

Havant Thicket Reservoir Project

Environmental Statement Volume 4 - Appendices

Appendix A15 Water

A15.4 Biodiversity Net Gain for Rivers

Portsmouth Water Ltd.

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1. Introduction

Atkins Limited (Atkins) was commissioned by Portsmouth Water to undertake a study where the Department for Environment, Food and Rural Affairs (Defra) Biodiversity Metric 2.0 published by Natural England would be applied where possible to the Havant Thicket Reservoir Project. This report focusses on the river component of the Biodiversity Metric 2.0 only because rivers are treated as separate linear features in the metric. Other habitats that are classed as areal habitats (e.g. ditches, reservoir, wetland and other terrestrial ecology) have their own component in the metric along with other linear habitats that have their own metric component (e.g. hedgerows) and are not included in this report. A separate report HTR-ATK-XX-XX-RP-0039 discusses the need for biodiversity net gain at a national and scheme level, and the Biodiversity Net Gain calculations for the other components in this project.

This project is a special case because of the loss of 3.7 km of river, that can only be compensated for with the creation or enhancement of rivers off-site.

This report presents:

- Baseline condition for on-site rivers and the biodiversity units that will be lost during the scheme.
- Baseline condition of off-site rivers that may be used as off-site habitat enhancement, and their biodiversity units.
- The extent of off-site habitat enhancement required achieve net gain for the river component of the Biodiversity Metric 2.0 using two approaches (linear and areal) to account for inconsistencies in the metric.

It must be noted that although Natural England has stated that the Biodiversity Metric 2.0 can now be used, at the time of preparing this document, the metric has been published as a 'beta test' version in December 2019. Whilst the metric is being tested and before official release, the metric is undergoing periodical fixes/corrections and consultation. Due to the use of the 'beta test' version it is acknowledged that there may be errors within the calculations. At the time of preparing this proposal, this was the most recent version available with its use for the river metric advocated by the Environment Agency.

Terminology: Biodiversity Net Gain

Biodiversity Net Gain is an approach to development that leaves biodiversity in a better state than before by creating or enhancing natural habitats to mitigate or compensate for biodiversity losses. Defra have developed the Biodiversity Metric 2.0 to quantify how much habitat will be lost as a result of a development in 'biodiversity units' to calculate how much habitat creation or enhancement is required to deliver sufficient net gain.

2. Methodology

To conduct the Biodiversity Net Gain assessment, the river network being considered was split into reaches with relatively homogenous characteristics to streamline the assessment. Each reach requires three key inputs to the Biodiversity Metric 2.0, the distinctiveness of the habitat (i.e. rarity of the habitat), the condition of the habitat (i.e. the degree of human modification) and the strategic significance of the site (Natural England, 2019a). The methods for assessing these components are described below.

2.1. Reach delineation

The first stage in this assessment was to delineate the river network both on and off-site into distinct reaches. This enabled the assessment to be streamlined by assessing distinctiveness and condition for areas with similar features and influences. The reaches were defined based on prior knowledge of the site gained during a previous walkover survey and by visual inspection of satellite imagery of the river on Google Earth.

Eight reaches were identified on-site and seven identified off-site. Their locations are shown in Figure 1 and details about each reach are described in Table 1. The site locations of the field surveys used to assess river condition, MoRPh surveys, as also shown in Figure 1 with respect to the on and off-site reaches. The locations of the MoRPh surveys were agreed to by the Environment Agency and are designed to capture the full range of river habitat condition both on and off-site¹.

Table 1 - Length of each on-site and off-site reach identified in Figure 1 and description of the reach location. Reach names are consistent with reaches identified in WFD report (HTR-ATK-ZZ-ZZ-RP-Z-0123).

On-site Reach	Length (km)	Description
On.HS1	0.994	Headwater Stream 1
On.HS2a	0.412	Headwater Stream 2, upstream of the pond
On.HS2b	0.23	Headwater Stream 2, downstream of the pond
On.HS3	0.563	Headwater Stream 3, upstream of confluence with Headwater Stream 4
On.HS4	0.508	Headwater Stream 4
On.HS5	0.361	Headwater Stream 5
On.HS2c	0.441	Headwater Stream 3, downstream of confluence with Headwater Stream 4
On.R1a	0.234	Reach 1, Riders Lane Stream
Off-site Reach	Length (km)	Description
Off.HS1-3	0.998	Headwater Streams 1, 2 and 3 upstream of reservoir footprint
Off.R1a	0.794	Reach 1, Riders Lane Stream, downstream of reservoir footprint
Off.R1b	0.485	Reach 1, Riders Lane Stream, Great Copse woodland
Off.R1c	1.140	Reach 1, Riders Lane Stream, runs through Leigh Park to Hermitage Stream
Off.R5	3.506	Reach 5, Hermitage Stream, upstream of restored reach
Off.R3	0.703	Reach 3, Hermitage Stream, restored reach with concrete bed upstream of Riders Lane confluence
Off.R4	2.005	Reach 4, Hermitage Stream, downstream of Riders Lane confluence to six weirs at nominal tidal limit (NTL), concrete bed and banks.

¹ Approval email received by Adam Cave on 17th June 2020

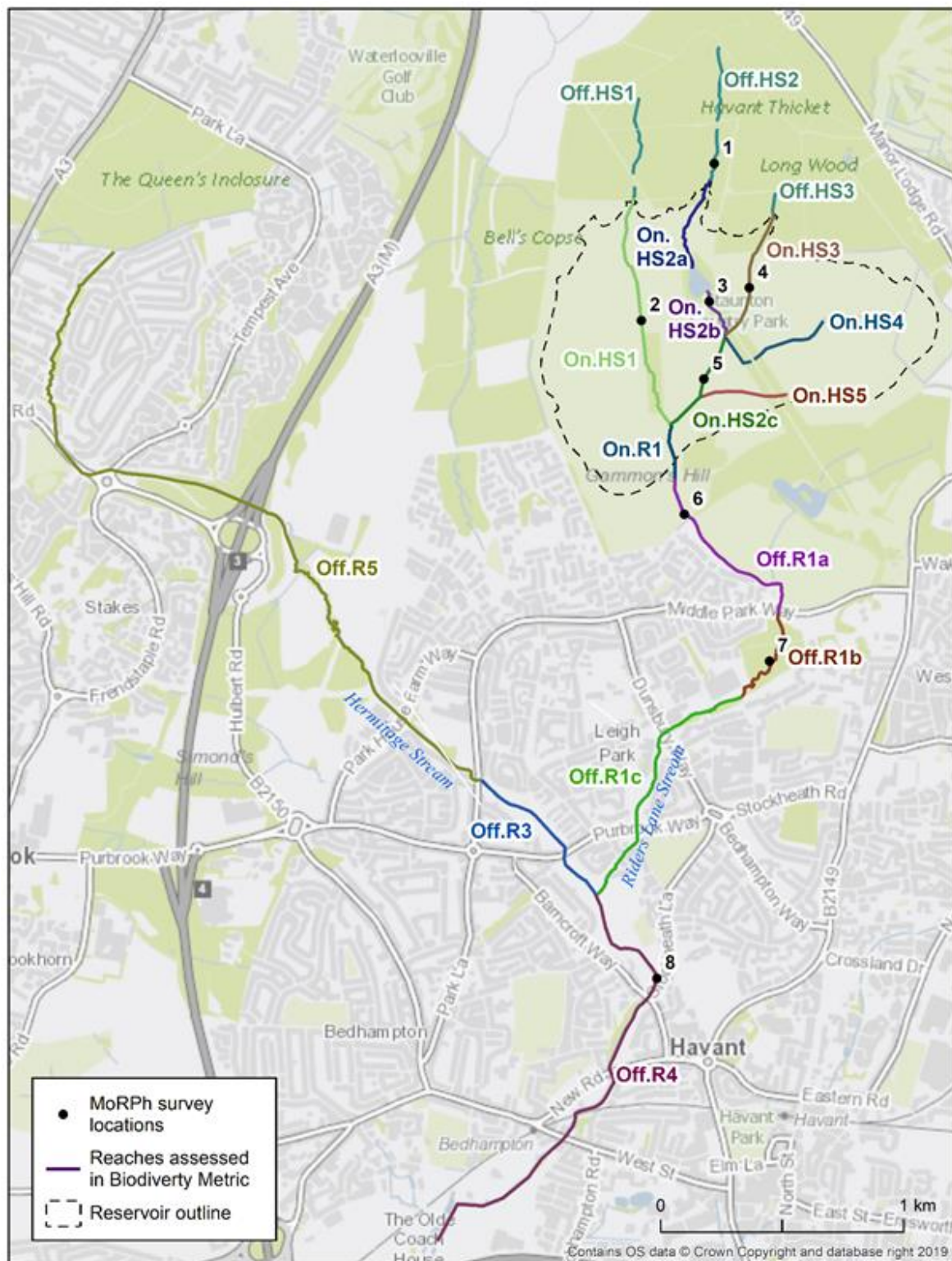


Figure 1 - Plan of site showing reaches on-site (indicated by On prefix) within the reservoir outline and reaches considered for off-site compensation (indicated by Off prefix). Reach names are consistent with reaches identified in WFD report (HTR-ATK-ZZ-ZZ-RP-Z-0123). Locations and site number of MoRPh surveys used in the river condition assessment are also displayed.

2.2. Biodiversity Metric inputs

2.2.1. Introduction to the metric

The Biodiversity Metric 2.0 is a tool that calculates the biodiversity value of a habitat area (or in this case, a length of river) based on the distinctiveness, condition and strategic significance of the habitat. It scores and weights this information, derived from field and desk-based studies, to quantify a number of 'biodiversity units' for each area. The biodiversity units currently present in each area are known as the baseline. The metric compares the baseline biodiversity units that will be lost on-site during a development project to an estimate of those that will be created both on and off-site through habitat creation and enhancement works to improve habitat distinctiveness and/or condition. Biodiversity Net Gain is achieved when the number of biodiversity units created through habitat creation or enhancement exceeds those lost due to the development. Below, the methods to extract the key inputs to the Biodiversity Metric 2.0 (habitat distinctiveness, condition and strategic significance) that are used to calculate the baseline biodiversity units, are described. Calculation of the new biodiversity units created by habitat creation and enhancement works are described in section 3.

2.2.2. River distinctiveness

The distinctiveness score is based on the type of habitat present and its value based on its rarity. In the river component of the metric, rivers can be classed as 'very high', 'high' or 'medium' which result in weightings used to calculating biodiversity units (Table 2).

According to the Biodiversity Metric guidance (Natural England, 2019a), river distinctiveness is classed as 'high' if the river in question appears on the Priority River Habitats sub-type maps that include headwater streams with natural land cover (Natural England, 2014). While the majority of the rivers considered here are headwater streams, they are not included in the priority river habitat sub-type headwater dataset. Natural England do highlight that the headwater sub-type is the least certain component of the Priority River Habitat data package.

Where a river is not a Priority River Habitat, distinctiveness is classified using a River Naturalness Assessment. The River Naturalness Assessment uses components of the WFD investigations; physical, hydrological, chemical and biological (Table 3).

Table 2 - Distinctiveness weightings for rivers and streams in the BNG metric.

Distinctiveness	Description	Weight	Metric description
Very High	Is on the Priority Habitat Rivers map OR meets Class 1 on the River naturalness assessment system.	8	Priority Habitat Rivers and streams of very high hydromorphological and ecological status
High	Meets Class 2 or 3 on the river naturalness assessment system and/or is a River Priority habitat Sub-type including: - headwater streams - chalk rivers - rivers with an abundance of water-crowfoots - active shingle rivers	6	Rivers and streams of high distinctiveness and/or naturalness status.
Medium	Meets Class 4 or 5 on the River naturalness assessment system	4	Rivers and streams (other)

Source: Natural England (2019a, p.59).

Observations from the walkover surveys, MoRPh surveys (discussed in section 2.2.3) and additional sources of information for the reaches (Table 4) were used to qualitatively estimate river naturalness scores for each site according to the descriptions in Table 3 (Mainstone, 2019).

Table 3 - Naturalness class descriptions

Class	Physical	Hydrological	Chemical	Biological
1	No evidence of human physical modifications within the reach – channel straightening/deepening/ widening, bank reprofiling or reinforcements, impounding structures (weirs/dams). At least patchy cover (>1/3 of channel length) of riparian trees*, providing lead litter and woody material to the channel, some of which is retained. Tree roots strongly influencing channel dynamics (patterns of erosion and deposition, channel sinuosity). Riparian zone (up to 5 metres from bank top) with semi-natural vegetation.	No evidence of impacts on the natural flow regime from abstraction, upstream impoundment or discharges (e.g. abstraction pipes or pumps, leats, discharge pipes, upstream artificial lakes). Note that if the reach is in the headwaters it may naturally dry up in the summer months – such naturally intermittent stream sections are highly important for a range of specialist species.	No evidence of pollution within the reach. No sewage fungus, or substantial filamentous algal growths that are likely to be attributable to nutrient enrichment. No direct effluent discharges. If used, water quality test kits do not register any positive results. Biological sampling indicates no impacts on water quality.	No evidence of non-native species (plants or animals). As a minimum assessment should include Himalayan Balsam, Japanese knotweed and Giant Hogweed.
2	Physical modifications (described above) of limited spatial extent within the reach - no more than 5% of channel length). BUT no artificial impounding structures. At least patchy cover (>1/3 of channel length) of riparian trees*, providing lead litter and woody material to the channel, some of which is retained. Tree roots having some influence on channel dynamics (patterns of erosion and deposition, channel sinuosity). Riparian zone (up to 5 metres from bank top) with semi-natural vegetation.	Minor impacts on the natural flow regime from abstraction, upstream impoundment or discharges	Evidence of low-level pollution. Small amounts of sewage fungus in the reach, or patches of filamentous algal growth that are likely to be attributable to nutrient enrichment (e.g. downstream of effluent discharge). If used, water quality test kits register positive results but at low concentrations. Biological sampling indicates only minor impacts on water quality.	One or more non-native species are present in small numbers or spatial extent. Non-native plants should occupy no more than 5% of channel length. Non-native animals (e.g. signal crayfish) should rarely be encountered during searches.
3	Physical modifications of moderate spatial extent – no more than 30% of reach length. Artificial impounding structures may be present but rare and with limited impact on physical habitat or free movement of species.	Moderate impacts on the natural flow regime from abstraction, upstream impoundment or discharges	There may be moderate levels of filamentous algal growth or sewage fungus through most of the reach. If used, water quality test kits register moderate levels of pollution. Biological sampling indicates moderate impacts on water quality.	One or more non-native species have a significant presence in the reach, occupying up to 25% of the reach.
4	Physical modifications extensive – more than 30% of reach length but still some segments of natural channel and bank. And/or artificial impoundments have a considerable impact on physical habitat.	Natural flows are heavily depleted by abstraction, upstream impoundment or water diversion	There may be high levels of filamentous algal growth or sewage fungus through most of the reach. If used, water quality test kits register high levels of pollution. Biological sampling indicates high impact on water quality.	One or more non-native species are a major component of the flora or fauna, occupying up to 60% of reach length.
5	Physically modified throughout the reach (i.e. 100% of reach length). Channel is uniformly straightened and oversized, or with reinforced banks.	The reach is dry for the majority of the year due to abstraction or water diversion.	Major pollution issues. There may be very high levels of filamentous algal growth or sewage fungus throughout the reach, or chronically poor water clarity (not just after heavy rain). If used, water quality test kits register very high pollutant concentrations. Biological sampling indicates high impact on water quality - very few types of aquatic invertebrates present.	One or more non-native species are widespread in the reach, dominating the riparian zone or the channel.

Source: Mainstone (2019, p.3)

Physical naturalness was primarily assessed based on the results of the MoRPh surveys which measured the same components as the physical criteria (Table 3). The River Habitat Survey (RHS) was used to inform the physical naturalness score in reach Off.R5 where no MoRPh survey was conducted.

Hydrological naturalness was assessed based on abstraction information from the Environment Agency (Table 4) highlighting an abstraction in the tributary that joins Hermitage Stream in the Off.R5 reach. This may influence the hydrological naturalness of downstream reaches. Impoundments to create ponds on-site were also present.

Table 4 - Additional information extracted from the online databases or from previous site visits

Survey type and source	NGR	Site ID	Date	Details	Reach
River Habitat Survey (Environment Agency)	SU6930009200	3839	30/05/1995	HMS Score: 3 HQA score: 65 Feature: Bridges, deflectors, reinforced bed and/or bank, resectioned bed and/or bank, invasive knotweed	Off.R5
Macrophyte (Environment Agency)	SU7100007540	81176	17/09/2012	High percentage algal cover	Off.R3
Surface water abstractions (Environment Agency)	SU7100011190	11/42/3 6.1/3ca	-	Spray irrigation in tributary that joins Hermitage Stream in Off.R5	Off.R5 Off.R4 Off.R3
Active consented discharges (Environment Agency)	SU7138008240	P04452	10/04/2001	Trade discharge, site drainage	Off.R1c
	SU7103007430	A01016	13/07/2001	Sewage – water company	Off.R4
	SU7089006530	N01098	18/05/1983	Misc. discharge	Off.R4
Aquatic ecology WHPT_ASPT score	SU7149410519	1	14/04/2020	4.76	On.HS2a/Off.HS1-3
	SU7119409873	2	14/04/2020	5.68	On.HS2a
	SU7147309951	3	14/04/2020	4.7	On.HS2b
	SU7163810008	4	14/04/2020	5.49	On.HS3
	SU7145109632	5	14/04/2020	5.22	On.HS2c
	SU7137109075	6	14/04/2020	5.45	On.R1/Off. R1a
	SU7172108471	7	14/04/2020	4.62	Off.R1b
	SU7100007521	8	14/04/2020	4.84	Off.R3
Water quality (Portsmouth Water)		HT9	2008-2020	BOD – moderate, ammoniacal nitrogen - moderate	Off. R1a
		All exc. HT4+5		Reactive phosphorous – moderate	All exc. Off.R1a
		HT2		Ammoniacal nitrogen – bad pH – poor	On.R1a /Off.HS1-3
		HT1, 3		pH – moderate	On.HS2a /On.R1c

HT1-9

Total iron - fail

 On.HS2a -
R1/Off.R1a

Chemical naturalness was assessed using observations of filamentous algae and outfalls from the MoRPh surveys in Off.R4 and macrophyte surveys from the Environment Agency in Off.R1c. Aquatic invertebrate data collected as part of the ecology chapter for the EIA (HTR-ZZ-ZZ-RP-Z-0147) provides an indication of chemical condition using the WHPT_ASPT score which reflects the average sensitivity of the community to organic pollution. Misconnections were also identified in the Great Copse on Riders Lane (Off.R1b), decreasing naturalness. There are also three active consented discharge licences (Environment Agency) in the rivers of interest: in the downstream reach of Riders Lane Stream (Off.R1c), and the downstream reach of Hermitage Stream (Off.R4). Portsmouth Water's water quality monitoring data from 2008-2020 (HTR-ZZ-ZZ-RP-Z-0115) highlighted certain areas with poorer water quality (only those with water quality not deemed high or good recorded in Table 4).

Biological naturalness is based on the presence of invasive species (Table 3). MoRPh surveys in Off.R4 and the RHS survey in Off.R5 note trace coverage of invasive Himalayan Balsam and/or Japanese Knotweed.

The naturalness score for each component is shown in Table 5 with one indicating the most natural and five the least natural. The final score is the highest score (i.e. the worst naturalness) recorded for a single component as it limits the overall naturalness of the reach. Reaches scored between two and five on the naturalness scale.

Table 5 - River naturalness for each reach based on field survey and secondary data.

On-site

Reach	Physical	Hydrological	Chemical	Biological	Final score
On.HS1	3	1	2	1	3
On.HS2a	2	1	3	1	3
On.HS2b	3	2	2	1	3
On.HS3	3	1	2	1	3
On.HS4	3	1	2	1	3
On.HS5	3	1	2	1	3
On.HS2c	2	1	2	1	2
On.R1a	3	1	2	1	3

Off-site

Reach	Physical	Hydrological	Chemical	Biological	Final score
Off.HS1-3	2	1	3	1	3
Off.R1a	3	1	3	1	3
Off.R1b	2	1	3	1	3
Off.R1c	4	1	3	1	4
Off.R5	5	3	2	2	5
Off.R3	5	3	2	2	5
Off.R4	5	3	4	2	5

2.2.3. River condition

River condition was assessed as directed by the Biodiversity Metric guidance (Natural England, 2019a), using the MoRPh method which is a quantitative visual geomorphological assessment of a river and riparian zone. Eight MoRPh survey were conducted between 26th June, 29th June and 2nd

July 2020. They recorded a list of features which were marked as extensive, present, trace or absent based on their extent across the survey river length. Five contiguous MoRPh surveys were conducted at each site.

A desk study was then conducted where the information collected in the field was upload to the MoRPh cartographer workspace. Cartographer calculated 32 indicators of river condition for each site. Positive indicators (e.g. complex vegetation structure, diverse hydraulic conditions) and negative indicators (e.g. artificial beds/banks, invasive species, poached banks) were combined to produce a preliminary river condition score. The indicators for each site were extracted from cartographer and are presented in Appendix A. The preliminary score was then scaled according to river type in cartographer to produce the final river condition score for each site. Details of the desk study process are available in Gurnell *et al.*'s (2020) guide. The surveyor who conducted the MoRPh surveys and desk study was a trained MoRPh surveyor.

As Figure 1 indicates, MoRPh survey sites were located on a range of on-site and off-site reaches capturing the best and the worst conditions present in the rivers of interest. They were also undertaken at comparable locations to the macroinvertebrate surveys and previous RHS surveys of the site. According to the Biodiversity Metric guidance (Natural England, 2019a), MoRPh surveys must cover at least 20% of the total length of river onsite. However, with agreement from the Environment Agency and cartographer, fewer surveys were deemed appropriate in this project due to the size of the area impacted by the scheme and the homogeneity of rivers on-site meaning that river condition scores were unlikely to vary between similar reaches.

The condition scores were extrapolated for the reach they were located within or have similar conditions to. Reaches Off.R3 and Off.R5 did not have MoRPh surveys but condition scores were estimated based on the MoRPh survey results from other reaches and knowledge of the area. The final river condition scores that were input into the Biodiversity Metric 2.0 are listed in Table 6.

Table 6 - River condition scores for each reach and an indication of which MoRPh condition scores were used to derive the score for the reach.

<u>On-site</u>			<u>Off-site</u>		
Reach	Final score	MoRPh survey	Reach	Final score	MoRPh survey
On.HS1	Moderate	Site 2	Off.HS1-3	Fairly good	Site 1
On.HS2a	Fairly good	Site 1	Off.R1a	Moderate	Site 6
On.HS2b	Moderate	Site 3	Off.R1b	Fairly good	Site 7
On.HS3	Moderate	Site 4	Off.R1c	Fairly poor	Estimated
On.HS4	Moderate	Site 4	Off.R5	Fairly poor	Estimated
On.HS5	Moderate	Site 4	Off.R3	Fairly poor	Estimated
On.HS2c	Fairly good	Site 5	Off.R4	Poor	Site 8
On.R1a	Moderate	Site 6			

2.2.4. Strategic significance

Strategic significance is another key input for the Biodiversity Metric. Rivers that have identified actions within river basin management, catchment or local plans are weighted more highly in the metric (Natural England 2019a). Hermitage Stream was named in the River Basin Management Plan but the other rivers of interest were not so have a lower weighting in the metric.

3. Results

3.1. Inconsistencies with the Biodiversity Metric 2.0 and their influence on the calculations

As stated at the beginning of this report, Biodiversity Metric 2.0 is a 'beta' version that is still being tested but has been recommended for use by the Environment Agency for the river metric. We have identified a number of inconsistencies in the metric that would influence the Biodiversity Net Gain calculations for Havant Thicket Reservoir:

- The distinctiveness score in the rivers component of the metric does not have a 'low' class (Table 2). This is important because there is a large difference between rivers with a naturalness score of four (i.e. >30% is physically modified etc.) and rivers with a score of five (i.e. 100% is physically modified etc.) (Table 3). Yet both rivers of naturalness four and five have a distinctiveness score of 'medium'. Differentiation between the classes would reflect the greater enhancement opportunities for class five rivers to create more biodiversity units. This would be particularly influential for this scheme as over 6km of off-site river is class five.
- The 'time to target' multiplier in the metric is automatically calculated based on the type of enhancements proposed. The user guide (Natural England 2019a) shows that the time to target logically increases with greater change in condition (e.g. 'moderate' to 'good' condition would take five years whereas 'poor' to 'good' condition would take ten years). However, there seems to be a discrepancy between the user guide, the technical data in the tool itself and the technical supplement for the river component of the metric (Natural England 2019b). The technical document and tool state the opposite (e.g. 'poor' to 'good' condition would take two years) which adds greater negative weights in the calculations for smaller, potentially more achievable, enhancements.
- The metric calculates river biodiversity units based on river length, despite river habitats existing as areas. This creates fundamental issues when calculating biodiversity net gain. Using this project as an example, the amount of habitat in 1 km of river that is <1 m wide (e.g. the headwaters on-site) is not comparable to the amount of habitat in 1 km of river that is 9 m wide (e.g. Hermitage Stream). This means that more enhancement is required than may be necessary if the river biodiversity units were calculated based on area rather than by length.

These inconsistencies are highlighted based on our expertise and knowledge of the river environment. They will be fed back to Environment Agency and Natural England in the hope that updates to the metric may solve some of these issues. Therefore, two approaches to calculating Biodiversity Net Gain are considered. The first is the linear approach (Section 3.2) using the rivers component of the metric as is suggested by the Natural England guidance (2019a and 2019b). The second approach is an area-based approach (Section 3.3) using the habitat component of the metric that is used for calculating biodiversity units of area habitats such as woodlands and lakes. The habitat component of the tool also has the capability to assign 'low' distinctiveness classes and has the correct 'time to target' multipliers, both features that are highlighted as inconsistencies with the river component of the metric.

3.2. Biodiversity Net Gain using linear approach

The Biodiversity Metric 2.0 is first run using a linear approach according to the guidance from Natural England (2019a and 2019b). The metric inputs were length (Table 1), distinctiveness (Table 5), condition (Table 6) and strategic significance of each on-site and off-site reach. The output was the number of biodiversity units currently present in each reach. These are the baseline biodiversity units and are recorded for each reach in Table 7.

Table 7 shows that 72.49 river biodiversity units will be lost on-site and must be created through off-site habitat creation and enhancements to achieve net zero. The off-site baseline is 106.9 biodiversity units so the biodiversity units created must be added to the off-site baseline to create a minimum of 179.39 biodiversity units in total off-site to achieve net zero or above. Habitat enhancement to rivers off-site is the only way to mitigate or compensate for the loss of river habitat on-site as significant river creation off-site is not a feasible option. All off-site enhancements proposed are within the same catchment as the on-site habitat loss supporting the Environment Agency's preference for identifying in-catchment compensation or mitigation. Improvements to

condition and distinctiveness scores after the enhancement works were estimated to calculate the increase in biodiversity units off-site after enhancement works are completed. The difference between baseline and the estimated scores adds additional weights to the biodiversity unit algorithm within the Biodiversity Metric 2.0. For example, a 'time to target' weighting reflects that habitat enhancement is not instantaneous and it will take time for new habitats to establish. The 'extent of encroachment' of the development is set to 0m as there is no development encroachment into the riparian zone in the off-site reaches. 'Off-set location' highlights the location of the off-site reaches in relation to the on-site reaches. This is set to 'within water body'.

Table 7 - Biodiversity units for each on-site and on-site reach including the river length and condition score from Table 6 for reference.

On-site				Off-site			
Reach	Biodiversity units	Length (km)	Condition	Reach	Biodiversity units	Length (km)	Condition
On.HS1	17.89	0.994	Moderate	Off.HS1-3	23.95	0.998	Fairly good
On.HS2a	9.888	0.412	Fairly good	Off.R1a	14.29	0.794	Moderate
On.HS2b	4.14	0.23	Moderate	Off.R1b	11.64	0.485	Fairly good
On.HS3	10.13	0.563	Moderate	Off.R1c	9.12	1.140	Fairly poor
On.HS4	9.144	0.508	Moderate	Off.R5	32.26	3.506	Fairly poor
On.HS5	6.498	0.361	Moderate	Off.R3	6.468	0.703	Fairly poor
On.HS2c	10.58	0.441	Fairly good	Off.R4	9.223	2.005	Poor
On.R1a	4.212	0.234	Moderate				
Total on-site biodiversity units			72.49	Total off-site biodiversity units			106.9

Here, an optimistic but realistic indication of the types of enhancement works that would be possible off-site are input to the metric. Only enhancements in the headwaters (Off.HS1-3), Riders Lane downstream of Havant Thicket Reservoir (Off.R1a) and Hermitage Stream (Off.R4 and Off.R5), excluding the restored reach (Off.R3) are considered feasible. The enhancements proposed are described in Table 8.

According to the results of the MoRPh surveys (Appendix A), Off.HS1-3 (headwaters) has poor riparian vegetation structure, low natural bank and channel feature diversity and small culverts. Off.R1a (Riders Lane Stream downstream of the reservoir) has severely poached banks, bed siltation in addition to low diversity of natural features. The condition of these reaches may be realistically improved from 'fairly good' to 'good', and 'moderate' to 'good', respectively, with enhancement works. However, distinctiveness is unlikely to increase from 'high' to 'very high'. In Off.R5 and Off.R4 (Hermitage Stream), condition scores were 'fairly poor' and 'poor' respectively, owing to the straightening of the channels and the artificial riparian area, banks and bed. The condition of these reaches could be improved to 'good' following more intensive enhancement works such as the removal of the artificial bed and banks. These works would likely increase the distinctiveness class from 'medium' (the lowest class available in the rivers component of the metric) to 'high'. For the purposes of this metric run, we assume that 100% of the four selected reaches would be enhanced to identify whether net gain is achievable with the maximum extent of enhancement feasible. This totals 7.3km of enhancements. Enhancements would have to achieve the 'good' condition in subsequent surveys to achieve the net gain calculated here.

As part of the scheme, Portsmouth Water will also be creating 250m of new compensation flow channel from the reservoir to the Riders Lane Stream. While the channel will be modified to some degree, Portsmouth Water have committed to making it as natural as possible so it will be given a 'high' distinctiveness score and 'fairly good' condition score.

The results in Table 9 show that 45.19 biodiversity units would be created by enhancing 7.3 km of river and creating 250m of new watercourse. This is 62% of the 79.49 biodiversity units required to achieve net zero. This results in Biodiversity Net Gain of -37.66% for the rivers component of Havant Thicket Reservoir which could be interpreted as an overall loss of 37.66% of river habitat biodiversity. Even in this optimistic case where the maximum length of river feasible is enhanced

(7.3km) and 250m of new channel is created, net gain is not achieved using the linear rivers component of the Biodiversity Metric 2.0.

Table 8 - Proposed enhancements and constraints on those enhancements for the four reaches. Photographs of the current condition of the reach where possible and example of similar restoration methods. Also included is the resultant change in condition and distinctiveness score.

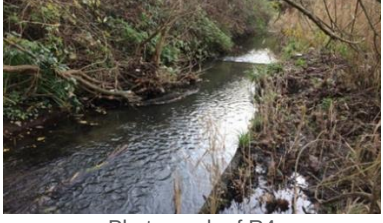
Reach	Photograph of site currently	Photograph of the type of enhancement proposed	Proposed enhancement	Constraints on enhancement	Change in distinctiveness	Change in condition
Off.HS1-3		 Example of restoration to Highland Water	Removal of culverts Open woodland Large wood in channel Increase diversity of channel features	Accessibility	High – High	Fairly good – Good
Off.R1a			Fencing to protect banks from poaching Increase diversity of channel features	Stock access to water	High – High	Moderate – Good
Off.R5	 Photograph of R4	 Example of removal of concrete channel on the Brent at Tokyngton Park	Removal of artificial bed and banks Addition of nature channel and bank features	Flood risk implications Available area for delivery limited by nearby residential areas Culverts under roads will remain	Medium – High	Fairly poor – Good
Off.R3			Removal of artificial bed and banks Addition of nature channel and bank features	Flood risk implications Available area for delivery limited by nearby residential areas Culverts under roads will remain	Medium - High	Poor - Good

Table 9 - Biodiversity units delivered by the habitat creation and enhancements and the resultant net gain based on baseline information.

Reach	Baseline biodiversity units	Biodiversity units after enhancement	Length of reach enhanced (km)
Off.HS1-3	23.95	19.36	0.998
Off.R1a	14.29	14.86	0.794
Off.R5	32.26	56.75	3.506
Off.R4	9.223	32.45	2.005
New compensation flow channel	n/a	1.49	0.250
Biodiversity units required to achieve net gain	72.49	Length of river enhanced (km)	7.30
Total biodiversity units created	45.19 (62% of required)	Length of river created (km)	0.25
Biodiversity net gain	-37.66%		

3.3. Biodiversity Net Gain using area-based approach

The current Natural England guidance (2019a and 2019b) states that rivers must be included in the Biodiversity Metric 2.0 as linear rather than areal elements. This is inconsistent, considering that rivers are not one-dimensional habitats. To combat this issue in the metric, we adapted the areal habitat component of the metric to calculate biodiversity units for rivers.

Table 10 shows how inputs were selected in the areal habitat component of the metric to mimic the weightings used in the linear rivers component where possible. The exception is the condition score weightings which ranges from 1 to 5 in the linear component but only 1 to 3 in the areal component. Scores for encroachment and ecological connectivity were not present in both components of the metric so weighting multipliers of 1 were selected so they would have no bearing on the results.

Table 10 - Conversion of inputs from the linear rivers component of Biodiversity Metric 2.0 to areal habitats component.

<u>Linear</u>		<u>Areal</u>	
Input	Weighting	Input	Weighting
Distinctiveness		Distinctiveness	
River Naturalness 2/3	High - 6	Lakes – Temporary lakes, ponds and pools	High – 6
River Naturalness 4/5	Med - 4	Lakes - Ditches	Med – 4
-	-	Urban – Sustainable urban drainage feature	Low - 2
Condition		Condition	
Good	5	Good	3
Fairly good	4	Fairly good	2.5
Moderate	3	Moderate	2
Fairly poor	2	Fairly poor	1.5
Poor	1	Poor	1

Table 10 (continued). Conversion of inputs from the linear rivers component of Biodiversity Metric 2.0 to areal habitats component.

<u>Linear</u>		<u>Areal</u>	
Input	Weighting	Input	Weighting
Strategic significance		Strategic significance	
Low potential/ action not identified in any plan.	1	Area/compensation not in local strategy/ no local strategy	1
Within River Basin Management Plan	1.15	Within area formally identified in local strategy	1.15
Spatial risk		Spatial risk	
Within water body	1	Compensation inside LPA or NCA, or deemed to be sufficiently local, to site of biodiversity loss	1
Encroachment		Encroachment	
0m	1	-	-
Ecological connectivity		Ecological connectivity	
-	-	N/A	1

The same distinctiveness, condition and strategic significance scores are used for the calculation of Biodiversity Net Gain as in the linear approach based on the field and desk-based assessments conducted. The only exception is reaches in Hermitage Stream (Off.HS3, Off.HS4 and Off.HS5), that scored a 'low' distinctiveness score in the areal component which was not possible in the linear component of the metric. This is because these reaches have concrete beds and/or banks which significantly lower their condition compared to other reaches which, although modified, have some degree of natural functioning.

To create an area habitat as opposed to a linear one, the width and length of each reach was used to calculate the area. The width of each reach was based on average bankfull width measured during MoRPh surveys where possible. Where not available, widths are taken from Watercourse Mitigation and Compensation Strategy (HTR-ATK-XX-XX-RP-Z-004) or measured using Google Earth (Table 11). Based on this information, the on-site baseline that must be created to achieve net gain is 11.17 biodiversity units (Table 11).

The first run of the metric using the linear approach created enhancements for 100% of the four reaches totalling 7.3 km of enhancement (including 5.5 km enhancement on Hermitage Stream). This run of the metric only selects sections of the reaches on Hermitage Stream (Off.R4 and Off.R5) that reflect the Environment Agency's restoration strategy for Hermitage Stream totalling 3.36 km of enhancements with only 1.48 km of enhancements on Hermitage Stream (Figure 2). As with the first run of the metric, the new habitat creation in the 2m wide compensation channel is also included.

The results of the area-based approach in Table 11 show that 11.26 biodiversity units would be created by enhancing 3.36 km of river (1.48 km on Hermitage Stream, 1.08 km in the headwaters and 0.80 km on Riders Lane, see Figure 2) and creating 250m of new watercourse in the compensation channel. This is over 100% of the 11.17 biodiversity units required to achieve net zero. This results in Biodiversity Net Gain of 0.86%, an increase in net gain compared to the linear metric in section 3.2, although less length of river is enhanced. This demonstrates the utility in considering rivers as areal features rather than linear features.

Table 11 - Biodiversity units for each on-site and on-site reach including condition score from Table 6, reach widths and area used to calculate revised biodiversity units for reference.

On-site					Off-site				
Reach	Biodiversity units	Width (m)	Area (ha)	Condition score	Reach	Biodiversity units	Width (m)	Area (ha)	Condition score
On.HS1	4.75	3.98	0.40	Moderate	Off.HS1-3	1.65	1.02	0.11	Fairly good
On.HS2a	0.63	1.02	0.04	Fairly good	Off.R1a	2.97	3.12	0.25	Moderate
On.HS2b	0.28	1.02	0.02	Moderate	Off.R1b	2.17	2.98	0.14	Fairly good
On.HS3	1.22	1.81	0.10	Moderate	Off.R1c	2.05	3.00	0.34	Fairly poor
On.HS4	1.10	1.81	0.09	Moderate	Off.R5	7.26	6.00	2.10	Fairly poor
On.HS5	0.78	1.81	0.07	Moderate	Off.R3	1.46	6.00	0.42	Fairly poor
On.HS2c	1.52	2.30	0.10	Fairly good	Off.R4	4.15	9.00	1.80	Poor
On.R1a	0.88	3.12	0.07	Moderate					
Total on-site biodiversity units					11.17	Total off-site biodiversity units			
						21.71			

Table 12 - Biodiversity units delivered in the area-based approach and the resultant net gain based on the areal baseline information.

Reach	Baseline biodiversity units based an area	Biodiversity units after enhancement	Length/area of reach enhanced
Off.HS1-3	1.65	1.85	0.99 km / 0.11 ha
Off.R1a	2.97	3.81	0.79 km / 0.247 ha
Off.R5	7.26	10.07	0.58 km / 0.348 ha
Off.R4	4.15	11.17	0.9 km / 0.814 ha
New compensation flow	n/a	0.39	0.25 km / 0.05 ha
Biodiversity units required to achieve net gain	11.17	Length/area of river enhanced	3.36 km / 1.52 ha
Total biodiversity units created	11.26 (>100% of required)	Length/area of river created	0.25 km / 0.05 ha
Biodiversity net gain	0.86%		

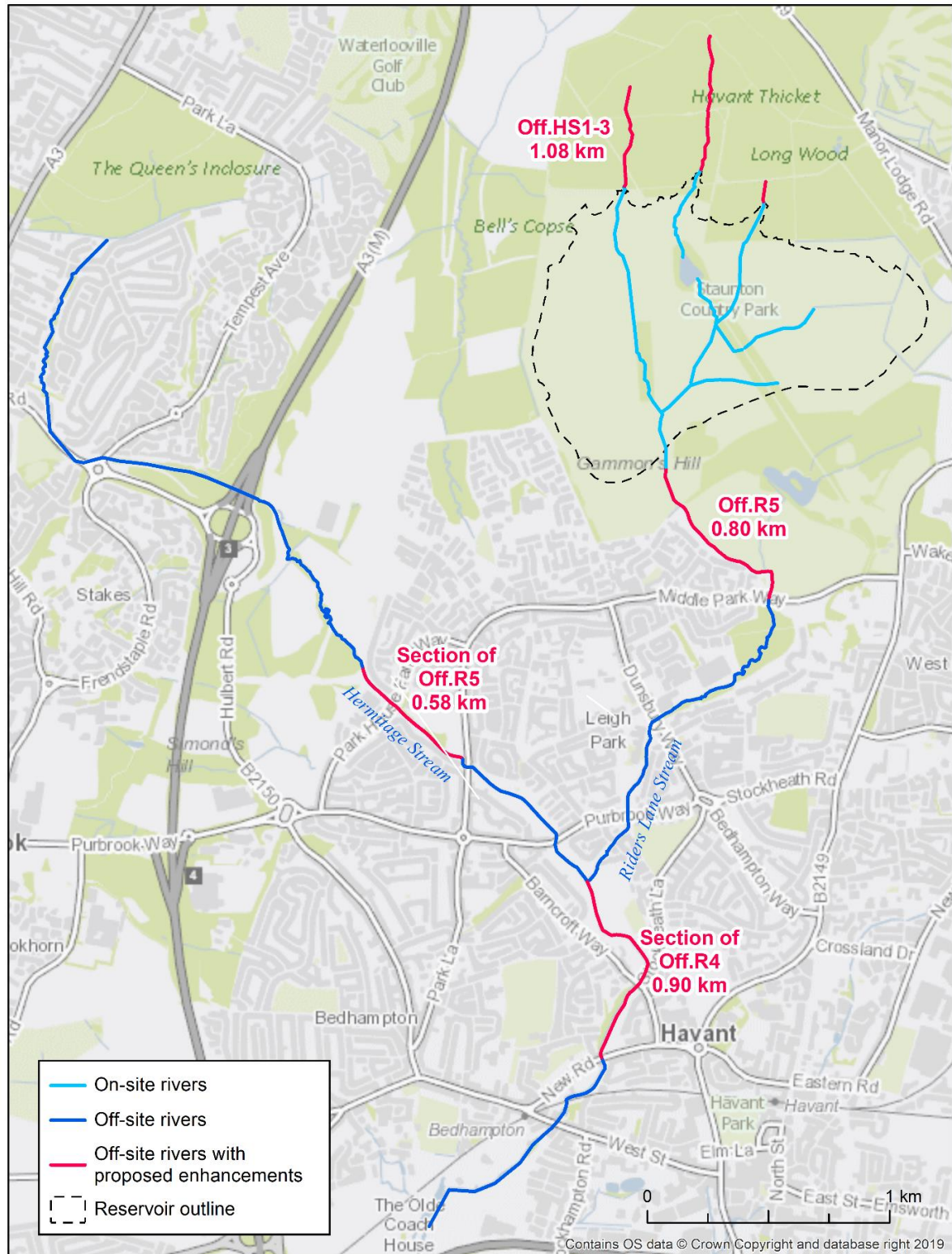


Figure 2 - Map of proposed enhancements using area-based approach.

4. Concluding remarks

In summary, the loss of 3.7km of river habitat within the Havant Thicket Reservoir footprint results in a high biodiversity loss that will be difficult to create through off-site enhancements. This is because the habitats on-site are of moderate-fairly good condition and high distinctiveness. By calculating Biodiversity Net Gain using rivers as linear features (based on current guidance, Natural England 2019a and 2019b), **enhancing 7.3km of poor-fairly good condition rivers with medium-high distinctiveness only created around 60% of the river biodiversity lost through the reservoir scheme.**

However, there are inconsistencies in DEFRA's current method of calculating net gain. It is our hope that our feedback to Environment Agency and Natural England may influence the updated version of the tool that will likely make delivering biodiversity net gain for the river component of the scheme more achievable.

Here, we demonstrate the impact of using an area-based approach for river habitats on Biodiversity Net Gain instead of a linear approach. With the area-based approach we can achieve **net gain of 0.86% for the scheme with 1.5 km of enhancements on Hermitage Stream (and an additional 1.87 km of enhancements to the headwaters and Riders Lane)**. This approach makes more sense scientifically and is in keeping with the use of area-based approach for other water features such as the ditches, reservoir and wetland which have not been included in this calculation. Using the area-based approach, Portsmouth Water will be able to achieve no net loss in biodiversity for the rivers component of the project with the proposed habitat enhancement and creation.

5. References

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Appendix A. MoRPh survey results

River condition score for each site and break down of scores for each component of the MoRPh survey. Green indicates positive scores and red indicates negative scores. May be used to help identify areas of improvement and protection for future enhancement works.

Site	Final condition class	Final condition score	Bank top					Bank face									
			Vegetation structure	Tree feature richness	Water related features	Invasive species	Managed ground cover	Riparian vegetation structure	Tree feature richness	Natural bank profile extent	Natural bank profile richness	Natural bank material richness	Bare sediment extent	Artificial bank profile extent	Reinforcement extent	Reinforcement material severity	Invasive species
1	Fairly Good	4	3	2	2	0	0	1	1	3	4	1	2	0	0	0	0
2	Moderate	3	1	0	0	0	0	2	1	2	3	1	2	-3	0	0	0
3	Moderate	3	2	2	0	0	0	1	1	3	3	1	3	0	0	0	0
4	Moderate	3	2	0	0	0	0	1	0	1	1	1	1	-4	0	0	0
5	Fairly Good	4	2	1	1	0	0	2	2	3	4	2	3	-1	0	0	0
6	Moderate	3	2	1	0	0	0	2	1	3	4	2	3	-3	0	0	0
7	Fairly Good	4	3	2	0	0	0	2	1	3	4	2	3	0	0	0	0
8	Poor	1	3	0	1	0	-3	2	1	0	0	0	0	-4	-4	-4	-1

(Continued) River condition score for each site and break down of scores for each component of the MoRPh survey. Green indicates positive scores and red indicates negative scores. May be used to help identify areas of improvement and protection for future enhancement works.

Site	Water margin					Channel											
	Aquatic vegetation extent	Aquatic morphotype richness	Physical feature extent	Physical feature richness	Artificial features	Aquatic morphotype richness	Tree feature richness	Hydraulic richness	Natural feature extent	Natural feature richness	Material richness	Bed siltation	Reinforcement extent	Reinforcement severity	Artificial feature severity	Invasive species	Filamentous algae
1	0	0	1	1	0	0	3	0	2	1	3	0	0	0	-4	0	0
2	0	0	1	1	0	2	3	0	0	0	1	0	0	0	0	0	0
3	0	0	1	2	0	0	3	0	1	1	2	-1	0	0	0	0	0
4	2	2	1	1	0	2	0	0	0	0	1	0	0	0	0	0	0
5	1	0	1	1	0	2	3	0	1	1	2	0	0	0	0	0	0
6	1	0	2	2	0	1	3	0	3	2	2	-1	0	0	-2	0	0
7	1	0	3	2	0	0	2	0	1	1	3	-3	0	0	0	0	0
8	1	0	1	1	-1	0	0	1	0	0	2	0	-4	-4	-1	0	-4

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