has some capacity to accommodate morphological change without changes to its ecological status; there is a relationship between the extent of morphological alteration and the impact on ecological status; the response of waters morphology to an engineering or other pressure is predictable for that type of water body; and the response of the ecology to morphological change is predictable and depends on the sensitivity of the ecology of the water body. These assumptions are considered valid on the basis of lessons learnt from previous dredging operations on the lower River Parrett and the capacity of the system to recover. However, given that there are inherent assumptions, the assessment below has not been based on the TraCMImAS tool guidance only, a more detailed site specific assessment approach has also been incorporated into the WFD assessment table below. This refers to existing knowledge of the location and system and ecological surveys carried out for the purpose of assessing the potential impacts of the project. A consideration of proposed mitigation measures (dredge design) has also been incorporated into the overall assessment conclusions.

Finally, the in-combination impacts of the proposed dredge alongside the annual maintenance dredging carried out on the lower River Parrett has also been incorporated into the below assessment.

WFD Considerations for Heavily Modified Water Body (HMWB)

It is important to consider that the Parrett Transitional Waterbody is designated as a Heavily Modified Water Body for the purpose of flood protection and to understand what this means for WFD classification and assessment of morphological impacts. The EU WFD Guidance on the identification and designation of HMWB's specifically states that:

"The concept of HMWB was created to allow for the continuation of these specified uses which provide valuable social and economic benefits but at the same time allow mitigation measures to improve water quality."

"These specified uses tend to require considerable hydromorphological changes to water bodies of such a scale that restoration to "good ecological status" (GES) may not be achievable even in the long-term without preventing the continuation of the specified use."

"GEP is a less stringent objective than GES because it makes allowances for the ecological impacts resulting from those physical alterations that (i) are necessary to support a specified use or (ii) must be maintained to avoid adverse effects on the wider environment. This means that appropriate objectives can be set for the management of other pressures, including physical pressures, not associated with the specified use, while ensuring that the adverse ecological effects of the physical alteration can be appropriately mitigated without undermining the benefits they serve."

Part of the formal process for designation of a HMWB requires a step to assess the ecological status of the water body, the likelihood of failing to achieve good ecological status [Annex II No. 1.5]. This should consider whether the risk of failing GES is due to hydromorphological changes and not other pressures such as toxic substances or other quality problems. In order to assess the likelihood of failing to achieve GES, the ecological impacts of physical alterations on the water bodies in question are estimated. Those water bodies which are going to reach GES despite their hydro-morphological modifications are excluded from the HMWB or AWB identification and designation. See Figure 1 at the end of this table. Step 10 in Figure 1 involves establishing a Maximum Ecological Potential once the water body is defined as a HMWB, considering all mitigation measures possible which do not have a significant adverse effect on the specified use or the wider environment.

These definitions are important within the assessment phase of the WFD assessment for the following reasons:

1. The proposed dredging operation is consistent with the maintenance of the function that the Heavily Modified Water Body serves (flood protection – flood banks and flow conveyance).
2. The proposed dredging operation should not result in morphological alterations (in addition to the existing morphological alterations required for the function that the HMWB serves) that threaten the existing and objective biological status of the water body. The objective is Good Ecological Potential and relates to a Maximum Ecological Potential.
3. The HMWB mitigation measures in place for the water body should focus on the management of 'other pressures' but should not be associated with the specified use in so far as they would undermine the benefits they serve. See Table 5 for assessment of mitigation measures.

Table 1: WFD Compliance Assessment – Hydro-morphological Supporting Conditions

WFD Quality Element	Assessment of the effects of the proposed activity on the WFD quality elements	Risk to WFD compliance	Scale & certainty of impact before mitigation	Actions for WFD compliance including proposed mitigation during design and implementation of works	Scale and certainty of impact after mitigation
Depth variation	There is a potential for the dredging operation to negatively impact depth variation if the dredge profile is not designed appropriately (i.e. including mitigation). However the area proposed for dredging (2.1km) represents 2.6% of the length of bank within the waterbody. Not all of this 2.1km will be dredged. Therefore, the scale of impact may not be significant at the water body scale. Re-siltation back to an equilibrium sediment flux would be expected over approximately 4-5 years (based on monitoring and evidence from 2014 dredge on the lower River Tone and through professional knowledge of the system). Therefore, the depth profile resulting from the dredge would be expected to vary over this time due to re-sedimentation. The WFD assessment includes an assumption that maintenance will be carried out after approximately 5 years and repeated over the medium term (i.e. remaining SRA 20 year flood action plan). However it cannot be assumed that maintenance dredging will take the same form as proposed here. It is much more likely that future maintenance dredging will be incorporated into the existing SRA maintenance dredging programme which takes the form of	Yes - risk of deterioration in depth variation if dredge not designed appropriately. **Mitigation must be included.**	Negative - medium term. Not water body scale impact. Certainty – medium (due to uncertainty over scale of impact).	See cross sectional profiles in the dredge design drawings in Appendix 1 of the WFD assessment. The following mitigation measures ensure that the impact of the operations are not significant at the water body scale and the operation is compliant with WFD: **Bed** • The dredge design will not include dredging of the full channel width. The central low-flow channel (thalweg) will be unaffected by dredging. This includes a 1-2m retained vegetated reed buffer in the majority of locations. Therefore, there would be no effect on the depth variation regarding bed. **Berm** • A channel berm/bench will be maintained i.e. forming at least a two stage channel (noting the retained 1-2m of vegetated berm/bank interface) and in places a three stage channel (see Appendix 1 design drawings). The terrace will be designed at different elevations when both sides of the bank are dredged in order to enhance depth variation in the river cross section (e.g. see cross section R2 in Appendix 1, the left bank bench is established at 4.3m AOD and the right bank bench is 4m AOD. This will allow re-establishment of vegetation zones across varying depths. • During low and medium flows the design profile increases depth variation compared to the baseline as a result of reducing the elevation of the main channel bank height (which are currently very steep) – therefore increasing	**No significant impact at water body scale.** Certainty - high.

	Water Injection Dredging (refined to bed sediment, the opposite of this operation). WID dredging would focus only on specific locations identified through topographical surveys as having experienced significant sedimentation and is unlikely to include the whole 2.2km reach. Any increase/change to the area included in the annual maintenance dredging programme would require the maintenance dredging permit to be amended. As such the impacts including the Stathe to Burrowbridge section into the future maintenance dredging programme would require a separate assessment at that time.			the overall channel area that experiences marginal inundation during low/med flow. This represents a positive impact for most flow conditions. **% Bank** • The dredge design will not include both sides of the bank for the entire length of the dredged reach. The left hand bank is proposed to be dredged for approximately 400m in total out of the 2.2km length, this equates to approximately 18% and up to 1900m of the right hand bank could be dredged (186%). This would occur over a one year period providing opportunity to implement appropriate ecological mitigation, and restoration and enhancement proposals during this year and the following year. A 1-2m of vegetated reed margin at the interface between the thalweg and upper banks would be retained in most locations. • Dredging will only occur on downstream sections below Beazley's Spillway where considerable silt build up is evidenced. As seen in Appendix 1 design dredge drawings, but modified through the mitigation requirements driven by health and safety issues associated with future maintenance, avoiding increasing the risk of promoting seepage through the left hand bank in the lower reach close to residential properties and through compliance with the Wildlife and Countryside Act 1981 (as amended). • By dredging one side of bank only for 18% of the proposed reach, this further mitigates potential depth variation impacts by maintaining morphological diversity between the dredged sections and non-dredged sections. **5 year cycle** • Maintenance dredging will not be carried out/required for a minimum for 5 years. This will be informed and guided by monitoring. This will. provide sufficient time for vegetation/habitat re-establishment across the depth profiles and length and allow the establishment of further depth variation and hydro-morphological elements and fish habitat through natural processes. • Post-dredging monitoring of silt accretion, morphology and vegetation recovery will be carried out to inform the sustainable adaptive management of the river and allow maintenance dredging (likely to be WiD dredging) to be targeted only on areas identified from monitoring surveys.	
Quantity, structure and substrate of the bed	See cross sectional profiles in the dredge design drawings in Appendix 1 of the WFD assessment. Long term, there should be no significant negative effect on the overall structure and substrate of the bed via this operation for the following reasons:	Yes – bed sediment mobilisation. **Mitigation**	Negative - short term. Not water body scale impact.	The following mitigation measures ensure that the direct short term impacts of the dredging operations are not significant at the water body scale and the operation is compliant with WFD: • Agitation or water injection dredging techniques will not be used.	**No significant impact at water body scale.** Certainty - high.

	• The dredging operation is focused on removal of channel bank sediment and not bed sediment. • The dredging widens the overall channel, increasing the cross sectional area for normal and high flows, this will allow increased flow downstream to the confluence of the Parrett and Tone. During winter and high river flow periods, this is likely to increase scour of deposited silt/sediment in this downstream section. This may have a positive impact on the river by reducing the sedimentation here and there the frequency of maintenance water injection dredging. • Dredging will increase the channel width but is unlikely to draw in significant amounts of tidal flow and tidal sediment into this reach because the proposed works are at the upper tidal limit of the water body. The tide does not extent into the zone (but rather causes a backing up of water). Therefore the potential for increased deposition of sandy tidally derived sediments as a result of the dredge is not considered significant. In the short term, there may be some impact via the dredging operation: • There is a risk of sediment mobilisation and deposition on the bed during dredging operations. However the deposition of this material is more likely to be limited to the banks/terrace where the flow is lower, not the bed. • Any deposition on the bed following dredging is likely to be temporary (less cohesive and more likely to be entrained by high flow events).	**must be included.**	Certainty – high	• The excavator dredging operation will be focused on the banks, not the channel bed. The thalweg and a 1-2 m buffer of marginal reed vegetation will be left unaffected. • The works specification will follow good working practice (as developed through capital and maintenance dredging schemes since 2014) to mitigate risk of sediment dispersal into the channel and onto the bed during works. • Timing works to promote dry excavation where possible.	
Structure of the intertidal zone	There is a potential for the dredging operation to significantly impact the structure of the intertidal zone (also referred to as the riparian zone given the upstream and freshwater nature of the river at this location). Dredging will directly remove intertidal area (silt and vegetation) from along the 2.1km section of the River Parrett. See cross sectional profiles in the dredge design drawings in Appendix 1 of the WFD assessment.	Yes – short term loss of structure if not designed appropriately. **Mitigation must be included.**	Negative - short term. Not water body scale impact. Certainty – high (experience	The following mitigation measures ensure that the impact of the operations are not significant at the water body scale and the operation is compliant with WFD: • A channel berm/bench will be maintained to form at least a two stage channel (with a 1-2m of retained edge vegetation) and in places a three stage channel (see Appendix 1 design drawings). The terrace will be designed at slightly different elevations when both sides of the bank are dredged. This will allow re-establishment of vegetation zones across varying depths and re-establish intertidal structure. • The bank surface will not be finished to a smooth compacted surface. Final roughing up with a toothed bucket will help assist vegetation to become established on the bank.	**No significant impact at water body scale.** Certainty - high.

	In the long term, there should be no significant effect on the structure of the intertidal zone at the water body scale via this dredging operation for the following reasons: • The information detailed in Step 3 Baseline Assessment of the WFD assessment and Figure 2 and 3 below shows that the structural diversity is fairly limited as a result of the use of the waterbody as a HMWB for flood protection– i.e. steep artificial flood banks. Other factors such as cattle poaching also limit vegetation establishment and diversity on the upper banks. • The dredging operation will involve using excavators to remove sediment from the banks (above the thalweg) and widen the normal and high flow channel. The dredging will re-establish inter-tidal bank structure in the form of a berm/terrace and also creating narrow and wider sections (pinch points). In some locations where the overall channel width allows, the profile includes two defined benches. Where both sides of the bank are dredged, the design elevation for the bench is different on the two sides to increase structural diversity in vegetation establishment. • The new cross sectional profiles will differ from the existing profile by reducing the height of the existing bank at approx. 8m channel width. By reducing the bank height, it creates a larger area of marginal intertidal habitat that becomes submerged under normal flow conditions. This bench allows the establishment of reeds and marginal habitat. This will increase structural diversity compared to the current steep bank profile. • Following dredging, the channel will be wider at normal and high flows. This will allow future silt deposition on the bench/berms in the intertidal zone. This will result in a change to the structure of the intertidal zone over time as natural sedimentation resumes. Experience from the 2014 Environment Agency capital dredge on the Parrett and the 2015 SRA excavator maintenance dredge have both shown that seasonal processes of scour and deposition continue following capital dredging. The fundamental processes of erosion and deposition in the intertidal zone resume		from previous dredging).	• Diversity in intertidal structure in the river long section (plan view) will be introduced as necessary. This will be achieved using the excavator to recreate pinch points and wider sections experiencing minor bank instability. This would be incorporated into the design at specific locations. See Figure 2 – 4 at the end of this table for the examples of channel morphological features to be re-created. • The proposed operation includes retaining 86% of the left hand bank (1800 of the 2200m length) with no dredging. Up to 18% or 300m of the right hand bank will be retained with no dredging. Mitigation is proposed that will retain a 1-2m vegetated fringe with further measures (described below) being employed in the majority of locations to ensure sufficient habitat recovery prior to further dredging and ensuring legal compliance. Therefore the intertidal zone (and vegetation) will be retained along the bank not being dredged, which will mitigate some of the temporary impacts on the inter-tidal zone and encourage vegetation recovery. • Strip and recover/replanting of reed rhizomes will be applied to extend the retained 1-2m of retained buffer of edge reed vegetation/habitat ensuring sufficient riparian habitat is available and therefore supporting the lawful implementation of the dredging. The upper bank (above the normal inundation zone typically defined by grass rather than reed) will be reseeded with a suitable locally sourced native seed mix, as the works progress to give as long an opportunity for re-growth as possible before the following winter. Temporary fencing will be in place. This will facilitate recovery of the upper bank vegetation and also enhance the right hand bank habitat due to an absence of grazing pressure for a period of time, potentially resulting in a net gain of suitable habitat for a range of species including invertebrates and mammals such as water vole. • Maintenance dredging will not be carried out for a minimum for 5 years. This will provide sufficient time for vegetation re-establishment across the depth profiles. It is unlikely that the intertidal areas will be included in future maintenance dredging (likely to take the form of targeted WID dredging via the SRA maintenance dredging programme). The direct impact on the inter-tidal zone vegetation will therefore be short term only. • Post-dredging monitoring of silt accretion, morphology and vegetation recovery will be carried out to inform the sustainable adaptive management of the river and allow maintenance dredging to be targeted based on the results of monitoring surveys.	

	an equilibrium state in accordance with the new cross sectional profile. • The WFD assessment includes an assumption that maintenance will be carried out after approx 5 years and repeated over the medium term (i.e. remaining SRA 20 year flood action plan). However it cannot be assumed that maintenance dredging will take the same form as proposed here. It is more likely that future maintenance dredging will be incorporated into the existing SRA maintenance dredging programme which takes the form of Water Injection Dredging (refined to bed sediment, the opposite of this operation). WID dredging would focus only on specific locations identified through topographical surveys as having experienced significant sedimentation and is unlikely to include the whole 2.1km reach. In the short term there is likely to be a negative impact on the existing structure of the intertidal zone as a result of loss of vegetation and reprofiling. However this is not considered to have a significant impact on WFD compliance for the following reasons: • The impacts will be temporary and allow for vegetation recovery. • Habitat structure of the intertidal zone is relatively simple; common dominant species (see Step 3 of the WFD assessment), and would quickly re-establish on the new bank profiles. • Experience from the 2014 and 2015 capital dredges on the Parrett using excavators have both shown that the intertidal zone re-establishes with vegetation within 2 years and is fully recovered within 3 years (SDBC Ecologist expert opinion).				
Tidal Regime - Freshwater flow	The increased channel width/cross sectional area resulting from the dredging will increase flow conveyance capacity downstream to the confluence of the River Parrett and Tone. During winter and high river flow periods, this is likely to increase scour of deposited sediment in the section at Burrowbridge. This will have a positive impact on the water body by reducing the sedimentation and therefore the frequency of maintenance dredging required in this	No significant risk to WFD compliance.	Not water body scale impact. Certainty – high (from previous	N/A. No mitigation actions necessary.	N/A

	section (the section currently experiences maximum sedimentation and requires annual WID dredging). As this section of the River Parrett is at the tidal limit, it is unlikely that the increased flow capacity will significantly draw in more tidal water. The tidal regime described in Step 3 of this WFD Assessment shows that the tidal energy is dissipated by Burrowbrdge and rarely extends beyond this point. The river flows demonstrate a backing up of water instead of tidal inflow upstream of here. As a consequence, the influence on the tidal regime of this section of river and the water body as a whole is expected to be minimal. The increase in conveyance capacity is expected to reduce the severity and duration of flooding as a result of river overtopping. This change to the freshwater river flow regime is not expected to influence WFD quality elements. Other potential environmental impacts as a result of the change to flooding are assessed in the relevant sections of the Environmental Impact Assessment and Habitat Regulation Assessment for the works.		experience of dredging).		

Table 2: WFD Compliance – Physico-Chemical Supporting Elements					
WFD Quality Element	**Assessment of the effects of the proposed activity on the WFD quality elements**	**Risk to WFD compliance**	**Scale & certainty of impact before mitigation**	**Actions for WFD compliance including proposed mitigation during design and implementation of works**	**Scale and certainty of impact after mitigation**
Transparency	It is noted Step 3 Baseline Data that the reach from Stathe to Burrowbridge demonstrated good transparency levels during surveying (macrophytes on the river bed were clearly visible). Potential impacts during construction operations are considered below • There is a potential for the dredging to negatively impact transparency in the short term as a result of the entrainment of sediment into the water column (reducing light penetration and dissolved oxygen). • The water body has naturally high turbidity background levels, therefore effects will be limited to temporary impacts at the locality of the dredging operations only and not water body scale impacts. • Mitigation measures are required during the construction phase to ensure that the risk is controlled. • It is unlikely that these temporary impacts could adversely affect WFD compliance. It is not considered that there would be any long term impacts on transparency as a result of the dredging works and alteration to channel form.	Yes - short term impact during construction phase. **Mitigation necessary.**	Negative - short term. Not water body scale impact. Certainty – high (from experience of previous dredging).	The following mitigation measures ensure that the of operations are compliant with WFD: • Follow good working practice to mitigate risk of dispersal during works, as established during the EA 2014 and the SRA 2015 excavator dredges. • Timing works to promote dry excavation where possible. • During construction, dredged bank material will be removed using a closed bucket to limit dispersal into the water column. • No agitation dredging. An ***Environmental Action Plan*** will be in place during works. The aim is to ensure that the physico-chemical conditions in the water do not pose a threat to fish and invertebrate health. Where a risk is posed, dredging will be suspended, the methods re-assessed or necessary mitigation taken. This includes: • Water quality monitoring of dissolved oxygen and temperature against threshold at set times of day throughout the construction phase (as per the environmental mitigation processes established for annual maintenance dredging). • Visual inspections and photographic record.	**No significant impact at water body scale.** Certainty - high.
Thermal conditions	Potential impacts during construction are considered below: • Dredging operations will maintain stable thermal conditions if carried out during normal/high flow due to the larger capacity of the channel. • During low flows, the depth of water in the channel will be shallower and, therefore, vulnerable to increased temperatures as a result of mixing/turbidity from dredging (e.g. unsettling sediments). This may result in reduced dissolved oxygen levels, with potential impacts on fish within the affected reach. • The impacts are not likely to be significant at the water body scale and are temporary.	Yes - short term impact during construction phase.	Negative - short term. Not water body scale impact. Certainty –	The following mitigation measures ensure that the of operations are compliant with WFD: • Follow good working practice to mitigate risk of dispersal during works, as established during the EA 2014 and the SRA 2015 excavator dredges. • Timing works to promote dry excavation where possible so as not to disrupt the channel flow. • During construction, dredged bank material will be removed using a closed bucket to limit dispersal into the water column.	**No significant impact at water body scale.** Certainty - high.

	Potential long term impacts as a result of dredging are considered below: • During high to normal flows thermal conditions are considered to be the same as present. • During low flows, the depth of water in the channel will remain the same because the thalweg channel width is not being affected and consequently thermal conditions should remain the same. • During low – normal flows, the channel width is effectively increased because the height of the main bank (at 8m width) is reduced, allowing inundation of the marginal banks. As the water will be shallower, conditions are vulnerable to increases in temperature (reduced dissolved oxygen levels, with potential impacts on fish). The impact is considered local and not significant at the water body scale. The impact is relevant for specific flow conditions only. There would also be benefits to oxygen and fish/fauna as a result of the newly inundation bench elevation and shallower flow.	**Mitigation necessary.**	high (from experience of previous dredging).	• No agitation dredging. An ***Environmental Action Plan*** will be in place during works. The aim is to ensure that the physico-chemical conditions in the water do not pose a threat to fish and invertebrate health. Where a risk is posed, dredging will be suspended, the methods re-assessed or necessary mitigation taken. This includes: • Water quality monitoring of dissolved oxygen and temperature against threshold at set times of day throughout the construction phase (as per the environmental mitigation processes established for annual maintenance dredging). • Visual inspections and photographic record.	
Oxygenation conditions	Potential impacts during construction operations are considered below • Dredging operations will maintain stable oxygen conditions if carried out during normal/high flow due to the larger capacity of the channel. • During low flows, the depth of water in the channel will be shallower and, therefore, vulnerable to decreased oxygen levels as a result of increase in turbidity/mixing from dredging (e.g. unsettling sediments). Potential reductions in dissolved oxygen could impact fish within the affected reach. Potential long term impacts as a result of dredging works are considered below: • Dredging will improve oxygenation conditions during normal/high flows due to the larger capacity of the channel. • During low flows, the depth of water in the channel will remain the same because the main thalweg channel width is not being affected. • During low – normal flows, the channel width is effectively increased because the height of the main bank (at 8m width) is reduced, allowing inundation of the marginal banks. As the water would be shallower, the conditions are vulnerable to increased temperatures and reduced oxygen. However, the impacts would be very localised and considered to be offset by the benefits to oxygen for fish/fauna as a result of the newly created reed beds along the marginal bench.	Yes - short term impact during construction phase. **Mitigation necessary.**	Negative - short term. Not water body scale impact. Certainty – high (from experience of previous dredging).	The following mitigation measures ensure that the of operations are compliant with WFD: • Follow good working practice to mitigate risk of dispersal during works, as established during the EA 2014 and the SRA 2015 excavator dredges. • Timing works to promote dry excavation where possible so as not to disrupt the channel flow. • During construction, dredged bank material will be removed using a closed bucket to limit dispersal into the water column. • No agitation dredging. An ***Environmental Action Plan*** will be in place during works. The aim is to ensure that the physico-chemical conditions in the water do not pose a threat to fish and invertebrate health. Where a risk is posed, dredging will be suspended, the methods re-assessed or necessary mitigation taken. This includes: • Water quality monitoring of dissolved oxygen and temperature against threshold at set times of day throughout the construction phase (as per the environmental mitigation processes established for annual maintenance dredging). • Visual inspections and photographic record.	**No significant impact at water body scale.** Certainty - high.
Salinity	By increasing the channel capacity from Stathe to Burrowbridge it is possible that this could increase tidal ingress further inland. As a result, this would be expected to	No significant risk to WFD	Not water body scale impact.	N/A No mitigation actions necessary.	N/A

	increase salinity levels, particularly during summer months when river levels are low and freshwater influence is lowest. However, the dredging location is at the uppermost tidal limit of the water body. The Step 3 Baseline Assessment provides salinity levels at Burrowbridge and further downstream in the water body; it was noted that these upper reaches lie above the zone of saline water intrusion. The tides that reach Burrowbridge do not mix with freshwater and the salinity levels are very low. Consequently, it is considered that even with an increased channel capacity at this location, it is unlikely to significantly increase the tidal intrusion or salinity content to a noticeable extent. As such, there would be negligible impacts on biota (e.g. fish community composition) and the conditions would remain appropriate for the existing dominant fresh water fish species. It is not considered that there would be any short term impacts on salinity during the construction phase.	compliance.	Certainty – high (from experience of previous dredging operations).		
Nutrient conditions	The dredging operation is not considered to impact on nutrient conditions either during the construction phase (short term) or as a result of the new channel profile (long term).	No significant risk to WFD compliance.	Not water body scale impact. Certainty – high (from experience of previous dredging operations).	N/A No mitigation actions necessary.	N/A
Specific Pollutants **Priority Substances and Priority Hazardous Substances**	The Step 3 Baseline Assessment discussed the pollutant concentrations from sediment sampling at the dredging site. Mobilisation of pollutants and hazardous substances is not considered to be a risk to the water body due to the low pollutant concentrations. Mobilisation of silt during dredging can result in a risk of flourishing bacteria numbers, particularly in higher water temperatures. This can therefore impact on downstream beach water quality. E coli and Intertestinal entercocci (IE) are the main risks to Bathing Water Quality. However, the risk is considered to be very low in this location as a result of: • The limited scale of the dredging operation and the distance to the nearest Bathing Waters (Burnham) >40km downstream. • The proposed dredging works will remove the dredged sediments (and therefore any potential contaminants) from the river channel. There will	No significant risk to WFD compliance.	Not water body scale impact. Certainty – high (from experience of previous dredging operations).	N/A No mitigation actions necessary.	N/A

	only be a small percentage of material mobilised within the water column and transported downstream. • Bathing Water Quality at Burnham is affected by sources of bacteria from sewage outfalls downstream of the proposed dredging. It is very unlikely that any mobilisation of bacteria from the 2.2km dredge at Burrowbridge could have any significant impact on these other sources.				

Table 3: WFD Compliance – Biological Quality Elements					
WFD Quality Element	**Assessment of the effects of the proposed activity on the WFD quality elements**	**Risk to WFD compliance**	**Scale & certainty of impact before mitigation**	**Actions for WFD compliance including proposed mitigation during design and implementation of works**	**Scale and certainty of impact after mitigation**
Aquatic flora: **Angiosperms, macroalgae and phytobenthos**	Dredging will directly remove intertidal vegetation and sediment on those banks being dredged, this will have a potentially significant impact on flora. Dredging will also alter the shape of the channel, thus altering the quantity and dynamics of the flow and the width and depth of the channel overall; this could affect the species assemblage of aquatic flora regrowth. Macrophytes – • It was noted in the Step 3 Baseline Data that aquatic macrophytes were growing submerged within running water of the main thalweg channel in the reach from Stathe to Burrowbridge, albeit they were limited in species diversity. • The dredging focuses on the banks and will leave the thalweg and a 1-2m retained fringing reed buffer free from dredging, with further measures also proposed to support restoration of the habitat. Therefore direct impacts on macrophytes are negligible. • Short term negative impacts as a result of the mobilisation of sediment during construction are also likely to be minimal; any localised deposited sediment on the bed/macrophytes will rapidly be entrained within the channel flow. • The change to flow dynamics as a result of the new channel profile is not considered likely to significant impact macrophytes. The low flow channel will remain as per the present situation. During low – normal flows, the height of the main bank (at 8m width) is reduced to create the lower elevation bench/berm. This could reduce flow velocity in the thalweg during these conditions, however this would not cause a negative impact on macrophytes. Angiosperms – • As discussed in Step 3 Baseline Assessment, the riparian zone is dominated by reed canary grass and locally abundant stands of common comfrey among other species such as Himalayan Balsam. Vegetation at the margins of the River Parrett is species poor. • The dredging operation will directly remove the silt deposits that these species currently grow on (behind the retained 1-2m buffer) and	Yes - short term impact loss of bank flora. **Mitigation necessary.**	Negative - short term. Not water body scale impact. Certainty – high (from experience of previous dredging).	The following mitigation measures ensure that the operation is compliant with WFD: • A channel berm/bench will be maintained. This will allow re-establishment of vegetation zones across varying depths. • The bank surface will not be finished to a smooth compacted surface. Final roughing up with a toothed bucket will help assist vegetation to become established. • The proposed works retains 86% of the left hand bank and 18% of the right hand bank. Therefore the intertidal zone (and vegetation) will be retained along the bank not being dredged, which will help to mitigate temporary impacts and encourage nearby re-colonisation and recovery. • Strip and recover/replanting of reed rhizomes will be applied and will replace most of the angiosperms lost from the riparian zone. The upper bank (above the normal inundation typically defined by grass rather than reed) will be reseeded as the works progress to give as long an opportunity as possible for re-growth before the winter. The banks will be temporarily fenced to exclude cattle and encourage re-vegetation. • The 'strip and recover' methodology will help to reduce the impact on riverine Phytobenthos by replacing some of the plants on which phytobenthos live. • Should any macrophytes be deemed likely to be lost as a result of the final dredge design, 'strip and recover' will be considered (although they are also likely to recolonise naturally). • Maintenance dredging will not be carried out for a minimum for 5 years. This will provide sufficient time for vegetation re-establishment across the depth profiles. It is unlikely that the intertidal areas will be included in future maintenance dredging (likely to take the form of	**No significant impact at water body scale.** Certainty - high.

	therefore constitutes a temporary loss. On the water body scale this is not considered to be significant (see scale of impacts). It is noted in Step 3 that reed canary grass is common along much of the water body banks (especially the landward end around Burrowbridge and the lower River Tone). It is very likely that this species assemblage will re-establish on the new bank profiles following completion of the dredging. This is also validated from experience obtained through capital dredging of the banks of the Tone and Parrett during 2014 and 2015. The SDBC Ecologist noted that the banks were recovered within 2 years and mature fully recovered reed canary grass stands were observed after 3 years. • The dredging operation will result in a new riparian bank profile. During low – normal flows, the height of the main bank (at 8m width) is reduced to create a lower elevation bench/berm. This is likely to increase the riparian habitat available for marginal angiosperms, resulting in a net positive effect on these aquatic flora. • The lower elevation of the dredge bank profile compared to the existing bank deposits, will reduce habitat availability in the upper riparian zone (grassy top of bank rarely underwater, if ever) in order to create lower elevation and marginal/inundation habitat. This is not considered to be a significant loss given the lack of species diversity present on the upper bank, the abundance of semi-improved grassland in the area and the creation of marginal habitat in its place. Macroalgae or Phytobenthos – • There is limited baseline information available on macroalgae or phytobenthos from which to assess potential impacts. • Any vegetation that other phytobenthos are living on or attached to will be replaced by vegetation replanting and re-colonisation so any impacts will be short term. • It is likely that phytobenthos will re-colonise with ease following the completion of the new dredge profile. • There are limited solid substrates for macroalgae to reside in this reach of river, especially on the river banks proposed for dredging. The impacts on macroalgae are therefore considered negligible. • Macroalgae are most sensitive to toxic substances, as detailed in table 2 above, the risk of release of such substances form the dredging operation is low. Therefore the impact on macroalgae is considered low.			targeted WID dredging via the SRA maintenance dredging programme). The direct impact on the inter-tidal zone vegetation will therefore be short term only. The ***Environmental Action Plan*** includes: • Post-dredging vegetation monitoring programme. Using the fixed point photography completed and referred to in Step 3 Baseline Assessment along with the Phase 1 Habitat Survey. • This will identify further mitigation that may be necessary if vegetation recovery is not established against expected timeframes. • To be completed and reported on annually for 3 years after the 2019 dredge or until recovery is established.	
Invertebrate:	As detailed in the 'Step 3 Baseline Assessment', a benthic survey was carried out in May 2018 and concluded that there were no notable or rare species	No significant risk to WFD	Not water body scale impact.	N/A No mitigation actions necessary.	N/A

Benthic aquatic	found in any of the samples. All were characteristic of lowland waterbody habitat at or around the tidal limit with low diversity. The direct impact on benthic invertebrates is expected to be limited because the dredging operation focuses on the channel banks. Therefore the main habitat for benthic invertebrates (main channel thalweg) should remain relatively unaffected. Potential indirect effects include sediment dispersion and bed deposition in the watercourse during dredging (effecting benthic communities). This is expected to be insignificant. Any sediment temporarily entrained in the watercourse that deposits on the bed is likely to be rapidly dispersed as part of the normal sediment movements of the river. Another indirect effect could result from changes to the river flow regime as a result of a new channel profile. However, as mentioned in the sections above, the channel flow at the bed is not expected to be significantly affected such that it would affect benthic invertebrate communities. The benthic invertebrate survey carried out by Johns Associates concluded that whilst some of these species may be lost from the River Parrett as a result of dredging works, the mobile nature of these species together with their comparatively short life-cycles will mean that recovery will be rapid. Downstream drift of macroinvertebrates may also assist in the re-colonisation of the dredged section of river following completion of the works.	compliance.	Certainty – high (from experience of previous dredging operations).		
Invertebrate fauna: Terrestrial (marginal inundation) **Hairy Click Beetle**	**Ramsar invertebrate species** The Step 2 Baseline Assessment references the Ramsar Invertebrate Desk Study completed by Johns Associates (June 2018) in which the potential impacts of the proposed dredging on Ramsar invertebrate species was assessed. “Direct Dredging Impacts” were assessed as those arising from the operation of sediment removal from the main channel, whilst “Indirect Dredging Impacts” included those arising from impacts to bankside habitat and/or disposal of the dredged sediment. The report concludes a low impact for all identified Ramsar species except for one species (*Lejops vittata*) assigned a medium potential indirect impact. As a result, this species was considered further within a matrix previously used by the Environment Agency for identifying the likely magnitude and significance of potential impacts before mitigation, together with likely residual effects. The risk relates to the potential for loss of bankside habitat (sea club rush) as a result	Yes - medium term impact to protected species. **Mitigation necessary.**	Water body scale impact. Certainty – moderate (from existing knowledge of species).	Ramsar invertebrates and terrestrial/marginal invertebrates are not considered at significant risk (at water body scale) therefore mitigation measures are not necessary. However impacts on marginal and terrestrial invertebrate’s will be mitigated by measures put in place for the Hairy Click Beetle. A series of measures are proposed in the *WFD Hairy Click Beetle Assessment and Mitigation Programme* (in Appendix 3). The mitigation measures intend to limit the impacts of the works and promote the growth of the species population by increasing available habitat and reducing some of the pressures on the population at this locality. The potential magnitude and scale of impacts is considered to be managed sufficiently by the proposed mitigation programme,	**No significant impact at water body scale.**

	of the placement of dredged material on banks where sea club rush may be present. The overall risk of impacts is considered low and does not pose a risk of WFD non-compliance. **Benthic invertebrate species with terrestrial life stages** The benthic invertebrate survey noted that for some of the species recorded, the life cycles are not all aquatic, inferring that they utilise the marginal and riparian habitat. The silt accumulations on the banks that become inundated with changing water levels are likely to be directly affected by the dredging (direct removal of the sediment). This could impact invertebrate communities in the short term. However, the habitat will become re-established by the new dredge profiles and re-establishment of vegetation. As none of the species are identified as rare and are abundant in the locality, it is expected that the invertebrate communities will rapidly re-colonise. They are likely to also be aided by the mitigation measures proposed for Hairy Click Beetle, see below and opposite. Subsequently, the risk of WFD non-compliance is considered negligible. **Hairy Click Beetle** The Step 3 Baseline Assessment identifies the presence of Hairy Click Beetle at the location of proposed dredging. Given the current status of the Hairy Click Beetle as a schedule 41 species under the NERC 2006 regulations the proposed dredging could be considered to have a significant impact on protected riparian invertebrate fauna that could result in WFD non-compliance. Consequently a more detailed assessment of potential impacts has been carried out and is provided in Appendix 3 to this WFD Assessment. See *WFD Hairy Click Beetle Assessment and Mitigation Programme*.			which includes measures to actively enhance the Hairy Click Beetle habitat and population. With the implementation of such measures there is no risk of WFD non-compliance at the water body scale.	
Fish Fauna	It is not considered likely that the proposed dredging will have significant direct impacts on fish populations for the following reasons: - The dredge does not include direct dredging in the channel. - The operation is temporary. - Timing of the operation to avoid key migratory seasons. However there is a potential for sediment dispersal during that would disrupt fish behaviour. Monitoring carried out during water injection dredging (discussed in Step 3 baseline assessment) has shown that the fish populations generally avoid the area during water injection dredging and direct fish mortality is not observed. It is considered likely that a similar response will be noted by fish as a result of any sediment dispersal	Yes - medium term impact to protected species. **Mitigation necessary.**	Water body scale impact. Certainty – low (scale of impact uncertain, precautionary approach taken).	The following mitigation measures ensure that the fish habitat and refugia remain or is re-instated and the operation is compliant with WFD: • A channel berm/bench will be maintained to form at least a two stage channel and in places a three stage channel (see Appendix 1 design drawings). This will allow for a larger area of reed and inundated zone. Such vegetation can provide habitat and protection for fish. • Strip and recover/replanting of reed rhizomes will be applied, aiding the recovery of the reed zone. • Diversity in intertidal structure in the river long section (plan view) will be introduced as necessary. This will be	**No significant impact at water body scale.**

	There is a potential for indirect impacts on fish populations through disruption and change to the fish habitat and sites of fish refugia, which could be significant for spawning populations. Therefore mitigation measures are considered necessary to augment the design and ensure that fish habitat features are retained and reinstated such that there is no risk to WFD compliance.			achieved using the excavator to recreate pinch points and wider sections experiencing minor bank instability. Such areas of low flow and minor backwaters create fish refugia. These areas of bank instability will occur naturally. However, the process will be aided through the dredge design. At specific interspersed locations, the excavator will cut out bank features for this purpose (overseen by the environmental consultants as part of the project environmental mitigation programme). See Figure 2 – 4 at the end of this table for the examples channel morphological features to be re-created. • The proposed operation includes retaining 86% of the left hand bank undisturbed and 18% of the right hand bank undistributed. • Maintenance dredging will not be carried out for a minimum for 5 years. This will provide sufficient time for re-siltation and natural geomorphological processes along the bank that create and maintain fish habitat. • Post-dredging monitoring of silt accretion, morphology and vegetation recovery will be carried out to inform the sustainable adaptive management of the river and allow maintenance dredging to be targeted based on the results of monitoring surveys. An ***Environmental Action Plan*** will be in place during works. The aim is to ensure that the physico-chemical conditions in the water do not pose a threat to fish and invertebrate health. Where a risk is posed, dredging will be suspended, the methods re-assessed or necessary mitigation taken. This includes: • Water quality monitoring of dissolved oxygen and temperature against threshold at set times of day throughout the construction phase (as per the environmental mitigation processes established for annual maintenance dredging). • Visual inspections and photographic record. The ***Environmental Action Plan*** includes: • Post-dredging fish monitoring, included as part of the fish monitoring completed for the SRA annual maintenance dredging environmental mitigation.	

				• This will identify changes to fish behaviour and recovery in the entire water body. • To be completed and reported on annually as dictated in the annual maintenance dredging programme.	
Invasive Species	Step 3 Baseline Assessment references the Phase 1 Habitat Survey, Fish Habitat Survey and Fixed Point Photography Survey completed by Johns Associates at the end of May 2018. These reports note the occurrence of invasive species in the river corridor between Stathe and Burrowbridge. In particular the following species were identified: - Himalayan Balsam - Canadian Pondweed (small fragments from the thalweg which is not going to be disturbed and is therefore scoped out) - The proposed dredging is not considered to have a significant impact on those invasive species in the main channel (Canadian Pondweed) as no works will be carried out in this location. There is a risk that invasive species from the riparian bank could be spread to the location of deposition of the dredged materials. The this risk is not likely to be significant at the water body scale for the following reasons: • Existence of Himalayan Balsam is widespread along the river corridor and the adjacent fields already. Therefore the works do not pose a risk of spreading the species on to a new site. • The works will be completed in oct/sept when the plants are dying off (and not in flower/risk spread of seeds). • Vegetation will be covered by silt deposits and re-seeded with a suitable seed mix. Nonetheless mitigation measures are considered necessary to take active control of the potential spread of invasive species.	Yes – medium term. **Mitigation necessary.**	Not water body scale.	Mitigation measures to control the risk of the spread of invasive species and WFD non-compliance include the following: • Himalayan Balsam vegetation cutting prior to start of works. • Burying all vegetation with silt and reseeding with appropriate grass mix. The ***Environmental Action Plan*** includes: • Post-dredging vegetation monitoring programme, which will include invasive species monitoring. Using the fixed point photography completed and referred to in Step 3 Baseline Assessment along with the Phase 1 Habitat Survey. • This will identify further mitigation that may be necessary if invasive species spreading is identified as an impact. • To be completed and reported on annually for 3 years after the 2019 dredge or until vegetation recovery is established.	**No significant impact at water body scale.**

Table 4: WFD Classification and Status - HMWB Mitigation Measures

The following sources have been used to obtain information on the WFD HMWB mitigation measures for the Parrett Transitional Water Body:

- The EA Catchment Data Explorer – none are listed.
- The Environment Agency enquiries service was used in April May 2015 to obtain all WFD and ecological data available – no HMWB mitigation measures were provided or listed with the data.
- The Environment Agency SW biodiversity officer and geomorphology officer were consulted in consulted in May 2018 regarding mitigation measures for the water body – none were provided.

However the 2014 EA WFD assessment that accompanied the Environmental Statement for the 8km capital dredging on the Parrett and Tone references ***draft*** measures that were intended to be included in RBMP2 (quoted as 'to be confirmed in July 2014'). In order to take a precautionary approach to this WFD assessment, these draft measures are listed below as it may be possible that these are intended as future HWMB mitigation measures.

It is also worth noting that the WFD Assessment that formed part of the EA Environmental Statement for the 8km of capital dredging on the Parrett and Tone stated "Proposed measures from within the next RBMP2 (to be confirmed in July 2014) have been sense-checked against existing 2009 SW RBMP for a degree of future-proofing. No measures listed were identified to be in conflict with the proposed works". Therefore suggesting that 8km of capital dredging along the banks would not have any significant influence on the mitigation measures. It could therefore be assumed the same is true for 2.1km as proposed here 5 years later (when the 2014 dredge habitat has fully recovered).

HMWB Mitigation Measures DRAFT	**2015 RBMP2 data DRAFT –** quoted in EA 2014 WFD Assessment	**Impact Assessment**	
Overall Mitigation Measures Assessment	Moderate	N/A	**No significant negative impact at water body scale.** Certainty - high.
Structures or other mechanisms in place and managed to enable fish to access waters upstream and downstream of the impounding works	Measure is 'in place'	Not relevant to proposed dredging from Stathe to Burrowbridge. Dredging works will not involve additional structures of influence existing structures. Waters will not be impounded.	
Indirect / offsite mitigation (offsetting measures)	Measure is not 'in place'	Not clear what the mitigation measure is offsetting. The proposed dredging should have no impact on any offsetting mitigation measures.	
Manage disturbance	Measure is not 'in place'	There is a potential for a temporary WFD impact on this mitigation measure as a result of the proposed dredging. The dredging works will cause temporary disturbance to the water body in the following ways: - Excavator digging in the water column. - Disturbance to riparian habitat. - Construction noise from excavators. The disturbance of the water column will be managed by the measures described in the sections above. The works have been planned during autumn to minimise the risk of disturbance to: - winter breeding birds - nesting birds and Schedule 1 birds such as Kingfisher - Other protected species e.g. Water Vole.	

		- Migratory fish e.g. European Eel. An ***Environmental Action Plan*** will be in place during works. The aim is to ensure that the environmental risks are managed. This will include • Water quality monitoring of dissolved oxygen and temperature against threshold at set times of day throughout the construction phase (as per the environmental mitigation processes established for annual maintenance dredging). • Watching brief for protected species e.g. otter and water voles. • Visual inspections and photographic record. The direct disturbance is considered to be temporary over a period of 2 months. The riparian habitat will be expected to recover over a period of 2-3 years and maintenance dredging will not be carried out for a minimum of 5 years. Therefore disturbance to the ecosystem will be time limited. With regards to maintenance dredging, it can be assumed that maintenance would be planned for the section and that this would take place a minimum of 5 years after the capital dredge. The method of maintenance dredging is unknown. It is more likely that such dredging will take the form of Water Injection Dredging incorporated into the existing SRA dredging strategy maintenance dredging programme (refined to bed sediment, the opposite of this operation). WID dredging would focus only on specific locations identified through topographical surveys and bathymetry as having experienced higher rates of accretion. Consequently, the riparian habitat would not undergo further disturbance after the proposed dredging. Any addition of this section of the watercourse to the dredging programme and associated maintenance dredging permit would require a separate environmental assessment for compliance at that time and cannot be carried out as part of this assessment due to insufficient information of the potential works.	
Sediment management	Measure is not 'in place'	Sediment management is the purpose of the dredging project. To enable the accumulation of silt (resulting in a negative flood risk impact) to be managed, using the sediment to reinforce the banks for the river. As described in sections above relating to morphology, the dredging will widen the overall channel and increase the cross sectional area for normal and high flows. This will allow increased flow downstream to the confluence of the Parrett and Tone. During winter and high river flow periods, this is likely to increase scour of deposited silt/sediment in this downstream section. This will have a positive impact on the river by reducing the sedimentation here and there the frequency of maintenance water injection dredging in the section from Burrowbrdige to Moorland. Consequently it can be stated that the dredge design actively promotes compliance with this mitigation measure.	

Preserve and where possible enhance ecological value of marginal aquatic habitat, banks and riparian zone	Measure is not 'in place'	See section above on structure of the intertidal zone and aquatic flora. The dredge design has been completed in such a way to reduce the height of the main channel bank at 8m width and therefore create a larger area of marginal vegetation habitat that experiences regular inundation (e.g. reed beds) through the establishment of a channel berm. Consequently it can be stated that the dredge design actively promotes compliance with this mitigation measure.	
Managed realignment of flood defence	Measure is not 'in place'	The bank is a reservoir bank. Managed realignment is not permitted as part of this project due to the status of the bank as a reservoir bank. Furthermore, managed realignment as part of WFD mitigation could affect the purpose for which the HMWB has been designated (flood protection). Please see pg 4 above in which the WFD guidance for HMWB states that… *"…appropriate objectives can be set for the management of other pressures, including physical pressures not associated with the specified use, while ensuring that the adverse ecological effects of the physical alteration can be appropriately mitigated without undermining the benefits they serve."* As part of this project, measures have been proposed to widen the bank and set back the 'effective bank' as much as is possible within the limits of the designated reservoir bank. This ensures that the habitat value is maximised while also ensuring engineering requirements to maintain the standard of protection necessary for the reservoir bank. See the design drawings in Appendix 1, in which a 3 stage channel has been proposed in those locations where there is sufficient space to set back the effective bank and widen the normal-high flow channel. Consequently it can be stated that the dredge design actively promotes compliance with this mitigation measure.	

Figure 1 Identification process for HMWB from WFD CIS Guidance Document No. 4 Identification and Designation of Heavily Modified and Artificial Water Bodies.

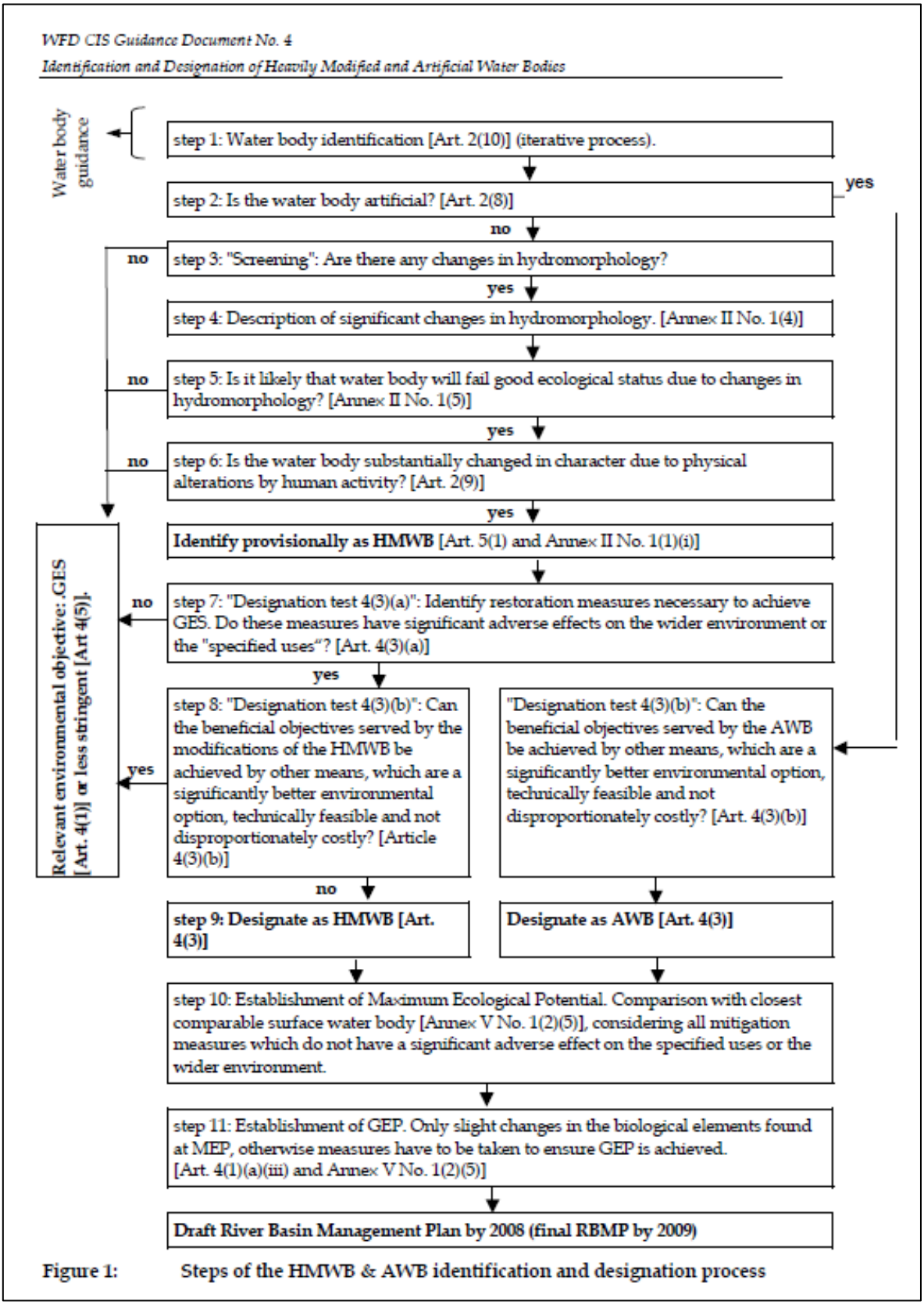


Figure 1: Steps of the HMWB & AWB identification and designation process

Figure 2

Fish habitat features (pinch points and local erosion/instability). To be recreated with excavators or retained where no dredging is planned.

Figure 3

Fish habitat features (pinch points and local erosion/instability). To be recreated with excavators or retained where no dredging is planned.

Oath to Burrowbridge Dredging Proposals
Water Framework Directive Assessment

STEP 5 – IN-COMBINATION ASSESSMENT

Introduction

The WFD Assessment for the proposed dredging operation from Stathe to Burrowbridge has been divided into the following sections:
Step 1 Background and Screening
Step 2 Scoping
Step 3 Baseline Assessment
Step 4 WFD Compliance Assessment
Step 5 In-combination Assessment
Step 6: WFD Environmental Mitigation Plan

In-combination assessment process

A WFD Assessment process has been completed to identify and assess the potential impacts of proposed dredging from Stathe to Burrowbridge on WFD elements and status (WFD compliance assessment).

A screening and scoping exercise was carried out and detailed in Step 1 and 2, which followed the Environment Agency template provided in the guidance document Clearing the Waters for All 2017. Using the outcome from the screening exercise, a baseline assessment was completed in Step 3 and a WFD compliance assessment was carried out in Step 4 (using the baseline data). The Step 4 WFD Compliance Assessment resulted in an outcome that there would be no risk to WFD compliance. An Environmental Mitigation Plan was proposed including specific measures relating to those WFD elements that could be potentially at risk. These measures are consolidated and provided in Step 6: Environmental Mitigation Plan.

Step 4 WFD Compliance Assessment did not include the in-combination impacts to WFD compliance when also considering those projects scoped into the in-combination assessment in Step 2. This has been carried out separately in the tables below.

Table 1 refers to an additional screening exercise using the guidance provided by UKTAG and a decision tool developed by Royal Haskonings TraC-MImAS tool for to help regulators screen for WFD impacts. This has been completed to supplement the in-combination assessment by estimating the potential combined scale of impacts of both the annual maintenance dredging and the Stathe to Burrowbridge capital dredging at the water body scale (assessing the system capacity for both projects without undue effect on WFD biological elements).

Table 2a-c provides a more detailed discussion of the potential in-combination impacts of each WFD quality element scoped in to assessment (as per the outcome of Step 2) and proposes mitigation measures as necessary (incorporated into Step 6: Environmental Mitigation Plan).

Table 4 provides a discussion and conclusions on the potential in-combination impacts on WFD Protected Areas (focusing on the Somerset Levels and Moors SPA and Ramsar Site) arising from the Environment Agency's Sowy Scheme.

Table 1 Assessment of Scale of Impact using TraC-MImAS for in-combination effects in the Parrett TraC

The TraC-MImAS tool is a risk based regulatory decision-support tool designed by Royal Haskonings through the UK Technical Advisory Group (UKTAG) for WFD. The technical document describing the processes underpinning the model was developed through a collaborative project managed and facilitated by SEPA, Environment Agency, Environmental and Heritage Service and SNIFFER, and involved the members and partners of UKTAG (the information is available through UKTAG website). The technical documents relating to TraC-MImAS provides information to support the ongoing development of the standards and classification methods for WFD compliance in transitional water bodies.

The excel tool itself is not available for use by Somerset Drainage Boards Consortium. However the technical documents relating to the background assumptions, assessments and calculations have been referred to within this in-combination assessment so that a high level assessment along the same basis as TraC-MImAS can be completed. The aim was to use an objective assessment tool (TraC-MImAS verified for regulatory use) as a guide to better understand the potential scale of impact of the capital dredge from Stathe to Burrowbridge dredge, and critically, when this dredge is combined with the SRA annual maintenance dredging further downstream from Burrowbridge to Moorland.

Background of the tool
The initial TraC-MImAS tool development project was tasked with developing a tool to help regulators determine whether proposals to alter morphological features could risk the ecological objectives of the WFD. Tool development was based on the methodology developed for rivers (Rivers-MImAS)1. Although the principles underpinning the Rivers and TraC-MImAS tools are largely analogous, TraCMImAS incorporates a number of significant customisations to suit application to TraC waters. It was developed as part of a wider UKTAG programme in 2007. For further details on the functionality of the tool the reader is referred to the UKTAG website (www.wfduk.org/).

The underpinning principles behind the TraC-MImAS tool is to ensure that there is appropriate 'space' for habitats to continue to thrive, and to ensure that there is no potential for deterioration. An impact rating is assigned for different activities based on the following equation.

Impact Rating	=	Relevance	X	Ecological Sensitivity	X	Morphological Sensitivity	X	Likelihood of Impact	X	Zone of Impact
		Output from typology module		*Output from sensitivity module*		*Output from sensitivity module*		*Output from pressure module*		*Output from pressure module*

The formula used to calculate the ecosystem capacity consumed by a single pressure, or combination of pressures within a predetermined assessment area/length, can be summarised as follows. Where n is the number of morphological alterations within the assessed length/area; and ∑() is the sum of results given by the equation specified in the parenthesis for each of the 'n' alterations.

$$\text{Capacity Used (\%)} = \sum n \left(\frac{\text{Impact rating} \times \text{Footprint of morphological alteration}}{\text{Length/area of assessment unit}} \right) \times 100$$

Impact ratings of dredging are given as follows:

Morphological alteration	Low impact dredging	High impact dredging
Intertidal	0.08	0.54
Subtidal	0.22	0.69
Hydrodynamic	0.03	0.13

Relevant definitions:

Morphological pressures:	Dredging (capital or maintenance):
Each pressure has been divided into high and low pressure categories. The purpose of this is predominantly to differentiate between historic pressures and new pressures. Historic pressures are categorised as low impact, due to their existing exposure to the water body (and its likely adjustment to them over time). This includes existing structures and maintenance dredging. New pressures (those to be constructed) are categorised as high impact. These include, for example, a capital dredge or the construction of a new structure.	Capital dredging for navigation purposes is the excavation of sediments to increase depths in an area, usually but not always for the first time, to accommodate the draft of vessels. May include maintenance dredging for the routine periodic removal of material in approach channels to port and harbour basins to maintain widths and depths in previously dredged areas to ensure the safe access for vessels.

Results for Stathe to Burrowbridge capital dredge and Parrett annual maintenance dredging:

The results are given below based on 2.2km of dredging Stathe to Burrowbridge and 4.25km maintenance dredging, within the 40km water body length to the Bristol channel. Note a precautionary approach has been carried out here for simplicity as follows:

- The entirely of the river and banks is not being dredged but has been assumed to be.
- Dredging should be calculated as area rather than length, the whole width of channel is not being dredged.

The two types of dredging influence different zones (4.25km influences the subtidal zone and the 2.1km influences the intertidal zone). The tool describes assessment scale units of local scale and water body scale. Only water body scale has been referred to here.

Water Body Scale Impact (40km) - % capacity used			
	Low Impact 4.25km maintenance dredge	**High Impact 2.1km capital dredge**	**Combined % capacity used**
Intertidal	0.85% *not relevant as no works in the intertidal zone*	2.84%	**2.84%**
Subtidal	2.34%	3.62% *not relevant as no works in subtidal zone*	**2.34%**
Hydrodynamic	0.32%	0.68%	**1%**

To help quantify the risk that a new morphological alteration could impair achievement of the ecological objectives of the WFD, a series of "Morphological Condition Limits" (MCLs) are defined in the technical report for three TraC zones- hydrodynamic, inter-tidal and sub-tidal zone. Distinguishing between these zones provides regulators with a simple method of identifying which aspect of a TraC water is likely to be impacted. This information is intended to be useful when defining the scope of a more detailed assessment. The morphological condition limits proposed for these zones are expressed in terms of percentage capacity used. Exceeding these limits would indicate a risk to WFD status objectives. The WFD requires regulators to manage for no deterioration in WFD status.

	Morphological Condition Limit (% capacity)			
Zone	High*	Good**	Moderate	Poor
Hydrodynamic	**5%**	**15%**	**30%**	**45%**
Intertidal	**5%**	**15%**	**30%**	**45%**
Subtidal	**5%**	**15%**	**30%**	**45%**

High Level Assessment of Impacts

On the basis of the calculations above, the WFD screening tool TraC-MImAS would suggest that the scale of impacts of both the Stathe to Burrowbridge capital dredge and the annual maintenance dredge of the Parrett downstream will not be significant at the water body scale. The water body is currently assigned Moderate status (on the basis of surface water supporting elements). The % capacity of the system used by the morphological alterations of the combined dredging are therefore well below the conditions limits (30%). Even if the stats was assigned as High (as is the case for certain individual biological quality elements), the morphological impacts of the combined dredging would be under the condition limit threshold.

References:

- TraC-MImAS Technical Report. (Development and Review of a TraC Hydromorphology Decision Support Tool for (a) screening proposed new or altered activities / structures for compliance with WFD water body status and (b) classifying TraC waters under the WFD). 2012. https://www.wfduk.org/sites/default/files/Media/TRaC-MImAS%20Technical%20Report%20201212_rev1.PDF
- TraC-MImAS Final Report. https://www.wfduk.org/sites/default/files/Media/UKTAG%20WFD21c%20Final%20report%20%28V2.1%29_0.PDF

Table 2a: WFD Compliance Assessment Parrett TraC – Hydro-morphological Supporting Conditions					
WFD Quality Element	**Assessment of the potential in-combination effects**	**Risk to WFD compliance**	**Scale & certainty of impact before mitigation**	**Actions for WFD compliance including proposed mitigation**	**Scale and certainty of impact after mitigation**
Depth variation	No in-combination effects anticipated. • No dredging of bed from Stathe to Burrowbridge dredge. • Dredge design includes improvement to depth variation on the banks, through creation of channel bench/berm. • Maintenance dredging focuses on annual WID dredging of the bed and does not influence bank depth variation. Therefore the Stathe to Burrowbridge dredge is not anticipated to combine with the annual maintenance dredge to result in wider impacts on depth variation that could risk WFD status.	No	N/A	No mitigation necessary.	**N/A**
Quantity, structure and substrate of the bed	No negative in-combination effects. Positive in-combination impact is likely. • No dredging of bed from Stathe to Burrowbridge dredge. • Increase in flow to the confluence with the Tone as a result of the dredge is anticipated to marginally increase scour of bed sediment at Burrowbridge and downstream towards Moorland. This will reduce the build-up of sediment and the requirement for annual maintenance dredging (which may reduce the disturbance to the river through the annual maintenance requirements). Therefore the Stathe to Burrowbridge dredge is not anticipated to combine with the annual maintenance dredge to result in wider impacts on depth variation that could risk WFD status.	No	N/A	No mitigation necessary.	**N/A**
Structure of the intertidal zone	An in-combination effect is possible with: • 2014 dredging – re-profiling of the intertidal zone along the lower Tone downstream on the Parrett to Moorland. • 2015 maintenance dredge (excavator). • Annual maintenance dredging (WID). However, it is not expected to cause a significant in-combination impact that could risk a reduction in WFD status for the following reasons: • Annual WID dredging does not impact the bank (intertidal zone). • 2014 and 2015 capital dredge on Parrett and Tone involved re-profiling of the bank within the intertidal zone, incorporating a berm. These banks have now fully re-established with	No	N/A	No mitigation necessary.	**N/A**

	vegetation (estimated full recovery within 3 years). Re-siltation of the inter-tidal zone has been occurring naturally over the course of the last 4-5 years, therefore the structure of the intertidal zone has developed into a non-uniform equilibrium state. • With past dredged banks having recovered, the timing of the projects do not overlap and in-combination impacts can be discounted. It is not expected that there could be an in-combination effect now that the banks have recovered, and as a result of the annual maintenance dredging now focusing on the bed sediments.				
Tidal Regime - Freshwater flow	As discussed in Step 3 and Step 4, it is not anticipated that the proposed dredging will have a significant impact on WFD elements with relation to tidal regime and freshwater flow. Likewise it is not expected that the annual maintenance dredging combined with the proposed Stathe to Burrowbridge dredge will significantly influence tidal regime/freshwater flow (from expert opinion and monitoring of dredging operations along the River Parrett).	No	N/A	No mitigation necessary.	**N/A**

Table 2b: WFD Compliance Parrett TraC – Physico-Chemical Supporting Elements					
WFD Quality Element	**Assessment of the potential in-combination effects**	**Risk to WFD compliance**	**Scale & certainty of impact before mitigation**	**Actions for WFD compliance including proposed mitigation**	**Scale and certainty of impact after mitigation**
Transparency **Thermal conditions** **Oxygenation conditions**	The proposed works are planned for autumn 2019 and expected to take 8 weeks (Sept – Oct), with a contingency of an additional 4 weeks. This time frame has been chosen as the least ecologically sensitive time. As discussed in Step 4 WFD Compliance Assessment, there is a minor risk that quality elements relating to transparency, temperature and oxygen could be impacted locally and temporarily from sediment mobilisation/disturbance during the construction phase of works. However, given that the dredging focuses on bank silt removal and includes removal of the silt from the water to the banks, the potential impacts are limited. Good working practices and monitoring mitigation measures will be in place to control the risk. The annual WID maintenance dredging that takes place downstream (approx. 4.25km of the River Parrett from Burrowbridge to Moorland) is carried out in December for approximately 2 weeks across the highest tides. The WID dredging methodology has the potential to negatively impact transparency, thermal conditions and oxygen levels in the water column if not appropriately managed. Through a dredging trials programme and subsequent successful WID dredging operations, an environmental mitigation and monitoring programme has been developed for these works that limits the risk of a significant reduction in the quality of physico-chemical supporting elements such that there is no risk to WFD compliance.	No	N/A	No mitigation necessary.	**N/A**

	The combination of risk to these elements from the autumn dredging excavator operations and the December WID dredging downstream is considered insignificant given the following reasons: • Impacts from the Stathe to Burrowbridge dredge will be limited, localised and earlier in the year. • Annual maintenance dredging has a proven method of managing risks from that activity, occurring later in the year and cannot interact with the Stathe to Burrowbridge dredge.				
Salinity	Negligible risk of impact on salinity from Stathe to Burrowbridge dredge and annual maintenance dredging downstream. Therefore the risk of a combined impact is discounted.	No	N/A	No mitigation necessary.	**N/A**
Nutrient conditions	Negligible risk of impact on nutrients from Stathe to Burrowbridge dredge and annual maintenance dredging downstream. Therefore the risk of a combined impact is discounted.	No	N/A	No mitigation necessary.	**N/A**
Specific Pollutants **Priority Substances and Priority Hazardous Substances**	As discussed in Step 4 WFD Compliance Assessment, the risk of pollutant mobilisation from the proposed dredging is negligible. The sediment is largely removed from the watercourse and deposited on the bank, with limited risk of dispersion into the water column. The annual maintenance dredging involves the re-mobilisation of recently deposited silt (within the last year) into the water column on a falling tide (transported into the Estuary), therefore it is not considered likely that this process would mobilise pollutants. Therefore the Stathe to Burrowbridge dredge is not anticipated to combine with the annual maintenance dredge to result in wider impacts on pollutants that could risk WFD status.	No	N/A	No mitigation necessary.	**N/A**

Table 2c: WFD Compliance Parrett TraC – Biological Quality Elements					
WFD Quality Element	**Assessment of the effects of the proposed activity on the WFD quality elements**	**Risk to WFD compliance**	**Scale & certainty of impact before mitigation**	**Actions for WFD compliance including proposed mitigation during design and implementation of works**	**Scale and certainty of impact after mitigation**
Aquatic flora: **Angiosperms, macroalgae and phytobenthos**	An in-combination effect is possible with: • 2014 dredging – re-profiling of the intertidal zone, temporary loss of riparian vegetation along the lower Tone downstream on the Parrett to Moorland. • 2015 maintenance dredge (excavator), similar to above. However, it is not expected to cause a significant in-combination impact that could risk a reduction in WFD status for the following reasons:	No	N/A	The following mitigation measure is proposed in the **Environmental Action Plan**, as a precautionary approach to achieve the following: • Monitor the vegetation and habitat recovery. • Monitor invasive species.	**No significant impact at water body scale.**

	• Annual WID dredging from 2016 onwards does not impact the bank (intertidal zone) vegetation. Consequently all bankside vegetation in the water body will have been undisturbed from dredging and other physical impacts for a minimum of 4 years. • 2014 and 2015 capital dredge on Parrett and Tone involved re-planting of reed rhizomes and natural re-colonisation from surrounding areas. These banks have now fully re-established with vegetation (estimated recovery in 2 years, full recovery was observed throughout in 3 years). • The Stathe to Burrowbridge proposals includes measures that actively enhance habitat availability for marginal angiosperm species and riparian mammals such as water vole. • With past dredged banks having recovered, the timing of the projects do not overlap and in-combination impacts can be discounted.			• Learn lessons for maintenance dredging. • Identify further mitigation that may be necessary if vegetation recovery is not occuring naturally as per expectation. • The vegetation monitoring should be reported on alongside the fish monitoring (annually for 3 years after the 2019 dredge or until recovery is established).	
Invertebrate: Benthic aquatic	As discussed in Step 4 WFD Compliance Assessment, the risk to benthic invertebrates is not considered to be significant as a result of the proposed dredging focusing on the banks (above the low flow channel at 4m AOD). Therefore benthic invertebrates will not be directly impacted by the dredging. Where there is a risk of indirect minor and localised impacts, it was concluded that the species assemblage recorded for the site will recover rapidly based on their mobile nature and short life cycles. The impact of WID dredging on benthic invertebrates is considered separately as part of the ongoing environmental monitoring programme of the SRA maintenance dredging programme. Some recent studies and reports from Loughborough University on the impacts of dredging on benthic invertebrates and fish species has been discussed briefly in the relevant section under Step 3 Baseline Assessment. WID is not considered to significantly affect the population assemblage, such that it cannot recover. The potential for an in-combination impact of these two projects on benthic invertebrates to the extent that it risks a reduction in biological quality status is considered unlikely. An in-combination impact can be discounted.	No	N/A	No mitigation necessary.	**N/A**
Invertebrate fauna: Terrestrial (marginal inundation) **Hairy Click Beetle**	The risk to Ramsar invertebrates as a result of the proposed dredging has been assessed as low (see Step 4 WFD Compliance Assessment). The in-combination impacts of the 2014 and 2015 excavator dredging downstream on the lower Tone and Parrett with the proposed Stathe to Burrowbridge dredging on Ramsar species is therefore discounted. Annual maintenance dredging does not affect the banks or riparian zone and is therefore not expected to affect marginal or terrestrial invertebrates. Consequently, in-combination impacts can be discounted. The 2014 and 2015 excavator dredging of the lower Tone and Parrett can be considered to have had a direct impact on Hairy Click Beetle habitat. Further to this, the existing Environment Agency mowing regime on the banks at these locations may be causing additional pressure on the	Yes – potential over the short term. **Mitigation required.**	Localised, limited to areas in which multiple pressures are experienced. Certainty – medium.	Hairy Click Beetle Assessment and Mitigation Programme has been proposed. See Appendix 3 to this WFD assessment submission.	**No significant impact at water body scale.**

	endangered species populations. Recent surveying of Hairy Click Beetle (referred to in Step 3 Baseline Assessment) has identified populations of the species within the zone previously dredged in 2014 (Burrowbridge and lower Tone banks). Not only does this demonstrate a level of resilience in the species population, but also demonstrates that the population has recovered from the 2014 dredge. In combination impacts of the proposed dredge with the 2014 dredge is therefore discounted as insignificant. However, there is a risk of in-combination pressures on the species as a result of mowing and grazing (as discussed in Step 4 WFD Compliance Assessment). Consequently a mitigation programme is necessary to ensure that the population of Hairy Click Beetle is actively encouraged with no net negative impacts in the long term. See Hairy Click Beetle Assessment and Mitigation Programme in Appendix 3.				
Fish Fauna	As discussed in Step 4 WFD Compliance Assessment, it is not considered likely that the proposed dredging will have a direct impact on fish populations as the dredge does not include direct dredging in the channel, the operation is temporary and the timing of the operation to avoid key migratory seasons. The risk of sediment dispersal during works is controlled via the mitigation measures listed in Step 4. There is a risk of loss of fish habitat and fish refugia through the re-profiling of banks, this is managed by the re-introduction of geomorphological habitat features. It is therefore concluded that the negative impacts would be temporary, localised and not significant at the water body scale. Further to this, the re-siltation of the channel (expected over 5 years) would re-establish conditions as per present and the impacts of the dredge are therefore temporary. The impact of WID dredging on fish is more direct. It is not considered that any fish habitat is lost as a result of the WID bed and recent studies and reports from Loughborough University (discussed in Step 3 Baseline Assessment) infer that fish avoid the dredger operation. These two impacts are slightly different and are not expected to cause a significant in-combination impact. Nonetheless, the overall disturbance of the water body could alter fish behaviour over time. Though it is unlikely to change behaviour to the extent that a reduction in WFD biological status would occur.	Yes – potential change to fish behaviour.	Temporary/ localised.	The following mitigation measure is proposed in the **Environmental Action Plan**, as a precautionary approach to achieve the following: • Monitor the change in fish assemblage after the dredge. • Monitor any recovery times of fish populations after the initial re-profiling. • Add to water body scale fish monitoring data in the Parrett Transitional Body to improve the understanding of fish behaviour. • The fish monitoring should be reported on alongside the vegetation monitoring (annually for 3 years after the 2019 dredge or until recovery is established).	**No significant impact at water body scale.**
Invasive Species	As discussed in Step 2 and Step 3, the presence of invasive species on the river banks and within the channel results in a risk of further spreading invasive species as a result of the dredging operation. Consequently mitigation measures are proposed that appropriately manage this risk (in particular, Himalayan Balsam on the banks). Invasive species monitoring has been included in the Environmental Action Plan for the works. The potential impacts of the 2014 and 2015 capital dredging on the spread of invasive species is unknown. However, it has not been flagged as a risk or impact. Annual maintenance dredging is not expected to increase the spread of invasive species due to the nature of the operation (water injection dredging of the bed) and the location in which the dredging takes place (limited ability for aquatic invasive species flora to establish).	No	N/A	No mitigation necessary.	**N/A**

WFD COMPLIANCE – SOWY SCHEME

Table 4 Assessment of In-combination effects with the Sowy Scheme and WFD Protected Area (Somerset Levels and Moors SPA and Ramsar).

A formal Habitats Regulations Assessment (Appropriate Assessment) has been completed by Johns Associates in support of the Oath to Burrowbridge Dredging Project including in-combination effects with the Environment Agency's Sowy Project. The HRA also supports this WFD Assessment and an Environmental Impact Assessment. This evaluation, together with extensive consultation between the PIDB, Environment Agency, Natural England and with consultation with the RSPB and Somerset Wildlife Trusts, has led to the agreement of a package of strategic mitigation to provide for both the Oath to Burrowbridge scheme and the Environment Agency's Sowy scheme, that will ensure no change in water levels of duration of flooding required to maintain Favourable Conservation Status of this Protected Area.

Please refer to the Appropriate Assessment (Johns Associates, 2019) for full details.

A hydrological modelling study compiled by SDBC has been used to assess the combined effects of the proposed dredging within the River Parrett with the proposed Sowy Flood Relief Channel Project on the surface water conditions within the SPA and Ramsar sites and on functionally linked land. The model has assessed a larger scheme on the Sowy than that which will be carried out. The model has predicted changes to the level and duration of winter surface splash flooding.

Hydraulic modelling of the combined effects of the Parrett Dredge and Sowy indicate a combined reduction in flood area of 15%, compared to 7% for dredging alone. Again, the greatest changes occur for Langport Moors, West Sedgemoor and Aller Moor. However, there is a slight reduction in the decrease in flood extent for Moors downstream of Beer Wall.

The actual changes flood extent and duration, delivered by both the Dredge and the Sowy, are likely to be less than indicated in the modelling, simply because the increases in flood flow conveyance will be approximately 50% less than the scheme designs modelled in this analysis.

The potential effect associated with water level management as a result of the Parrett dredging with the Sowy Dredging upon the Somerset Levels and Moors SPA and Ramsar site is predicted to be **minor adverse**.

Mitigation has been incorporated into the project scheme and this is summarized below, together with conclusions on residual in-combination effects on the WFD Protected Area.

Noise Disturbance & Vibration from Construction
Construction noise mitigation measures will be outlined in a site-specific CEMP. General principles for control will include: The maximum sound levels of all plant used on the remediation site will comply with EC directive 2001/14/EC; best practical means will be employed to limit noise levels; site vehicles will not be over-revved, or left with engines idling; and auxiliary equipment will be shut down when not in use and sited with due consideration.
On a site-specific basis, an Ecological Clerk of Works (ECoW) will conduct a daily assessment of migratory wintering birds present within South Lake adjacent to the site works and will ill monitor the behavioural response of the birds to the dredging works. Should birds not become habituated to the effect of constriction noise, the ECoW will direct the location of digging where feasible to avoid the effects of noise upon the birds using the site at that time. Following mitigation there is predicted to be a **negligible residual significant** effect.

Pollution Incidents from Construction
With operation management and control of deliveries the risk of pollution incidents during construction to the Somerset Levels and Moors SPA and Ramsar sites is small, however the area is highly sensitive. Mitigation includes: Bank re-instatement, Appropriate bunding for temporary fuel or chemical storage; use of less toxic alternatives; provision of emergency spill kits; examination of unusual solid materials or liquids, and following best practice approach in accordance with specifications with the Construction Environmental Management Plan (CEMP).

Loss/Disturbance of Habitat from Construction
The new bank created from the deposition of the dredged material will be re-seeded using a mix appropriate to the hydrological conditions, soil type and local area. The bank will be fenced off temporality over a 12-month period to prevent poaching and trampling by cattle while the vegetation re-establishes.
Following re-instatement of the grassland habitat there is predicted to be a **negligible residual significant** effect.

Water Level Management from Operation
Mitigation measures for changes to water level extent and duration have been informed through consultation with the EA, NE, RSPB and PIDB. Following implementation of the mitigation measures there is predicted to be a **negligible residual significant** effect.

In conclusion, the in-combination assessment of effects arising from the Environment Agency's Sowy scheme and the Oath to Burrowbridge Dredging confirms No Significant Effects will occur.

Oath to Burrowbridge Dredging Proposals
Water Framework Directive Assessment

STEP 6 – WFD ENVIRONMENTAL MITIGATION PLAN

Introduction

The WFD Assessment for the proposed dredging operation from Stathe to Burrowbridge has been divided into the following sections:
Step 1 Background and Screening
Step 2 Scoping
Step 3 Baseline Assessment
Step 4 WFD Compliance Assessment
Step 5 In-combination Assessment
Step 6: WFD Environmental Mitigation Plan

This document forms Step 6 WFD Environmental Mitigation Plan and is the consolidated list of mitigation measures proposed in Steps 5 and Step 6.

WFD Environmental Mitigation Plan (Measures to be implemented for WFD compliance)

General

A wide range of general environmental management and mitigation measures are included as a formal part of the contractors specification. This specification or Construction Environmental Management Plan (CEMP) is reproduced in Appendix 3.

Morphological Diversity

- The dredge design will not include dredging of the full channel width. The central low-flow channel (thalweg) will be unaffected by dredging. Therefore, there would be no effect on the depth variation regarding bed.
- A channel berm/bench will be maintained i.e. forming at least a two-stage channel and in places a three stage channel (see Appendix 1 design drawings). The terrace will be designed at different elevations when both sides of the bank are dredged in order to enhance depth variation in the river cross section.
- Diversity in intertidal structure in the river long section (plan view) will be introduced using the excavator to recreate pinch points and wider sections experiencing minor bank instability. This would be incorporated into the design at specific locations.
- The dredge design will not include both sides of the bank for the entire length of the dredged reach. The majority of the work is on all but 300m of the right-hand bank with dredging occurring from an estimated 1.9km in total out of the 2.2km length, this equates to approximately 86% of the right hand bank. By comparison, dredging will only occur from an estimated 400m of the left-hand bank from the 2.2km length, equating to 18%.

Maintenance Dredging Cycle

- Maintenance dredging will not be carried out/required for a minimum for 5 years. This will provide sufficient time for vegetation re-establishment across the depth profiles and allow the establishment of further depth variation through natural processes.
- Post-dredging monitoring of silt accretion, morphology and vegetation recovery will be carried out to inform the sustainable adaptive management of the river and allow maintenance dredging to be targeted only on areas identified from monitoring surveys.

Vegetation Recovery

- A 1-2 m. reed rhizome margin will be retained along the majority of the dredging working areas. Significant lengths of undisturbed left hand bank will be retained undisturbed and in-situ/
- The bank surface will not be finished to a smooth compacted surface. Final roughing up with a toothed bucket will help assist vegetation to become established on the bank.
- Strip and recover/replanting of reed rhizomes will be applied where possible with translocated reed rhizomes being moved minimum distances and placed in a shallow hollow created by an excavator and adjacent to retained habitat and compacted to anchor the rhizome in place, also by an excavator. Further measures may be required and would be adopted on site by the contractor (e.g. pinning the rhizome in place).
- Natural recolonization will also be promoted.
- The upper bank (above the normal inundation zone typically defined by grass rather than reed) will be allowed to recover through the natural local seed bank and the outer bank reseeded as the works progress to give as long an opportunity for re-growth as possible before winter, with further seeding in 2020 if necessary.

- Temporary fencing will be in place for 12 months.
- Changing in grazing management may be possible (the extent of which is to be confirmed with Natural England as the landowner on the grazed right bank).
- Post-dredging vegetation and invasive species monitoring programme. Using the fixed point and drone imagery/photography/mapping completed and referred to in Step 3 Baseline Assessment along with the Phase 1 Habitat Survey. This will identify further mitigation that may be necessary if vegetation recovery is not established against expected timeframes. To be completed and reported on annually for 3 years after the 2019 dredge or until recovery is established.

Fish Recovery Monitoring

- Post-dredging fish monitoring, included as part of the fish monitoring completed for the SRA annual maintenance dredging environmental mitigation. This will identify changes to fish behaviour and recovery in the entire water body. To be completed and reported on annually as dictated in the annual maintenance dredging programme.

Hairy Click Beetle Programme

See separate document: Hairy Click Beetle Assessment and Mitigation Plan, located in Appendix 3.

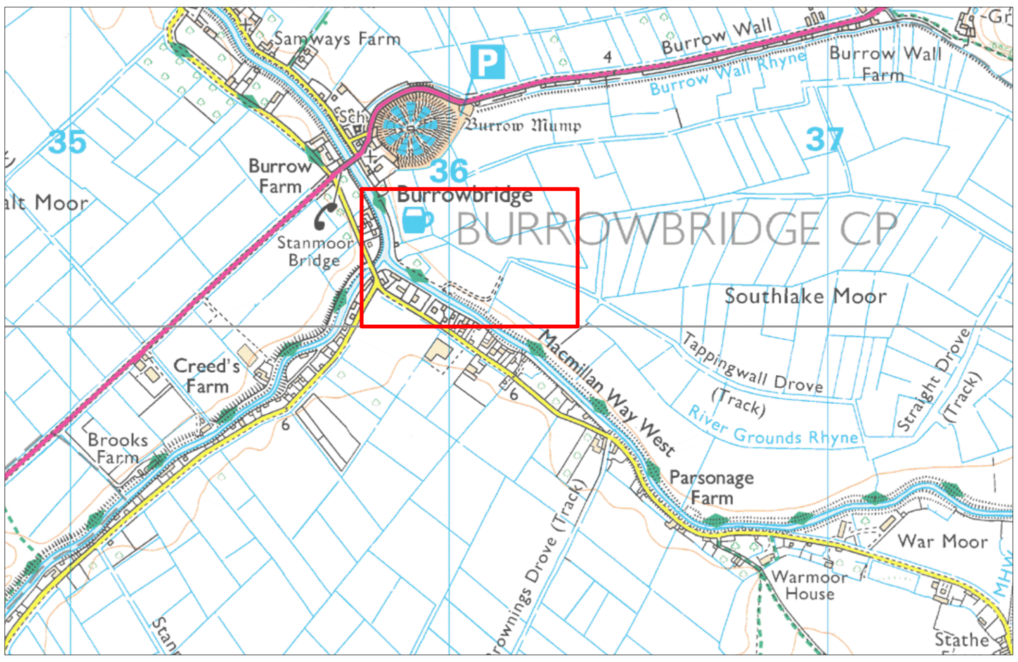
Construction Disturbance Management

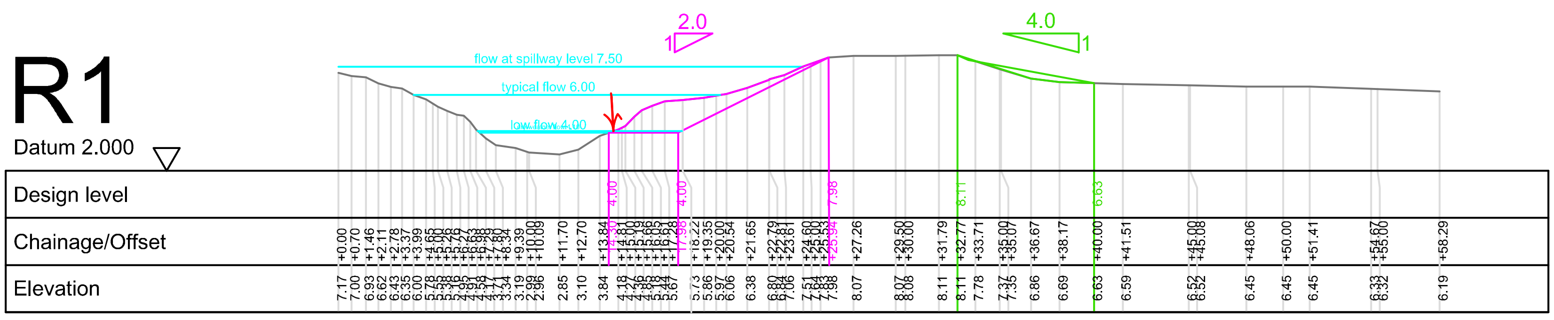
- The works specification will follow good working practice (as developed through capital and maintenance dredging schemes since 2014) to mitigate risk of sediment dispersal into the channel and onto the bed during works. Dredged bank material will be removed using a closed bucket to limit dispersal into the water column.
- Timing works to promote dry excavation where possible.
- Water quality monitoring of dissolved oxygen and temperature against threshold at set times of day throughout the construction phase (as per the environmental mitigation processes established for annual maintenance dredging).
- Visual inspections and photographic record.

Water Levels in the Somerset Moors and Levels SPA/Ramsar

A wide range of agreed operational protocols have been developed and agreed between the PIDB, Natural England and the Environment Agency. These will ensure no change from current conditions will arise as a result of the proposals, including the in-combination effects associated with the Environment Agency's Sowy Project. They also introduce some measure of additional flexibility in how conditions can be maintained. For full details please refer to Appendix 3 of this WFD.

Appendix 1





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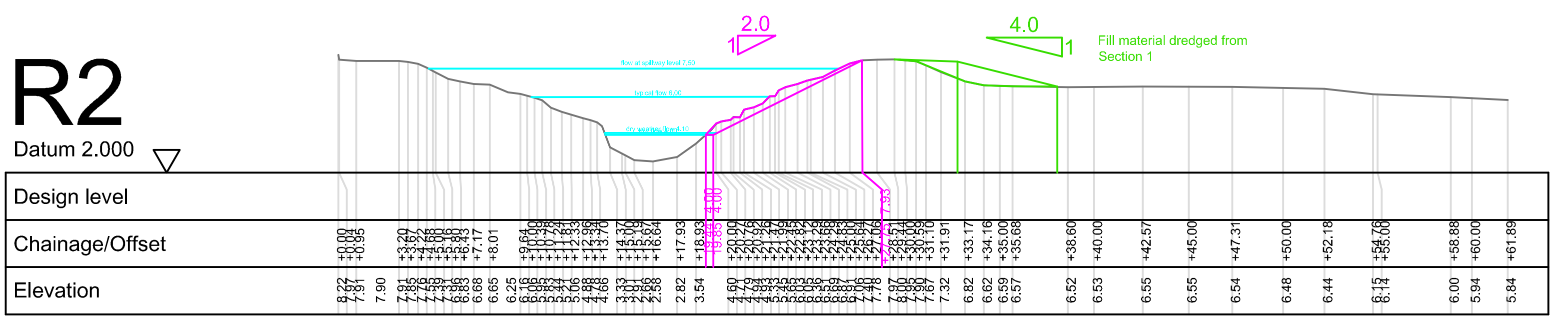

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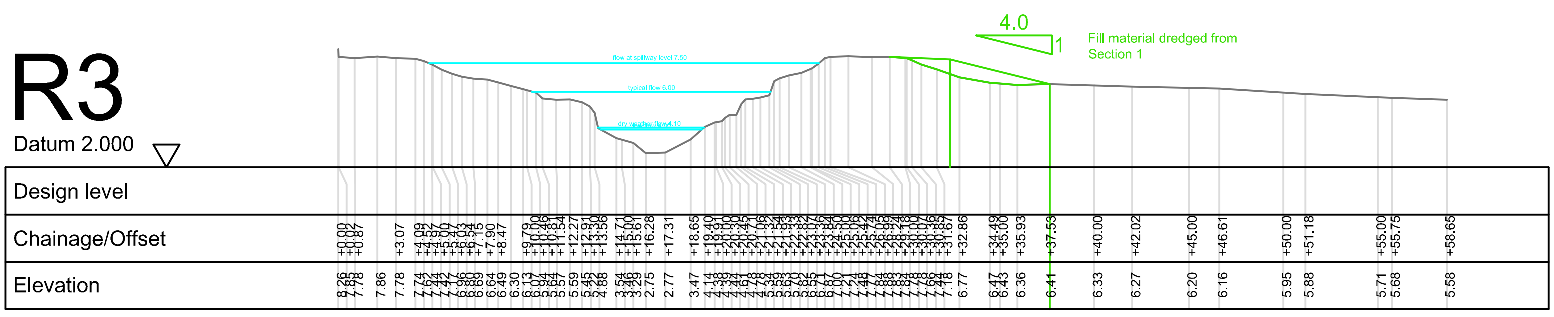

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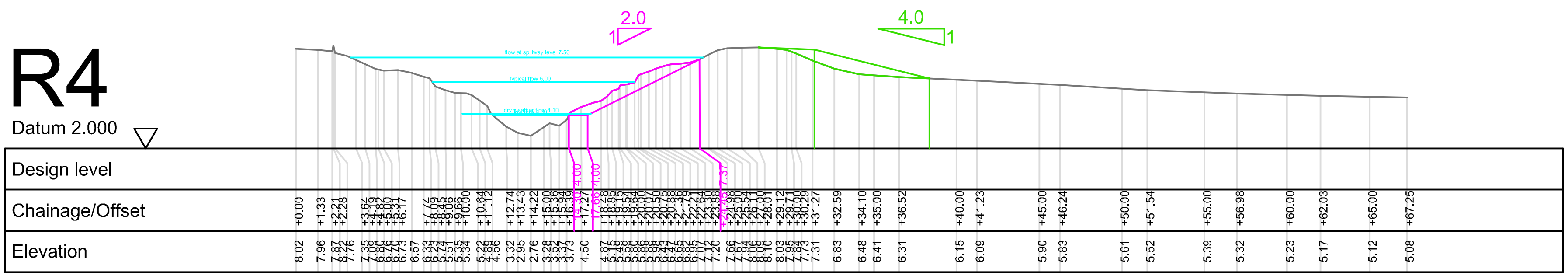

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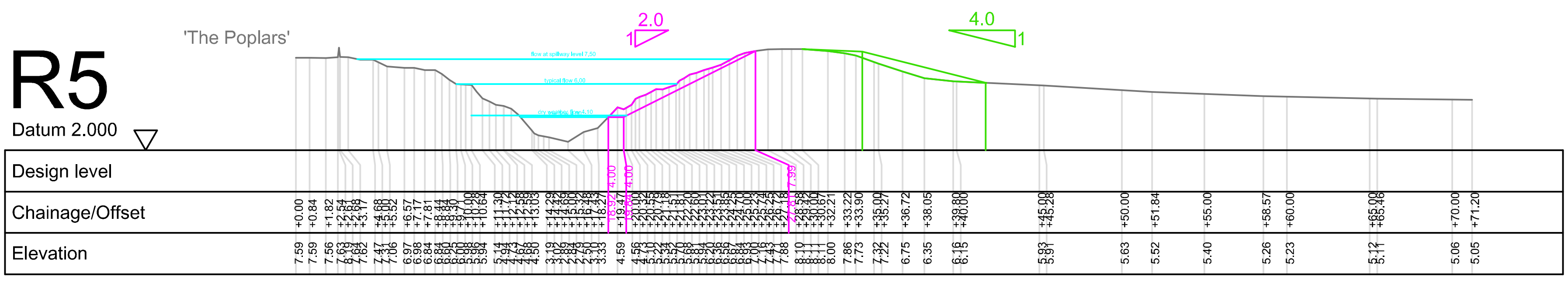

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SOMERSET DRAINAGE BOARDS CONSORTIUM
Parrett Internal Drainage Board
Bradbury House
33-34 Market Street
Highbridge
Somerset TA9 3BW
Telephone 01278 789906
email admin@somersetdbs.co.uk

safety health & environmental:

Safety:
1. Working with variying fluvial and tidal flows
2. Load bearing capacity of river banks
3. Access to parts of left bank may be difficult

Health:
1. Potential residual contamination from agricultural activity
2. Uneven ground that may be slippery when wet/frozen

Environment:
1. Part of the site is SSSI designated
2. Rare and protected species may be present

key:

- Flow at spillway level
- Cut
- 2.0 / 1 — Design bank cut gradient
- Fill
- 4.0 / 1 — Design bank fill gradient

project:

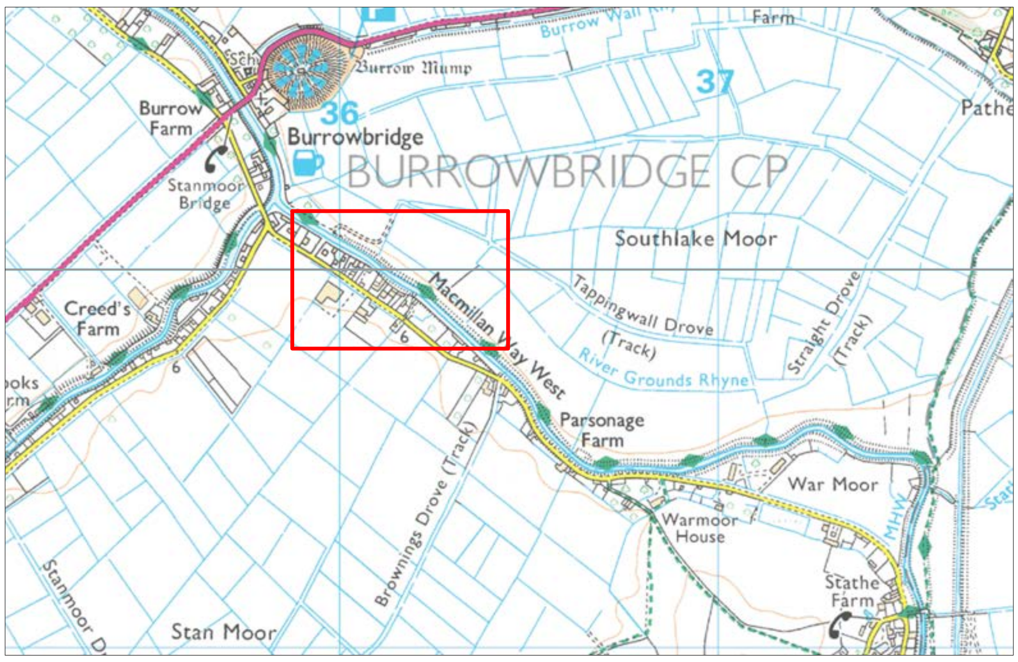
Pioneer dredging of River Parrett
Oath to Burrowbridge

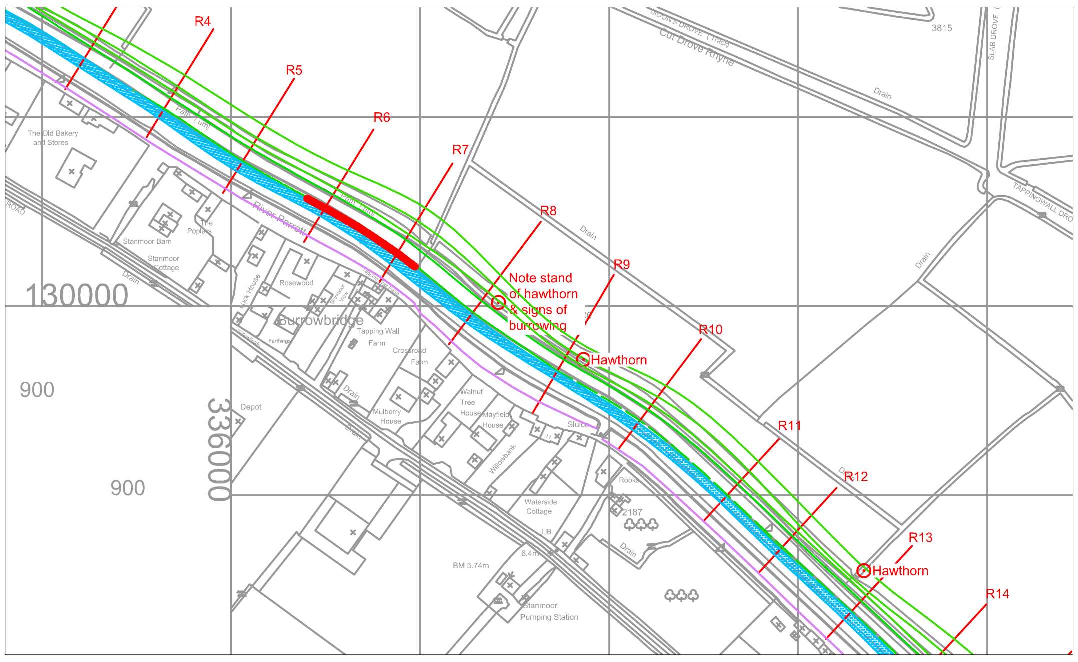
title:

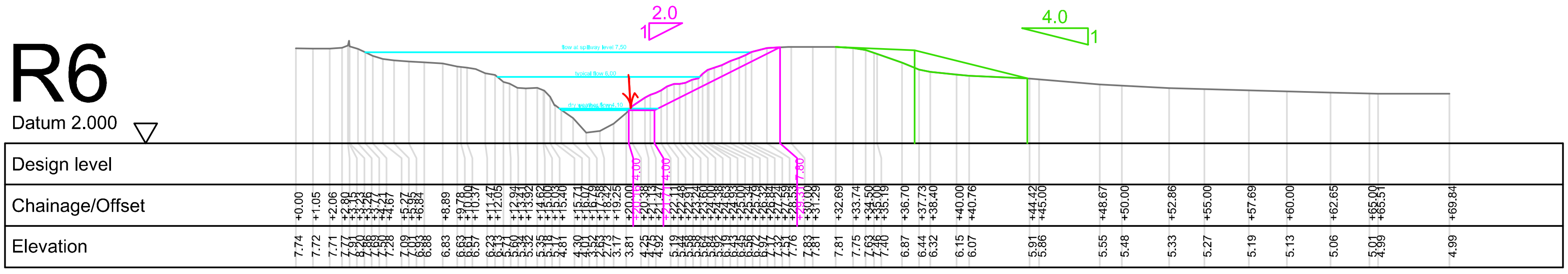
Design Profiles
Sections R1-R5

drawn: RK	date: Dec 2018
approved:	issue: Consultation
scale: 1:400 natural @ A3	
drg no: GD06-18-201B	

revisions:
Rev A: 03/19 Left bank design mods
Rev B: 03/19 Left bank reduction & fill adjusted







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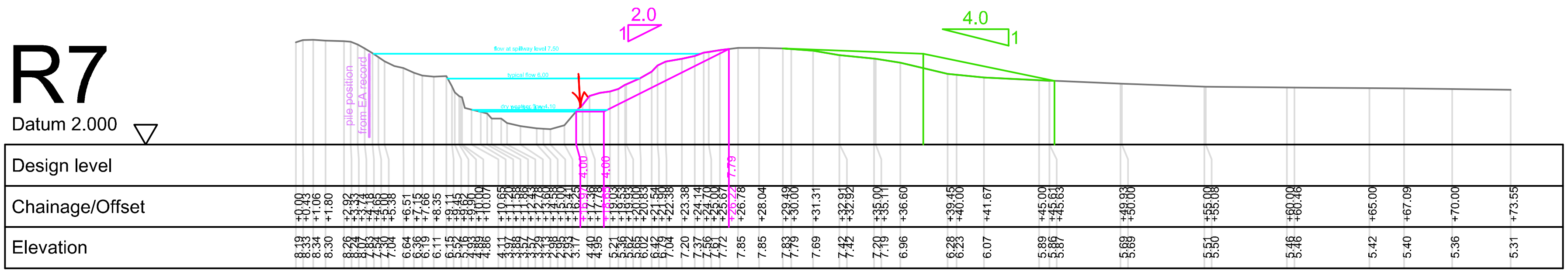

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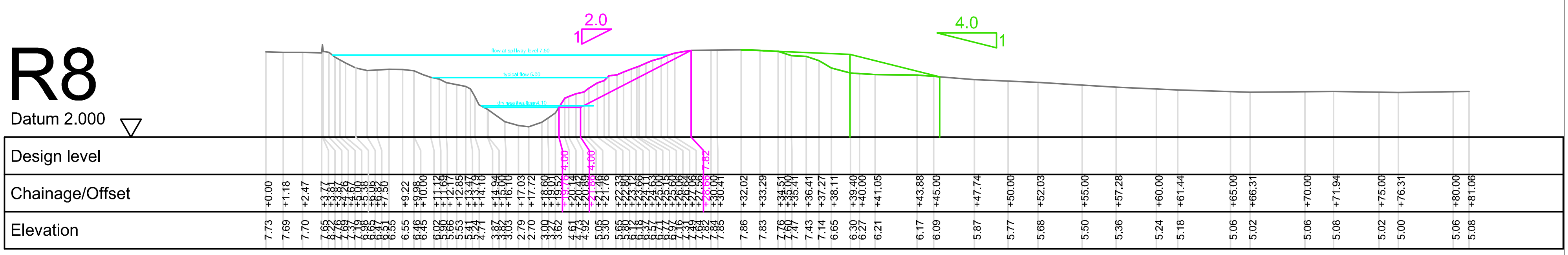

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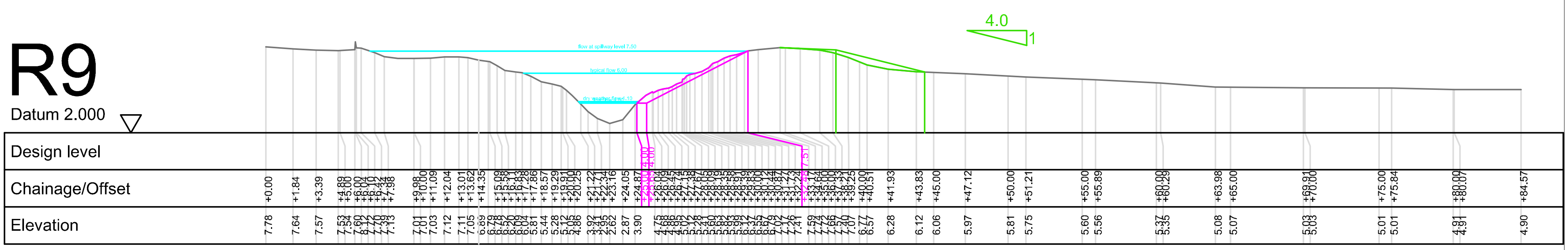

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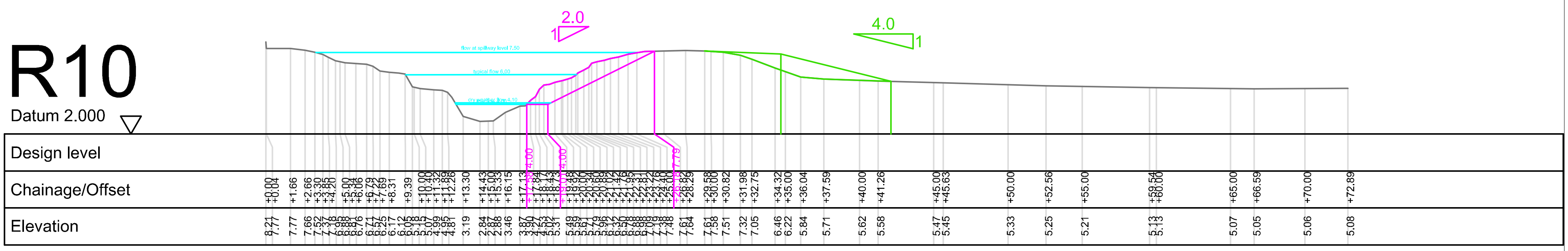

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SOMERSET DRAINAGE BOARDS CONSORTIUM

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email admin@somersetdbs.co.uk

safety health & environmental:

Safety:
1. Working with variying fluvial and tidal flows
2. Load bearing capacity of river banks
3. Access to parts of left bank may be difficult

Health:
1. Potential residual contamination from agricultural activity
2. Uneven ground that may be slippery when wet/frozen

Environment:
1. Part of the site is SSSI designated
2. Rare and protected species may be present

key:

- Flow at spillway level
- Cut
- 2.0 / 1 Design bank cut gradient
- Fill
- 4.0 / 1 Design bank fill gradient

project:

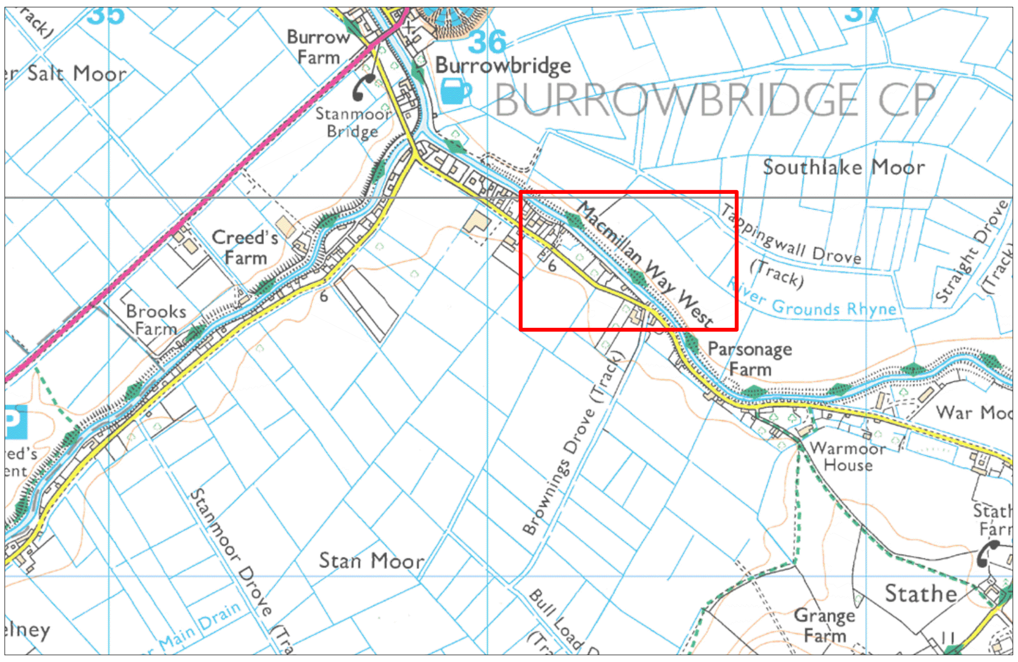
Pioneer dredging of River Parrett Oath to Burrowbridge

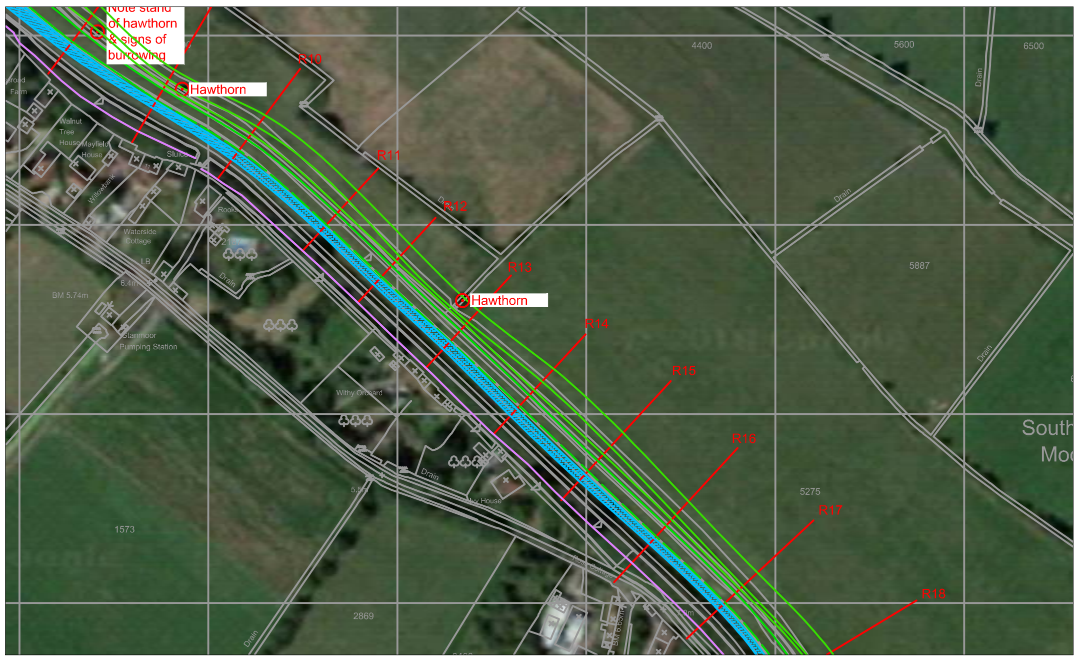
title:

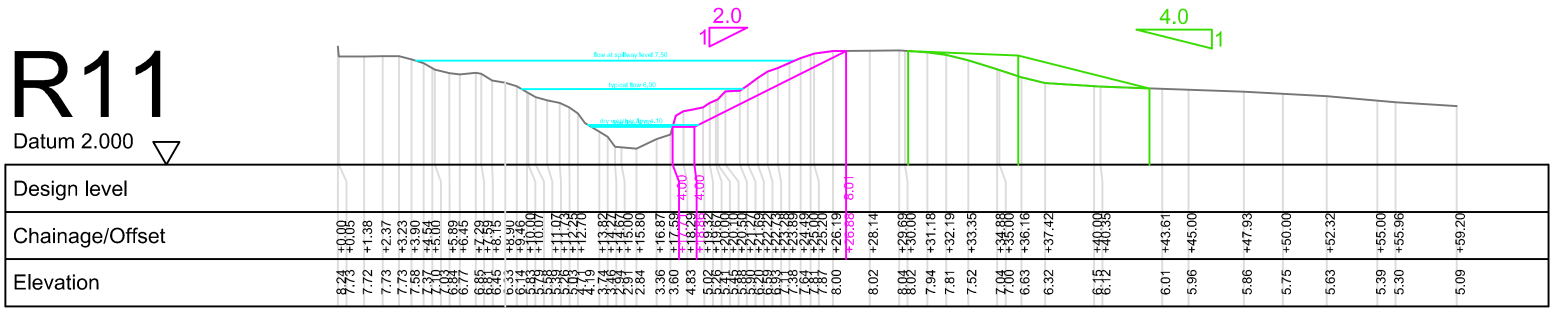
Design Profiles Sections R6-R10

drawn: RK	date: Dec 2018
approved:	issue: Consultation
scale: 1:400 natural @ A3	
drg no: GD06-18-202B	

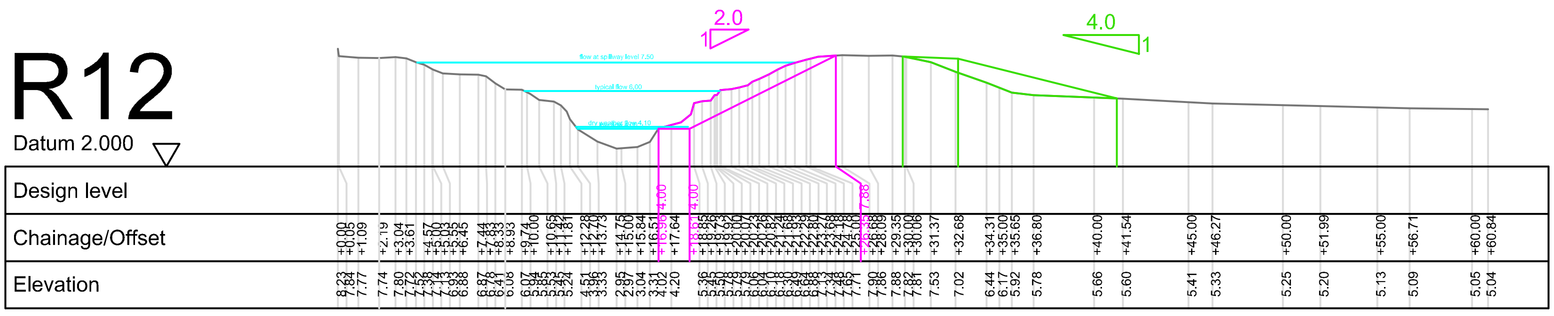
revisions:
Rev A: 20/03/19 Left bank design mods
Rev B: 21/03/19 Left bank reduction & fill adjusted



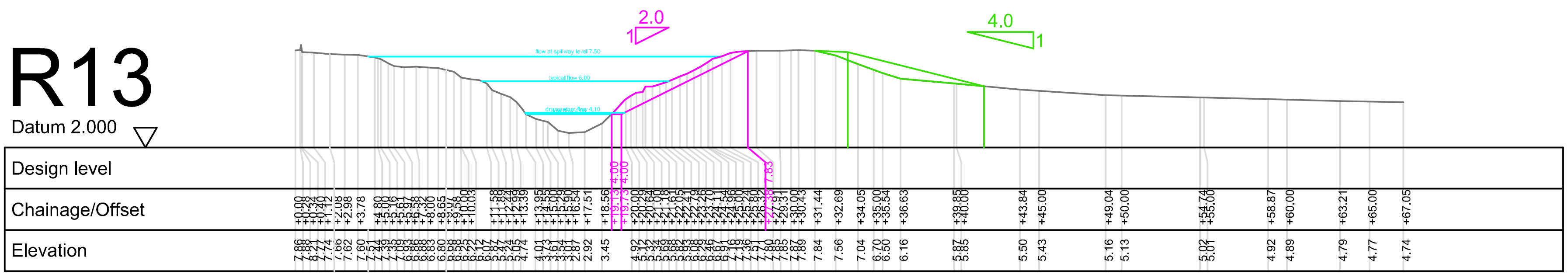




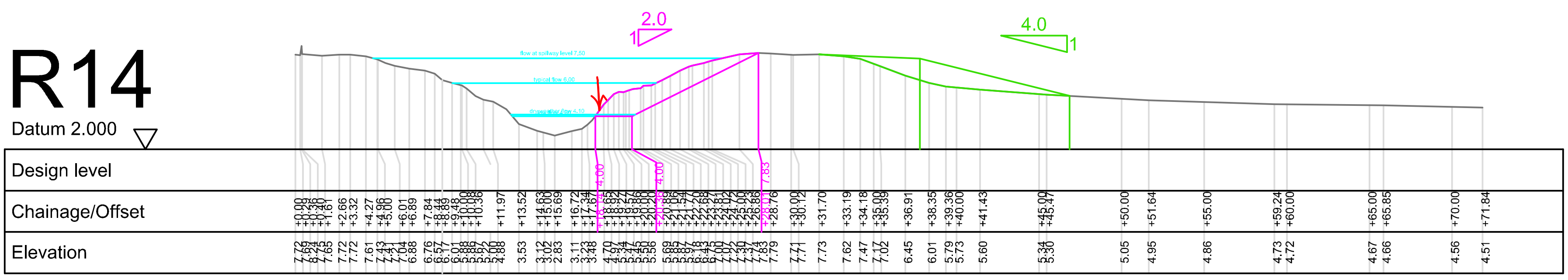
Chainage 504.669



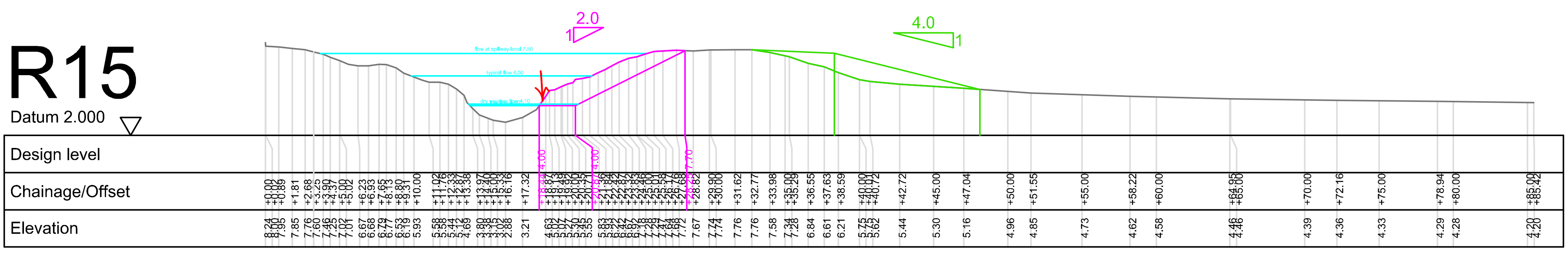
Chainage 544.658



Chainage 594.669



Chainage 644.677



Chainage 694.674

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safety health & environmental:

Safety:
1. Working with variying fluvial and tidal flows
2. Load bearing capacity of river banks
3. Access to parts of left bank may be difficult

Health:
1. Potential residual contamination from agricultural activity
2. Uneven ground that may be slippery when wet/frozen

Environment:
1. Part of the site is SSSI designated
2. Rare and protected species may be present

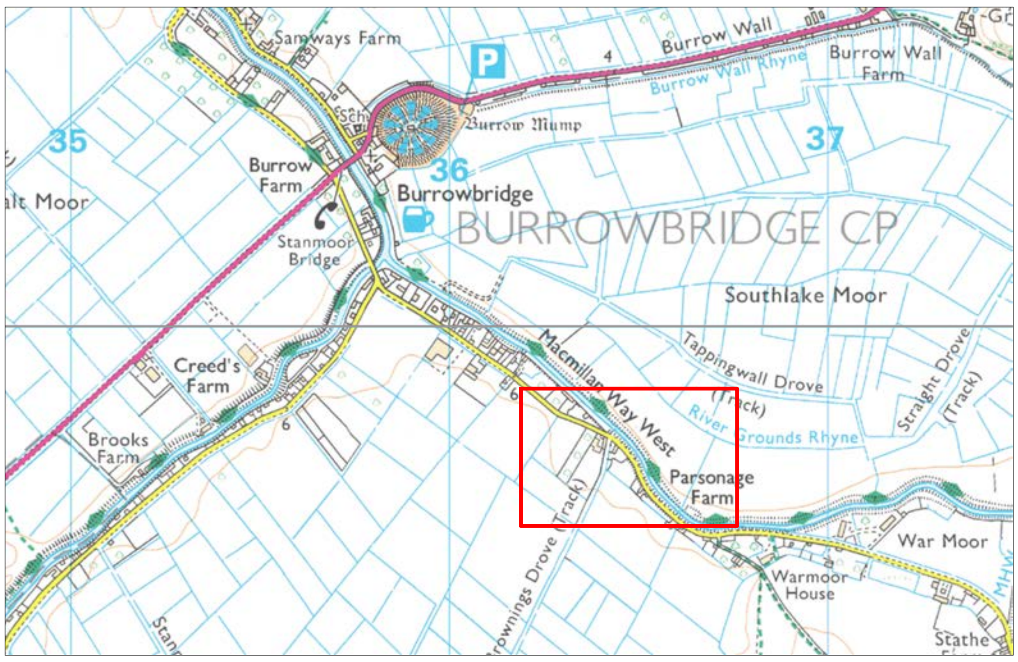
key:
- Flow at spillway level
- Cut
- 2.0 / 1 Design bank cut gradient
- Fill
- 4.0 / 1 Design bank fill gradient

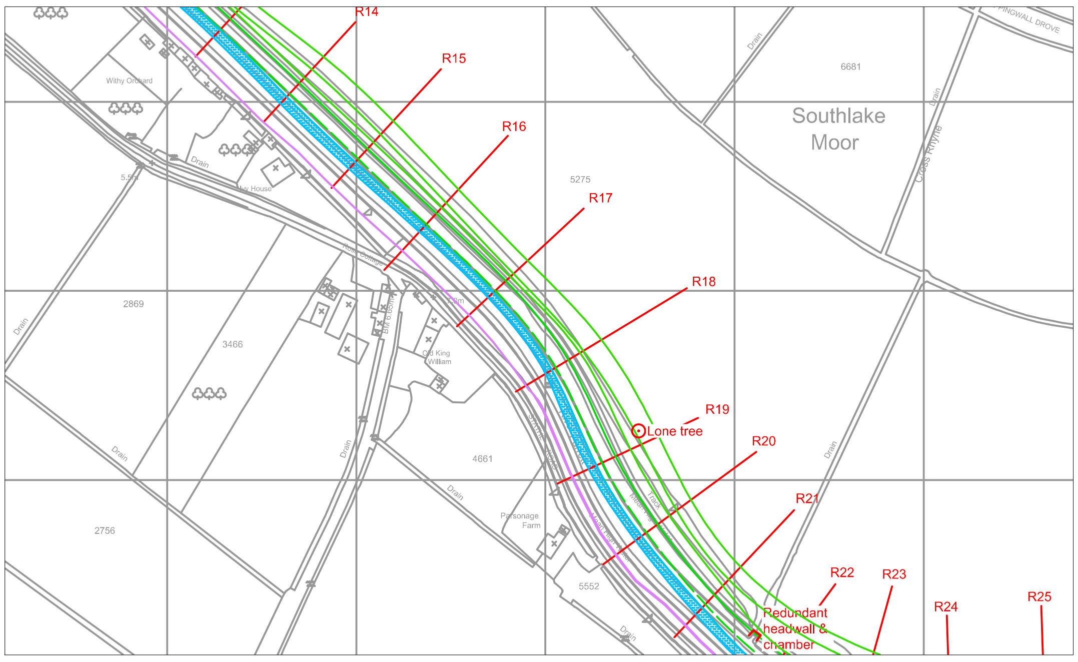
project: Pioneer dredging of River Parrett Oath to Burrowbridge

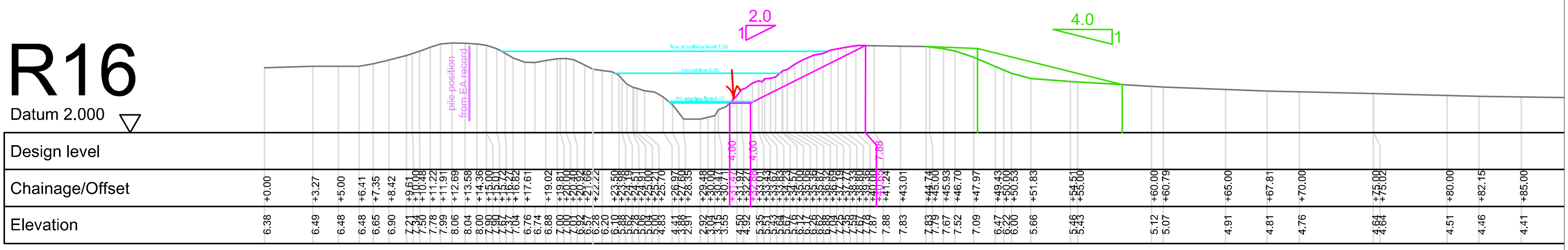
title: Design Profiles Sections R11-R15

drawn: RK	date: Dec 2018
approved:	issue: Consultation
scale: 1:400 natural @ A3	
drg no: GD06-18-203B	

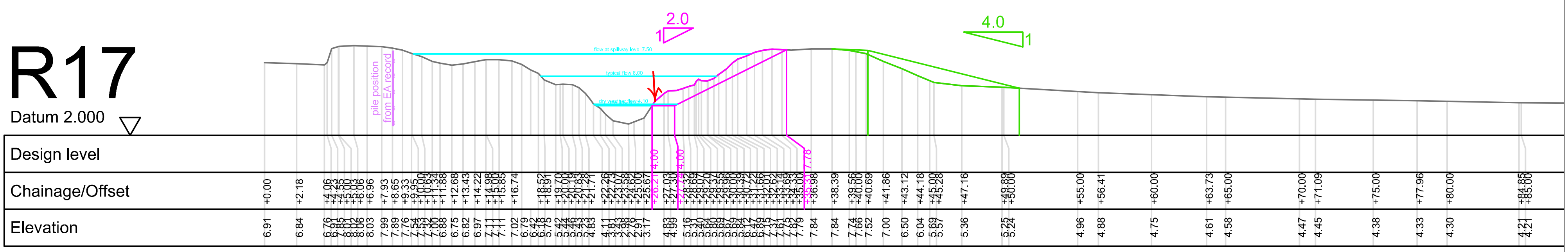
revisions:
Rev A: 20/02/19 Left bank design mods
Rev B: 21/03/19 Left bank reduction & fill adjusted



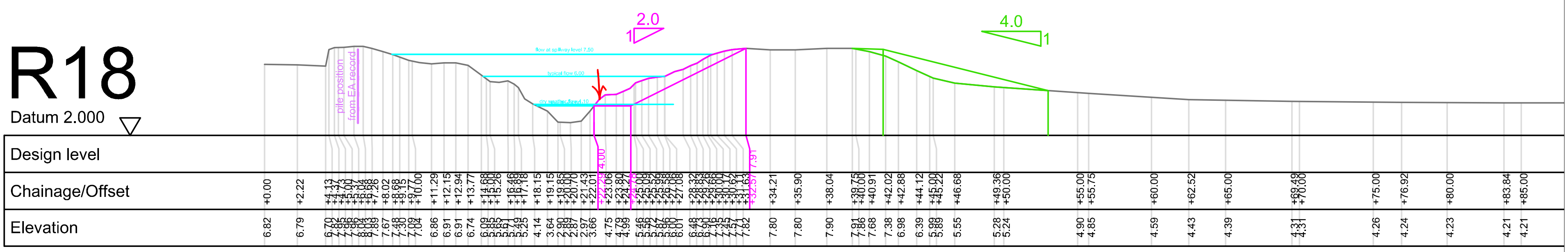




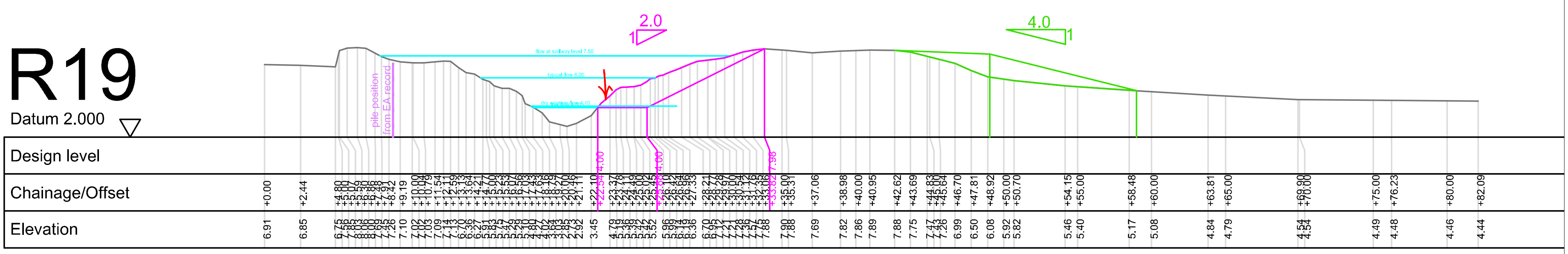
Chainage 744.672



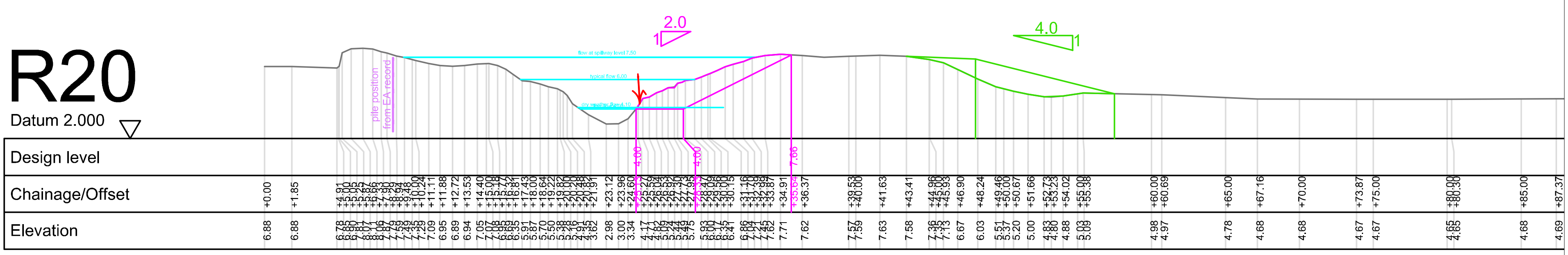
Chainage 794.659



Chainage 845.037



Chainage 900.267



Chainage 945.667

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Health:
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2. Uneven ground that may be slippery when wet/frozen

Environment:
1. Part of the site is SSSI designated
2. Rare and protected species may be present

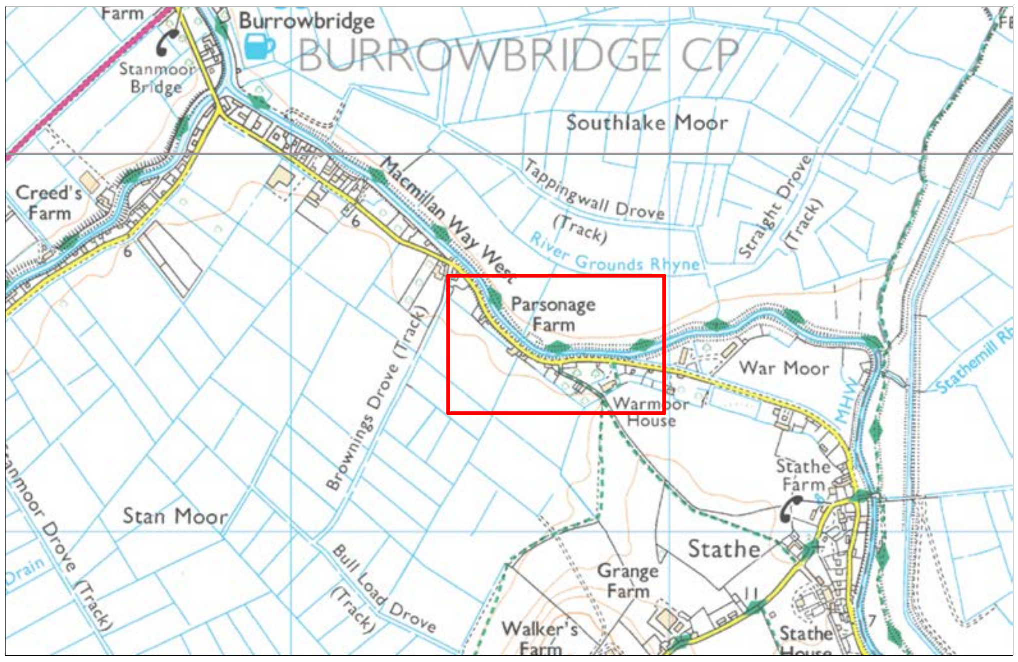
key:
- Flow at spillway level
- Cut
- Design bank cut gradient (2.0 / 1)
- Fill
- Design bank fill gradient (4.0 / 1)

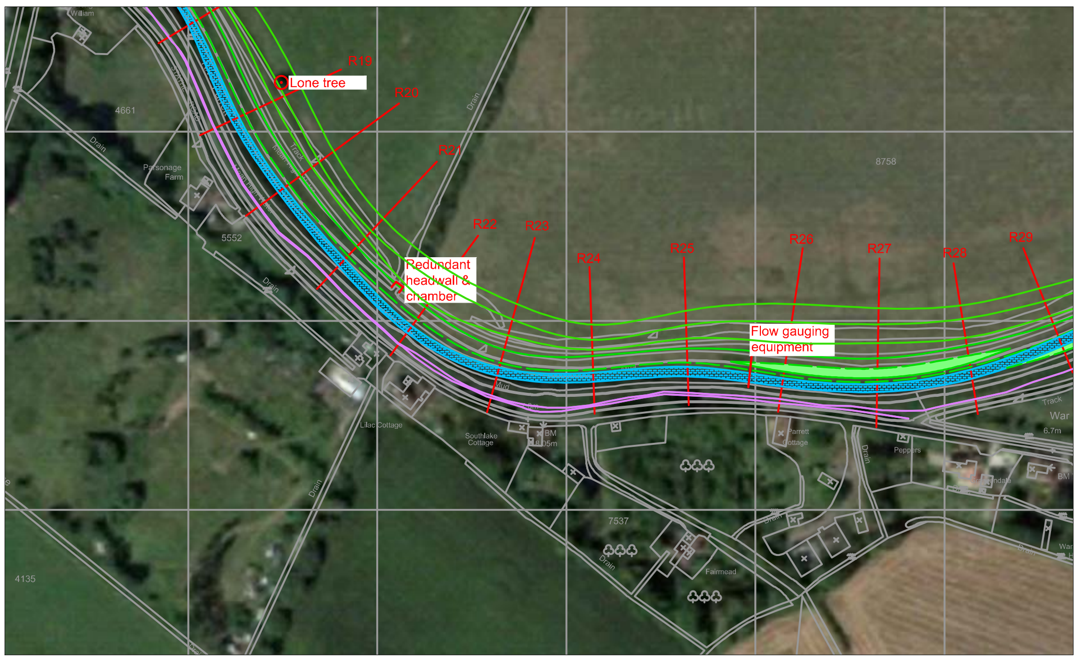
project: Pioneer dredging of River Parrett Oath to Burrowbridge

title: Design Profiles Sections R16-R20

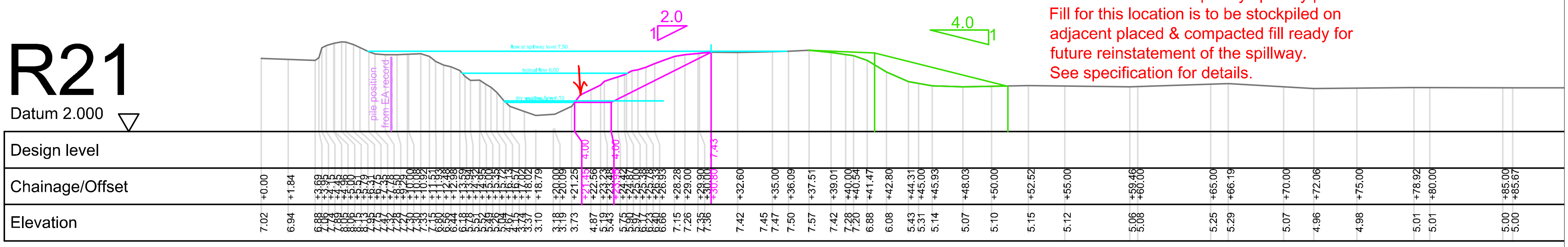
drawn: RK	date: Dec 2018
approved:	issue: Consultation
scale: 1:400 natural @ A3	
drg no: GD06-18-204B	

revisions:
Rev A: 20/02/19 Left bank design mods
Rev B: 21/03/19 Left bank reduction & fill adjusted

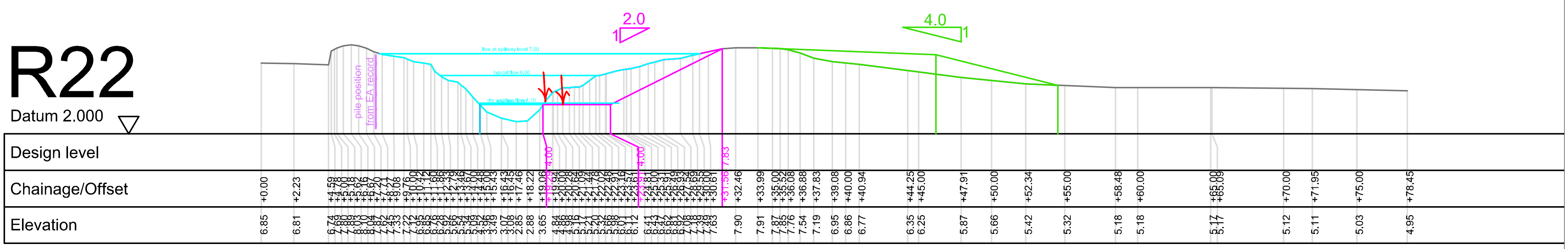




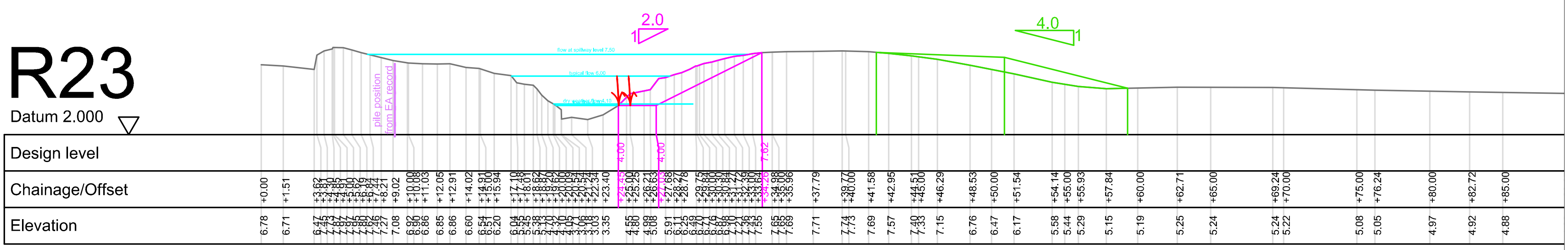
Section R21 is a temporary spillway position.
Fill for this location is to be stockpiled on adjacent placed & compacted fill ready for future reinstatement of the spillway.
See specification for details.



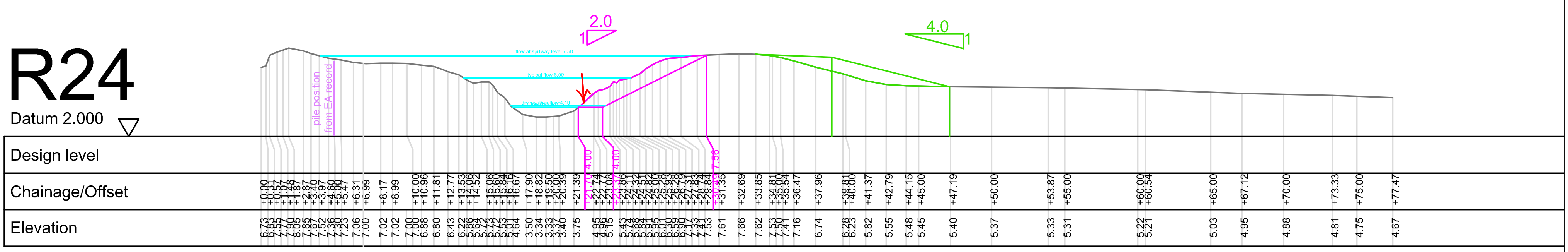
Chainage 996.216



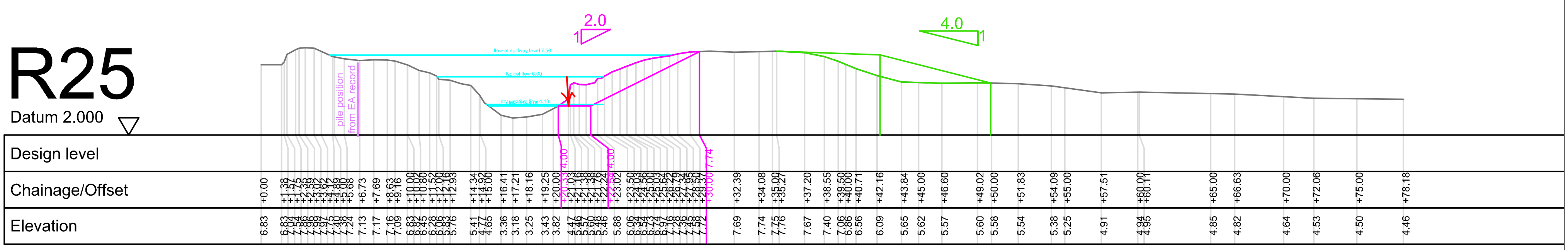
Chainage 1046.201



Chainage 1098.474



Chainage 1149.391



Chainage 1199.445

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Health:
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2. Uneven ground that may be slippery when wet/frozen

Environment:
1. Part of the site is SSSI designated
2. Rare and protected species may be present

key:

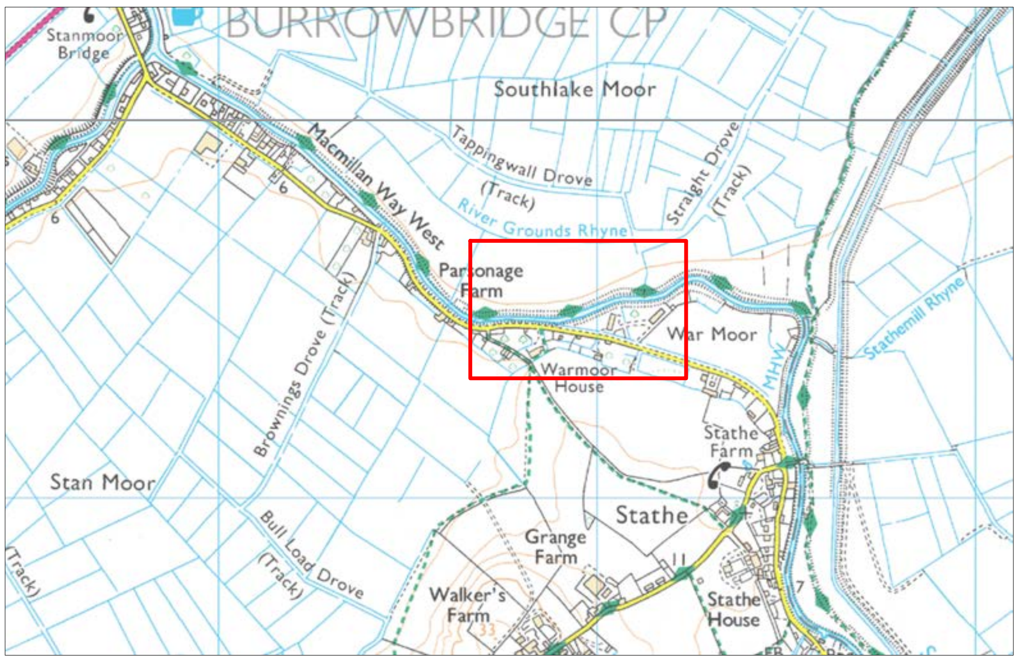
- Flow at spillway level
- Cut
- 2.0 / 1 — Design bank cut gradient
- Fill
- 4.0 / 1 — Design bank fill gradient

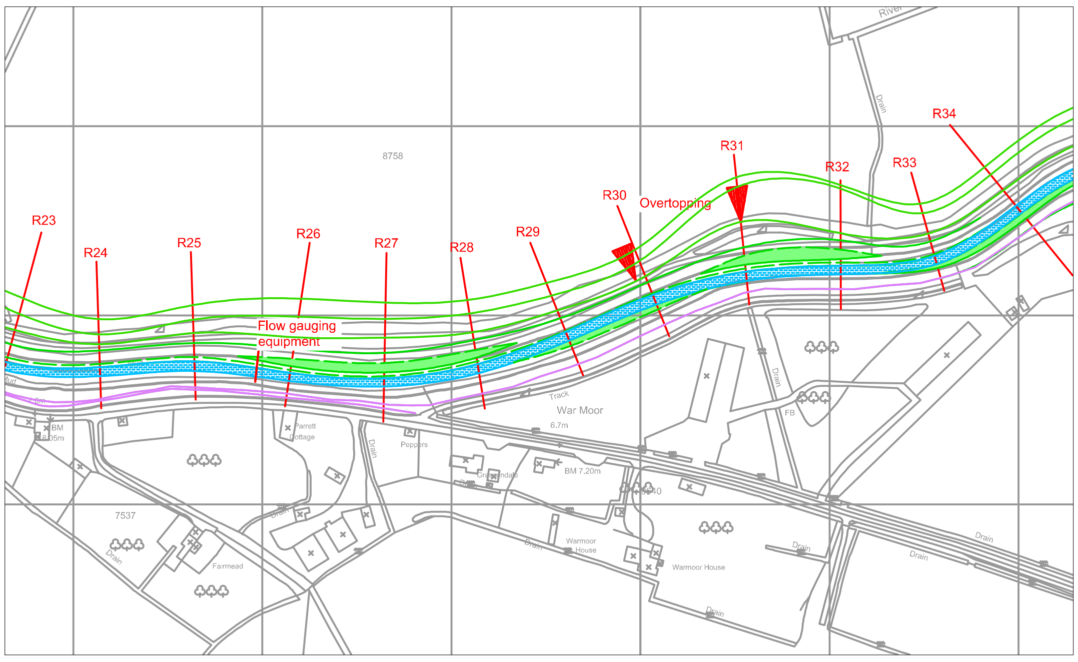
project:
Pioneer dredging of River Parrett
Oath to Burrowbridge

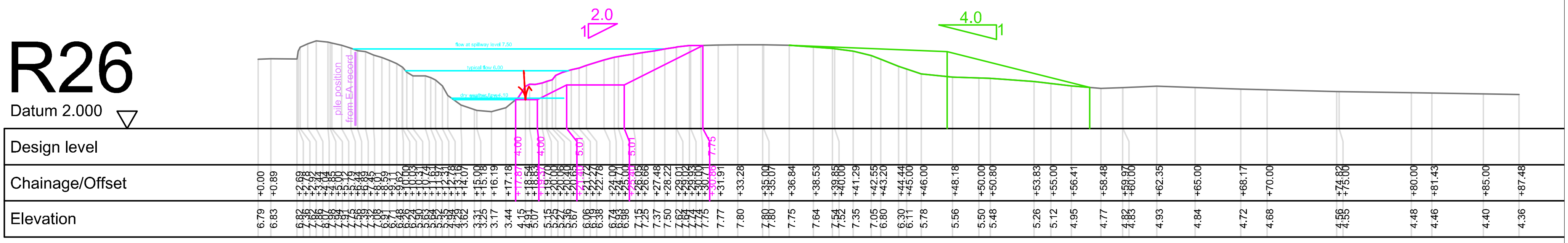
title:
Design Profiles
Sections R21-R25

drawn: RK	date: Dec 2018
approved:	issue: Consultation
scale: 1:400 natural @ A3	
drg no: GD06-18-205B	

revisions:
Rev A: 20/02/19 Left bank design mods
Rev B: 21/03/19 Left bank reduction & fill adjusted







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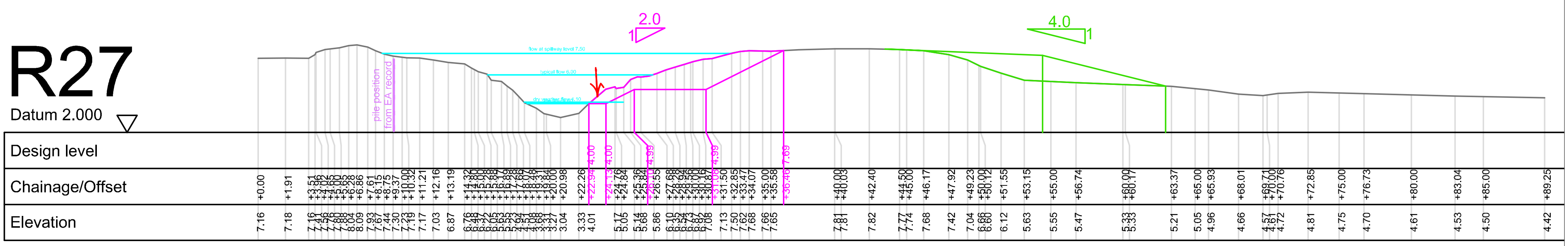
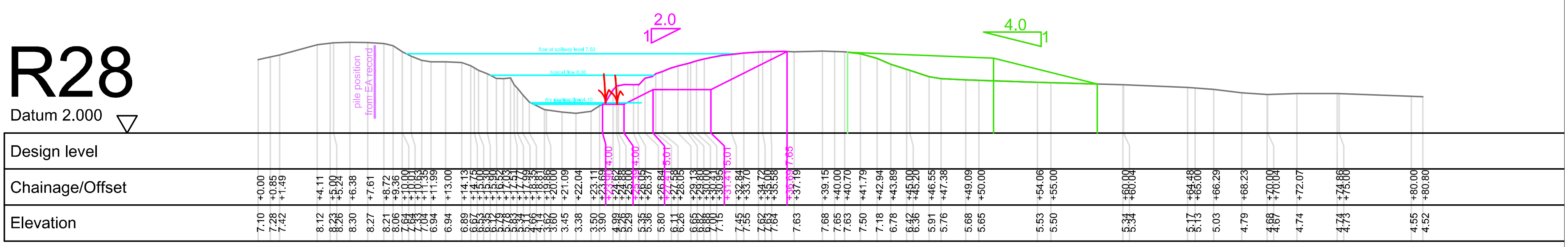


Chainage 1299.939



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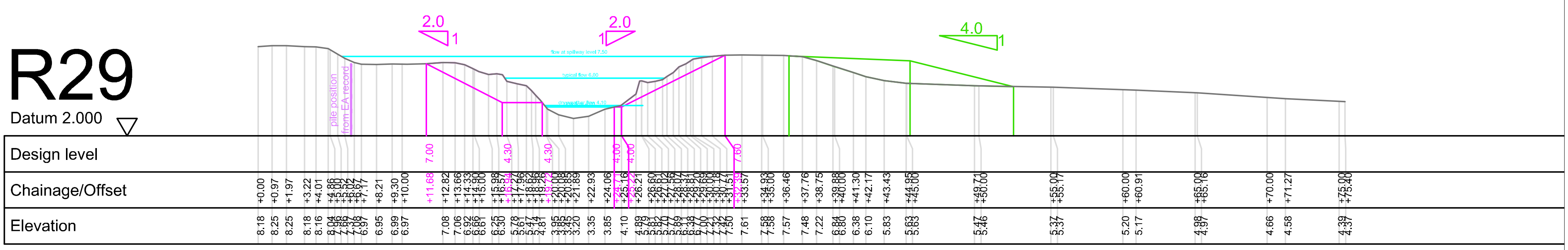
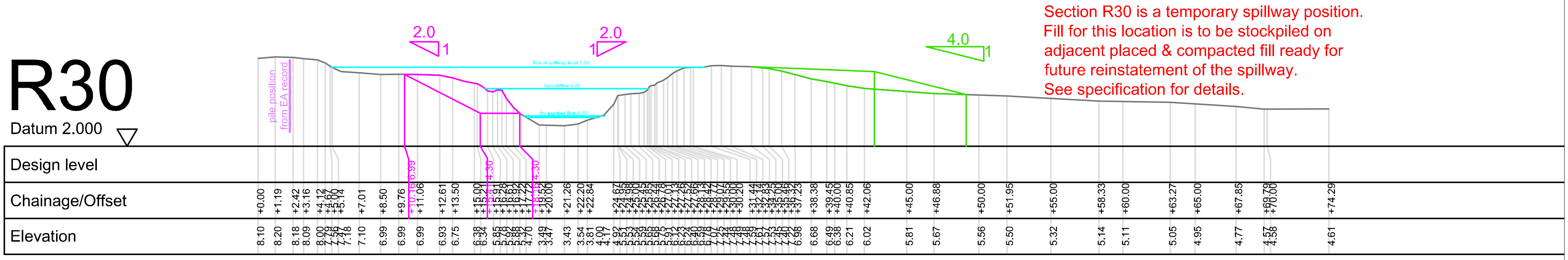


Chainage 1401.305



Chainage 1451.286

Section R30 is a temporary spillway position.
Fill for this location is to be stockpiled on adjacent placed & compacted fill ready for future reinstatement of the spillway.
See specification for details.

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safety health & environmental:

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Environment:
1. Part of the site is SSSI designated
2. Rare and protected species may be present

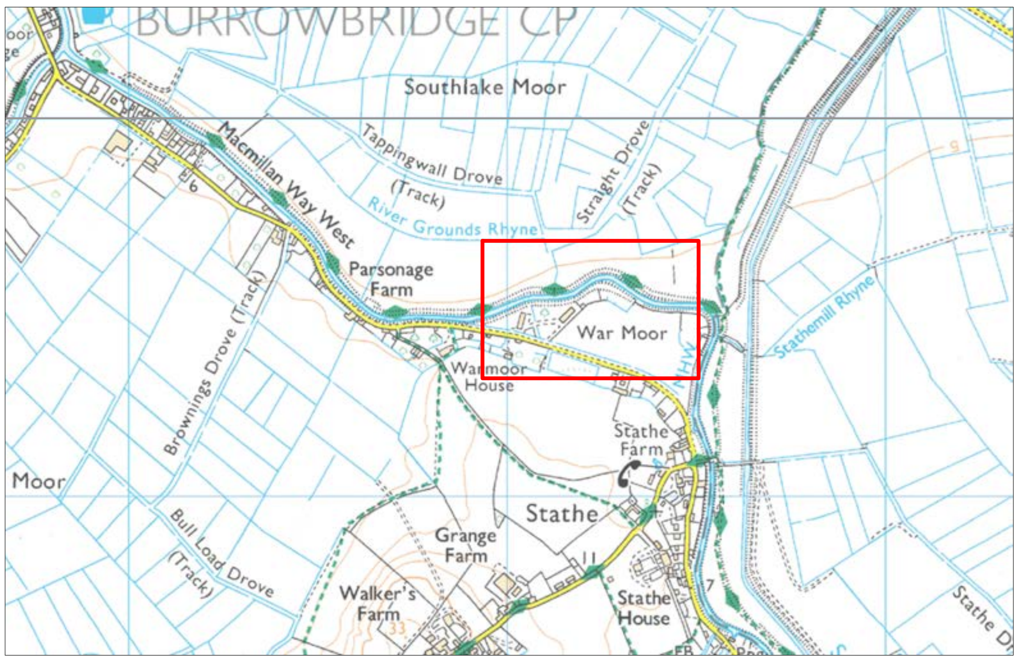
key:
- Flow at spillway level
- Cut
- 2.0 / 1 — Design bank cut gradient
- Fill
- 4.0 / 1 — Design bank fill gradient

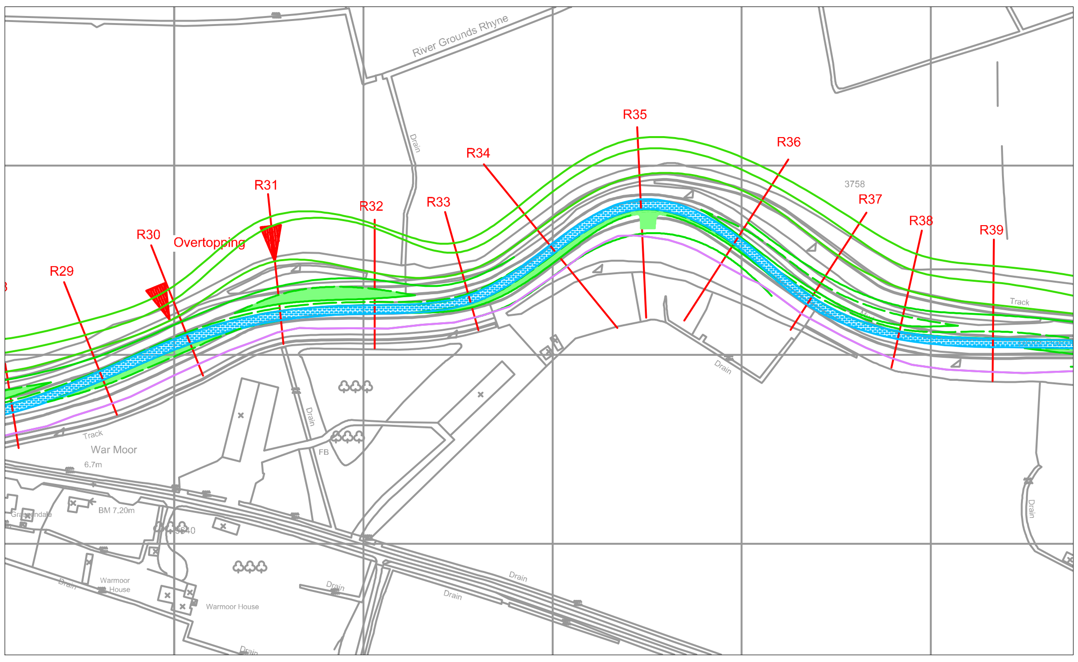
project:
Pioneer dredging of River Parrett Oath to Burrowbridge

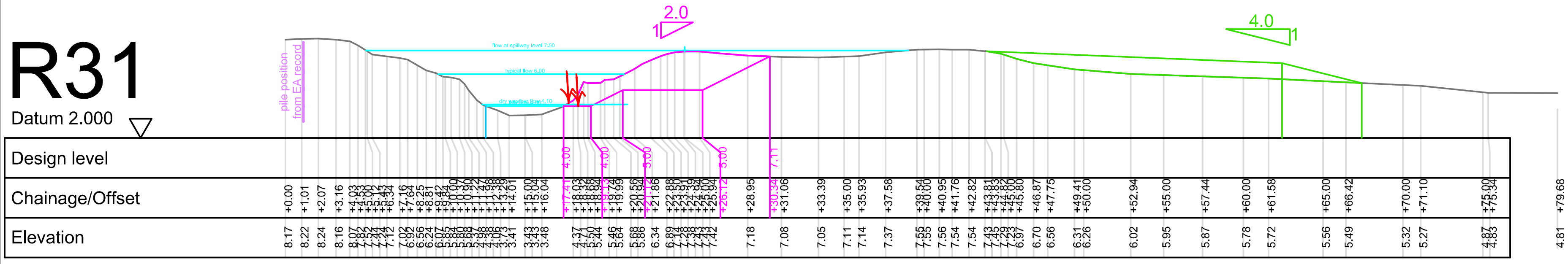
title:
Design Profiles Sections R26-R30

drawn: RK	date: Dec 2018
approved:	issue: Consultation
scale: 1:400 natural @ A3	
drg no: GD06-18-206B	

revisions:
Rev A: 20/02/19 Left bank design mods
Rev B: 21/03/19 Left bank reduction & fill adjusted







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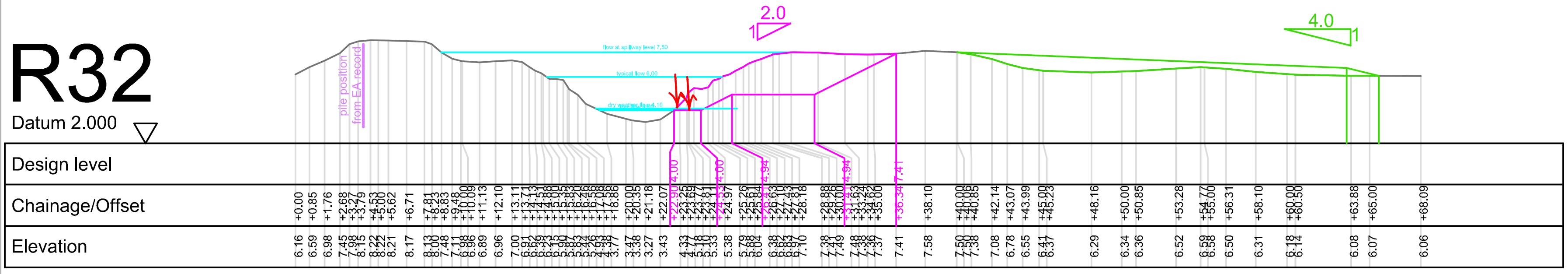
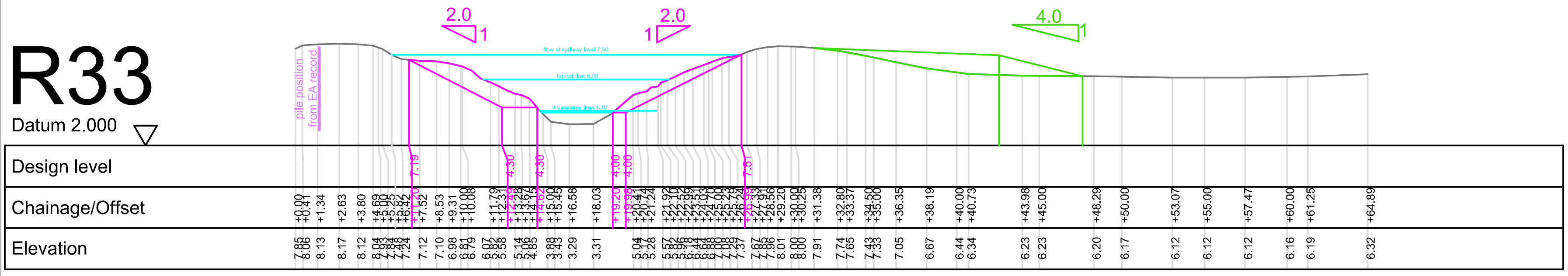


Chainage 1551.650



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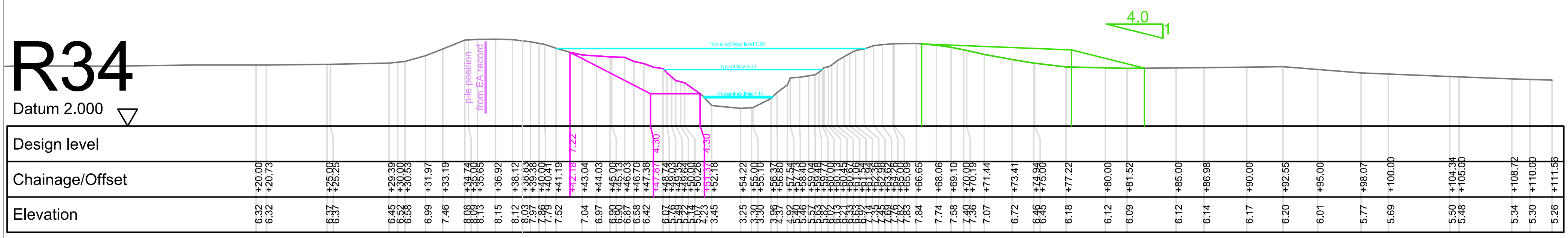

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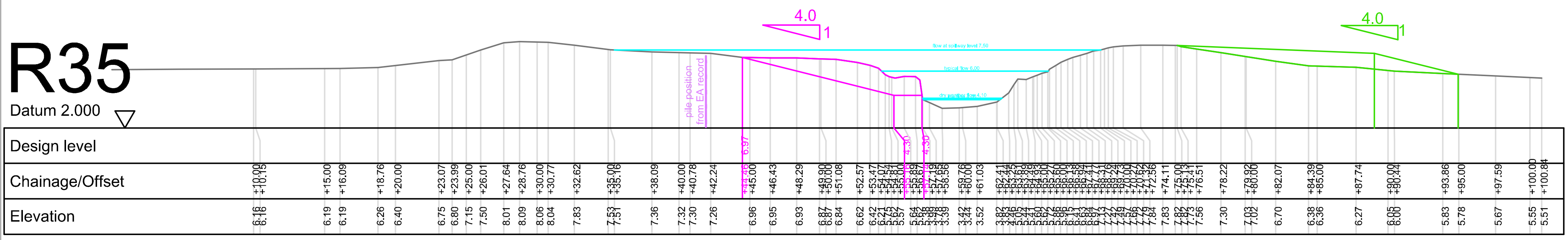

Chainage 1706.478

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2. Rare and protected species may be present

key:

- Flow at spillway level
- Cut
- 2.0 / 1 Design bank cut gradient
- Fill
- 4.0 / 1 Design bank fill gradient

project:

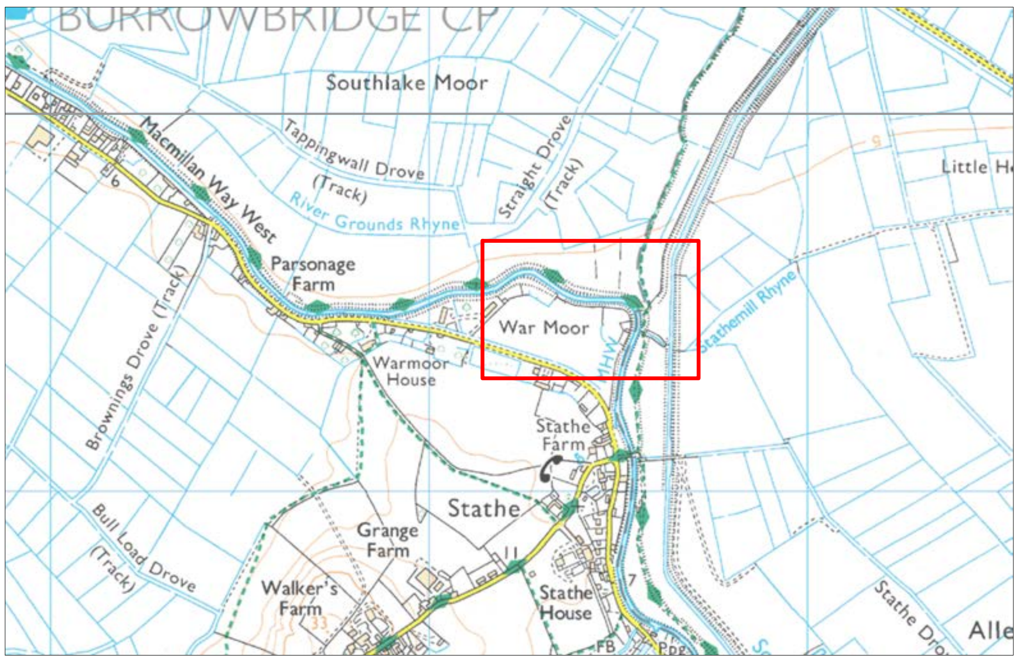
Pioneer dredging of River Parrett
Oath to Burrowbridge

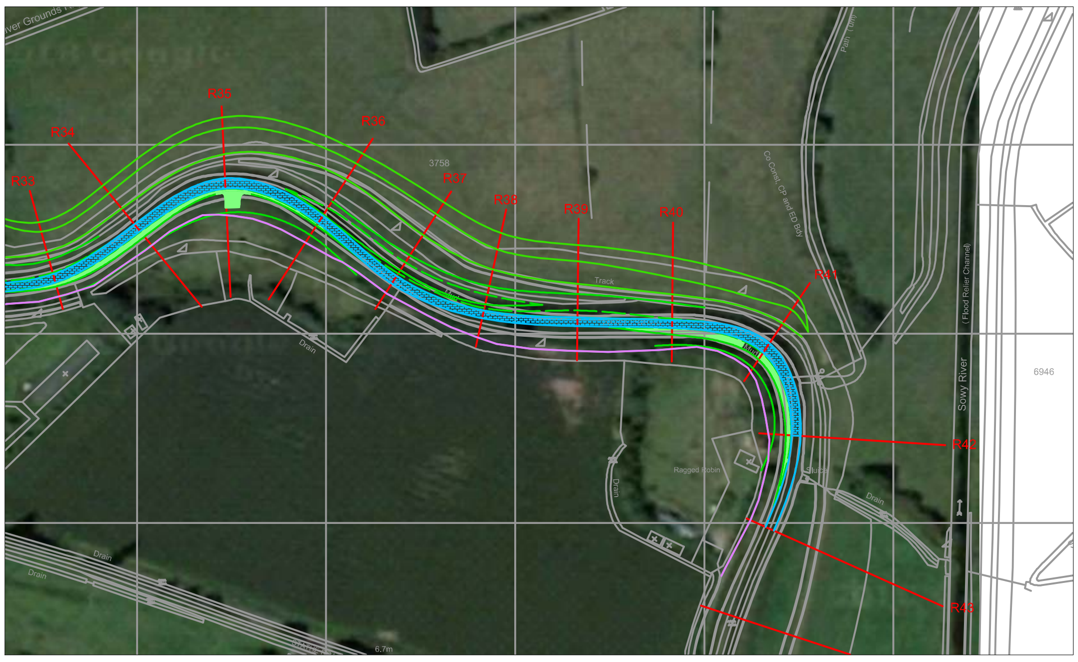
title:

Design Profiles
Sections R31-R35

drawn: RK	date: Dec 2018
approved:	issue: Consultation
scale: 1:400 natural @ A3	
drg no: GD06-18-207B	

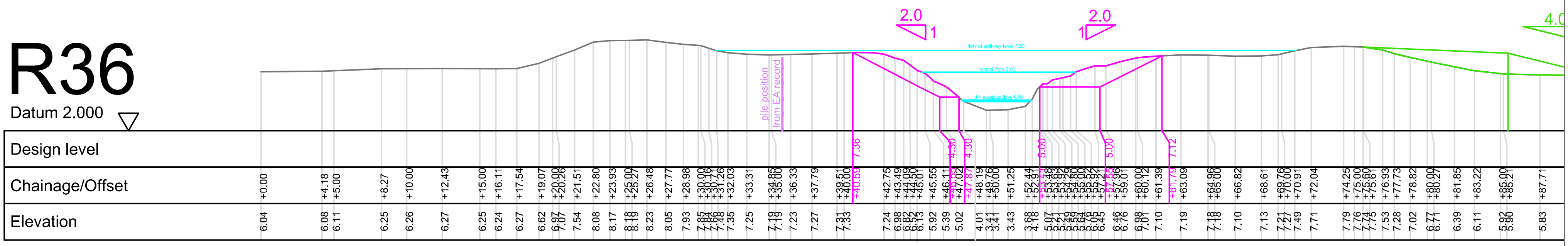
revisions:
Rev A: 20/03/19 Left bank design mods
Rev B: 21/03/19 Left bank reduction & fill adjusted





R36

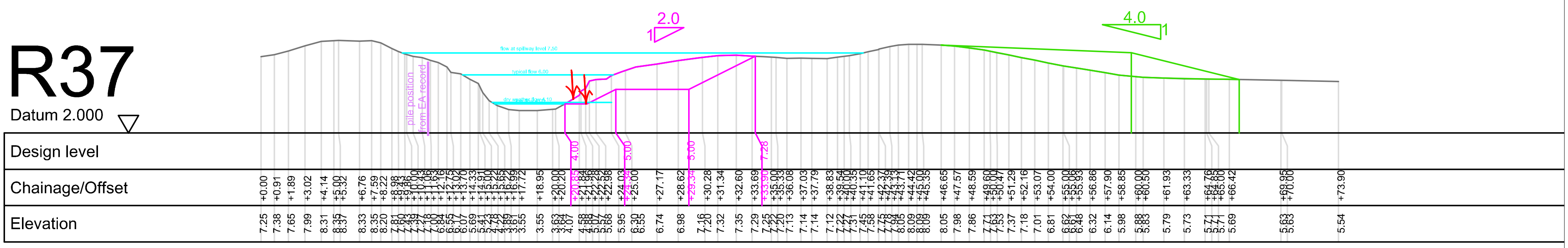
Datum 2.000



Chainage 1761.411

R37

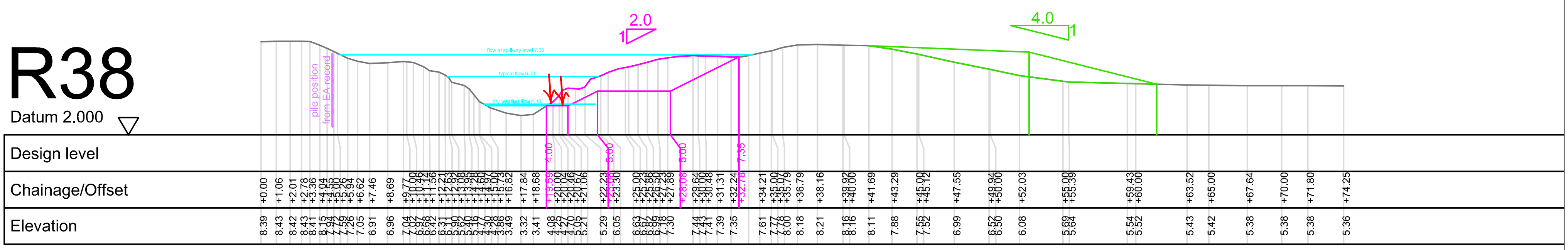
Datum 2.000



Chainage 1811.567

R38

Datum 2.000



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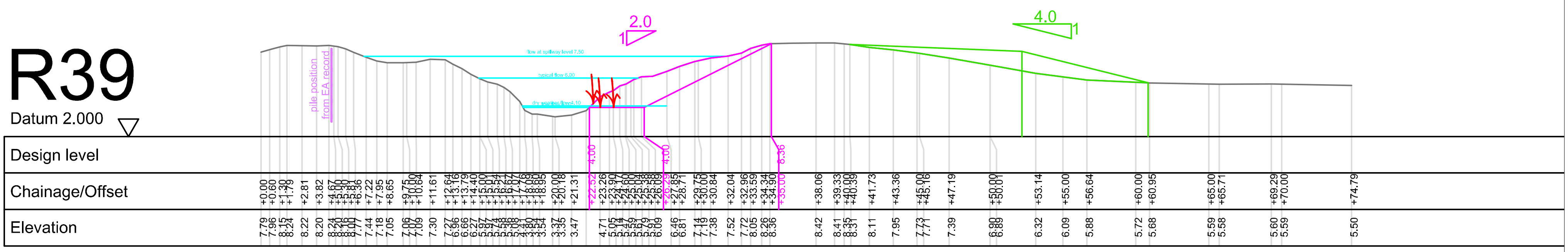
R39

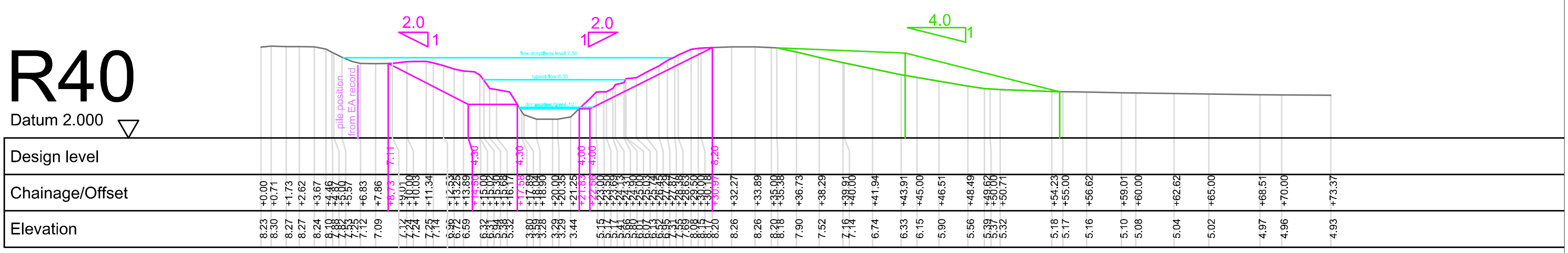
Datum 2.000



Chainage 1912.867

R40

Datum 2.000



Chainage 1962.918

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2. Rare and protected species may be present

key:
- Flow at spillway level
- Cut
- 2.0 / 1 Design bank cut gradient
- Fill
- 4.0 / 1 Design bank fill gradient

project: Pioneer dredging of River Parrett Oath to Burrowbridge

title: Design Profiles Sections R36-R40

drawn: RK	date: Dec 2018
approved:	issue: Consultation
scale: 1:400 natural @ A3	
drg no: GD06-18-208B	

revisions:
Rev A: 20/02/19 Left bank design mods
Rev B: 21/03/19 Left bank reduction & fill adjusted