Twyford Neighbourhood Plan Review Habitat Regulations Assessment

Likely Significant Effects and Appropriate Assessment of the Submission Version

South Downs National Park Authority

November 2020

Quality information

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1. Introduction

Scope of Project

1.1 AECOM was initially appointed by South Downs National Park Authority on behalf of Twyford Parish Council to assist in undertaking a Habitats Regulations Assessment (HRA) for the Twyford Neighbourhood Plan Pre-Submission version March 2019. This was for the purpose of informing Twyford Parish Council and the South Downs National Park Authority of the potential effects on European sites and how they were being addressed in the Pre-Submission Neighbourhood Plan, for that Council to take into account in their formal HRA.

1.2 The draft Neighbourhood Plan then underwent statutory consultation, including consultation advice from Natural England. This resulted in several changes being made to the plan, which now require HRA assessment. Furthermore, Natural England also advised that the concept of nutrient neutrality in the Solent (an issue that has emerged since the previous assessment) requires further appraisal in the HRA. The present HRA therefore assesses the post-consultation submission version of the Twyford Neighbourhood Plan and includes an Appropriate Assessment of water quality issues in relation to the Solent.

1.3 The South Downs Local Plan provides relevant context to this assessment which focuses on the River Itchen SAC. The Local Plan was subject to HRA prior to submission in July 2018 (post consultation and Local Plan policy modifications) and was adopted in July 2019. That Local Plan HRA examined several European sites including the River Itchen SAC, which is of relevance to Twyford.

1.4 The South Downs Local Plan does not detail site allocations for residential development within Twyford although the expected broad quantum of growth at Twyford was covered in the Local Plan HRA. The objective of this particular HRA of the Neighbourhood Plan is to identify if any particular site allocations and/or policies that have the potential to cause an adverse effect on the integrity of Natura 2000 or European designated sites (Special Areas of Conservation, SACs, Special Protection Areas, SPAs, and Ramsar sites designated under the Ramsar convention), either in isolation or in combination with other plans and projects, and to determine whether site-specific mitigation measures are required to ensure no adverse effect on site integrity results.

Legislation

1.5 The need for HRA is set out within Article 6 of the EC Habitats Directive 1992 and interpreted into British law by the Conservation of Habitats & Species Regulations 2017 (as amended). The aim of the Habitats Directive is to "*maintain or restore, at favourable conservation status, natural habitats and species of wild fauna and flora of Community interest*" (Habitats Directive, Article 2(2)). This aim relates primarily to habitats and species, and designated sites that have a significant role in delivering favourable conservation status. European sites (also called Natura 2000 sites) can be defined as actual or proposed/candidate Special Areas of Conservation (SAC) or Special Protection Areas (SPA). It is also Government policy for sites designated under the Convention on Wetlands of International Importance (Ramsar sites) to be treated as having equivalent status to Natura 2000 sites.

1.6 The Habitats Directive applies the precautionary principle to protected areas. Plans and projects can only be permitted having ascertained that there will be no adverse effect on the integrity of the site(s) in question. This contrasts with the SEA Directive which does not prescribe how plan or programme proponents should respond to the findings of an environmental assessment; merely that the assessment findings (as documented in the 'environmental report') should be 'taken into account' during preparation of the plan or programme. In the case of the Habitats Directive, plans and projects may still be permitted if there are no alternatives to them and there are Imperative Reasons of Overriding Public Interest (IROPI) as to why they should go ahead. In such cases, compensation would be necessary to ensure the overall integrity of the site network.

Habitats Directive 1992

Article 6 (3) states that:

"*Any plan of project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives."*

Conservation of Habitats and Species Regulations 2017 (as amended)

Regulation 105 states that:

"*A competent authority, before deciding to … give any consent for a plan or project which is likely to have a significant effect on a European site … must make an appropriate assessment of the implications for the plan or project in view of that site's conservation objectives… The competent authority may agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the European site."*

Box 1: The legislative basis for HRA

1.7 Over the years, 'Habitats Regulations Assessment' (HRA) has come into wide currency to describe the overall process set out in the Habitats Regulations, from screening through to identification of IROPI. This has arisen in order to distinguish the overall process from the individual stage of "Appropriate Assessment". Throughout this Report the term HRA is used for the overall process and restricts the use of Appropriate Assessment to the specific stage of that name.

2. Methodology

Introduction

2.1 This section sets out the approach and methodology for undertaking the HRA. HRA itself operates independently from the Planning Policy system, being a legal requirement of a discrete Statutory Instrument. Therefore, there is no direct relationship to the 'Test of Soundness'.

2.2 There is various guidance on HRA which has been taken into account in this assessment. Central government has released high level guidance[1]. The Department for Communities and Local Government (now the Ministry of Housing, Communities and Local Government, MHCLG) released a consultation paper on Appropriate Assessment (AA) of Plans in 2006[2]. As yet, no further formal guidance specifically devoted to assessment of plans has emerged. However, Court Judgements can be used to shape the approaches used.

2.3 The draft MHCLG guidance[3] makes it clear that when implementing HRA of land-use plans, the AA should be undertaken at a level of detail that is appropriate and proportional to the level of detail provided within the plan itself: "*The comprehensiveness of the [Appropriate] assessment work undertaken should be proportionate to the geographical scope of the option and the nature and extent of any effects identified. An AA need not be done in any more detail, or using more resources, than is useful for its purpose. It would be inappropriate and impracticable to assess the effects* [of a strategic land use plan] *in the degree of detail that would normally be required for the Environmental Impact Assessment (EIA) of a project*." More recently, the Court of Appeal[4] ruled that providing the Council (competent authority) was duly satisfied that proposed mitigation could be 'achieved in practice' to avoid an adverse effect, then this would suffice. This ruling has since been applied to a planning permission (rather than a Local Plan)[5]. In this case the High Court ruled that for *'a multistage process, so long as there is sufficient information at any particular stage to enable the authority to be satisfied that the proposed mitigation can be achieved in practice it is not necessary for all matters concerning mitigation to be fully resolved before a decision maker is able to conclude that a development will satisfy the requirements of reg. 61 of the Habitats Regulations*'.

2.4 In other words, there is a tacit acceptance that HRA can be tiered and that all impacts are not necessarily appropriate for consideration to the same degree of detail at all tiers.

2.5 Figure 1 below outlines the stages of HRA according to current draft MHCLG guidance. The stages are essentially iterative, being revisited as necessary in response to more detailed information, recommendations and any relevant changes to the plan until no significant adverse effects remain.

[1] https://www.gov.uk/guidance/appropriate-assessment
[2] MHCLG (was DCLG) (2006) Planning for the Protection of European Sites, Consultation Paper
[3] Ibid
[4] No Adastral New Town Ltd (NANT) v Suffolk Coastal District Council Court of Appeal, 17th February 2015
[5] High Court case of R (Devon Wildlife Trust) v Teignbridge District Council, 28 July 2015

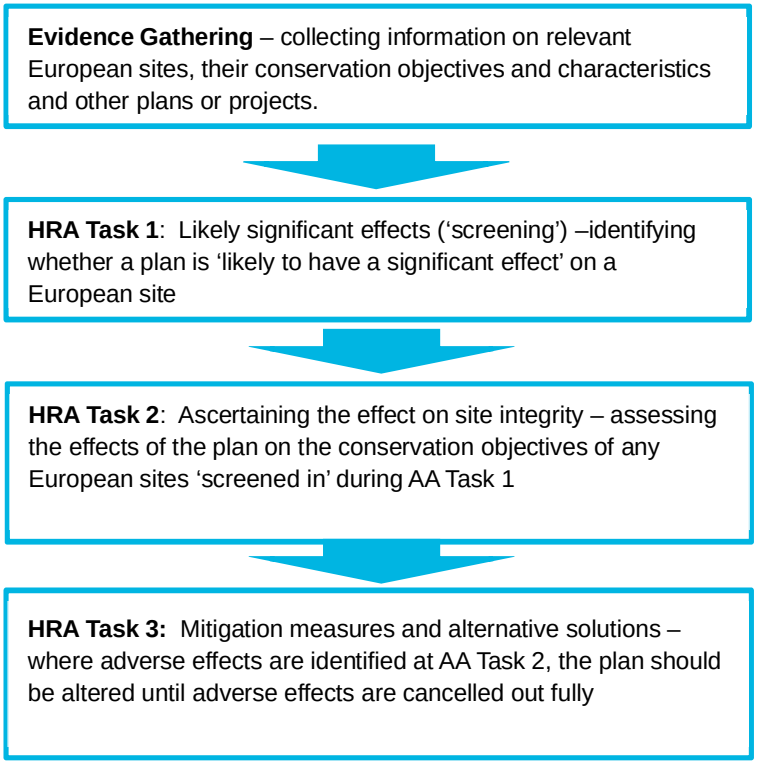


Figure 1: Four-Stage Approach to Habitats Regulations Assessment (Source: CLG, 2006)

Likely Significant Effects (LSE)

2.6 The first stage of any Habitats Regulations Assessment (HRA Task 1) is a Likely Significant Effect (LSE) test - essentially a risk assessment to decide whether the full subsequent stage known as Appropriate Assessment is required. The essential question is:

2.7 "Is the Plan, either alone or in combination with other relevant projects and plans, likely to result in a significant effect upon European sites?"

2.8 The objective is to 'screen out' those plans and projects that can, without any detailed appraisal, be said to be unlikely to result in significant adverse effects upon European sites, usually because there is no mechanism for an adverse interaction with European sites. The Likely Significant Effect test is the purpose of this HRA report.

HRA Task 2 – Appropriate Assessment (AA)

2.9 Where it is determined that a conclusion of 'no likely significant effect' cannot be drawn the analysis has proceeded to the next stage of HRA known as Appropriate Assessment. Case law has clarified that 'appropriate assessment' is not a technical term. In other words, there are no particular technical analyses, or level of technical analysis, that are classified by law as belonging to appropriate assessment rather than determination of likely significant effects.

2.10 One of the key considerations during appropriate assessment is whether there is available mitigation that would entirely/ appropriately address the potential effect. This reflects a recent decision by the European Court of Justice[6] that concludes that measures intended to avoid or reduce the harmful effects of a proposed project on a European site cannot be taken into account at the Likely Significant Effects or 'screening' stage of HRA. In practice, the appropriate assessment takes any policies or allocations that could not be dismissed following the determination of Likely Significant Effects with a view to concluding whether there would actually be an adverse effect on integrity (in other words, disruption of the coherent structure and function of the European site(s)).

[6] People Over Wind and Sweetman v Coillte Teoranta (C-323/17)

HRA Task 3 – Avoidance and Mitigation

2.11 Where necessary, measures are recommended for incorporation into the Plan in order to avoid or mitigate adverse effects on European sites. There is considerable precedent concerning the level of detail that a plan needs to contain regarding mitigation. The implication of this precedent is that it is not necessary for all measures that will be deployed to be fully developed prior to adoption of the Plan, but the Plan must provide an adequate policy framework within which these measures can be delivered.

2.12 This fits with the advice of Advocate-General Kokott[7] who commented that: '*It would …hardly be proper to require a greater level of detail in preceding plans* [rather than planning applications] *or the abolition of multi-stage planning and approval procedures so that the assessment of implications can be concentrated on one point in the procedure. Rather, adverse effects on areas of conservation must be assessed at every relevant stage of the procedure to the extent possible on the basis of the precision of the plan. This assessment is to be updated with increasing specificity in subsequent stages of the procedure'.*

2.13 In evaluating significance, AECOM has relied on professional judgement as well as the results of previous stakeholder consultation regarding development impacts on the European sites considered within this assessment.

2.14 When discussing 'mitigation' for the proposed development sites, one is concerned primarily with the policy framework to enable the delivery of such mitigation rather than the details of the mitigation measures themselves since the Neighbourhood Plan document is a high-level policy document.

Confirming Other Plans and Projects that may act 'In combination'

2.15 It is a requirement of the Regulations that the impacts and effects of any plan being assessed are not considered in isolation but in combination with other plans and projects that may also be affecting the European site(s) in question.

Table 1. Other projects and plans that may act 'in-combination' to the development of the Twyford NP.

Plans
• **Compton and Shawford** Village Design Statement, Adopted 2011
• The **Chilcomb** Parish Plan, Adopted May 2013
• **Colden Common** Village Design Statement, Adopted 2012
• The **Otterbourne** Village Design Statement, Adopted 2008
• **Lewes*** - Joint Core Strategy: Local Plan Part 1, Adopted June 2016
• **Adur** District Council, Adopted Adur Local Plan 2017.
• **Worthing** Borough Council, 2011. Core Strategy.
• **Chichester** District Council, Local Plan Key Policies: 2014-2029 (adopted July 2015), and relevant Neighbourhood Plans (e.g. Selsey Neighbourhood Plan)
• **East Hampshire***, The East Hampshire District Local Plan: Joint Core Strategy (adopted 2014), Local Plan Part 2: Housing and Employment Allocations (adopted April 2017).
• **Havant** Borough Council, 2011. Local Plan (Core Strategy). Adopted March 2011 and Local Plan (Allocations) adopted 2014
• **Horsham** District Local Development Framework (adopted November 2015), the Core Strategy (2007) and replacement Horsham District Planning Framework and associated Neighbourhood Plans.
• **Mid-Sussex** District Council. Mid-Sussex District Plan, 2018.

[7] Opinion of Advocate General Kokott, 9th June 2005, Case C-6/04. Commission of the European Communities v United Kingdom of Great Britain and Northern Ireland, paragraph 49. http://curia.europa.eu/juris/document/document.jsf?docid=58359&doclang=EN

- **Winchester*** City Council, 2013. Local Plan – Joint Core Strategy. (Adopted) and Local plan Part 2: Development Management & Allocations document. (adopted April 2017)

- **Arun** Local Plan 2011-2031 Main Modifications (March 2017); now awaiting adoption

- **Brighton and Hove** Submission City Plan Part One. February 2013, Further Proposed Modifications (2015) and associated Neighbourhood Plans.

- **Eastbourne** Borough Council, 2013. Core Strategy Local Plan and Employment Land Local Plan (2014).

- **Wealden*** District Council (Incorporating Part of the South Downs National Park), 2013. Core Strategy Local Plan. New Local Plan shortly to go to consultation

- **Transport Plans**: West Sussex Transport Plan 3 (2011-2026); East Sussex Local Transport Plan 3 (2011-2026); Hampshire Local Transport Plan (2011-2031); and Surrey Local Transport Plan LTP3 (2011-2026); South East River Basin Management Plan 2015 - 2021; Lower Tidal River Arun Strategy Environmental Report (2014).

- **Minerals and Waste Plans**: East Sussex, South Downs and Brighton & Hove Waste and Minerals Plan (adopted 2013); Hampshire Minerals and Waste Plan (adopted 2013); West Sussex Waste Plan (adopted 2014); The East Sussex, South Downs and Brighton & Hove Waste and Minerals Sites Plan (anticipated for adopted early 2018); West Sussex Joint Minerals Plan (at the time of writing (February 2018) modifications to the Proposed Submission version was subject to consultation).

3. Internationally Designated Sites:

River Itchen SAC

Introduction

3.1 This 309.26ha site comprises chalk stream and river, fen meadow, flood pasture and swamp habitats, particularly formations of in-channel vegetation dominated by water crowfoot *Ranunculus* spp, riparian vegetation communities (including wet woodlands) and side channels, runnels and ditches associated with the main river and former water meadows. There are significant populations of the nationally-rare southern damselfly *Coenagrion mercuriale* and assemblages of nationally-rare and scarce freshwater and riparian invertebrates, including the white-clawed crayfish *Austropotamobius pallipes*. Other notable species include otter *Lutra lutra*, water vole *Arvicola terrestris*, freshwater fishes including bullhead *Cottius gobbo*, brook lamprey *Lampetra planeri* and Atlantic salmon *Salmo salar*. A good range of wetland bird species breed.

Reasons for Designation

3.2 The River Itchen qualifies as a SAC for both habitats and species. Firstly, the site contains the Habitats Directive Annex I habitat:

- Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation. The Itchen is a classic example of a sub-type 1 chalk river.

3.3 Secondly, the SAC also contains the following Annex II species:

- Southern damselfly: Representing one of the major population centres in the UK
- Bullhead: High densities occur along much of the river's length
- White-clawed crayfish (though not a primary reason for site selection)
- Otter (though not a primary reason for site selection)
- Atlantic salmon (though not a primary reason for site selection)
- Brook lamprey (though not a primary reason for site selection)

Historic Trends and Current Pressures

3.4 A principal threat to the habitats within this SAC has been decreases in flow velocities and increases in siltation, in turn affecting macrophyte cover. Surveys during the 1990s showed declines in *Ranunculus* cover since 1990, attributable to increased abstractions in the upper catchment, coupled with a series of years with below-average rainfall. Low flows interact with nutrient inputs from point sources to produce localised increases in filamentous algae and nutrient-tolerant macrophytes at the expense of *Ranunculus*. The Environment Agency has undertaken assessments to inform licensed water abstraction at critical times. Efforts are currently being made to increase the viability of the southern damselfly population through population studies and a Species Action Plan.

3.5 Recent Condition Assessment process reviews indicated that large sections of the river are suffering from inappropriate water levels, with siltation and abstraction cited as problems in places. In some areas, discharges were causing reduced water quality.

3.6 The key environmental conditions needed to maintain site integrity include:

- Maintenance of flow velocities - low flows interact with nutrient inputs from point sources to produce localised increases in filamentous algae and nutrient-tolerant macrophytes at the expense of *Ranunculus*.
- Low levels of siltation,
- Unpolluted water and low nutrient inputs.
- Maintenance of grazing pressure is essential for southern damselfly habitat.

Solent & Southampton Water SPA / Ramsar

Introduction

3.1 The Solent and Southampton Water SPA / Ramsar covers an expansive area on the south England coast from Hurst Spit to Hill Head on the coast of Hampshire, and from Yarmouth to Whitecliff Bay along the north coast of the Isle of Wight. It is composed of several estuaries and harbours with mudflats, saltmarshes, saline lagoons, shingle beaches, reedbeds, damp woodland and grazing marsh.

3.2 The mudflats support beds of *Enteromorpha* spp. and *Zostera* spp. and harbour a rich assemblage of invertebrates that forms the main food source for estuarine birds. In the breeding season in summer, the site is important for seabirds such as gulls and terns. In winter the SPA holds a significant assemblage of waterfowl, including geese, ducks and waders. The brent goose *Branta bernicla bernicla* is known to feed in areas of surrounding agricultural land.

Reasons for Designation – SPA

3.3 This site qualifies under **Article 4.1** of the Directive (79/409/EEC) by supporting populations of European importance of the following species listed on Annex I of the Directive:

During the breeding season;

- Common tern *Sterna hirundo*, 267 pairs representing at least 2.2% of the breeding population in Great Britain (5 year peak mean, 1993-1997)
- Little tern *Sterna albifrons*, 49 pairs representing at least 2% of the breeding population in Great Britain (5 year peak mean, 1993-1997)
- Mediterranean gull *Larus melanocephalus*, 2 pairs representing at least 20% of the breeding population in Great Britain (5 year peak mean, 1994-1998)
- Roseate tern *Sterna dougallii*, 2 pairs representing at least 3.3% of the breeding population in Great Britain (5 year peak mean, 1993-1997)
- Sandwich tern *Sterna sandvicensis*, 231 pairs representing at least 1.7% of the breeding population in Great Britain (5 year peak mean, 1993-1997)

3.4 This site also qualifies under **Article 4.2** of the Directive (79/409/EEC) by supporting populations of European importance of the following migratory species:

Over winter;

- Black-tailed godwit *Limosa limosa islandica*, 1,125 individuals representing at least 1.6% of the wintering Iceland - breeding population (5 year peak mean, 1992/3-1996/7)
- Dark-bellied brent goose *Branta bernicla bernicla*, 7,506 individuals representing at least 2.5% of the wintering Western Siberia/Western Europe population (5 year peak mean, 1992/3-1996/7)
- Ringed plover *Charadrius hiaticula*, 552 individuals representing at least 1.1% of the wintering Europe/Northern Africa - wintering population (5 year peak mean, 1992/3-1996/7)
- Teal *Anas crecca*, 4,400 individuals representing at least 1.1% of the wintering Northwestern Europe population (5 year peak mean, 1992/3-1996/7)

Assemblage qualification: A wetland of international importance.

The area qualifies under **Article 4.2** of the Directive (79/409/EEC) by regularly supporting at least 20,000 waterfowl

Over winter, the area regularly supports 53,948 individual waterfowl (5 year peak mean 1991/2 - 1995/6) including: Gadwall *Anas strepera*, Teal *Anas crecca*, Ringed Plover *Charadrius hiaticula*, Black-tailed Godwit *Limosa limosa islandica*, Little Grebe *Tachybaptus ruficollis*, Great Crested Grebe *Podiceps cristatus*, Cormorant *Phalacrocorax carbo*, Dark-bellied brent Goose *Branta bernicla bernicla*, Wigeon *Anas penelope*, Redshank *Tringa totanus*, Pintail *Anas acuta*, Shoveler *Anas clypeata*, Red-breasted Merganser

Mergus serrator, Grey Plover *Pluvialis squatarola*, Lapwing *Vanellus vanellus*, Dunlin *Calidris alpina alpina*, Curlew *Numenius arquata*, Shelduck *Tadorna tadorna*.

Reasons for Designation – Ramsar

3.5 The Solent and Southampton Water qualifies as a Ramsar site under the following criteria:

Criterion 1

The site is one of the few major sheltered channels between a substantial island and mainland in European waters, exhibiting an unusual strong double tidal flow and has long periods of slack water at high and low tide. It includes many wetland habitats characteristic of the biogeographic region: saline lagoons, saltmarshes, estuaries, intertidal flats, shallow coastal waters, grazing marshes, reedbeds, coastal woodland and rocky boulder reefs.

Criterion 2

The site supports an important assemblage of rare plants and invertebrates. At least 33 British Red Data Book invertebrates and at least eight British Red Data Book plants are represented on site.

Criterion 5

Assemblages of international importance

Species with peak counts in winter

51,343 waterfowl (5 year peak mean 1998/99 – 2002/03)

Criterion 6 Species / populations occurring at levels of international importance

Qualifying species / populations (as identified at designation):

Species with peak counts in spring / autumn

- Ringed plover *Charadrius hiaticula*, Europe / Northwest Africa: 853 individuals, representing an average of 1.1% of the population (5 year peak mean 1998/9 – 2002/3)

Species with peak counts in winter

- Dark-bellied brent goose *Branta bernicla bernicla*: 12,987 individuals, representing an average of 6% of the population (5 year peak mean 1998/9 – 2002/3)
- Eurasian teal *Anas crecca*, NW Europe: 5,514 individuals, representing an average of 1.3% of the population (5 year peak mean 1998/9 – 2002/3)
- Black-tailed godwit *Limosa limosa islandica*, Iceland / W Europe: 1,240 individuals, representing an average of 3.5% of the population (5 year peak mean 1998/9 – 2002/3)

Current Pressures

3.6 The following threats and pressures to the integrity of the Portsmouth Harbour SPA have been identified in Natural England's Site Improvement Plan:

- Public access / disturbance
- Costal squeeze
- Fisheries: Commercial marine and estuarine
- Water pollution
- Changes in species distribution
- Climate change
- Change to site conditions

- Invasive species
- Direct land take from development
- Biological resource use
- Change in land management
- Inappropriate pest control
- Air pollution: Impact of atmospheric nitrogen deposition
- Hydrological changes
- Extraction: Non-living resources

Solent Maritime SAC

Introduction

3.7 The Solent comprises a major estuarine system on the south coast of England with four coastal plain estuaries and four bar-built estuaries. The maritime SAC is the only site that contains a cluster of physiographic sub-types of estuary. Furthermore, in contrast to all other European estuaries, the Solent has a unique hydrographic regime consisting of four tides per day.

3.8 The site also harbours a complex array of marine and estuarine habitats. Sediment habitats in the estuarine system include extensive estuarine flats with intertidal areas, supporting eelgrass *Zostera* spp., green algae, sand and shingle spits, and shoreline transitions. Mudflat habitats range from low or variable salinity in the upper reaches of the estuaries to fully marine mudflats in Chichester and Langstone Harbours. Unusual species in these habitats include rare sponges, communities of a polychaete *Sabellaria spinulosa* and smooth cord-grass *Spartina alterniflora*.

3.9 Within the Solent Maritime SAC, the second-largest aggregation of Atlantic salt meadows in south / south-west England is located. The saltmarsh is present as a large number of disjointed habitat patches. This ungrazed aquatic plant community is dominated by sea-purslane *Atriplex portulacoides*, common sea-lavender *Limonium vulgare* and thrift *Armeria maritima*. Overall, the site is less disturbed by man-made structures than other parts of the southern coast.

Reasons for Designation

3.10 Annex I habitats that are a primary reason for selection of this site:

- Estuaries
- Spartina swards (*Spartinion maritimae*)
- Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)

3.11 Annex I habitats present as a qualifying feature, but not a primary reason for selection of this site:

- Sandbanks which are slightly covered by sea water all the time
- Mudflats and sandflats not covered by sea water at low tide
- Coastal lagoons
- Annual vegetation of drift lines
- Perennial vegetation of stony banks
- *Salicornia* and other annuals colonizing mud and sand
- Shifting dunes along the shoreline with *Ammophila arenaria* (‘white dunes’)

3.12 Annex II species present as a qualifying feature, but not a primary reason for site selection

- Desmoulin’s whorl snail *Vertigo moulinsiana*

Current Pressures

3.13 The following threats and pressures to the integrity of the Portsmouth Harbour SPA have been identified in Natural England's Site Improvement Plan:

- Public access / disturbance
- Costal squeeze
- Fisheries: Commercial marine and estuarine
- Water pollution
- Changes in species distribution
- Climate change
- Change to site conditions
- Invasive species
- Direct land take from development
- Biological resource use
- Change in land management
- Inappropriate pest control
- Air pollution: Impact of atmospheric nitrogen deposition
- Hydrological changes
- Extraction: Non-living resources

4. Likely Significant Effects

Introduction

4.1 Twyford village is situated with the western extremity of the South Downs National Park. The River Itchen SAC passes through the Parish boundary to the west of the village. Twyford is built upon download that is naturally rich is biological diversity. The River Itchen SAC supports chalk river habitat and species of European Importance and supports rich water meadows also of conservation importance to the local area.

4.2 The River Itchen SAC supports habitats and species of conservation importance due to their specialised adaptions to environmental conditions. The most important element within a river ecosystem is the water chemistry that makes up a particular habitat type. The River Itchen SAC is a chalk river and therefore the most important water chemical signature is good water quality and appropriate water supply.

Water quality and abstraction

4.3 Water quality includes components such as dissolved oxygen, acidity/alkalinity, levels of other chemicals such as nitrogen and phosphorous, amounts of suspended solids and heavy metals. Dissolved oxygen is affected by the Biochemical Oxygen Demand (BOD); the higher the BOD the lower the dissolved oxygen available in the water for fish and other wildlife. Excess nutrients can lead to various impacts including algal blooms and smothering growth of large algae, while high ammonia concentrations and heavy metals are directly toxic to aquatic life. Each species has its own tolerance range with respect to water quality. For example, fish, such as the salmon, which are totally dependent on water are more sensitive to changes in water quality. Water quality can have other indirect effects, for example high volumes of nitrogen and phosphorous can lead to algal blooms and excessive growth of other water plants.

4.4 In addition, water quantity has a significant effect on the biodiversity of a river catchment in numerous ways. The amount of water falling on a catchment and getting into a river, has an effect on water levels (depth) in a river, water table levels in a floodplain, and a flow rate of a river. In turn, these properties influence other important river properties – for example levels of silt and dissolved oxygen in the water.

4.5 Different species have their own optimal ranges for these properties (and these can vary from season to season), and their own tolerance levels. For example, the southern damselfly is only found in scattered locations of south-west England and west Wales. Local populations of southern damselfly only occur due to specific habitat requirements (i.e. mid-successional, management dependent habitat) and are therefore highly sensitive to changes in environmental structure and integrity. Habitat requirements of the southern damselfly are as follows:

- **River bed**: inorganic substrate (i.e. gravel, with peat to 30cm),
- **Temperature**: warm to minimum water temperatures (i.e. intolerant of freezing),
- **Water flow**: permanent flow (i.e. intolerant of drought),
- **Water quality**: unpolluted with high oxygen content, and
- **Shade**: unshaded (i.e. oviposition and emergence occurs at exposed areas).

4.6 There is a considerable risk that, with increased urbanisation, water pollution could lead to a reduction in food abundance (i.e. macrophages and smaller invertebrates) and therefore have an indirect impact to the population health of southern damselfly at the SAC and by default the UK.

4.7 European sites in the Solent (e.g. the Solent & Southampton Water SPA / Ramsar and the Solent Maritime SAC) are also sensitive to water quality impacts, primarily from nitrogen in treated sewage effluent. A recent Natural England site condition assessment of SSSI component sites has shown many of the areas in the Solent to be at high risk of eutrophication and the concomitant emergence of algal mats. In turn, algal blooms can lead to low dissolved oxygen concentrations, impacting both SAC habitats and SPA / Ramsar bird species. The emerging issue of nutrient neutrality is taken account of in this HRA.

4.8 Table 2 identifies the environmental impact pathways to the River Itchen SAC due to increased development within Twyford NP. *Note: water quality impacts as a result of agriculture are not assessed as this is beyond the remits of a NP and its HRA.*

Table 2. Describes how the River Itchen SAC is susceptible water quality pressures due to increased urbanisation proposed by Twyford NP and associated development policies.

Impact pathway	Discussion
Water quality (surface water runoff)	As groundwater is a source of water for chalk streams there is a risk that poor drainage design and increased surface water runoff into the River Itchen SAC could reduce water quality[8]. The Environment Agency and Natural England have already identified that water discharge into the SAC is a current threat to integrity.
Water quality (discharge of treated sewage effluent)	Increased housing development within Twyford will lead to increase sewage production. There is therefore a risk that increased sewage could degrade the water quality (i.e. through increased phosphorus discharge) of the SAC when in the absence of environmental mitigation and adequate wastewater treatment works[9].
Water abstraction	Increased residential development within Twyford will lead to increased water uses within the Parish and by default increased water abstraction. Water abstraction controls to the River Itchen SAC have already been modified by the Environmental Agency to reduce pressures to the SAC[10]. Increased water abstraction could degrade the habitat structure of the SAC and therefore impact the SAC's ability to support designated features.

4.9 For the Screening assessment (Table 3) green shading in the final column indicates that the proposed development site or policy has been deemed not to lead to a likely significant effect on any European sites due to the absence of any mechanism for an adverse effect. Orange shading indicates that a pathway of impact potentially exists, and further discussion is therefore required.

[8] Stuart, M. E., & Smedley, P. L. (2009). Baseline groundwater chemistry: the Chalk aquifer of Hampshire.
[9] Jarvie, H. P., Neal, C., & Withers, P. J. (2006). Sewage-effluent phosphorus: a greater risk to river eutrophication than agricultural phosphorus?. *Science of the total environment*, *360*(1-3), 246-253.
[10] Southern Water (2018) Draft Water Resources Management Plan 2019 Annex 3: Supply Forecast. Available online: https://www.southernwater.co.uk/media/1311/annex-3-supply-forecast.pdf, accessed on the 10th September 2019.

Screening of Twyford NP policies

Table 3. Screening outcome of likely significant effects.

Policy	Designated Site Location	Brief Summary	Screening outcome
Policy SB1 - The Settlement Boundary Policy	Policy boundary located 75m east of SAC.	Policy describes the development and redevelopment boundary within Twyford settlement area.	Development boundary is located approximately 75m to the east for the River Itchen SAC and development within the boundary could pose likely significant effects to the river as well as impacting downstream sites in the Solent, such as the Solent Maritime SAC and the Solent & Southampton Water SPA / Ramsar. This is due to potential water quality issues.
Policy SB2 – Development outside the Settlement Boundary	Policy area directly adjacent SAC.	Policy describes the development and redevelopment boundary within Twyford outside settlement area. This is subject to policy constraints.	As this policy identifies that development is expected outside the Twyford settlement boundary there is a risk that likely significant effects could be present for the River Itchen SAC as well as European sites in the Solent. This policy specifically relates to Policy HN7, which provides for housing in the countryside.
Policy HN1 – Local housing needs and housing mix	Within the Twyford Parish.	Policy describes housing mix/ types and size.	This policy does not allocate sites for development; rather this policy provides building guidance for mixed housing (i.e. sizes and number of bedrooms). As such, this policy is not expected to lead to likely significant effects to the River Itchen SAC and Solent's maritime sites.
Policy HN2 – Housing provision and allocation of land	Site boundary directly adjacent SAC.	Policy allocates additional 20 dwellings from SDNPA LP Review (development route through 'infilling' and redevelopment).	The allocation of land for development to facilitate the development of an additional 20 dwellings (on Site 26) is expected to have likely significant effects. It is also noted that additional dwellings may come forward on unspecified sites within the Settlement Boundary. Development is therefore expected to pose likely significant effects in the absence of water quality and environmental mitigation due to the proximity of development.
Policy HN3 - Affordable provision on allocated and windfall sites	Within the Twyford Parish.	Policy describes requirements and eligibility of affordable housing with Twyford.	This policy does not allocate sites for development rather this policy provides guidance for the proportion of affordable housing to be developed (i.e. allocated in other HN policies) within Twyford. As such, this policy is not

			expected to lead to likely significant effects to the River Itchen SAC and Solent's maritime sites.
Policy HN4 - Rural Exception Sites	Policy area directly adjacent SAC.	This policy describes the Council's aims that for residential development outside of the settlement boundary should deliver 100% affordable housing.	Since this policy described potential for development outside the Twyford settlement boundary there is a risk that likely significant effects could occur in the River Itchen SAC, the Solent Maritime SAC and the Solent & Southampton Water SPA / Ramsar.
Policy HN5 Housing within the Settlement Boundary.	Policy area located 75m east of SAC.	Policy describes development restrictions and requirements for extensions, change of use, redevelopment and new developments. Restrictions include size of redevelopment and new development and enhancing environmental and historical character.	Since the development boundary is located approximately 75m to the east of the River Itchen SAC net new housing development is therefore expected to pose likely significant effects to the SAC and downstream European sites in the Solent. This is due to potential water quality and water level/flow issues.
Policy HN6 – Housing outside the settlement boundary	Policy area directly adjacent SAC.	Policy describes development restrictions and requirements for proposals outside the settlement area. Types of development described include for resident staff for large houses or institutions, annexes for dependent relatives, hostel accommodation for racing stables and the subdivision of larger houses.	Again, since this policy described development outside to the Twyford settlement area, without being able to specify locations or quanta (although the types of development are restricted), there is a risk that likely significant effects could occur to the River Itchen SAC, the Solent Maritime SAC or the Solent & Southampton Water SPA / Ramsar.
Policy – HN7 Orchard Close	Policy located 630m to the east.	Policy describes the future allocation of Orchard close expansion for elderly residential living, specifying key development criteria.	Due to the proximity of Orchard Close there is a risk that development could lead to likely significant effects to the River Itchen SAC due to drainage and water quality issues. It could also result in LSEs on sites in the Solent, including the Solent Maritime SAC and the Solent & Southampton Water SPA / Ramsar.
Policy BE1 – Employment and business provision	Within the Twyford Parish boundary.	Policy describes the Council's aims to maintain existing use of current employment areas and support proposal for new employment development within the settlement boundary. Allocation outside the settlement boundary is subject to higher levels of policy constraint.	Due to the lack of spatial detail within the NP regarding new employment delivery under this policy there is a risk of likely significant effects arising to the River Itchen SAC in the absence of environmental mitigation.
Policy BE 2.1 - Northfields Farm and Hazeley Enterprise Park	Policy area located 440m to the east.	Part of the site already has planning permission and is part way through construction to provide employment space. The most western side of	At the time of writing this policy already holds planning permission consent. Screening assessment is therefore not required.

		site has consent for two different development types. This policy describes consent for the *'development of additional land and buildings with redevelopment of commercial buildings.'*	
Policy BE3 - Twyford Preparatory School	Policy area located 325m to the east.	This policy describes the future expansion at Twyford Preparatory School to increase pupil capacity, with new buildings likely to be limited to the upper parts of the site.	This policy is located 325m east from the SAC and the potential for new buildings is referenced. Consequently, there is the risk of water quality or flow/level issues associated with discharge of treated sewage effluent in particular that pose a likely significant effect to the River Itchen SAC and downstream European sites in the Solent.
Policy ST1: Visitor Attractions and Tourism Facilities	Within the Twyford Parish boundary.	This policy provides for the improvement of existing facilities as attractions (e.g. Twyford Waterworks), with provisions for development both inside the settlement boundary and the surrounding countryside. Visitor accommodation will only be permitted within the settlement boundary.	Due to the lack of spatial detail within the NP of tourism allocation there is a risk of likely significant effects arising to the European sites (although not the River Itchen SAC as its features have low sensitivity to recreational disturbance). Furthermore, LSEs of visitor accommodation could arise in relation to nitrates in the Solent.
Policy ST2 - Visiting and enjoying Twyford	Within the Twyford Parish.	This policy promotes opportunities for the understanding and enjoyment of the Parish's heritage, landscape and wildlife.	This is a positive policy aimed to improve public understanding of the local environment to promote public protection. This policy is therefore of benefit to the River Itchen SAC and not expected to have likely significant effects.
Policy CP1 - Community and sports facilities and open spaces	Within the Twyford Parish.	This policy identifies the need to protect and, in some cases, improve and update local amenity spaces.	This policy essentially refers to Policy SD46 of the adopted South Downs Local Plan, rather than making a policy of its own. Therefore, no likely significant effect will result.
Policy CP2 - New and Existing Community Facilities	Within the Twyford Parish.	This policy provides protection to current community facilities and provides protection to other buildings or land that are considered important to the local community.	This is a positive policy aims to protect current community facilities. Moreover, the policy essentially refers to Policy SD43 of the adopted South Downs Local Plan, rather than making a policy of its own. This policy is therefore not expected to have likely significant effects on the River Itchen SAC or Solent's European sites.
Policy CP3 – Twyford St Mary's Primary School	Policy located 215m to the east.	This policy promotes maintenance and development of St Mary's Primary School to improve access and capacity.	The site covered by this policy is located only 215m east from the SAC consequently there is the risk of likely significant effects due to any increase student capacity through associated water quality issues that pose a likely

			significant effect to the River Itchen SAC and downstream European sites in the Solent.
Policy LHE1 - Protected Gaps	Within the Twyford Parish.	This policy protects settlement boundaries between Twyford and Colden Common and Twyford and Shawford.	This policy ensures protection to settlement gaps between Twyford and surrounding villages. This policy is aimed to prevent/ reduce development in these areas and is therefore of benefit to the River Itchen SAC and not expected to have likely significant effects.
Policy LHE2 – Landscape features and views	Within the Twyford Parish.	Policy describes requirements and eligibility of housing design and landscape setting in Twyford.	This policy does not allocate sites for development; rather this policy provides building guidance for housing design. As such, this policy is not expected to lead to likely significant effects to the River Itchen SAC.
Policy LHE3 - The historic environment	Within the Twyford Parish.	Policy provides protection to area of Archaeological potential.	This is a positive policy aiming to protect to area of Archaeological potential. This policy is therefore of benefit to the River Itchen SAC and not expected to have likely significant effects.
Policy LHE4 – Twyford Conservation Area	Within the Twyford Parish	Policy identifies that Twyford's Conservation Area will be protected in collaboration with SDNP authority.	This is a policy protecting Twyford,s Conservation Area, which has no tangible consequences for European sites. This policy is not expected to have likely significant effects.
Policy LHE5 - Green Infrastructure	Within the Twyford Parish.	Policy provides protection to green infrastructure (Itchen Valley together with Twyford Down and Hockley Golf Course). It also specifies that all development will be assessed for its impact on and contribution to Green Infrastructure.	This is a positive policy aiming to protect to the natural environment. This policy is therefore of benefit to the River Itchen SAC and not expected to have likely significant effects.
Policy LHE6 - Local biodiversity, trees and woodlands	Within the Twyford Parish.	This policy promotes the Council's aims to work with other stakeholders / agencies to improve local biodiversity, encouraging voluntary community, participation in the care and maintenance of Twyford's natural environment. Importantly, a cross-border policy with Winchester City Council and the SDNP authority will be prepared to ensure the protection of the River Itchen SAC.	This is a positive policy aiming to protect to the natural environment. It contains specific wording relating to the River Itchen SAC, providing an extra layer of policy protection to the site. This policy is not expected to have likely significant effects.
Policy LHE7 - Dark night skies	Within the Twyford Parish.	This policy aims to protect the dark skies above Twyford and to reduce light pollution. It applies	This is a positive policy aiming to protect the status of the South Downs National Park which, since 2016, is

		to any proposal which involves the installation of external lighting and where the design of developments may result in light spill from internal lighting. It will also apply to specific lighting schemes which require planning permission or listed building consent, including car parks and sports pitches.	designated as an International Dark Sky Reserve. This policy is therefore of benefit to the River Itchen SAC and not expected to have likely significant effects.
Policies WE1 Flood Risk Management of the water environment	Within the Twyford Parish.	This policy aims to protect the water environment by providing flood mitigation schemes, storm water drainage and contributions to drainage improvements.	This is a positive policy aiming to protect the water environment. This policy is therefore of benefit to the River Itchen SAC and downstream European sites in the Solent and not expected to have likely significant effects.
Policies WE2 Foul Sewerage including Surcharging	Within the Twyford Parish.	This policy aims to formally register the history of sewage flood problems of Twyford with Southern Water and seek for Twyford to be added to its Flood Reduction Project and to seek active support from Southern Water for the flood prevention measures. Applications are required to provide a drainage plan, illustrating that the drainage associated with the site will use an existing foul sewer or will be dealt with by a small Package Treatment Plant (PTP).	Again, this is a positive policy aiming to protect the water environment, which applies to all new developments. It is particularly important for protecting the integrity of the River Itchen SAC and Solent's European sites, which are all sensitive to declines in water quality. This policy is therefore of benefit and not expected to have likely significant effects.
Policy MA1 – Rights of Way, walking and cycling	Within the Twyford Parish.	This policy protects and promotes enhancement to facilities for pedestrians, cyclists and the less mobile members of the community.	This policy aims to improve public use of paths and cycle routes thereby having a benefit to air quality and water quality. This policy is therefore of benefit to the River Itchen SAC and not expected to have likely significant effects.
Policy MA2 – Parking Provision	Within the Twyford Parish.	This policy provides for parking standards set out by the SDNP. It also reserves land adjacent to the existing Parish Hall car park for 40 additional parking spaces.	This policy aims to maintain appropriate parking opportunities in accordance with those set out by overarching authorities. This policy is not relevant to European sites and not expected to have likely significant effects.
Policy MA3 – Minor traffic management improvements	Within the Twyford Parish.	This policy manages excessive speed and parking within the Parish. It also requires that new developments mitigate impacts of additional traffic.	This policy aims to improve road safety and traffic management. It is therefore of benefit to European sites and not expected to have likely significant effects.

Policy MA4 - Access to Northfields Farm/Hazeley Enterprise Park	Within the Twyford Parish.	This policy promotes the formation of a new direct link from the bottom of Whites Hill into Northfields Farm/Hazeley Enterprise Park would provide environmental benefits to the village and reinforce the existing weight restriction along the village end of Hazeley Road.	This policy aims to prevent the movement of large goods vehicles over 7.5 tonnes through Twyford village. It is therefore of benefit to European sites and not expected to have likely significant effects.
Policy MA5 – Transport in the village	Within the Twyford Parish.	This policy promotes the development of pedestrian movement, cycle routes and public transport. For traffic there are several requirements for management systems to improve road safety and reduce parking within the town centre.	This policy aims to improve road safety and traffic management. It is therefore of benefit to European sites and not expected to have likely significant effects.
Policy SS1 Renewable Energy	Within the Twyford Parish.	This policy promotes the use of renewable energy sources where appropriate.	This is an environmentally positive policy and is therefore not expected to have likely significant effects to the River Itchen SAC or European sites in the Solent.
Policy SS2 Sustainable and Adaptable Buildings	Within the Twyford Parish.	This policy promotes all new development to be highly energy efficient and sustainable is considered.	This is an environmentally positive policy and is therefore not expected to have likely significant effects on European sites.
Policy - PO1 Pollution and Contaminated Land	Within the Twyford Parish.	This policy aims to reduce existing levels of pollution and mitigate further rise on contaminated land. Furthermore, it is specified that new development proposals will have to quantify additional nitrate emissions and mitigate their effects upon the Solent SPA.	This is an environmentally positive policy and is therefore not expected to have likely significant effects to the River Itchen SAC, the Solent Maritime SAC or the Solent & Southampton Water SPA / Ramsar.
Policy DE1 - Design	Within the Twyford Parish.	This policy describes requirements for building design. This includes development that are in keeping of local character and are of high-quality design, specifically taking account of the distinctive village character of Twyford village.	This policy does not allocate sites for development; rather this policy provides building guidance for housing design. As such, this policy is not expected to lead to likely significant effects on European sites.
Policy IDC1- Infrastructure	Within the Twyford Parish.	This policy ensures that developer provides adequate services and utilities for new development and in particular for the additional housing. Development proposals will also be required to mitigate any additional harm arising from such infrastructure.	This policy does not allocate sites for development; rather this policy provides infrastructure and services guidance for new housing. As such, this policy is not expected to lead to likely significant effects on European sites.

Policy DB1 - Development Brief for Land adjacent to the Parish Hall	Policy located 324m to the east.	This policy allocates land (Site 26) for a development of 20 residential dwellings, 20 or 40 car parking spaces, community facilities and open amenity space. It specifies that a drainage plan must be set up, providing details about preventing surface water run-off.	This development site (Site 26) is located 324m to the east of the River Itchen SAC. It is therefore expected that in the absence of appropriate environmental mitigation likely significant effects could arise to the River Itchen SAC and downstream European sites in the Solent regarding nitrogen neutrality. Although this is a design brief rather than a policy allocating development it is screened in to appropriate assessment for completeness.
Policy DB2 - Site Redevelopment: Stacey's Garage	Policy located 367m to the east.	Policy allocated land for re-development provided contamination from past use can be dealt with and facilities for pedestrian movement along the High Street frontage are provided.	Again, the area covered by this policy is located only 367m to the east of the River Itchen SAC. It is therefore expected that in the absence of appropriate environmental mitigation likely significant effects could arise to the River Itchen SAC and downstream European sites in the Solent regarding nitrogen neutrality. Impact pathways could be via water quality issues due to inappropriate management during development and/or in appropriate drainage systems post-development. It is noted that this policy is primarily intended to ensure contamination remediation takes place, but the policy is screened in for completeness.

5. Consideration of Effects 'In Combination'

5.1 The SDNP LP was subject to HRA in 2017 and updated in 2018. That HRA included a strategic assessment of air quality, hydrology and urbanisation 'in combination' with growth in other authority areas (including Twyford Parish) over the same time period. The 'in combination' assessment is discussed further in the appropriate assessment section of this report.

6. Appropriate Assessment

River Itchen SAC

Introduction

6.1 The law does not prescribe how an appropriate assessment should be undertaken or presented but the appropriate assessment must consider all impact pathways that have been screened in, whether they are due to policies alone or to impact pathways that arise in combination with other projects and plans. That analysis is the purpose of this section. The law does not require the 'alone' and 'in combination' effects to be examined separately provided all effects are discussed. The impact pathways of concern to this HRA (water quality, water resources and recreational pressure) are inherently 'in combination' since the amount of new development in the Twyford Neighbourhood Plan is too small to result in an adverse effect alone but only 'in combination' with other plans and projects.

6.2 The HRA screening exercise undertaken in Chapter 4, Table 3 indicated a total of 14 policies that were expected to have likely significant effects to the River Itchen SAC due to water quality, flow or runoff and abstraction issues. For the purpose of this appropriate assessment policies were grouped under 'housing and infrastructure development' or 'employment and tourist development'.

Housing and infrastructure development

6.3 At the screening stage the following policies were screened in, requiring further assessment:

- Policy SB1 - The Settlement Boundary Policy
- Policy SB2 – Development outside the Settlement Boundary
- Policy HN2 – Housing provision
    - 20 dwellings (development brief provided in Policy DB1)
- Policy HN3 – Land for housing: site selection
    - 20 dwellings (development brief provided in Policy DB1)
- Policy HN5 - Rural Exception Sites
- Policy HN6 - Housing - New proposals within the Settlement Boundary
- Policy HN7 – Housing in the countryside
- Policy BE3 - Twyford Preparatory School
- Policy CP3 – Twyford St Mary's Primary School
- Policy DB1 - Development Brief for Land adjacent to the Parish Hall
    - 20 residential dwellings, 20 or 40 car parking spaces, community facilities and open amenity space, associated with Site 26 allocated in Policy HN3.
- Policy DB2 - Site Redevelopment: Stacey's Garage
    - Land identified as supported for redevelopment (dwelling number undecided/ not submitted)

Employment and tourist development

6.4 At the screening stage the following policies were screened in, requiring further assessment:

- Policy BE1 – Employment and business provision
- Policy ST1 - Visitor Attractions and Tourism Facilities

Recreational pressure

6.5 The impact pathways assessed at the screening stage regarding tourist development and associated increases in recreational pressure, not specifically for the River Itchen (which has interest features identified in the HRA of the adopted Local Plan as being low risk from this pathway) but for other European sites, in combination with development elsewhere in the National Park and beyond.

6.6 This is an issue that is most appropriate to tackle at a Local Plan level and it was discussed extensively in the HRA of the adopted Local Plan. Due to its distance from sensitive European sites development at Twyford was not identified as a concern for any European sites regarding recreational pressure. Therefore,

a conclusion of no adverse effect on integrity can be drawn. Moreover, there are several general protective policies for European sites in the adopted Local Plan which will apply to any development in the Twyford Neighbourhood Plan. Policy SD9: Biodiversity and Geodiversity: '*Development proposals with the potential to impact on one or more international sites(s) will be subject to a Habitats Regulations Assessment to determine the potential for likely significant effects. Where likely significant effects may occur, development proposals will be subject to Appropriate Assessment… Development proposals that will result in any adverse effect on the integrity of any international site will be refused unless it can be demonstrated that: there are no alternatives to the proposal; there are imperative reasons of overriding public interest why the proposal should nonetheless proceed; and adequate compensatory provision is secured*'.

Water quality (treated effluent)

6.7 Eutrophication in the River Itchen, specifically regarding phosphate inputs (from wastewater discharge), is something the Environment Agency is seeking to resolve. In recent years the Agency has worked with WRc plc to develop modelling evidence to enable permit changes for managing and reducing phosphate loads entering chalk streams in the Upper Itchen catchment and specifically the River Itchen SAC. The Agency used this evidence during 2013/14 to engage with stakeholders and agree revisions to discharge permits for fish farms and watercress farms in the upper catchment to reduce the levels of phosphate discharged to the Itchen. The watercress farms are aiming to comply with these new permits in 2016, while on-going action will reduce loadings from other agriculture sectors in the catchment.

6.8 The Environment Agency undertook a series of Reviews of Consents for the River Itchen. These identified that phosphorus concentrations in the River Itchen SAC were leading in combination to an adverse effect on the integrity of this site. The major discharge to the River Itchen SAC is from the Chickenhall Lane WwTW in Eastleigh, downstream of the SDNP. Harestock WwTW (also located downstream of the SDNP) also makes a significant contribution. The Agency subsequently introduced a series of amendments to WwTW discharge consents into these receiving watercourses intended to reduce the inputs of these nutrients to acceptable levels.

6.9 Further to this, in 2016 Natural England produced a report presenting findings from investigations relating to phosphorous inputs to watercourses from small sewage discharges[11]. Essentially this identified that small package treatment plants that discharge to ground, the phosphorous can move within the soakway up to 20-30m in the soil laterally and up to 1.5m in depth. Where there is no hydrological connectivity within this area then the soakaway is effective in removing phosphorous and will pose a low risk in terms of phosphorus entering any receiving water. However, where there is hydrological connectivity e.g. watercourse or local drainage channels or a high water-table, in this area the soakaway will not be effective and there will be a high risk that phosphorous will be transferred into waterbodies and to protected sites such as the River Itchen SAC.

6.10 Natural England's Site Improvement Plan for the River Itchen SAC identifies further works to be undertaken by Partners to aid in improving the water quality of the River Itchen SAC via a Diffuse Water Pollution Plan. Actions include:

- Reducing road runoff (both as pathway for sediment from elsewhere, and as source from roadside) and a review of settling pond maintenance, both trunk roads and other public roads; quantifying the extent of the problem, through systematic catchment-wide risk appraisal, and address septic tank phosphate input. e.g. Compulsory registration of septic tanks and small package plants, to quantify inputs to the system and help reduce them, and to ensure best practice management of septic tanks/package plants is adhered to; and
- Addressing diffuse pollution from agriculture through a catchment-based approach.
- In addition, the Itchen Valley Grazing project aims to allocate funds to support project advice on land management of existing HLS agreements, and non-HLS grazed land

6.11 The Site Improvement Plan includes additional actions such as: a review of consents for water cress farms and fish farms based on revised phosphate standards for the SAC; and, ensure existing HLS agreements continue to benefit water quality (particularly through control and monitoring of stocking densities where grazed) and southern damselfly habitat. These can all help improve water quality of the SAC

[11] Natural England (2016) A summary of Natural England's research on Small Sewage Discharges and the risk to protected sites.

6.12 In addition to these the Environment Agency is leading a River Restoration Strategy with the aim of improving the quality of the River Itchen. Policy SD54: Pollution and Air Quality in the adopted SDNP Local Plan provides protection from pollution with which all new applications must comply: '*Development proposals will be permitted provided that levels of air, noise, vibration, light, water, odour or other pollutants do not have a significant negative affect on people and the natural environment now or in the foreseeable future, taking into account cumulative impacts and any mitigation'.*

6.13 Development of 20 new dwellings at Site 26, in addition to any additional school buildings at the Preparatory School or Primary School, any redevelopment of employment premises or any small-scale residential development under other policies (i.e. HN5-HN7) are likely to be served by a Wastewater Treatment Works (WwTW) which discharges into the River Itchen SAC, if they are served by mains drainage. However, they would not be served by the two works that have the biggest impact on Itchen water quality (Chickenhall WwTW and Harestock WwTW). The HRA of the adopted Local Plan identifies that (including the 20 dwellings allocated to Twyford) there are c. 50 new dwellings likely to come forward in parishes within the National Park that line the River Itchen. This is a relatively small number of new dwellings and the WwTW most likely to serve these dwellings have not been identified as being major contributors to exceedance of the River Itchen's water quality targets in the Review of Consents. Provided new development can be accommodated within the existing consent headroom for the relevant wastewater treatment works the Neighbourhood Plan will not contribute to an adverse effect on any European sites. Given the small number of dwellings involved it is considered very unlikely that there will be a difficulty accommodating these dwellings if they were to be served by mains drainage.

6.14 However, it is understood that some developments within the Itchen area may not be served by mains drainage. Therefore, in order to ensure no adverse effects on integrity result from potential increase in phosphorous levels as a result small sewage discharges associated with discharges from septic tanks and package treatment works associated with development, recommendations are made in the next section for additions to the Neighbourhood Plan text.

Surface runoff and floodplain impacts

6.15 The only development sites specifically identified in the Neighbourhood Plan (Site 26, the schools and Stacey's Garage) are all located at least 200m (and in most cases more than 300m) from the River Itchen SAC at their closest. However, the parish boundary extends up to the River Itchen SAC and includes the flood zone (Flood Zone 3) of the river, as identified in Map 14 of the Neighbourhood Plan. Sites proposed for development in such close proximity to the River Itchen could have issues with run off from the sites into the river, reducing water quality and changes in hydrology within the SAC, and would also involve a potential loss of floodplain. While in practice this will be assessed on an application by application basis, it is considered that an explicit commitment is required in the Neighbourhood Plan. **It is strongly recommended that wording is included in Policy WE1 that states new development within Flood Zone 3 will not be supported.**

6.16 There is a small risk that development in Twyford, even if outside Flood Zone 3, could potentially affect the ground water flows to the River Itchen SAC if the development is inappropriately designed. However, careful design using standard practices would avoid this occurrence and it will be a standard requirement of the Environment Agency that surface water flows off site do not exceed existing greenfield rates. This requirement is also included in Policy SD50: Sustainable Drainage Systems of the adopted South Downs Local Plan. Policy SD50 requires: '*Development proposals will be permitted where they ensure that there is no net increase in surface water run-off, taking account of climate change… major development will be permitted where they provide suitable sustainable drainage systems… [sustainable drainage systems must] enhance biodiversity and other public benefits as appropriate*'. Therefore, no specific additional wording is recommended for the Neighbourhood Plan.

Abstraction for public water supply

6.17 The River Itchen is covered by the Environment Agency's Test and Itchen CAMS. The surface water resource is identified as having no water available for licencing, while the Itchen Groundwater supply is identified as 'restricted water available for licensing'. Water availability in the Itchen parts of the CAMS area is therefore very restricted. For salmon, flow rates are critical to the success of the species. Low flow rates affect food availability and migration. Low flows mean reduced invertebrate food, and increased concentrations of pollutants significantly reducing the numbers of salmon returning up river to spawn. In low flow years, salmon returning to spawn can be reduced by as much as 50%. Low flow also means more silt

and less oxygen in the water, significantly reducing the survival rate for the eggs of the salmon that do spawn.

6.18 Natural England's Site Improvement Plan for the River Itchen SAC identifies further works to be undertaken by Partners to aid in improving the hydrology of the river. Actions include:

- Amending water company abstraction licence identified through the Review of Consent process;
- Amend/ revoke Environment Agency permits to abstract and then augment river (Candover and Arle schemes respectively) and linked Water Resource Management Plan process; and,
- Investigate causes of apparent drying on floodplain meadows, with a focus on abstractions (if not covered by RoC) and water level management issues. Implement any changes identified through existing mechanisms. Affects discrete areas of the SAC floodplain

6.19 The Site Improvement Plan for the River Itchen SAC includes a Water Level Management Plan to manage water levels and avoid potentially damaging low flows. This is linked to the River Restoration Strategy.

6.20 Historically, the Environment Agency Review of Consents for the River Itchen SAC identified that abstraction could (during a dry year) result in flows in Candover Stream and the main River Itchen south of Winchester to fall to approximately 35% below naturalised flow in September. The Agency has therefore introduced a series of amendments to abstraction licences for the River Itchen SAC to reduce abstraction to acceptable levels. As part of its Review of Consents process, the EA has decided to modify licences to meet the Environment Agency target flow regime for the river by imposing a hands off flow condition (i.e. a condition which stipulates that the abstraction must cease when the river flow drops to a certain point) and by applying monthly totals for June to September (inclusive) (i.e. a maximum volume of water that can be abstracted).

6.21 An analysis of future water supply-demand balance across Southern Water supply area identified that in 2019 the level of abstraction on the River Itchen must be reduced for environmental reasons. As such the River Itchen will require Sustainability Reductions in abstraction to prevent likely significant effects upon the SAC. New restrictions limit the amount of water that can be abstracted from the River Itchen between the months of June and September each year. To counter this and to meet water demand within the Hampshire South Water Resource Zone (WRZ), Southern Water has developed a Water Resource Strategy.

6.22 Southern Water have identified that to meet the future water supply requirements to 2040 implemented in the Hampshire South and Isle of Wight WRZs, so that the security of supplies is maintained throughout the planning period[12].

- Universal metering;
- Leakage reduction;
- Asset improvement schemes for groundwater sources;
- Increase of Testwood Water Supply Works to licence limit; and
- Development of the enabling Testwood to Otterbourne transfer and associated distribution infrastructure.

6.23 Given these interventions identified to meet the public water supply requirement by 2040 it is therefore considered that increased abstraction from the River Itchen should not be required and there should therefore be no likely significant effect upon the River Itchen SAC. The HRA screening for the Southern Water WRMP concluded that likely significant effects arising from implementation of the revised draft WRMP could not be ruled out due to potential effects of the Candover groundwater scheme for river augmentation on the River Itchen SAC. However, the subsequent Appropriate Assessment (AA) by Cascade Consulting confirmed that no adverse effects on integrity of the SAC/SPA/Ramsar site would arise.

6.24 Since the adoption of the WRMP (including drought options), the Environment Agency has announced plans to renew its Candover abstraction licence at a much reduced five million litres a day rather than the previous 27 million litres a day as had been accounted for in the WRMP and associated HRA/ AA. At time of writing an inquiry is being held regarding this matter. The Candover abstraction licence was a key component of the WRMP's ability to adhere to the Habitats Directive, as water from the Candover abstraction was to be used to top up the River Itchen at Otterbourne Water Supply Works, thus ensuring sustainable flows during

[12] Southern Water. Water Resource Management Plan 2015 – 2040
https://www.southernwater.co.uk/Media/Default/PDFs/water-resources-drought-strategy-summary.pdf [accessed 13/09/2019]

drought periods. This was due to be used from 2018, As such it may be that Southern Water is unable to provide the quantum of water required to support new development that relies on water from this new scheme.

6.25 To ensure that the quantum of development identified within the Neighbourhood Plan does not affect the integrity of the River Itchen SAC through changes in water levels due to abstraction for public water supply, it is recommended that the South Downs National Park Authority liaise with Southern Water before relevant applications are consented to confirm how their water supply requirements are to be met in the absence of the Candover Augmentation Scheme. It may be that the scale of planned development is sufficiently small that the company can meet it from elsewhere in their supply network. New development in Twyford should not be consented until Southern Water can confirm that they can sustainably supply the water required without affecting the integrity of the River Itchen SAC. This is an action on the National Park Authority rather than the Neighbourhood Plan group. Therefore, no recommendations are made for changes to the Neighbourhood Plan.

Mitigation

6.26 The above policies at the screening stage were expected to have likely significant effects to SAC integrity due to water quality issues, as described in Table 1. The appropriate assessment documented above has identified the need for some additional wording to be included in the Neighbourhood Plan to address issues of water quality and surface water runoff and floodplain impacts.

6.27 Mitigation to prevent surface water runoff is through good drainage design. The Twyford NP does not provide policy requirements for sustainable drained but the SDNP LP does incorporate a sustainable drainage system within their LP. **It was recommended that a requirement is added to Policy WE2 that any applicant will need to provide a drainage plan to show that the drainage associated with the site will either utilise an existing mains drainage system at the nearest point of capacity or will be dealt with by a small package treatment plant (or similar). The supporting text should clarify that if the decision is to use a small package treatment plant, this will need to demonstrate that there is no hydrological connectivity from the proposed package treatment plant to the River Itchen. The plan should assess if there are existing watercourse, local drainage channels or a high water-table in the area of the proposed package treatment that will mean that the proposed package treatment would not be effective and would result in there being a high risk that phosphorous transferred into the protected watercourses (the River Itchen SAC and SSSI). If emission of phosphorous from the new development could not be prevented, the scheme would not be supported until a suitable solution is identified.** A review of Policy WE2 indicates that this wording has now been including in the policy / supporting text. Therefore, it can be concluded that the Twyford NP will not result in adverse effects on the integrity of the River Itchen SAC regarding water quality, in-combination with other plans and projects.

6.28 With regard to controlling surface runoff and floodplain impacts, **it is strongly recommended that wording is included in Policy WE1 that states new development within Flood Zone 3 will not be supported.**

Solent & Southampton Water SPA / Ramsar & Solent Maritime SAC

Water quality (treated effluent)

6.29 An Integrated Water Management Strategy (IWMS) for the Partnership for South Hampshire (PfSH) examined the capacity of the region to accommodate future housing growth without adversely affecting the ecological interest of Solent's European sites. This process determined that there currently is considerable uncertainty as to whether more growth can be accommodated. This conclusion was underpinned by Natural England condition assessments, showing qualifying habitats of the Solent Maritime SAC to be failing with regard to nutrient water quality attributes. While assessments of SPAs / Ramsars are yet to be completed, the abundance of several qualifying bird species is decreasing in contrast to wider national trends. Therefore, site-specific factors (potentially nutrient concentrations) are likely to be causing this decline.

6.30 Due to the results of the IWMS, Natural England have developed a nutrient neutral approach, specifying that there can be no further net increase in nutrients to the Solent. In marine habitats, nitrogen is the primary limiting nutrient and the calculations therefore centre entirely around nitrogen (and its various inorganic and organic forms). Furthermore, the nutrient neutral approach must be tested through the Appropriate Assessment stage in HRAs. A neutral nutrient budget provides sufficient evidence and reasonable certainty that a development will not result in adverse effects on the integrity of Solent's maritime sites. Therefore, this section presents the nutrient calculations for the allocations in the Twyford NP, namely for Site 26 Land

adjacent to the Parish Hall. While the TNP allocates three sites for potential development (Policies DB1, DB2 and HN7), nutrient calculations can only be undertaken for Policy DB1 (Site 26, Land adjacent to the Parish Hall). This is because no specific detail relating to development in the other sites has come forward. Should residential dwellings be delivered as part of either of these policies, nutrient budget calculations will be required for the planning application stage HRA.

6.31 A nitrogen budget for Site 26 was calculated using Natural England's latest advice note on nutrient neutrality in the Solent region (see Apendix A). The calculations require the Total Nitrogen (TN) permit limit at the relevant Wastewater Treatment Works (WwTWs). However, not all WwTWs have a TN permit and the sewage treatment plant responsible for a given development is often not available until later development stages. If such data are unavailable, Natural England advises that a precautionary TN figure of 27mg/l is used in the calculations, which is the average nitrogen concentration in effluent measured in the Solent. This figure has been used to determine the nitrogen loading associated with Site 26.

6.32 Table 4 details the values for different stages of the nitrogen calculations, with Stage 4 establishing the overall nutrient budget for Site 26. This highlights that the development has a nitrogen surplus of 33.28 kg/TN/yr and therefore (in the absence of mitigation) would result in additional nitrogen input to the Solent. It is to be noted that in the event a WwTW with a nitrogen permit is identified, this is likely to considerably reduce this nitrogen surplus. WwTWs with stringent nitrogen removal are likely to achieve much lower nitrogen effluent concentrations (e.g. approx. 9-10mg/l) than the generic figure of 27mg/l used in this HRA. However, in summary, the calculations suggest that Natural England's requirement of achieving nutrient neutrality currently is not met by the site allocated in Twyford NP.

Table 4: Nutrient neutrality calculation for Site 26 allocated in the Twyford NP (see Appendix B for detailed breakdown of calculation).

Site allocation	Stage 1 – Nitrogen load in future treated wastewater effluent (kg/TN/yr)	Stage 2 – Loss of nitrogen input due to the conversion of existing land uses (kg/TN/yr)	Stage 3 – Nitrogen leachate from future land uses (kg/TN/yr)	Stage 4 – Overall nutrient budget (kg/TN/yr) with a 20% precautionary buffer
Site 26 (Land adjacent to the Parish Hall)	48.18	34.32	13.87	33.28

6.34 Several solutions are available to mitigate potential nutrient-related adverse impacts in treated sewage effluent. These include:

- Provision of measures to reduce nitrogen draining from the development site or discharging from the relevant WwTW (such as through downstream constructed wetlands or reedbeds)
- Increasing the extent of open space provision surrounding the development site (ideally by removing agricultural land from production), which is associated with reduced nitrogen leaching
- Establishing in-perpetuity changes in agricultural land management in the wider landholding or acquiring agricultural land in the discharge catchment of the WwTW for land use conversion (e.g. into woodland, wetland or conservation grassland)
- Securing an agreement with the wastewater treatment provider to maintain increased nitrogen removal at the relevant WwTW
- Securing an agreement with the wastewater treatment provider to increase nitrogen removal through additional point-source measures (e.g. small wetlands / reedbeds immediately downstream from the plant)

6.35 In practice, the more strategic of these measures (e.g. agreements with wastewater treatment providers) are unlikely to be achievable at the NP level or for individual planning applications. These are more likely to be relevant regarding the in-combination strategic growth across Local Planning Authorities; they have been mentioned here for completeness only. AECOM considers that the most straightforward mitigation solution for the Twyford NP would be to take additional agricultural land out of production. In order to mitigate the

33.28 kg/TN, only approx. 1ha of cereal crops or 1.1ha of horticultural land[13] would have to be acquired and its land use converted.

6.36 It is also to be noted that the UK government is currently developing an online platform for nitrate trading[14]. Through this housing developers will be able to buy credits, which will be used towards the creation of new interceptor habitats (e.g. meadows, woodlands and wetlands). These will sit in the same hydrological catchments between new development and Solent's coastal sites, providing vital buffers to the marine ecosystems protected by the coastal SPA / Ramsar / SAC designations. At the same time, the creation of these new habitats will enable new housing growth to come forward. Depending on when the trading platform becomes operational, the developer of Site 26 may also choose to pursue mitigation by purchasing nitrate credits.

6.37 Due to the above, it is recommended that further protective policy text is inserted into **Policies DB1 (Development Brief for Land adjacent to the Parish Hall), DB2 (Housing Allocation: Stacey's Garage) and HN7 (Orchard Close)** in the next iteration of the Twyford NP to secure adequate water quality mitigation in line with NE guidance. The following text (or similar) could be inserted: '***Development proposals will only be supported if they are nitrogen neutral. An updated nitrogen budget will have to be calculated for the planning application stage, using Natural England's latest guidance note on achieving nutrient neutrality in the Solent region. Should a nitrogen surplus be identified, the proposal will have to be supported by adequate mitigation measures agreed upon by Natural England***'. More detailed examples on the type of mitigation potentially provided (see text above), could be added to the supporting text of that same policy.

6.38 Assuming an updated nutrient budget is calculated and, if required, appropriate mitigation measures are secured at the planning application stage, it is concluded that the Twyford NP will not result in adverse effects on the integrity of the Solent & Southampton Water SPA / Ramsar and the Solent Maritime SAC regarding water quality, in-combination with other plans and projects. The provision of adequate mitigation measures would ensure that the Conservation Objectives of Solent's European sites are protected.

7. Conclusion

7.1 For those policies brought forward for appropriate assessment the appropriate safeguarding policy wording should be added. With the above recommendations incorporated it is concluded that no adverse effect would occur on the integrity of the River Itchen SAC and Solent's European sites (most notably the Solent & Southampton Water SPA / Ramsar and the Solent Maritime SAC).

[13] Based on the respective average nitrogen losses for these farm types given in Natural England's Advice Note.
[14] The new nitrate trading platform is referred to in recent government bulletin. Available at: https://www.gov.uk/government/news/wildlife-protection-plan-to-unlock-hampshire-housebuilding [Accessed on the 26/10/2020]

Appendix A Natural England advice on achieving nutrient neutrality in the Solent region

ADVICE ON ACHIEVING NUTRIENT NEUTRALITY FOR NEW DEVELOPMENT IN THE SOLENT REGION

SECTION 1 INTRODUCTION

1.1 The water environment within the Solent region is one of the most important for wildlife in the United Kingdom. It is internationally important for its wildlife and is protected under the Water Environment Regulations[i] and the Conservation of Habitats and Species Regulations[ii] as well as national protection for many parts of the coastline and their sea.[iii] There are high levels of nitrogen and phosphorus input to this water environment with sound evidence that these nutrients are causing eutrophication at these designated sites. These nutrient inputs currently mostly come either from agricultural sources or from wastewater from existing housing and other development. The resulting dense mats of green algae and other effects on the marine ecology from an excessive presence of nutrients are impacting on the Solent's protected habitats and bird species.

1.2 There is uncertainty as to whether new growth will further deteriorate designated sites. This issue has been subject to detailed work commissioned by local planning authorities (LPAs) in association with Natural England, Environment Agency and water companies. This strategic work, which updates early studies, is on-going. Until this work is complete, the uncertainty remains and the potential for future housing developments across the Solent region to exacerbate these impacts creates a risk to their potential future conservation status.

1.3 One way to address this uncertainty is for new development to achieve nutrient neutrality. Nutrient neutrality is a means of ensuring that development does not add to existing nutrient burdens and this provides certainty that the whole of the scheme is deliverable in line with the requirements of the Conservation of Habitats and Species Regulations 2017 (as amended).

1.4 This report sets out a practical methodology to calculating how nutrient neutrality can be achieved. This methodology is based on best available scientific knowledge, and will be subject to revision as further evidence is obtained. It is our advice to local planning authorities to take a precautionary approach in line with existing legislation and case-law when addressing uncertainty and calculating nutrient budgets.

1.5 This report includes a brief summary of the planning and environmental context for this nutrient neutral approach, the detailed methodology and advice on mitigation. Further information and guidance is included in the annexes.

SECTION 2 PLANNING CONTEXT

2.1 The Partnership for Urban South Hampshire (PUSH), Natural England (NE), and Environment Agency (EA) have been jointly working to develop an Integrated Water Management Strategy (IWMS) since before 2008. This work examines the potential for the PUSH region to accommodate future housing growth without having a detrimental effect upon the water environment. A Water Quality Working Group has been set up to identify and analyse the existing evidence gaps and evaluate the need for strategic mitigation measures. A Water Quality Group including Natural England, Environment Agency and Chichester District Council have been working to identify solutions to water quality concerns in Chichester Harbour for at least 10 years. However, there is currently uncertainty as to whether there is sufficient capacity to accommodate the new housing growth.

2.2 Since March 2018, Natural England has been advising that one means of addressing this uncertainty for larger development (in excess of 200-300 houses), including all EIA development, is to calculate a nutrient budget and achieve nutrient neutrality.

2.3 During the summer of 2018, a review of the condition of designated sites water environment in the Solent harbours was undertaken (see next section). The best available up-to-date evidence has identified that some interest features at the designated sites, such as intertidal mudflat habitat and the wildlife they support are widely in unfavourable condition due to existing levels of nutrients and are therefore at risk from additional nutrient inputs.

2.4 It is Natural England's view that there is a likely significant effect on several internationally designated sites (Special Protection Areas, Special Areas of Conservation and Ramsar sites) due to the increase in wastewater from the new developments coming forward.

2.5 The uncertainty about the impact of new development on designated sites needs to be recognised for all development proposals that are subject to new planning permissions and have inevitable wastewater implications. These implications, and all other matters capable of having a significant effect on designated sites in the Solent, must be addressed in line with Regulation 63 of the Conservation of Habitats and Species Regulations 2017.

2.6 LPAs and applicants will be aware of CJEU decisions regarding the assessment of elements of a proposal aimed toward mitigating adverse effects on designated sites and the need for certainty that mitigating measures will achieve their aims. The achievement of nutrient neutrality, if scientifically and practically effective, is a means of ensuring that development does not add to existing nutrient burdens.

2.7 The Water Quality Working Groups draw together expertise from local planning authorities, Environment Agency, Natural England and the water companies to examine this uncertainty further and develop an approach that ensures that

development can progress in a timely manner whilst ensuring the requirements of the Habitats Regulations are met. Further information is included in Annex 1.

SECTION 3 ENVIRONMENTAL CONTEXT

3.1 In 2018 and 2019 Natural England undertook a number of condition assessments of the features of the designated international sites around the Solent (the Solent Maritime SAC, Chichester and Langstone Harbours SPA, Portsmouth Harbour SPA, Solent and Southampton Water SPA) as well as the nationally designated SSSIs that underpin these international designations. An account of the outcome of these assessments, together the evidence used to support the conclusions, is given in Annex 2 with a brief summary below. Annex 2 also includes information on the Solent and Dorset Coast SPA and the Solent and Isle of Wight Lagoons SAC.

Solent Maritime SAC

3.2 For the Solent Maritime SAC the condition assessments completed considered the SAC features across the site as a whole and found the condition of these features - estuary, mudflat & sandflats, sandbanks – to be unfavourable. The unfavourable assessment is based on a number of attributes failing, including the nutrient water quality attribute. Other attributes were also found to be failing, such as, for seagrasses, their extent, distribution, rhizome structure and reproduction as well as biomass, and for the intertidal mud and sand features their infaunal quality. These failures are considered to be in part due to impacts from elevated nutrients.

3.3 Currently the site condition assessment does not include the saltmarsh feature which has not yet been assessed. However preliminary analysis of data shows that there was a loss of extent of saltmarsh across the Solent between 2008 and 2016.

Special Protection Areas and Ramsar sites (Solent and Southampton Water, Portsmouth Harbour and Chichester and Langstone Harbours)

3.4 Condition assessment for the SPAs and Ramsar sites have yet to be undertaken, but a number of bird features are declining as highlighted by recent Wetland Bird Survey alerts. A comparison with regional and national trends indicates that several of the declines are likely to be due to site specific reasons rather than reflecting wider national or regional population trends. While the cause of these site specific declines in the Solent area are largely unknown there are possible links to the elevated nutrient loading.

Sites of Special Scientific Interest (SSSI)

3.5 During 2018 and 2019, Natural England revised and updated the SSSI assessments in the greater Solent area in relation to the influence of the water environment on the condition of estuarine SSSI interest features that underpin the SAC and SPAs. These assessments especially included littoral sediment habitat (mudflat and other tidally

exposed sediment flats). The review of parts of the greater Solent area and some SSSI interest features is ongoing.

3.6 The SSSI interest feature assessments completed consider the concentrations of inorganic nitrogen status in each harbour and estuary, and evidence for ecological responses. Particular attention was given to records on phytoplankton abundance and the presence and abundance of opportunistic green macroalgae.

3.7 These SSSI assessments give a spatially more specific account of the condition of protected sites and details are given in Annex 2 with condition varying across different parts of the Solent. Overall some 81% of the total area assessed is in unfavourable condition. Breaking down this unfavourable area, 40% if it is classed as recovering condition, most of this being in Langstone Harbour but these units are considered 'at risk' of not recovering to a favourable situation as it is unclear whether the nutrient status will become adequate to substantially prevent the growth of dense macroalgae mats in parts of the Harbour.

3.8 In 2019 and 2020, a more detailed review of Chichester Harbour's intertidal features was undertaken of all the overlapping national and internationally designated features including saltmarsh, wintering and nesting birds. More than 3000 hectares of the harbour is in unfavourable declining condition. Reasons for feature declines are complex with many factors acting together, but water quality is one of the contributing causes to the observed declines.

SECTION 4 NUTRIENT NEUTRALITY APPROACH FOR NEW DEVELOPMENT

Introduction

4.1 Achieving nutrient neutrality is one way to address the existing uncertainty surrounding the impact of new development on designated sites. This practical methodology provides advice on how to calculate nutrient budgets and options for mitigation, should this be necessary.

4.2 There is evidence that inputs of both phosphorus and nitrogen influence eutrophication of the water environment. However, the principal nutrient that tends to drive eutrophication in the marine environment is nitrogen and this is supported by modelling and evidence. Please see Annex 2 for further details.

4.3 The best available evidence is for focus in the Solent harbours to be on nitrogen reduction, and reduction in both nitrogen and phosphorus in the Medina catchment. However, this approach may be refined if greater understanding of the eutrophication issue is gained by thorough new research or updated modelling.

4.4 The nutrient budget in this report calculates quantities of nitrogen (N) generated by development. This N comes in different forms and measured N concentrations vary according to exactly what is measured. These differences need to be recognised when calculating nutrient budgets. The key measurement is Total Nitrogen (TN), i.e. both organic and inorganic forms of nitrogen, because this is what is available for

plant growth. TN is the sum of the inorganic forms - nitrate-nitrogen (NO_3-N), nitrite-nitrogen (NO_2-N), ammoniacal - N - and organically bonded nitrogen.

4.5 For developments on the Isle of Wight that are impacting on the Medina estuary, both a phosphorus and nitrogen budget may be required. Natural England will work closely with the Isle of Wight Council and applicants to provide advice on a bespoke case-by-case basis.

Approach to calculating nutrient budgets

4.6 For those developments that wish to pursue neutrality, Natural England advises that a nitrogen budget is calculated for new developments that have the potential to result in increases of nitrogen entering the international sites. A nutrient budget calculated according to this methodology and demonstrating nutrient neutrality is, in our view, able to provide sufficient and reasonable certainty that the development does not adversely affect the integrity, by means of impacts from nutrients, on the relevant internationally designated sites. This approach must be tested through the 'appropriate assessment' stage of the Habitats Regulations Assessment. The information provided by the applicant on the nutrient budget and any mitigation proposed will be used by the local planning authority, as competent authority, to make an appropriate assessment of the implications of the plan or project on the designated sites in question. Further information of this process is available here.

4.7 The nutrient neutrality calculation includes key inputs and assumptions that are based on the best-available scientific evidence and research. It has been developed as a pragmatic tool. However, for each input there is a degree of uncertainty. For example, there is uncertainty associated with predicting occupancy levels and water use for each household in perpetuity. Also, identifying current land / farm types and the associated nutrient inputs is based on best-available evidence, research and professional judgement and is again subject to a degree of uncertainty.

4.8 It is our advice to local planning authorities to take a precautionary approach in line with existing legislation and case-law when addressing uncertainty and calculating nutrient budgets. This should be achieved by ensuring nutrient budget calculations apply precautionary rates to variables and adding a precautionary buffer to the TN calculated for developments. A precautionary approach to the calculations and solutions helps the local planning authority and applicants to demonstrate the certainty needed for their assessments.

4.9 By applying the nutrient neutrality methodology, with the precautionary buffer, to new development, the competent authority may be satisfied that, while margins of error will inevitably vary for each development, this approach will ensure that new development in combination will avoid significant increases of nitrogen load to enter the internationally designated sites.

Location of development

4.10 The nutrient neutrality approach only applies to developments where the treated effluent discharges into any Solent international sites (Solent Maritime SAC, Solent and Southampton Water SPA and Ramsar, Portsmouth Harbour SPA and Ramsar, Chichester and Langstone Harbours SPA and Ramsar), or any water body (surface or groundwater) that subsequently discharges into such a site. The catchment area is shown on Figure 1.

4.11 This approach may be refined if greater understanding of the eutrophication issue is gained by thorough new research or updated modelling.

Type of development

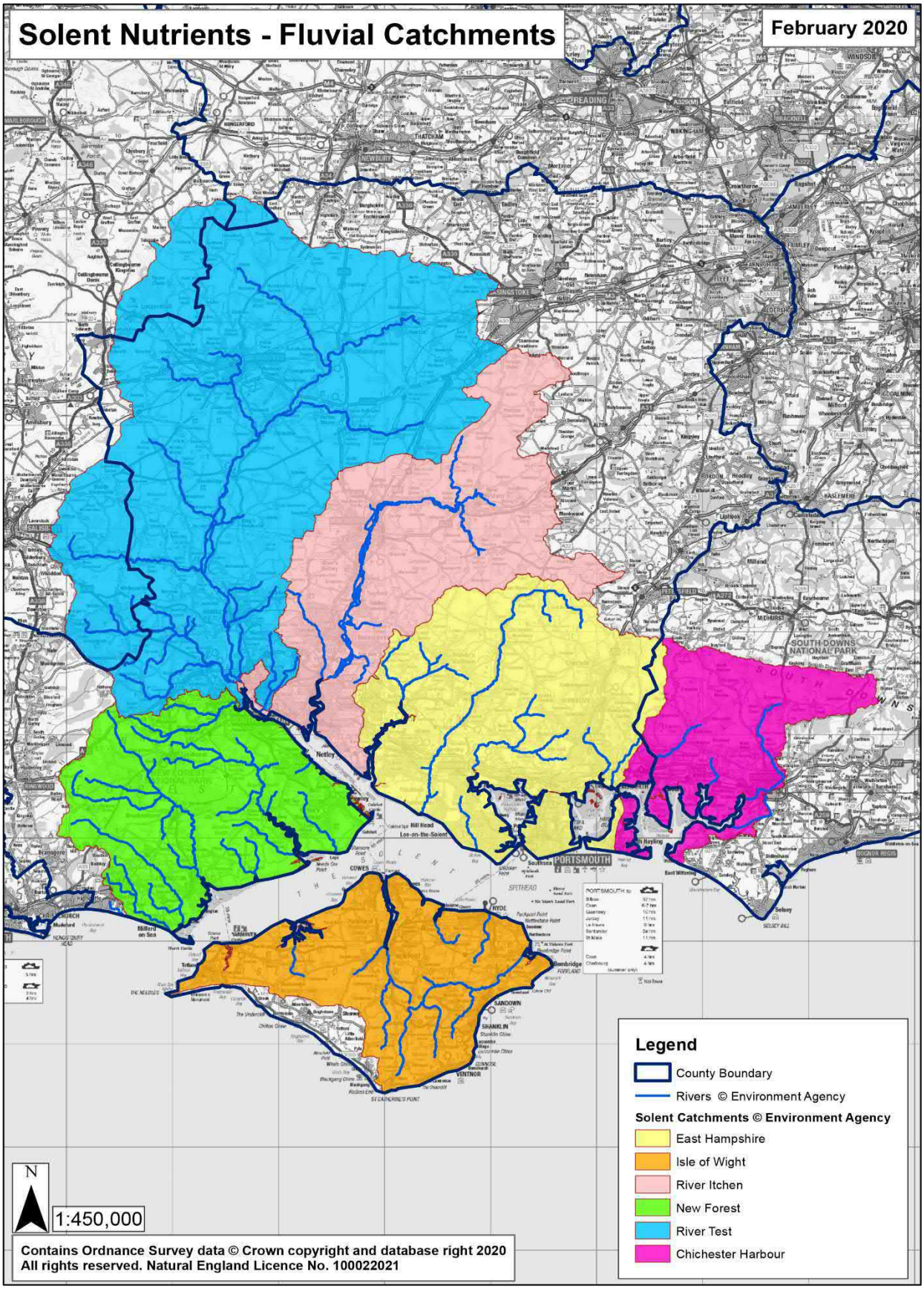
4.12 This methodology is for all types of development that would result in a net increase in population served by a wastewater system, including new homes, student accommodation, tourism attractions and tourist accommodation. This development will have inevitable wastewater implications.

4.13 Other commercial development not involving overnight accommodation will generally not be included. It is assumed that anyone living in the catchment also works and uses facilities in the catchment, and therefore wastewater generated by that person can be calculated using the population increase from new homes and other accommodation. This removes the potential for double counting of human wastewater arising from different planning uses.

4.14 Tourism attractions and tourism accommodation are exceptions, as these land uses attract people into the catchment and generate additional wastewater and consequential nitrogen loading on the Solent. This includes self-service and serviced tourist accommodation such as hotels, guest houses, bed and breakfasts and self-catering holiday chalets and static caravan sites. Other applications will be considered on their individual merits, for example new cruise ship facilities etc.

4.15 There may be cases where planning applications for new commercial or industrial development or changes in agricultural practices could result in the release of additional nitrogen into the system. In these situations, a case-by-case approach will be adopted. Early discussions with Natural England via our chargeable services (DAS) are recommended.

Figure 1 Solent Catchment Area *Contains public sector information licensed under the Open Government Licence v3.0*



Methodology for nutrient budgets

4.16 The initial stage is to determine whether the development will drain to the mains network or to a non-mains facility e.g. an on-site package treatment plants.

4.17 The methodology for development that drains to the mains network is in Section A. Please go to Section B if the new development is not on the mains network.

Section A

Stage 1 Calculate Total Nitrogen (TN) in kilograms per annum derived from the development that would exit the Wastewater Treatment Works (WwTW) after treatment

Stage1 *Step 1Calculate additional population*

4.18 New housing and overnight accommodation can increase the population as well as the housing stock within the catchment. This can cause an increase in nitrogen discharges. To determine the additional population that could arise from the proposed development, it is necessary that sufficiently evidenced occupancy rates are used. Natural England recommends that, as a starting point, local planning authorities should consider using the average national occupancy rate of 2.4, as calculated by the Office for National Statistics (ONS), as this can be consistently applied across all affected areas.

4.19 However competent authorities may choose to adopt bespoke calculations tailored to the area or scheme, rather than using national population or occupancy assumptions, where they are satisfied that there is sufficient evidence to support this approach. Conclusions that inform the use of a bespoke calculation need to be capable of removing all reasonable scientific doubt as to the effect of the proposed development on the international sites concerned, based on complete, precise and definitive findings. The competent authority will need to explain clearly why the approach taken is considered to be appropriate. Calculations for occupancy rates will need to be consistent with others used in relation to the scheme (e.g. for calculating open space requirements), unless there is a clear justification for them to differ.

Stage 1 *Step 2 Confirm water use*

4.20 Determine the water use / efficiency standard for the proposed development to be defined in the planning application and, where relevant, the Environmental Statement. The nitrogen load is calculated from the scale of water use and thus the highest water efficiency standards under the building regulations will minimise the increase in nitrogen from the development.

4.21 It is recommended that each Local Planning Authority impose a planning condition on all planning permissions for one or more net additional new dwellings requiring construction to the optional requirement[iv] under G2 of the Building Regulations 2010.

4.22 A model condition is set out below:

"*The dwellings shall not be occupied until the Building Regulations Optional requirement of a maximum water use of 110 litres per person per day has been complied with."*

4.23 The water use figure is a proxy for the amount of wastewater that is generated by a household. New residential development may be able to achieve tighter water use figures, with or without grey water recycling systems, and this approach is supported from a water resource perspective (for example in support of Southern Water's Target 100 litres per person per day). However, the key measurement is the amount of wastewater generated by the development that flows to the wastewater treatment works.

4.24 If tighter water use restrictions are used in the nutrient calculation – with or without grey water recycling systems – these restrictions should reflect the wastewater expected to be generated over the lifetime of the development. There is a risk that when kitchen and bathroom fittings are changed by occupants over the years, less water-efficient models could be installed. It is Natural England's view that it would be difficult to evidence and secure delivery of tighter restrictions at this time. However, if sound evidence can be provided, this will be considered on a case-by-case basis.

4.25 It is Natural England's view that while new developments should be required to meet the 100 litres per person a day standard, the risk of standards slipping over time and the uncertainty inherent in the relationship between water use and sewage volume should be addressed by the use in the calculation of 110 litres per person per day figure.

Stage 1 *Step 3 Confirm WwTW and permit level*

4.26 Identify the Wastewater treatment works (WwTW) that the development will drain to and whether it has a TN permit.

4.27 For most planning applications, the WwTW provider is not confirmed until after planning permission is granted. The nutrient calculation should be based on the permit levels of the most likely WwTW. In any cases where the WwTW changes, a reassessment of the nutrient calculation will be required to ensure the development is nutrient neutral.

<u>WwTWs with TN permit</u>

4.28 Identify the permit concentration limit for Total Nitrogen at the proposed WwTW. If the WwTW will have a tightened permit concentration limit for Total Nitrogen under the company's Water Industry Asset Management Plan by 2024 then use this tightened value. If a new WwTW is proposed, obtain a determination from the

Environment Agency on the permit limit for Total Nitrogen that would apply to the works and when they are likely to be built.

4.29 Where there is a permit limit for Total Nitrogen, the load calculation will use a worst case scenario that the WwTW operates at 90% of its permitted limit. A water company has the option of operating the works as close to the consent limit as practicable without breaching the consent limit. Natural England and the Environment Agency have agreed to take 90% of the consent concentration limit as the closest the water company can reasonably operate the works without risk of breaching the consent limit.

WwTWs without a TN permit

4.30 For developments that discharge to WwTWs with no TN permit limit, best available evidence must be used for the calculation. In the first instance, Southern Water or other wastewater provider should be contacted for details of the nitrogen effluent levels for the specific WwTW. Robust evidence may be available to derive a value for nitrogen in the wastewater stream based on the type of wastewater treatment at the works.

4.31 However, if this data is not available, a figure of 27mg/l can be used. This figure has been derived by Southern Water from nitrogen effluent concentrations at two WwTWs in the Solent area and this average figure may change if new evidence becomes available.

4.32 It is not possible to apply the 90% correction in these cases as these WwTWs are not regulated by a Total Nitrogen consent limit.

Relationship between TN and water use

4.33 For WwTWs with TN consents there is a direct relationship between TN and water use. For example, for WwTWs with a permit of 9 mg /l, it can be calculated that for each litre of water that passes through the works, 8.1mg (90% of 9 mg/l) of nitrogen could be released into the water environment. If a household uses 150 litres, this equates to 1215 mg of TN; if this is reduced to 100 litres, 810 mg of TN is released.

4.34 For WwTWs without a TN consent level, the relationship between water use and TN in the effluent is more complex, but applying the same methodology for nutrient neutrality is considered appropriate.

4.35 For these WwTWs, there is no guarantee that reductions in water use will lower TN discharges. These WwTWs are not regulated by the concentration of TN in each litre of effluent. Instead, the TN concentration could vary depending on the flow volume and concentration of TN coming into the WwTW. Growth in area will lead to more people which will increase the amount of nitrogen reaching a WwTWs and this could then change TN levels in the effluent. However, there is currently no clear correlation

between the TN concentration of the WwTW discharge and size of population served. It is therefore not considered necessary to correct for this factor. The processes at WwTWs and how nitrogen changes its form during treatment are complex, especially the interaction between different levels of nitrogen and carbon in the wastewater. Any error due to marginal increases in TN concentration with increases in population served by a particular WwTW will be covered by the precautionary 20% buffer.

4.36 Please note that due to this uncertainty the use of measures designed to reduce water consumption as a means of reducing TN are not appropriate in areas served by WwTWs without an N permit. This is likely to affect authorities with WwTWs that drain into rivers, as many of these WwTWs do not have TN permit limits currently.

Stage 1 *Step 4 Calculate Total Nitrogen (TN) in Kg per annum that would exit the WwTW after treatment derived from the proposed development*

4.37 The TN load is calculated by multiplying the water use of the proposed development by the appropriate concentration of TN after treatment at the WwTW.

4.38 An element of the TN within the wastewater coming from a household is from the drinking water supplied to that household. However, this forms a relatively small proportion (<10%) of this total. This has been calculated by using a nitrate-N concentration in drinking water of 8mg/l and a TN generated per person of 3.5kg/yr.

4.39 Moreover, in order for favourable condition for the Solent sites to be achieved it is necessary for there to be substantial reductions in ground and river water nitrogen concentrations. Since drinking water comes from these same sources these reductions will in turn affect TN concentrations in drinking water. It is therefore not appropriate to calculate TN budgets over the lifetime of the development based on the current elevated TN levels in drinking water. To do so would lock in a higher TN discharge from development that would offset the required improvements in TN levels in drinking water from changes in agricultural practice over time.

4.40 Notwithstanding the above, it is our advice that it is appropriate to discount an amount of N that would be present in groundwater and river water if they were in a more natural condition. Peer review research indicates that the mean natural river concentration would have been below 0.45 mg/l nitrate-nitrogen[v]. Evidence also suggests that a nitrate concentration in rivers of c2 mg/l equates to the average concentrations in rivers before the 1960s, prior to the dramatic increase in N concentrations during the subsequent decades[vi]. This nitrate concentrations corresponds well with emerging evidence from the Poole Harbour catchment where it is considered that restoration to a favourable conservation status would require a nitrogen load below 1000 tonnes of TN per year landward input. To achieve this, average TN levels in river water in the Poole Harbour catchment would need to be <c2.75 mg/l TN.

4.41 The total annual nitrogen load reductions necessary to achieve a favourable conservation status for the international sites within the greater Solent area have yet to be determined. However, for the purpose of the methodology, a river and groundwater TN concentration of 2 mg/l is considered at this stage to be likely to meet the restoration objectives for the Solent international sites. We therefore recommend that a discounted figure of 2 mg/l is used to reflect the amount of N that would otherwise be present in river and groundwater.

4.42 Natural reductions in nitrogen concentrations, mainly through de-nitrification processes, also occur within watercourses. The scale of de-nitrification is complex and dependent on a number of variables, including the characteristics of the water channels, season, water flows, N concentrations, and uptake by plant communities, etc. Insufficient evidence is currently available to properly evaluate de-nitrification rates within the greater Solent catchments and therefore this factor has not been included within the current methodology. Nevertheless natural de-nitrification processes, particularly for discharges in the upper Solent catchment, provide an additional precautionary factor for the methodology.

Worked example of a nutrient budget calculation for discharge to a WwTW using methodology.

4.43 The following worked example calculates the Total Nitrogen load of a development of 1000 dwellings based on a WwTW with a consent limit for Total Nitrogen of 9 mg/l.

4.44 Where residential developments also include other overnight accommodation such as tourist accommodation and attractions, the associated water use from these additional land uses will need to be included in the calculation. These rates should be based on empirical evidence from similar developments or published literature and will be assessed on a case by case basis.

Table 1 – Calculating wastewater Total Nitrogen load from proposed development

STAGE 1 - WORKED EXAMPLE TO CALCULATE TOTAL NITROGEN (TN) LOAD FROM DEVELOPMENT WASTEWATER				
Step	**Measurement**	**Value**	**Unit**	**Explanation**
Development proposal	Development types that would increase the population served by a wastewater system	1000	Residential dwellings	
Step 1	Additional population	2400	Persons	Uses an average household size of 2.4 x 1000 dwgs (greenfield site).
Step 2	Wastewater volume generated by development	264,000	litres/day	2400 persons (step 1) x 110 litres. Where relevant, deduct wastewater volume of population displaced by the proposed development.
Step 3	Receiving WwTW environmental TN permit limit. Assume discharge to be at 90% of consent limit.	8.1	mg/l TN	90% of the consent limit = 8.1 mg/l TN.
Step 4	Deduct acceptable TN loading (@ 2 mg/l TN) (as defined in paragraph 4.40)	6.1	mg/l TN	8.1 (step 3) – 2 mg/l TN
Step 5	TN discharged after WwTW treatment	1,610,400	mg/TN/day	264000 (step 2) x 6.1 (step 4) =1,610,400
Step 6	Convert mg/TN to kg/TN per day	1.6104	Kg/TN/day	Divide by 1,000,000
Step 7	Convert kg/TN per day to kg/TN per year	587.8	Kg/TN/yr	1.6104 x 365 days
Wastewater total nitrogen load	**587.8 kg/TN/yr**			

Stage 2 Adjust nitrogen load to account for existing nitrogen from current land use

4.45 This next stage is to calculate the existing nitrogen losses from the current land use within the redline boundary of the scheme. The nitrogen loss from the current land use will be removed and replaced by that from the proposed development land use. The net change in land use will need to be subtracted from or added to the wastewater Total Nitrogen load.

4.46 Nitrogen–nitrate loss from agricultural land can be modelled using the Farmscoper model. A study commissioned by Natural England from ADAS modelled this loss for different farm types across the river catchments that drain to the Solent (ADAS UK Ltd. 2015. Solent Harbours Nitrogen Management Investigation).

4.47 If the development area covers agricultural land that clearly falls within a particular farm type used by the Farmscoper model then the modelled average nitrate-nitrogen loss from this farm type should be used. The farm types used in the ADAS model are set out in Table 2, with the nitrate-nitrogen loss. Further details on farm classification are included in Appendix 1.

Table 2 Farm types and average nitrogen-nitrate loss

AVERAGE NITRATE-NITROGEN LOSS PER FARM TYPE IN THE SOLENT CATCHMENT AREA (kg/ha)	
Cereals	31.2
Dairy	36.2
General Cropping	25.4
Horticulture	29.2
Pig	70.4
Lowland Grazing	13.0
Mixed	28.3
Poultry	70.7
Average for catchment area	**26.9**

4.48 If the proposed development area covers several or indeterminate farm types then the average nitrate-nitrogen loss across all farmland may be more appropriate to use. The average figure is also included in Table 2.

4.49 The figures in the ADAS report are based on 2010 land use data and may be updated from time-to-time as land use and agricultural practice to control nitrate loss changes.

4.50 For maize farms, it is recommended that the general cropping nitrogen leaching rate is used in the calculation. For sites that are in use as allotments, it is recommended

that the most appropriate farm type for allotments is the average rate of 26.9 kg/ha/yr. For sites that are currently in use as horse paddocks, it is recommended that the lowland grazing figure should be used in the calculation.

4.51 It is important that farm type classification is appropriately precautionary. It is recommended that evidence is provided of the farm type for the last 10 years and professional judgement is used as to what the land would revert to in the absence of a planning application. In many cases, the local planning authority, as competent authority, will have appropriate knowledge of existing land uses to help inform this process.

4.52 There may be areas of a greenfield development site that are not currently in agricultural use and have not been used as such for the last 10 years. In these areas as there is no agricultural input into the land a baseline nitrogen leaching value of 5 kg/ha should be used. This figure covers nitrogen loading from atmospheric deposition, pet waste and nitrogen fixing legumes.

4.53 Where development sites include wildlife areas, woodlands, hedgerows, ponds and lakes that are to be retained, these areas can either be excluded from the calculation as there will be no change in nitrogen input onto this land, or included with the same nitrogen leaching rate in stage 2 and 3. This approach assumes that if they are adopted as green infrastructure or a wildlife area in the new development, appropriate management can be secured with any planning permission (see next section) to restrict nitrogen loading.

4.54 A similar approach can also be taken for the redevelopment of urban land as the nitrogen leaching rate would be 14.3 kg/ha in stage 2 and 14.3 kg/ha in stage 3. If there is no change in site area, these areas can be excluded from the calculation.

4.55 For sites, where existing land use is not confirmed, it is Natural England's advice to local planning authorities and applicants to take a precautionary approach in line with existing legislation and case-law.

4.56 Please note if evidence can be provided to support an alternative nitrogen figures for any existing land use, then this information will be reviewed by the local planning authority and Natural England.

4.57 A worked example to calculate the nitrogen load from existing land use is set out in Table 3.

Table 3 Calculating nitrogen load from current land use

STAGE 2 - WORKED EXAMPLE TO CALCULATE NITROGEN LOAD FROM CURRENT LAND USE				
Step	**Measurement**	**Value**	**Unit**	**Explanation**
1	Total area of existing agricultural land	40	Hectares	This is the area of agricultural land that will be lost due to development
2	Identify farm type and confirm nitrate loss.	26.9	Kg/ha/yr	The developable area covers several farm types therefore an average has been used. Reference Appendix 1 and Table 2
3	Multiply area by nitrate loss	1,076	Kg/N/yr	40 ha x 26.9 kg/N/yr
Nitrogen load from current land use	1,076 Kg/N/yr			

Stage 3 Adjust nitrogen load to account for land uses with the proposed development

4.58 The last stage is to add in the nitrogen load that will result from the new development that is not received by a WwTW. This includes the nitrogen load from the new urban development and from the new open space including any Suitable Alternative Natural Greenspace (SANG), Nature Reserves, or Bird Refuge Areas as identified within the redline boundary of the scheme.

4.59 The calculation only includes the areas of the site where there will be a change in land use, for example from agricultural land to new urban development or agricultural land to Suitable Alternative Natural Greenspace (SANG) / open space. Where there is no proposed change to land use, this land should be excluded from the nitrogen budget as there will be no change to the nitrogen load from this area.

4.60 A worked example is shown in the table below. This is based on a developable area of 38 hectares covering land in a mix of farm types with the removal of 2 hectares of agricultural land to create SANG.

Urban development

4.61 The nitrogen load from the new urban development results from sewer overflows and from drainage that picks up nitrogen sources on the urban land. Urban development includes the built form, gardens, road verges and small areas of open space within

the urban fabric. These nitrogen sources include atmospheric deposition, pet waste, fertilisation of lawns and gardens and inputs to surface water sewers. The nitrogen leaching from urban land equates to 14.3 kg/ha/yr[vii]. Appendix 2 sets out the scientific research and literature in relation to this figure.

Open Space and Green Infrastructure

4.62 Nitrogen loss draining from new designated open space or Suitable Alternative Natural Greenspace (SANG) should also be included. The nitrogen leaching from this land is likely to equate to 5 kg/ha/yr. Appendix 3 sets out the scientific research and literature in relation to this figure. This figure can also be used where new nature reserves or bird refuge areas are created and for new woodland planting areas.

4.63 The competent authority will need to be assured for that this open space will be managed as such and there will be no additional inputs of nutrients or fertilisers onto this land for the duration of the development. Appropriate conditions or other legal measures may be necessary to ensure it will not revert back to agricultural use, or change to alternative uses that affect nutrient inputs in the long term. It is therefore recommended that the 5 kg/ha/yr rate applies to areas of designated open space on-site of around 0.5 hectares and above. These sites will also need long term management to ensure the provision of dog bins and that these are regularly emptied.

4.64 Small areas of open space within the urban fabric, such as road verges, gardens, children's play areas and other small amenity areas, should not be included within this category. The urban development figure is appropriate for these land uses.

Community food growing provision

4.65 For any areas of the site that are proposed for community food growing provision such as allotments, it is recommended that the average farm type rate is used (26.9 kg/ha/yr).

Table 4 – Adjust nitrogen load to account for future land uses

STAGE 3 - WORKED EXAMPLE TO CALCULATE NITROGEN LOAD FROM FUTURE LAND USES				
Step	**Measurement**	**Value**	**Unit**	**Explanation**
1	New urban area	38	Hectares	Area of development that will change from agricultural land to urban land use
2	Nitrogen load from future urban area	543.4	Kg/N/yr	38 ha x 14.3 Kg/N/yr
3	New SANG / open space	2	Hectares	Area of development that will change from agricultural land to SANG / open space
4	Nitrogen load from SANG / open space	10	Kg/N/yr	2 ha x 5.0 Kg/N/yr
5	Combine nitrogen load from future land uses	553.4	Kg/N/yr	543.4 Kg/N/yr + 10 Kg/N/yr
Nitrogen load - future land uses	553.4 Kg/N/yr			

Stage 4 Calculate the net change in the Total Nitrogen load that would result from the development

4.66 The last stage is to calculate the net change in the Total Nitrogen load to the Solent catchment with the proposed development. This is derived by calculating the difference between the Total Nitrogen load calculated for the proposed development (wastewater, urban area, open space etc) and that for the existing land uses.

4.67 It is necessary to recognise that all the figures used in the calculation are based on scientific research, evidence and modelled catchments. These figures are the best available evidence but it is important that a precautionary buffer is used that recognises the uncertainty with these figures and in our view ensures the approach prevents, with reasonable certainty, that there will be no adverse effect on site integrity. Natural England therefore recommends that a 20% precautionary buffer is built into the calculation.

4.68 There may be instances where it is the view of the competent authority that an alternative precautionary buffer should be used on a site-specific basis where sufficient evidence allows the legal tests to be met.

4.69 Table 5 sets out a worked example.

Table 5 Nitrogen Load Budget

STAGE 4 - WORKED EXAMPLE TO CALCUATE THE NET CHANGE IN NITROGEN LOAD FROM THE DEVELOPMENT				
Step	**Measurement**	**Value**	**Unit**	**Explanation**
1	Identify nitrogen load from wastewater (stage 1)	587.8	Kg/TN/yr	See Table 1
2	Calculate the net change in nitrogen from land use change - subtract existing land uses nitrogen load (stage 2) from future land uses nitrogen load (stage 3)	-522.6	Kg/TN/yr	553.4 (stage 3) - 1076 (stage 2) = -522.6 Kg/TN/yr
3	Determine nitrogen budget – the Total Nitrogen wastewater load for the proposed development plus the change in nitrogen load from land use change (the latter figure may be positive i.e. the change in land use will generate more nitrogen, or negative i.e. the change in land use will generate less Nitrogen)	65.2	Kg/TN/yr	587.8 (step 1) + -522.6 (step 2) = 65.2 Kg/TN/yr
4	Where TN budget is positive add 20% precautionary buffer	78.24	Kg/TN /yr	64.8 + 20% = 78.24
Total Nitrogen that needs to be neutralised	**78.24 Kg/TN /yr**			

Section B

Methodology for calculating TN budgets for package treatment plants (PTPs)

4.70 The Environment Agency has a presumption against private sewage treatment works in sewered areas and will always seek connection to the mains sewer where possible and practicable. A principle concern relates to the failure rates of PTPs and the lack of review and periodic upgrades via regulatory systems that apply to mains. There will be site specific factors (e.g. in proximity to watercourses, soil saturation levels, etc.) that would need to be considered when evaluating this risk.

4.71 Further advice from the Environmental Agency on the use of PTP may be found at - https://www.gov.uk/guidance/discharges-to-surface-water-and-groundwater-environmental-permits. Additional guidance may also be available via local planning authorities. For example, Chichester District Council has adopted a supplementary planning document for surface and foul drainage - https://www.chichester.gov.uk/article/29757/Supplementary-planning-documents-and-policy-guidance.

4.72 Where development are proposing to use package treatment plants, or similar, it is recommended that the TN level is calculated on a per person basis. On average each person produces sewage containing 0.0035 tonnes of nitrogen per year (3.5 kilograms)[viii].The TN prior to treatment = number of additional population x 3.5 Kg = Kg/TN/yr.

4.73 The percentage reduction of TN that may be applied as result of treatment will depend on the efficiency of the treatment processes employed and must be assessed on a case by case basis. NB The evidence supporting the efficiency of PTPs should include the test result documents from the lab (in English) and/or measured effluent concentrations from real world applications, not just the covering certificate. Information will also need to be provided on the long term monitoring and management of these installations and this will need to be secured.

4.74 Bespoke calculations of the TN load may be possible for larger PTPs in instances where robust evidence of the performance of the system in removing nitrogen is provided. In addition to the above, the evidence will need to include, as a minimum, a full year of operation and supporting information to ensure that the concentration of total nitrogen within the effluent can be reliably predicted. In these cases, early consultation with Natural England, through our charged advice service, and the competent authority is recommended.

4.75 Table 6 sets out a worked example for Stage 1. Stages 2, 3 and 4 of the above methodology can then be applied.

Table 6 Alternative Stage 1 methodology for package treatment plants (PTPs)

STAGE 1 - WORKED EXAMPLE TO CALCULATE TOTAL NITROGEN (TN) LOAD FROM DEVELOPMENT WASTEWATER WITH AN ONSITE PTP (prior to treatment)				
Step	**Measurement**	**Value**	**Unit**	**Explanation**
Development proposal	Development types that would increase the population served by a wastewater system	100	Residential dwellings	
Step 1	Additional population	240	Persons	Based on average household size of 2.4
Step 2	TN prior to treatment Based on 3.5 Kg TN per person per year	840	Kg TN /yr	240 (step 1) x 3.5 Kg TN per person per yr
Step 3	Receiving PTP TN reduction efficiency	70	%	Efficiency of PTP used must be evidenced.
Step 4	TN discharged after PTP treatment	252	Kg TN /yr	30% of 840
Step 5	Acceptable N loading (as defined in paragraph 4.40) Based on 110 l per day per person	52,800	mg TN /day	Total waste water from development (110l x 240 persons) x Acceptable N loading of 2 mg/l
Step 6	Convert acceptable TN loading to TN Kg / Yr	19.3	Kg TN / Yr	Divide by 1000000 x by 365 days
Step 7	TN discharged - acceptable N loading (@ 2 mg/l)	232.7	Kg TN / Yr	252 (step 4) – 19.3 (step 6)
PTP Total Nitrogen Load	**232.7 Kg TN / Yr**			

SECTION 5 MITIGATION

Introduction

5.1 If there is a nitrogen surplus from the WwTW discharge (a positive figure), then mitigation is required to achieve nitrogen neutrality. If the calculation identifies a deficit (a negative figure), no mitigation is required. In the worked example set out in Table 5, the nitrogen budget with 20% buffer is 77.8 Kg/TN/yr. Nitrogen neutrality would therefore require appropriate mitigation measures that would remove a minimum of 77.8 Kg/TN/yr.

5.2 Mitigation can be 'direct' through upgrading sewage treatment works and through alternative measures, e.g. interceptor wetlands; or 'indirect' by taking land out of high nitrogen uses, e.g. crops or intensive livestock systems that result in an excess of nitrogen lost to the water environment.

5.3 The purpose of the mitigation measures is to avoid impacts to the designated sites, rather than compensating for the impacts once they have occurred. Avoiding impacts is achieved by neutralising the additional nutrient burden that will arise from the proposed development, achieving a net zero change at the designated sites in a timely manner.

5.4 To ensure it is effective mitigation, any scheme for neutralising nitrogen must be certain at the time of appropriate assessment so that no reasonable scientific doubt remains as to the effects of the development on the international sites. This will need consideration of the delivery of mitigation, its enforceability and the need for securing the adopted measures for the duration of the development's effects, generally 80-125 years.

5.5 Schemes that are being delivered by other sectors (for example water industry and agricultural sector) for the purpose of meeting the necessary conservation measures designed for the international sites and to take appropriate steps to avoid the deterioration of the international sites should not also be used as mitigation for plans and projects, as this would compromise the original purpose and would be unlikely to meet the legal tests of the Habitats Regulations.

5.6 Further information has been included in this section on recommended mitigation measures. Each mitigation scheme will be assessed on its own merits and on a case by case basis, based on the submitted evidence. We recommend applicants to discuss options with local planning authorities and Natural England through our charged advice service, at the earliest opportunity. However, it is ultimately the decision of the local planning authorities, as competent authorities, to determine the suitability of the proposed mitigation scheme in line with the legal tests in the Habitats Regulations.

Types of mitigation

Conversion of agricultural land for community and wildlife benefits

5.7 Permanent land use change by converting agricultural land with higher nitrogen loading to alternative uses with lower nitrogen loading, such as for local communities, wildlife, and under schemes for flood management or to deliver the UK Government's Net Zero greenhouse gas emissions target by 2050[ix], is one way of neutralising nutrient burdens from development. It is important to retain the best and most versatile agricultural land in food production, particularly food crop production. However, there are a number of reasons to support conversion of agricultural land where the land is less economic to farm. There may also be a wide range of incidental benefits for the local community and wildlife from this change, as well as delivery of wider planning policy objectives and climate emergency pledges.

On-site options

5.8 One option is to increase the size of the SANGs and Open Space provision for the development on agricultural land that reduces the nitrogen loss from this source. This can be secured as designated open space or by other legal mechanisms.

Off-site options

5.9 Another option is to acquire, or support others in acquiring, agricultural land elsewhere within an appropriate river catchment area. By changing the land use in perpetuity (e.g. to woodland, heathland, saltmarsh, wetland or conservation grassland), this reduces the nitrogen loss from this source.

5.10 Mitigation land should be appropriately secured to ensure that at the time of appropriate assessment it is certain that the benefits will be delivered in the long term. Natural England advises that this can be achieved through an appropriate change of ownership to a local planning authority or non-government organisation. However, it is recognised that there may be other legal mechanisms available to the competent authority to ensure deliverability and enforceability of a mitigation proposal. These can be considered on a case by case basis.

5.11 Small scale developments are encouraged to consider opportunities for providing local small scale mitigation measures that deliver multiple benefits. Possible options include the creation of local ponds, wetlands, local nature reserves, community orchards (without nitrogen inputs), or copse. Another example is to turn a strip (in excess of 10m width) of agricultural land immediately adjacent to a public footpath into a greenway. This could be demarcated by hedges or woodland planting for both public and wildlife benefits.

Woodland planting

5.12 Woodland planting on agricultural land is a means of securing permanent land use change without necessitating land purchase. It can be evidenced easily by aerial photography and site visits. The level of woodland planting required to achieve nutrient neutrality is 20% canopy cover at maturity. In very broad terms, this equates to 100 trees per hectare, although this is dependent on the type of trees planted and there are also options that this can be achieved by natural regeneration, especially if adjacent to existing native woodland. It is our preference that native broadleaf species are selected where possible, to secure wider biodiversity gains. A nitrogen leaching rate from woodland planting is likely to equate to 5 kg/ha/yr.

5.13 In a relatively short time, the woodland planting would require a felling licence and woodland removal would also be covered by the EIA Regulations where woodland is planted as mitigation for internationally designated sites. There are therefore a number of layers of security for the competent authorities to ensure this mitigation is being delivered effectively. Planted woodland does require management for the first decade in terms of plug fencing and maintenance until the canopy has reached above browsing height, thereafter management is relatively minimal though some thinning is preferable to enable mature trees to develop.

5.14 Woodland planting would secure carbon capture, biodiversity and recreational benefits. The established woodlands could also be used for wood fuel production or coppice timber production.

Wetlands

5.15 Wetlands receiving nitrogen-rich water can remove a proportion of this nitrogen through processes such as denitrification and sedimentation. Wetlands can be designed as part of a sustainable urban drainage (SUDs) system, taking urban runoff/stormwater; discharges from STWs can be routed through wetlands; or the flow, or part of the flow, of existing streams or rivers can be diverted through wetlands. Wetlands deliver incidental wildlife and biodiversity benefits, with possible drainage and flood defence benefits (by reducing risk of harm from natural hazards).

5.16 It is essential that wetlands and SUDs are maintained to provide ongoing nutrient removal. Provisions for resourcing the ongoing maintenance of SUDs will need to be secured with any planning permission. Further information on the potential for nitrogen mitigation using wetlands is included in Appendix 4.

Wastewater Treatment Work Upgrades

5.17 Mitigation options at WwTWs include the agreement with the wastewater treatment provider that they will maintain an increase in nitrogen removal at the WwTW. This may include either upgrades to infrastructure (long term), or where the existing WwTW infrastructure has capacity an agreement to operate the WwTW at a higher standard than required by the discharge consent. Natural England, Environment

Agency, Local Planning Authorities and water companies are working together to explore these options.

5.18 There may also be opportunities to progress a wetland at a WwTWs, at the final stage of the process, once the permit consents have been met. It is possible to discharge the WwTWs outfall through wetlands, prior to release into the wider environment. Further details of this option is included in Appendix 4.

Size of mitigation land

5.19 The mitigation land must be sufficient to ensure the legal tests in the Habitats Regulations can be met.

5.20 Larger schemes create more opportunities for other sources of funding. Land that is taken out of agriculture for nutrient mitigation could also qualify for additional funding for future management to meet other legislative and policy requirements. For example, with additional management and infrastructure, this land may qualify as Suitable Alternative Natural Greenspace to relieve recreational pressure on international designated sites or, alternatively, to deliver a strategic bird reserves in line with Solent Waders and Brent Goose Strategy. Furthermore, larger schemes have the potential to deliver wider community and biodiversity benefits and these options should be encouraged where possible.

5.21 Smaller schemes will also be acceptable where the legal tests in the Habitats Regulations are met so there is certainty around these measures, for example, their deliverability, enforceability and long term use

Location of mitigation

5.22 The location of the mitigation site will also influence the effectiveness of the measure. The appropriate location for mitigation land firstly depends on the catchment of the development and location of the WwTWs outfall. Consideration then needs to be given to site specific factors such as geology, hydrology and topography.

Identifying the catchment for mitigation land

5.23 The fluvial catchment for the Solent internationally designated sites is shown on Figure 1. Figures 2 – 7 show the catchment area at a larger scale[x].

5.24 A key objective is to ensure mitigation land is situated in the most effective location. In order to achieve this, it may be appropriate to establish mitigation land in a number of locations or catchments. For example, for some of the coastal WwTWs, there is a widespread distribution of output to a number of designated sites within the Solent. Therefore a number of catchments would be appropriate locations for mitigation land. This view is based on modelling that has been undertaken by the Environment Agency and analysed by water quality specialists within Natural England in relation to the internationally designated sites. The modelling identifies the relative contributions

of all nitrogen sources within the harbours and estuaries of the Solent and is the best available scientific evidence available[xi].

5.25 The following recommendations can generally be applied to determine the suitability of the mitigation location. These recommendations are based on spatial principles and temporal principles

Spatial principles

5.26 It is Natural England's view that mitigation land within the same catchment as the development location is appropriate.

River catchments

5.27 For WwTWs that drain into the rivers, it is appropriate for the mitigation land to be within the same river catchment as the outfall location. This is the preferred solution in all cases. If this is not possible, mitigation in close alternative catchments would be appropriate in the following cases.

River Test and River Itchen

5.28 It is appropriate for the River Test and River Itchen catchment to be considered as one catchment. Therefore development located in the River Test catchment could be mitigated in the River Itchen catchment and *vice versa*.

Bartley Water

5.29 It is also appropriate for development within the Bartley Water catchment (New Forest) to be included with the Test and Itchen catchment. This is due to the close proximity of the outfalls within Southampton Water and the tidal flows between these estuaries.

New Forest Rivers

5.30 It is appropriate for the New Forest rivers that outfall to the southern coast of the New Forest to be considered as one catchment – River Beaulieu, River Lymington, Danes Stream, Dark Water, Sowley Stream and the coastal areas.

River Meon

5.31 For development that outfalls to the River Meon, it would be appropriate to mitigated within the River Hamble catchment and within the Portsmouth Harbour catchment.

River Hamble

5.32 For development that drains to ground within the River Hamble catchment or to a WwTWs that drains to the River Hamble, eg Bishops Waltham WwTW, mitigation land is limited to within the River Hamble catchment.

Isle of Wight Rivers

5.33 For development that drains to ground within the catchment of or direct to the each of the Isle of Wight rivers, eg Eastern Yar, mitigation land is limited to within the same river catchment.

Portsmouth Harbour, Langstone Harbour and Chichester Harbour

5.34 For the WwTWs that drains to each harbour (Portsmouth Harbour, Langstone Harbour and Chichester Harbour), priority locations for mitigation are the same river catchment as the WwTW outfall.

5.35 For example, the Bosham WwTW outfalls at the base of Bosham and Fishbourne Channels within Chichester Harbour. The most effective location for mitigation is within the same catchment as these arms of Chichester Harbour.

5.36 In some cases there may be opportunities to mitigate within other river catchments within the harbours. These will be examined on a case by case basis and we advise early consultation with Natural England and the local planning authority.

Coastal WwTWs

5.37 For development that drains to coastal WwTW (Portswood WwTW, Woolston WwTW, Millbrook WwTW) within the northern part of Southampton Water, mitigation is appropriate in the following catchments – River Test, River Itchen, Bartley Water.

5.38 For development that drains to other coastal WwTWs in Southampton Water eg Ashlett Creek WwTW, mitigation is appropriate in the following catchments - River Test, River Itchen, River Meon, River Hamble, eastern catchments of the New Forest.

5.39 For development that drains to Peel Common WwTW, mitigation is appropriate in the following catchments – River Meon, Portsmouth Harbour, Medina Estuary, Wootton Creek, Newtown Harbour, Langstone Harbour.

5.40 For development that drains to Budds Farm WwTW, mitigation is appropriate in the following catchments – River Meon, Portsmouth Harbour, Langstone Harbour, Chichester Harbour, Wootton Creek, Medina Estuary (and the estuaries in between).

5.41 For development that drains to Pennington WwTW, mitigation is appropriate in the following catchments, south coast of New Forest, Western Yar, Newtown Harbour

Drain to ground

5.42 For developments that drain to ground via a package treatment plant (PTP) or mains WwTWs, it is appropriate for mitigation land to be within the same catchment as the outfall location of the PTP or WwTW.

Temporal principles

5.43 Within chalk geology where the nitrogen discharge is to ground and remote from watercourses there is likely to be a considerable delay (it may take up to 1 year for ground water discharges to percolate through a meter of chalk) before the nitrogen discharged reaches the international designated sites. In such circumstances mitigation measures that take effect quickly may not need to be implemented immediately. We advise that these issues are examined on a case by case basis in consultation with the relevant local planning authority or authorities and Natural England.

Identifying optimal locations for mitigation

5.44 Any discharge from a development that is directed to a WwTW that outfalls to the estuaries and harbours has the potential to reach the designated sites in a matter of hours or tide cycle. It is therefore important for any mitigation sites to be located in the most optimal locations. Sites that are downstream of the WwTWs and upstream of the designated sites are ideally located to reduce the nutrient load reaching the designated sites.

5.45 It is our preference that mitigation sites are prioritised within the lower fluvial catchment and in close proximity to water courses that drain into the Solent estuaries and harbours. Sites that are located on tertiary geology or clay are preferred or sites that are located on the break of slope onto chalk bedrock. These sites reduce the time lag between the nutrient benefits of changes to land use within the catchment and the benefits to the designated sites.

5.46 For sites located on the upper fluvial catchment of the Solent on the chalk bedrock, without any water course in close proximity, there may be a time lag for consideration. It is our advice that the depth of the chalk groundwater is considered. For sites where the groundwater is more than 5m below ground level, then this land is unlikely to be appropriate for mitigation for short term development. Although it may be appropriate for development that is phased over more than 5 years, provided the mitigation land is delivered straightaway.

5.47 There may be sites where there is evidence of a short time lag between nutrient reduction at the mitigation site and the designated sites, or where the mitigation site is located on a geology or in an area that will result in additional benefits for nutrient removal, over and above the change in land use at the site itself. These options will be considered on a case by case basis.

Strategic Solutions

5.48 It is appreciated that achieving nutrient neutrality may be difficult for smaller developments, developments on brownfield land, or developments that are well-progressed in the planning system. Natural England is working closely with local planning authorities to progress Borough /District/ City/ Authority wide and more

strategic options that achieve nutrient neutrality and enable this scale of development to come forward.

5.49 A number of options are coming forward. It is recommended that discussions are held with the relevant local planning authorities with regard to these options. Further information will be available on the Partnership for South Hampshire website and Chichester District Council website in due course.

5.50 Natural England can provide further advice on the methodology and mitigation options through our chargeable services (DAS).

[i] The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017

[ii] Conservation of Habitats and Species Regulations (England and Wales) Regulations 2017 (as amended)

[iii] Including Wildlife and countryside Act 1981 as amended, Countryside and Rights of Way Act 2000, Marine and Coastal Access Act 2009, Natural Environment and Rural Communities Act 2006

[iv] The optional requirement referred to in G2 requires installation and fittings and fixed appliances for the consumption of water at 110 litres per person per day.

[v] Desmit, X., Thieu, V., Billen, G., Campuzano, F., Dulière, V., Garnier, J., Lassaletta, L., Ménesguen, A., Neves, R., Pinto, L., Silvestre, M., Sobrinho, J.L., Lacroix, G., 2018. Reducing Marine Eutrophication May Require a Paradigmatic Change. Science of the Total Environment 635 (2018) 1444–1466

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Howden, N.J.K., Burt, T.P., 2009. Statistical analysis of nitrate concentrations from the Rivers Frome and Piddle (Dorset, UK) for the period 1965–2007. Ecohydrology 2, 55–65. doi:10.1002/eco.39,

Howden, N. J. K., Burt, T. P., Worrall, F., Whelan, M. J., & Bieroza, M. (2010). Nitrate concentrations and fluxes in the River Thames over 140 years (1868-2008): Are increases irreversible? *Hydrological Processes*, **24**, 2657– 2662. https://doi.org/10.1002/hyp.7835

[vii] Supplementary Planning Document – Achieving Nitrogen Neutrality in Poole Harbour. 2017

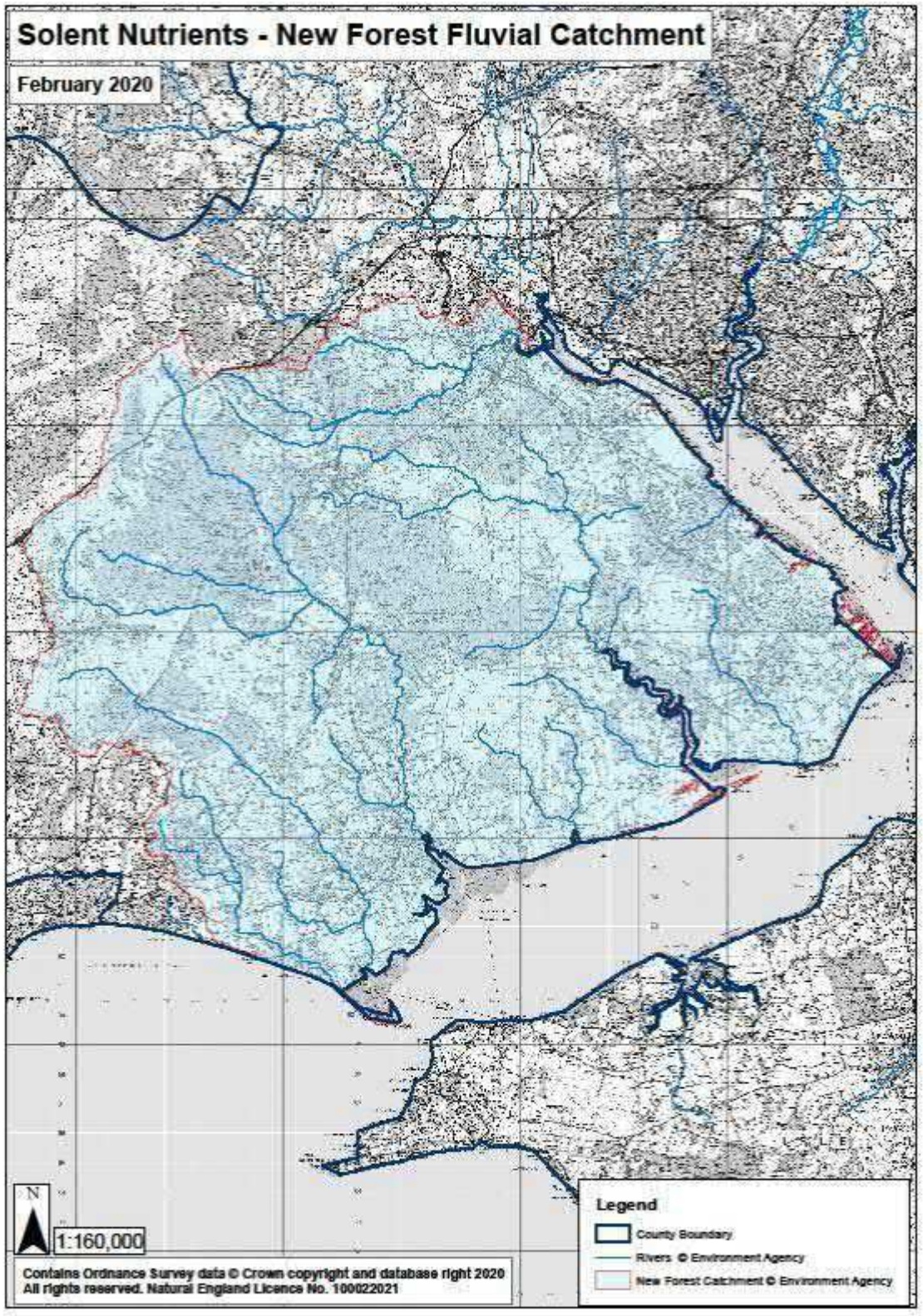
[viii] Supplementary Planning Document – Achieving Nitrogen Neutrality in Poole Harbour, 2017

[ix] https://www.theccc.org.uk/publication/land-use-policies-for-a-net-zero-uk/

[x] These plans contain public sector information licensed under the Open Government Licence v3.0

[xi] Environment Agency – CPM modelling, SAGIS/SIMCAT and Telemac modelling for Water Framework Directive DIN and Ecological Impact Investigations, 2014

Figure 2


Solent Nutrients - New Forest Fluvial Catchment
February 2020
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Legend
County Boundary
Rivers © Environment Agency
New Forest Catchment © Environment Agency

Figure 3

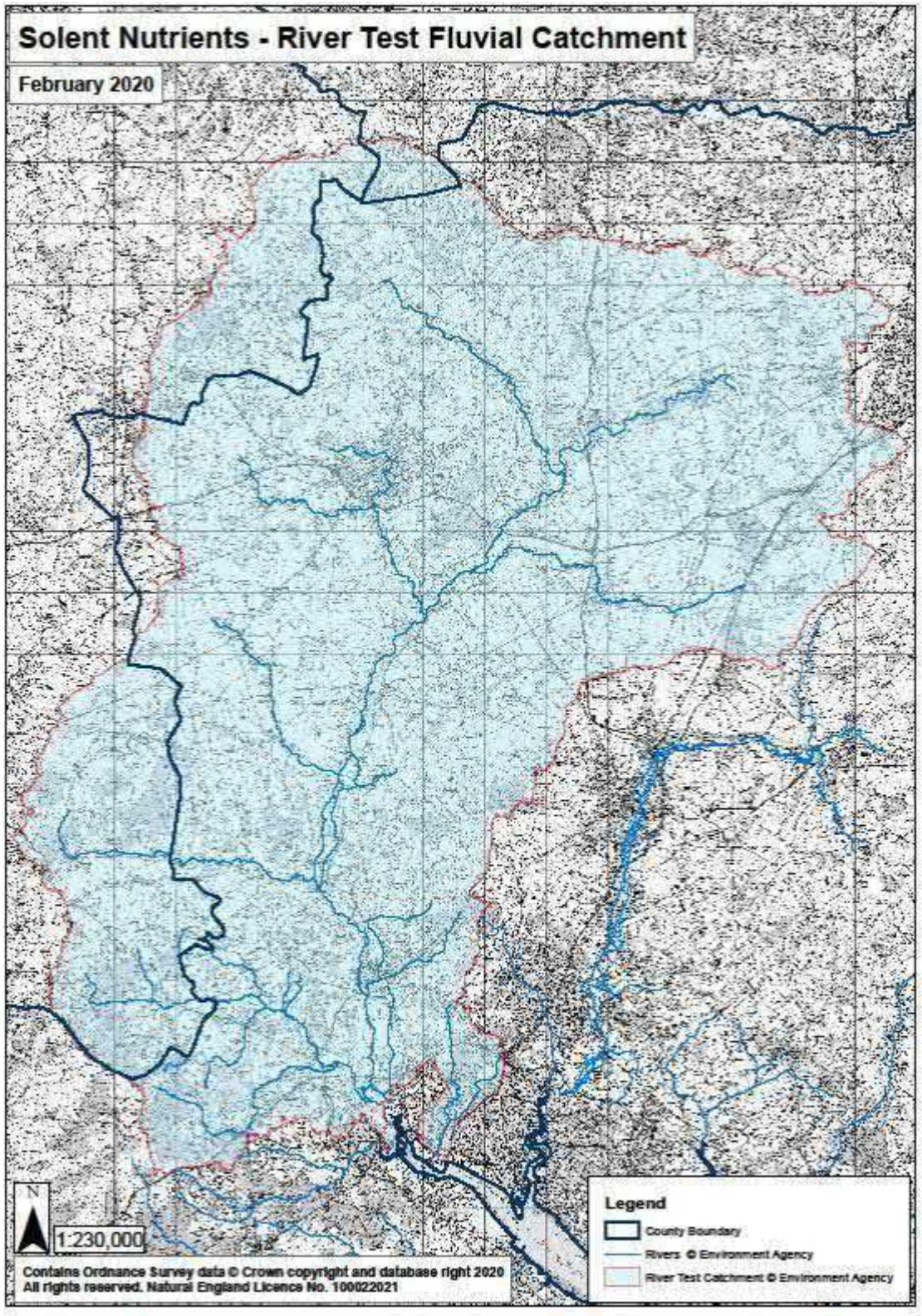
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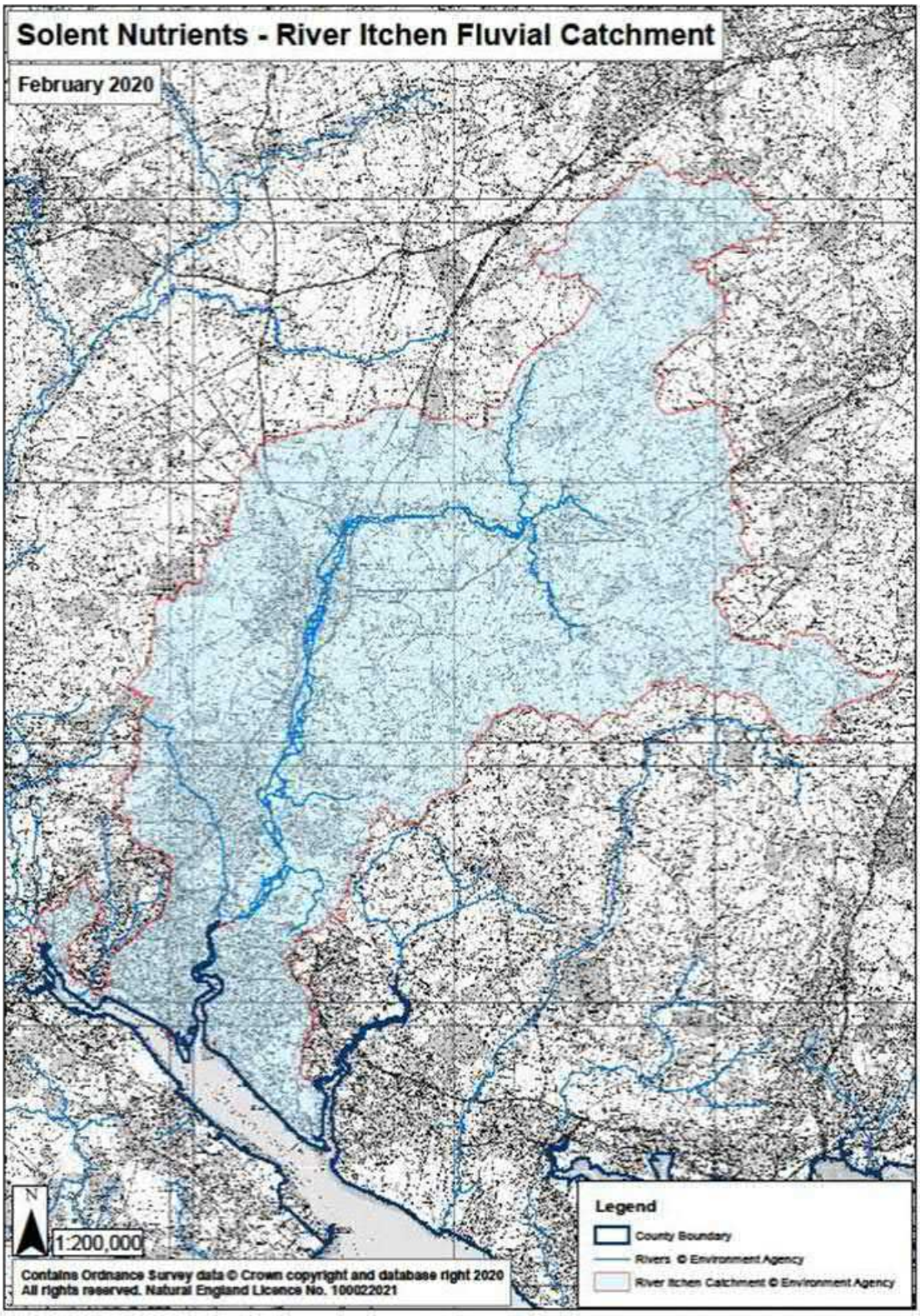
Figure 4


Solent Nutrients - River Itchen Fluvial Catchment
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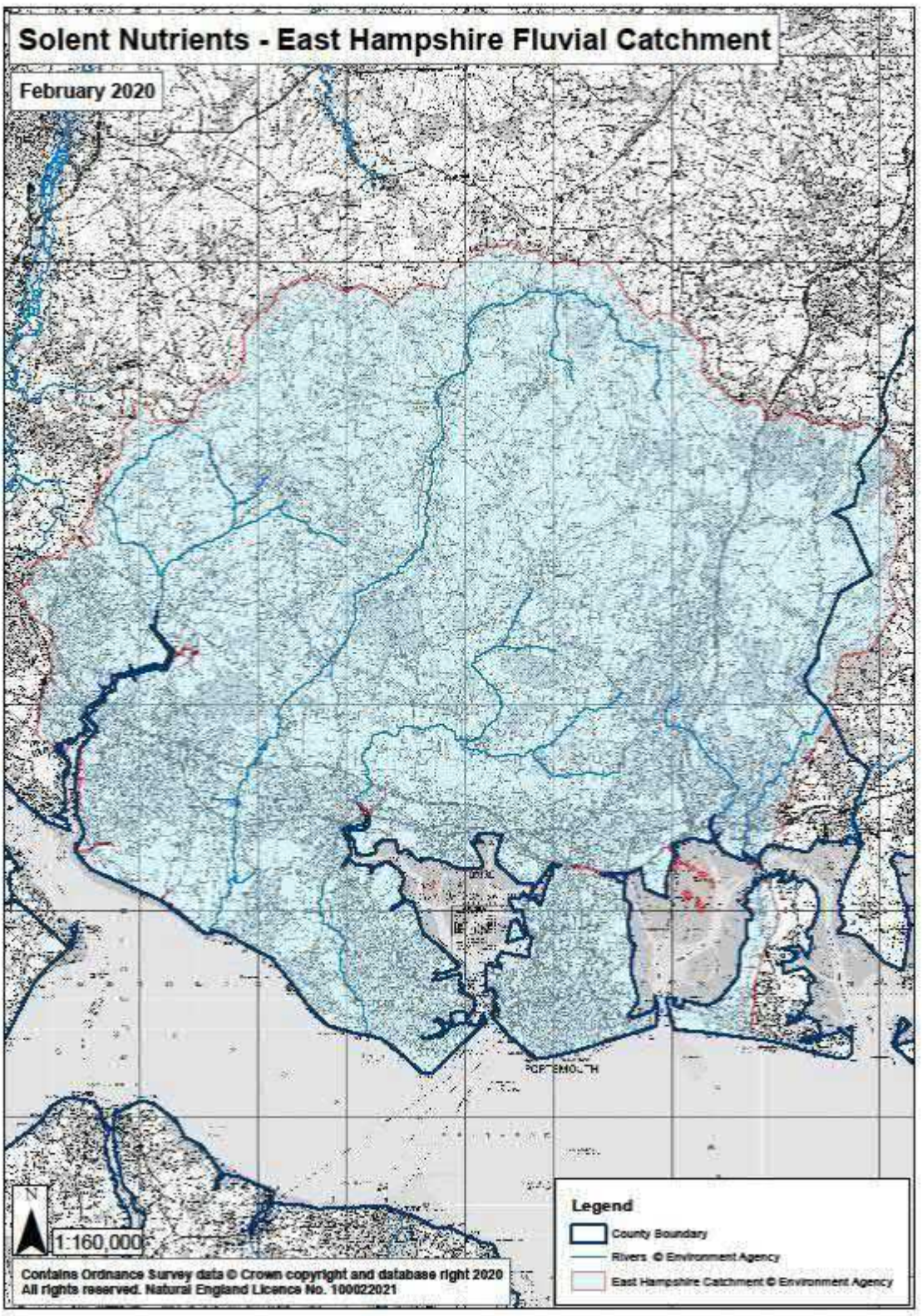
River Itchen Catchment © Environment Agency

Figure 5


Solent Nutrients - East Hampshire Fluvial Catchment
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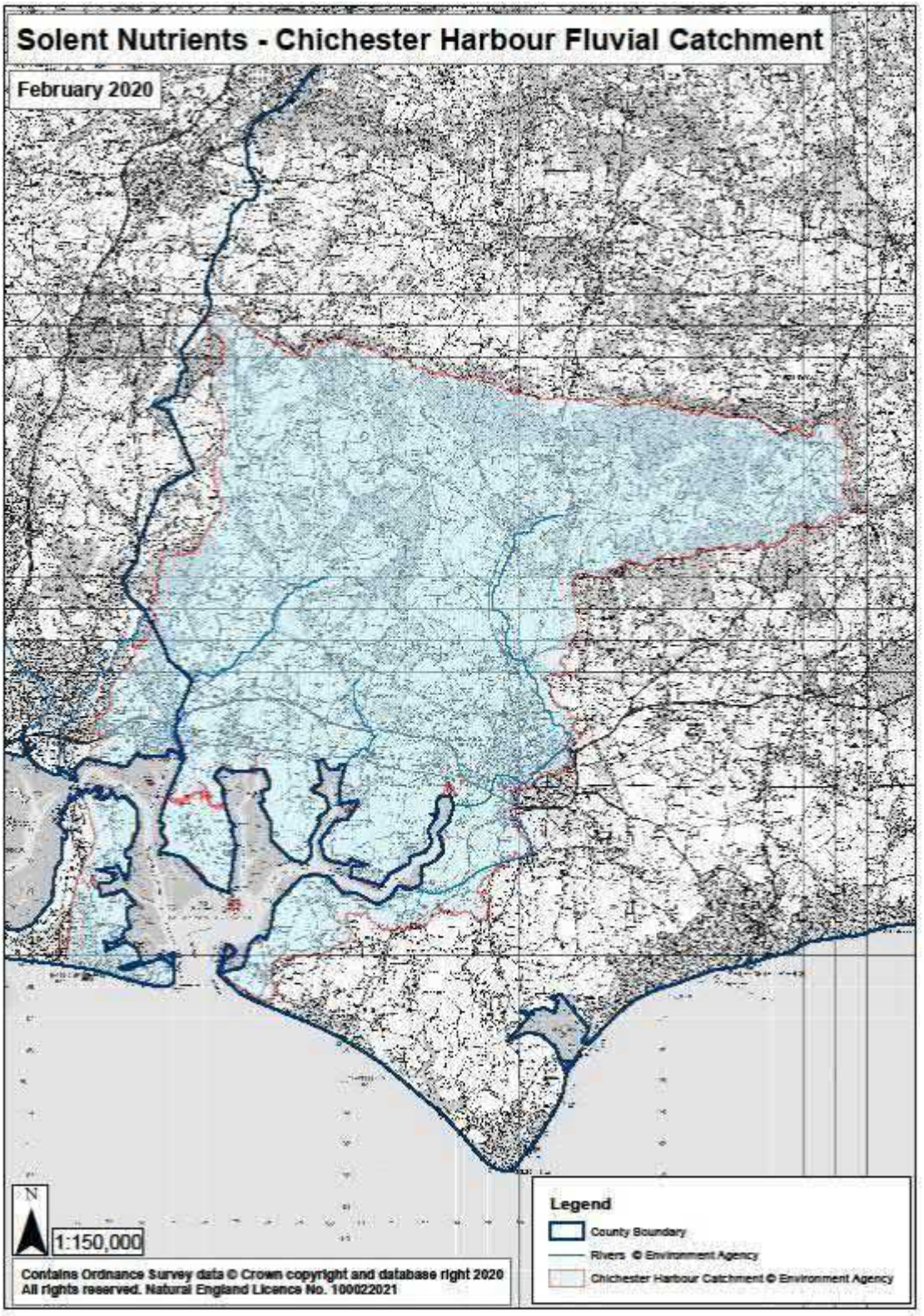
East Hampshire Catchment © Environment Agency

Figure 6


Solent Nutrients - Chichester Harbour Fluvial Catchment
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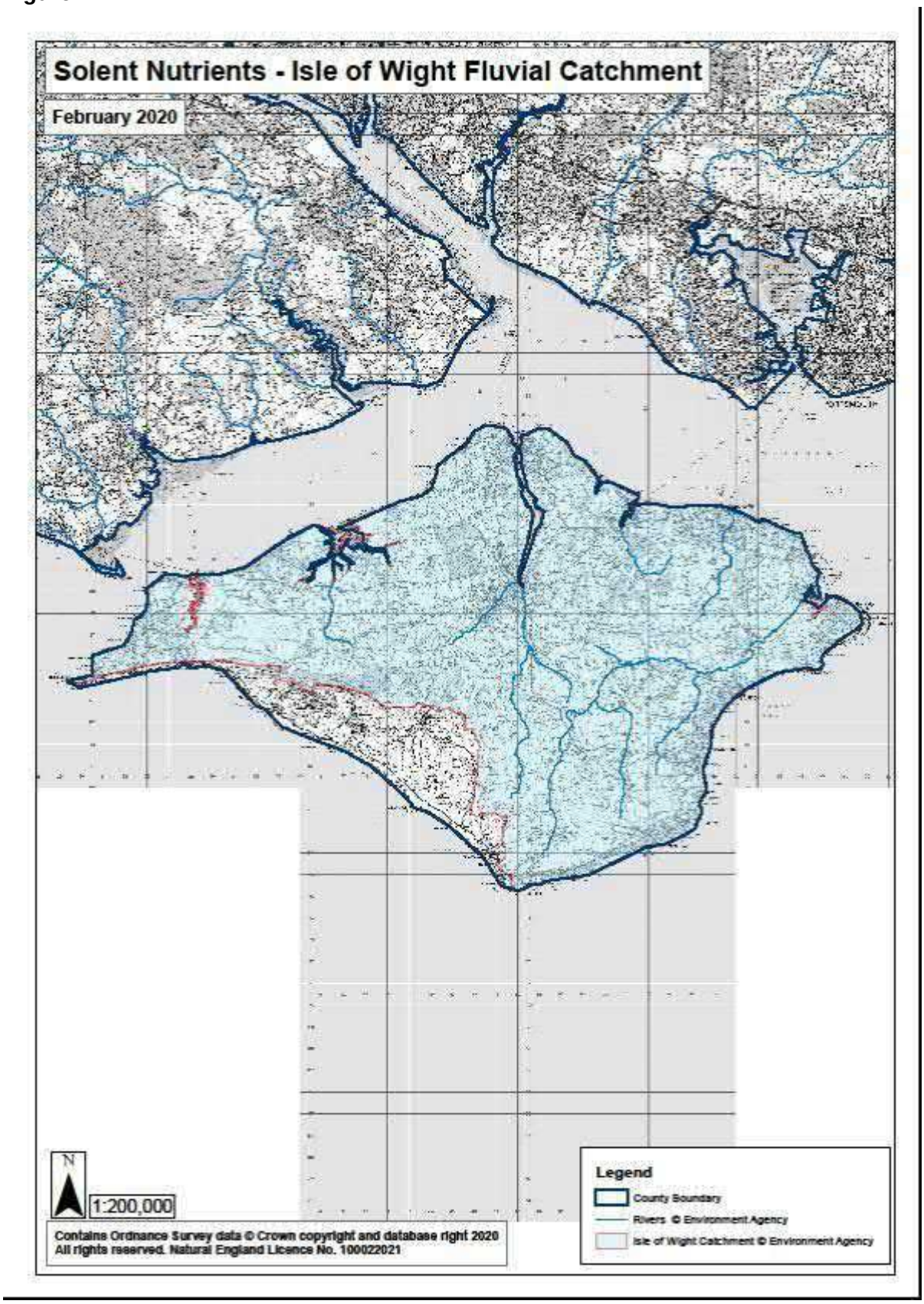
Chichester Harbour Catchment © Environment Agency

Figure 7


Solent Nutrients - Isle of Wight Fluvial Catchment
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Rivers © Environment Agency
Isle of Wight Catchment © Environment Agency

ANNEX 1 PLANNING CONTEXT

A1.1 In 2016, an Integrated Water Management Study (IWMS) for South Hampshire was commissioned by the Partnership for Urban South Hampshire (PUSH) Authorities, with the Environment Agency and Natural England. This examined the delivery of development growth in relation to legislative and government policy requirements for designated sites and wider biodiversity. It updated an earlier study in 2008. Similar studies have also been undertaken for Chichester Harbour and growth in Sussex (2018) though this study was largely for Water Framework Directive assessments.

A1.2 The IWMS for South Hampshire was completed in March 2018 and identified that there is currently uncertainty as to whether new housing growth can be accommodated without having a detrimental effect upon the water environment.

A1.3 The updated IWMS report in March 2018 concluded that there is uncertainty about the impact of local plan growth on the designated sites, especially after 2020. There was uncertainty about the efficacy of catchment measures to deliver the required reductions in nitrogen levels, and/or whether the upgrades to wastewater treatment works will be sufficient to accommodate the quantity of new housing proposed.

A1.4 To examine this issue further, local planning authorities set up a Water Quality Working Group in South Hampshire to add to the one already in existence for Chichester with the Environment Agency, Natural England and water companies. The objectives of these groups include identifying and analysing the existing evidence gaps and evaluating the need for strategic mitigation measures. The primary focus of this work is to address the uncertainty associated with strategic local plan growth.

A1.5 Natural England is working closely with local planning authorities to address this wider issue and progress options that achieve nutrient neutrality. It is appreciated that this may be difficult for smaller developments, developments on brownfield land or developments that are well-progressed in the planning system.

A1.6 Natural England has advised affected local planning authorities to set up Borough-wide, or strategic approaches that developments can contribute to thereby ensuring that this uncertainty is fully addressed by all applications and is working closely with affected local planning authorities to help address this issue.

ANNEX 2 ENVIRONMENTAL CONTEXT

Designated sites review

Solent Maritime SAC and SPAs

A2.1 In 2018, condition assessments of the estuary, mudflat & sandflats, and sandbanks features of the Solent Maritime SAC were undertaken. The condition assessments completed considered the SAC features across the site as a whole and found the condition of these features assessed to be unfavourable. The unfavourable assessment is based on a number of attributes failing, including the nutrient water quality attribute. Other attributes were also found to be failing, such as the extent, distribution, rhizome structure and reproduction, and biomass of seagrasses, as well as the infaunal quality of the intertidal mud and sand features. These failures are likely to be in part due to impacts from nutrients. Currently the site condition assessment does not include the saltmarsh feature which has not yet been assessed. However preliminary analysis of data shows that there was a loss of extent of saltmarsh across the Solent between 2008 and 2016. The cause of this loss it is not known but elevated nutrients can contribute towards the susceptibility of saltmarsh to erosion through effects on plant root growth and the cohesion of mud around the roots. In 2019/20 the intertidal areas of the Chichester Harbour estuary were examined in detail including the saltmarsh feature. The saltmarsh feature of this part of the SAC is in unfavourable declining condition due to the poor quality of the remaining marsh and ongoing net loss. Chichester Harbour contained half the saltmarsh feature area at designation of the SAC. Water quality impacts (macroalgal mats rotting and living) were recorded on all the saltmarsh surveyed.

A2.2 A full SPA condition assessment has yet to be undertaken, however the 2019/20 assessment of Chichester Harbour included assessment of the Chichester and Langstone Harbours SPA as well as the SSSI birds. This showed that shelduck populations on the SSSI and the SPA are showing a 71% decline in the long term that appears to be tracking that of the region although not the British trend. The declining proportion of the regional numbers supported by this site suggest that site-specific pressures are affecting this species. While the cause of these site specific declines in Chichester Harbour and the Solent area more widely are yet to be confirmed, research has found that the foraging ability of shelduck can be affected by algal mats. The wintering bird assemblage in general across Chichester Harbour is in unfavourable no change condition.

Solent and Dorset Coast Special Protection Area

A2.3 The Solent and Dorset Coast Special Protection Area (SPA) protects important foraging areas at sea used by qualifying interest features from colonies within adjacent SPAs, namely the Solent and Southampton Water SPA and the Chichester and Langstone Harbours SPA. These qualifying interest features are the foraging and nesting of three species of tern: common tern, Sandwich tern and little tern. This

site was designated in 2020. Given the relationship between the designated sites for the foraging areas and the colonies, the threats and condition of each these interrelated designated sites should be considered in combination as part of the Habitat Regulations Assessment. The SPA has not yet been fully condition assessed but the Chichester Harbour review of 2020 looked at not only breeding numbers of the three tern species in but also the productivity (how many chicks survived). The terns in Chichester Harbour, which are also a feature of the SSSI, are considered to be overall in unfavourable declining condition. The relationship of the tern breeding and foraging populations to water quality impacts in the Solent is not currently known, although it is not thought to be the primary reason for declining numbers of poor productivity in Chichester Harbour.

Solent and Isle of Wight Lagoons Special Area of Conservation

A2.4 The Solent encompasses a series of coastal lagoons, including percolation, isolated and sluiced lagoons. The site includes a number of lagoons in the marshes in the Keyhaven – Pennington area, at Farlington Marshes in Langstone Harbour, behind the sea-wall at Bembridge Harbour and at Gilkicker, near Gosport.

A2.5 The water quality target for the coastal lagoon features is to maintain nutrient levels at which biological indicators of eutrophication (opportunistic macroalgal and phytoplankton blooms) do not affect the integrity of the site and features, avoiding deterioration from existing levels. Surveys in 2013, noted several lagoons had high pH levels likely due to photosynthetic activity, however there were no records of opportunistic macroalgae or phytoplankton blooms and most lagoons (except for Butts Lagoon and Shut Lake) continue to support good lagoonal communities. The sediment in Butts Lagoon has remained anoxic in surveys in 2013, although this represents similar conditions to that present in baseline surveys. Therefore, available evidence does not indicate that eutrophication is affecting site integrity at any of the lagoons within the SAC, except for Butts Lagoon.

SSSI

A2.6 During 2018 and 2019, Natural England revised and updated the SSSI assessments in the greater Solent area in relation to the influence of the water environment on the condition of estuarine SSSI interest features that underpin the SAC and SPAs. These assessments especially included littoral sediment habitat (mudflat and other tidally exposed sediment flats). The review of parts of the greater Solent area and some SSSI interest features is ongoing.

A2.7 The SSSI interest feature assessments completed consider the concentrations of inorganic nitrogen status in each harbour and estuary, and evidence for ecological responses. Particular attention was given to records on phytoplankton abundance and the presence and abundance of opportunistic green macroalgae. Other responses to elevated nutrients may also occur, such as effects on phytoplankton composition and seagrass and saltmarsh extent and composition. These have not yet been assessed.

A2.8 Where there is sufficient information to show that the water environment causes interest features to be in unfavourable condition, this has been recorded within the completed assessments. In addition, in cases where there is significant uncertainty that elevated nutrient levels are affecting the condition of interest features, a provisional assessment of borderline favourable condition is recorded, along with a potential threat that unfavourable condition may become apparent with more evidence. In cases where there is currently inadequate information to come to a conclusion the SSSI assessment has remained unchanged. Some parts of the greater Solent area are also recorded to be in unfavourable condition for SSSI interest features for reasons other than the water environment, such as coastal squeeze and disturbance. A brief summary of the condition classes in relation to the water environment for interest feature condition follows.

Unfavourable Declining Condition

A2.9 The 2018 assessment did not assign units to this condition as this condition requires demonstration of significant deterioration or declines in populations above threshold numbers for birds or loss of habitat for features or demonstrable and consistent worsening of attributes over time.

A2.10 The more detailed, follow-on assessment, to review trends in the interest features of Chichester Harbour in 2019/20 has determined that the Chichester Harbour condition is declining due to the continued net loss of the saltmarsh feature, poor condition of the remaining marsh, declining numbers of some species of terns and low or zero productivity of nesting terns in the Harbour. Overall the wintering bird assemblage was unfavourable no change not because the birds populations were stable but because on average the declines in populations were not sufficient to trigger a declining status. Trends varied with species, with those species that can switch to other foraging methods and habitats away from the intertidal in general showing lesser declines or even increases. The other features assessed (littoral sediment, eelgrass were all given unfavourable status but with low confidence and Natural England were unable to discern a trend due to insufficient data. The units were assigned to the features in the worst condition where the data was of high confidence so overall the intertidal habitats in Chichester Harbour in unfavourable declining condition.

Unfavourable no change

A2.11 This work identified that there are sections of the designated sites in the Solent that are unfavourable for the interest features on the weight of evidence of elevated levels of inorganic nitrogen and biological indication of eutrophication shown by the abundance of macroalgae. Where sites are recorded as unfavourable, opportunistic green macroalgae is recorded to reach >75% cover, or a biomass of 1kg/m^2 or more. In these cases there is also little or no evidence of any reduction in nutrient status that would be adequate to substantially prevent the growth of dense macroalgae mats.

A2.12 There are unfavourable (no change) assessment on units within the following estuaries and harbours in Hampshire: Southampton Water, Hamble estuary, Portsmouth Harbour, Chichester Harbour and on the Isle of Wight: Yar estuary, Newtown Harbour, Medina estuary, Wootton Creek and Bembridge Harbour.

Unfavourable recovering (at risk)

A2.13 The review identified that there are parts of Langstone Harbour where the water environment of a unit is assessed as unfavourable for the interest features on the weight of evidence on inorganic nitrogen concentrations and biological indications of eutrophication, shown by the abundance of macroalgae (>75% cover density or a biomass of ≥ 1kg/m^2), but recovering on the basis of a large reduction in nutrient inputs through diversion of wastewater. These units are considered 'at risk' of not recovering to a favourable situation on the water environment as it is unclear whether the nutrient status will become adequate to substantially prevent the growth of dense macroalgae mats in parts of the Harbour. Also other potential ecological responses to elevated nutrient concentrations that could affect the condition of the designated features, such as impacts on saltmarsh and seagrass, have not been assessed.

A2.14 The 2018 assessments did not identify any Unfavourable (recovering) units where there is a littoral sediment feature in any of the other estuaries and harbours.

Favourable – high threat

A2.15 Some sections of the designated sites in the Solent are provisionally assessed as borderline favourable for the interest features. Here there is elevated levels of inorganic nitrogen but, at a local unit scale, the data that is available only demonstrates slight biological indication of eutrophication shown by some presence of macroalgae (<75% cover density, or a biomass of <1kg/m^2). These are provisional assessments with a high threat that the nutrient status is inadequate to substantially prevent detrimental ecological effects on designated features, particularly if there is change in environmental conditions. The high threat assessment also reflects the fact that other potential ecological responses to elevated nutrient concentrations that could affect the condition of the designated features, such as impacts on saltmarsh and seagrass, have not yet been assessed.

A2.16 There are favourable (high threat) units within the following estuaries and harbours in Hampshire: Lymington estuary, Solent and Itchen Estuary, Test Estuary, Southampton Water, Portsmouth Harbour, Chichester Harbour, Langstone Harbour, and on the Isle of Wight: Newtown Harbour and Bay and Bembridge Harbour.

Catchment work

A2.17 The high levels of nitrogen and phosphorus input to the water environment is currently caused by agricultural sources and wastewater from existing housing.

There are a number of mechanisms already in place to reduce the amount of nutrient inputs within our rivers and coastal waterbodies.

A2.18 Within the river catchments; Defra's Catchment Sensitive Farming (CSF) programme works with agriculture to reduce diffuse sources of pollution such as fertiliser and slurry run-off. One of the aims of this work is to deliver environmental benefits from reducing diffuse water pollution. To achieve these goals CSF delivers practical solutions and targeted support which should enable farmers and land managers to take voluntary action to reduce diffuse water pollution from agriculture to protect water bodies and the environment.

A2.19 In addition, Southern Water is upgrading their wastewater treatment works to reduce the amount of phosphorus inputs from human sewage. There are agreed improvements to phosphorus permits on four Southern Water Services on the River Test and phosphorus upgrades at two wastewater treatment works on the River Itchen.

A2.20 Natural England has recently published a review of the effectiveness of catchment sensitive farming approaches in the report "Catchment Sensitive Farming Evaluation Report – Water Quality Phases 1 to 4 (2006-2018) (NE731)". Work is on-going to evaluate the effectiveness of such work in reducing existing inputs into the Solent's water environment. Nationally, the results in this report state that water quality is estimated to have improved, due to reduced pollutant loadings, by between 1.2 and 6.5 per cent across water bodies associated with Phase 1 CSF Target Areas.

Type of nutrient inputs to designated sites

A2.21 There is evidence that inputs of both phosphorus and nitrogen influence eutrophication of the water environment. However, the principal nutrient that tends to drive eutrophication in the marine environment is nitrogen and this is supported by modelling and evidence.

A2.22 A modelling assessment has been undertaken by the Environment Agency to understand the importance of nitrogen in causing the growth of macroalgae and phytoplankton within estuaries in the Solent. This work used the Combined Phytoplankton and Macroalgae model developed by Cefas and was assessed at a water body scale. This scale provides an overview and may mask conditions that are unfavourable for designated interest features at a more local scale. The modelling suggests that in one estuary, the Medina, both nitrogen and phosphorus availability may control macroalgae growth (e.g. Rees-Jones et al 2014 and Udal *et al* 2014).

A2.23 The best available evidence is for focus in the Solent harbours to be on nitrogen reduction, and reduction in both nitrogen and phosphorus in the Medina catchment. However, this approach may be refined if greater understanding of the eutrophication issue is gained by thorough new research or updated modelling.

A2.24 The nutrient budget in this report calculates quantities of nitrogen (N) generated by development. This N comes in different forms and measured N concentrations vary according to exactly what is measured. These differences need to be recognised when calculating nutrient budgets. The key measurement is Total Nitrogen (TN), i.e. both organic and inorganic forms of nitrogen, because this is what is available for plant growth. TN is the sum of the inorganic forms - nitrate-nitrogen (NO3-N), nitrite-nitrogen (NO2-N), ammoniacal-N - and organically bonded nitrogen.

A2.25 Total Nitrogen is measured by WwTW where there is a permit with a TN limit consent. However, for WwTWs without permits, measurements could be inorganic nitrogen (nitrate + nitrite + ammoniacal N) or TN or a mix. Most river quality monitoring by EA only records the inorganic N forms. The Farmscoper report measures nitrate-nitrogen not TN. Nitrate is normally the largest component of TN but quantities of organic N are significant. In the Test catchment dissolved organic nitrogen has been found to comprise 7% of the potential biologically available nitrogen in the river and 13% of that in the estuary (Purdie, 2005). Thus, the land use change element of this methodology will underestimate TN leaching. We therefore advise that this uncertainty is recognised as one of the several factors taken into account by the recommended precautionary buffer approach adopted by this methodology.

A2.26 For developments on the Isle of Wight that are impacting on the Medina estuary, both a phosphorus and nitrogen budget may be required. Natural England will work closely with the Isle of Wight Council and applicants to provide advice on a bespoke case-by-case basis.

A2.27 This approach is also supported by scientific literature which confirms that whilst both nitrogen and phosphorus should be reduced to tackle estuarine eutrophication, primarily the focus should be on nitrogen. Phosphorus reduction alone does not address the mechanisms caused by elevated nitrogen that affect sea-grass health and the structural stability, extent and plant species diversity of saltmarsh. In addition, most land use measures to reduce nitrogen are also likely to reduce phosphorus concurrently.

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Appendix 1 – Farm Types

The UK system is based on weighting the contributions of each enterprise in terms of their associated outputs. The weights used (known as 'Standard Outputs' or SOs) are calculated per hectare of crops and per head of livestock and used to calculate the total standard output associated with each part of the Farm Business.

Cereals
Holdings on which cereals, combinable crops and set-aside account for more than two thirds of the total SO and (pre-2007) where set-aside alone did not account for more than two thirds of the total SO. (Holdings where set-aside accounted for more than two thirds of total SO were classified as specialist set aside and were included in "other" below.)

General cropping
Holdings on which arable crops (including field scale vegetables) account for more than two thirds of the total SO, excluding holdings classified as *cereals;* holdings on which a mixture of arable and horticultural crops account for more than two thirds of their total SO excluding holdings classified as *horticulture* and holdings on which arable crops account for more than one third of their total SO and no other grouping accounts for more than one third.

Horticulture
Holdings on which fruit (including vineyards), hardy nursery stock, glasshouse flowers and vegetables, market garden scale vegetables, outdoor bulbs and flowers, and mushrooms account for more than two thirds of their total SO.

Specialist Pigs
Holdings on which pigs account for more than two thirds of their total SO.

Specialist Poultry
Holdings on which Poultry account for more than two thirds of their total SO.

Dairy
Holdings on which dairy cows account for more than two thirds of their total SO.

Lowland Grazing Livestock
Holdings on which cattle, sheep and other grazing livestock account for more than two thirds of their total SO except holdings classified as *dairy.* A holding is classified as lowland if less than 50 per cent of its total area is in the Less Favoured Area (LFA).

Mixed
Holdings for which none of the above categories accounts for more than 2/3 of total SO. This category includes mixed pigs and poultry farms as well as farms with a mixture of crops and livestock (where neither accounts for more than 2/3 of SOs).
http://farmbusinesssurvey.co.uk/DataBuilder/UK_Farm_Classification_2014_Final.pdf

Appendix 2 – Leaching of nitrogen from urban areas

The average total nitrogen leaching rate from an urban area (14.3kg/ha/yr) comes from values for hydrologically effective rainfall (478mm - precipitation minus losses from evapo-transpiration) and the nitrogen concentration of leachate (3mg/l) given in Bryan et al (2013) the latter figure derived from an AMEC report. The value for nitrogen concentration is similar to one quoted in House et al (1993) who give a mean event concentration of 3.2mg/l for total nitrogen (with this value derived from other sources) with a range of 0.4-20mg/l. Thus although it is not specified by Bryan et al (2013), it is probably reasonable to take the 3mg/l to be total nitrogen especially since the organic component of N from urban areas is likely to be relatively small.

Mitchell (2001) gives the following event mean concentrations in mg/l total N from urban areas; Urban Open 1.68; Ind/Comm 1.52; Residential 2.85; Main roads 2.37.
It is recognised that the datasets that produced these figures are not large (n = 14 in this case), a good deal of uncertainty remains and that further sampling is needed to validate models of pollutant effects from urban runoff (Leverett et al 2013).

Typical nutrient concentrations in urban stormwater runoff in the U.S. are 2.0 mg/l for total N (TN) (Schueler 2003). Population densities seem to be less in the most studied urban catchments (eg Groffman et al 2004 in Baltimore, Hobbie et all 2017 in Minnesota) than those in the UK but this does not necessarily lead to an increase in the rate of nitrogen leaching from the catchment for the factors affecting this value are complex. Thus although there will clearly be variation between different urban areas, there is insufficient knowledge to be able to predict N leaching from the different characteristics of these areas. And for practical purposes an overall N leaching figure is needed; nothing found in the literature indicates that another value would be more representative than 3mg/l.

An N leaching figure can also be derived by using the relationship between mean stream and river flow rate and catchment area. The ratio for the gauging station on the River Meon at Mislingford is 0.014m^3/sec/km^2 and, with a TN concentration of 3mg/l, this equates to a TN leaching rate of 13.2mg/l, similar to the value obtained when hydrologically effective rainfall is used.

Comparison can also be made with direct measurements of TN urban outputs from studies in the USA (Hobbie et al 2017, Groffman 2004). The values in the Hobbie paper for urban catchments in Minnesota varied from 12.5-27.2 kg/ha/yr with a mean of 17.3 kg/ha/yr. The outputs measured by Groffman (2004) were smaller (between 5.5 and 8.6kg/ha/yr) but these were less urbanised catchments, several including areas of old growth forest where nitrogen retention was very high. Thus these values are broadly of the same order as the 14.3 kg/ha/yr leaching figure initially calculated.

Nitrogen inputs in these studies come predominantly from three sources - atmospheric deposition, pet waste and lawn fertilisation. N deposition was slightly lower in both Baltimore and Minnesota than values from APIS in the around the Solent (23.8kg/ha/yr for hedgerows

or woodland, 14.7kg/ha/yr for grassland). No UK studies have been found to compare with the US ones for N inputs in urban areas from pet waste or from lawn fertilisation.

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Appendix 3 - Estimating the leaching of total nitrogen (TN) from natural greenspace (SANG).

A number of assumptions must be made about the management of the SANG to allow an estimate of TN leaching to be made. These are as follows:

- The vegetation of the SANG would be predominantly permanent grassland but with an element of tree and scrub cover (this will of course vary for different SANGS but a 20% average figure is used here). The degree of tree and scrub cover will not greatly affect the result as both permanent grassland and woodland/scrub exhibit a high degree of N retention. It matters most because of the differences in the rate of atmospheric N deposition between the two habitats.
- The grassland would be permanent (ploughing will release large amounts of N) and is not fertilised either with artificial fertiliser or manures. It may be ungrazed or grazed very lightly (<0.1LU/ha/yr) with no supplementary feeding (even without supplementary feeding, grazing can increase N leaching because N retention is lower when N is delivered in the form of cattle urine and dung [Wachendorf et al 2005]).
- The grassland may be cut with the cutting regime dependent on other factors. Cuttings may be left or removed from site as the case may be but should not gathered and composted in heaps on site. Any gorse within the scrub should be controlled so it is no more than rare across the mitigation area since a significant amount of nitrogen fixation occurs within gorse stands.

A generic leaching value for N concentration from AMEC for 'rough grazing', quoted in Bryan et al (2013), is 2mg/l. Using this concentration together with a value of 478mm for the hydrologically effective rainfall (HER) gives a leaching value for N of 9.6 kg/ha/yr. A similar value (8.8kg/ha/yr) is obtained if the relationship between mean stream flow and catchment area (0.014 cumecs/km^2 which is the ratio for the gauging station on the nearby River Meon at Mislingford) is used instead, keeping the same N concentration of 2mg/l. It is not clear whether these AMEC concentrations are for total nitrogen or for inorganic nitrogen.

The particular grassland management regime for which the 2mg/l N concentration applied is not known. However, even though studies of N leaching from natural unfertilised grasslands are rare in the literature (most are of agricultural grasslands with fertiliser inputs of some sort) it seems likely that this value is higher than might be expected from a natural grassland with no fertiliser inputs such as a SANG. Thus for example TN leachate concentrations were between 0.44 and 0.67 mg/l in an extensively managed montane grassland (that still had one slurry application per year) and the equivalent mean TN loss was 1.0, 2.6 and 3.1 kg/ha/yr for three different areas (Fu et al 2017).

Adjusting for a SANG with 20% woodland/scrub, using the AMEC woodland generic leaching value of 0.5mg/l (Bryan et al 2013) for the woodland/scrub component, results in an N output of 8.1 kg/ha/yr.

The 0.5mg/l value is also much higher than the very low nitrate concentrations in streams from purely forested catchments (Groffman 2004) and from those reported by for a large sample of forested streams by Mulholland et al 2008 where the mean nitrate-N concentrations were <0.1mg/l. All but a few of the samples from an unfertilised suburban lawn had nitrate-N concentrations below the detectable limit of 0.2mg/l (Gold et al 1990). The same was true for a forest plot and the average nitrate-N losses from both home lawn and the forest plots averaged 1.35 kg/ha/yr over 2 years. These studies of both grassland and woodland nutrient cycling suggest that the AMEC generic leachate concentration of 3mg/l, resulting in an N output of 9.6kg/ha/yr, is too high when applied to a SANG.

Despite there being no direct N fertiliser inputs on a SANG, N inputs will still occur from three main sources. These are atmospheric deposition, pet waste and N fixation from legumes and estimating the contribution of each of these sources, together with the proportion of N retained, is an alternative method of working out the N contribution from a SANG.

N deposition

The following are typical values taken from APIS for TN deposition in the Solent area. .

Improved grassland 14.7 kgN/ha/yr; Arable horticultural 14.7 kgN/ha/yr; Neutral grassland 14.7 kgN/ha/yr

Hedgerows 23.8 Kg N/ha/year; Broadleaved, Mixed and Yew Woodland 23.8 Kg N/ha/year

Using the value for hedgerows and woodland for the 20% scrub component of the hypothetical SANG and the neutral grassland value for the rest results in a deposition rate of 11.76 + 4.76 = 16.5 kg/ha/yr.

Pet waste

SANGs are specifically designed to attract increased levels of public access particularly dog walkers so the potential inputs of N from dog waste are likely to be significant.

Hobbie et al (2017) give a figures for TN inputs from this source for entire urban areas and these vary between 3.56 and 21.2kg/ha/yr for 7 urban catchments with a median of 6.9kg/ha/yr. A figure of 17kg/ha/yr can be gleaned from Baker 2001 which was worked out using information on pet numbers, nutritional needs, pet weights etc; 76% of this was from dogs.

The heavy use of SANGS by dogs suggests that N inputs would most likely be higher than these figures averaged over the whole urban area. Nevertheless, inputs to the SANG from this waste means that it is not deposited elsewhere in the urban area where N may anyway end up in the same receiving water.

TN retention in grasslands will also be higher than the average over other parts of the urban area but the characteristics of the inputs from dogs is likely to lower the amount of TN

retained because the concentrated patchy nature of the input will reduce the proportion of TN retained compared with more evenly spread inputs, as mentioned above.

Picking up dog faeces will obviously reduce the input from but not remove inputs from urine. Dog urine has a high N content.

In these circumstances there is clearly uncertainty about the level of input from this source the highest figure from Hobbie et al (21.2kg/ha/yr) has been used but adjusted downwards because not all of this will be from dogs resulting in an overall value of 16.1 kg/ha/yr.

This has also been done on the basis that funding, together with a binding commitment, is provided for in perpetuity collection of dog waste and enforcement of pick up rather than relying on direct LA resources which could stop at any time.

TN fixation

Hobbie et al (2017) give a value for this of 17.5kg/ha/yr from direct investigation of unfertilised urban parks and this is the value used. Fixation would only be in the grassland part of the SANG which reduces the figure to 14 kg/ha/yr.

TN retention

A number of studies have shown high TN retention in urban areas (eg 80% Hobbie et al 2017) thought to be mainly attributable to TN retention in urban grasslands and lawns which may be in turn related to high carbon within organic matter in the soils. The release of large quantities of N when permanent grassland is ploughed illustrates the capacity of these grassland for N storage (eg Howden et al 2011).

Direct measurements of total N outputs from urban grasslands in the Groffman et al (2009) studies in Baltimore also show high N retention in urban grassland but there are difficulties in applying these results directly to SANGs partly because the plots were either quite heavily fertilised or may have had unmeasured N inputs from neighbouring land. Nitrate-N losses from an unfertilised home lawn averaged 1.35 kg/ha/yr over 2 years (Gold et al 1990). Generally the complex processes and uncertainties about how the management of these grasslands might affect the degree of TN retention and TN output makes estimation of the proportion retained difficult. Nevertheless a value of 90% given in Groffman et al (2009), and supported by a number of references given there, would seem reasonable considering also that overwatering and over fertilising, neither of which would happen on a SANG, seem to be factors that lead to more leaching.

Woodland and scrub. N retention measured in forest plots in Baltimore was very high (95%) Groffman (2004). N percolation losses measured by Gold et al 1990 in forest plots were low and similar to those in unfertilised lawn. However, it is probably not valid to equate a scrub/woodland part of a SANG with the forest plots measured in the Groffman studies in Baltimore for these were old growth well established forests. Nevertheless there is still likely to be high N retention in these areas even if not as much as 95%.

Given all of the above, a 90% TN retention rate over the SANG as a whole has been used in the calculation below**Inputs**

N Deposition (APIS) = 16.5 kg/ha/yr
Pet waste 16.1 kg/ha/yr
N fixation 14 kg/ha/yr

Total = 46.6 kg/yr

Watershed retention of TN 90%

Total TN output = 4.66 kgN/ha/yr

Conclusion

The question of estimating TN outputs from a SANG has been approached from different angles. These investigations all indicate that the value used so far – 13 kg/ha/yr is too high. Instead an TN output of 5 kg/ha/yr is considered to be close to the true value but still sufficiently precautionary.

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Appendix 4 – Potential for N mitigation using wetlands

Where N budget calculations indicate that N outputs from proposed developments are greater than pre development conditions, the use of new constructed wetlands to retain some of the N output is one mitigation option.

There are a number of possibilities for different types of constructed wetland. Wetlands can be designed as part of a sustainable urban drainage (SUDs) system, taking urban runoff/stormwater; discharges from STWs can be routed through wetlands; or the flow, or part of the flow, of existing streams or rivers can be diverted through wetlands.

Wetlands receiving nitrogen-rich water can remove a proportion of this nitrogen through processes such as denitrification and sedimentation. This has been demonstrated in numerous studies; a recent systematic review of the effectiveness of wetlands for N (and P) removal (Land et al 2016) used data from 203 wetlands worldwide of which the majority were free water surface (FWS) wetlands (similar in appearance and function to natural marshes with areas of open water, floating vegetation and emergent plants). The median removal rate for wetlands that were included in this review was 93g/m^2/yr (or just under a tonne/ha/year). The proportion of N removed is termed the efficiency and the median efficiency of wetlands included in the Land review was 37%.

Many factors influence the rate of N removal in a wetland the most important being hydraulic loading (HLR - a function of the inlet flow rate and the wetland size), inlet N concentration and temperature. Together inlet N concentration and flow rate determine the amount of N that flows through the wetland which ultimately limits the amount of N saving that can be achieved.

The rate of removal can also be expressed in terms of the amount of N removed per unit wetland area. This removal rate will typically increase as the inlet N concentration increases, at least within the normal range of inlet N concentrations. Thus wetlands that treat the N rich discharges, for example from STWs, or water in rivers where the N concentrations are high, will remove more N per unit area than say, wetlands treating water in a stream where water quality is very good and the N concentration is low. Thus if space is at a premium, and the goal is to remove as much N as possible, it makes sense to site wetlands where N concentrations are high.

For wetlands to work well, specialist design input based on sound environmental information will be necessary. There will be a need for consultation with relevant statutory bodies. These processes are likely to be easier where wetlands are an integral part of a larger development. Wetlands do offer additional benefits above offering neutrality but will also require ongoing monitoring, maintenance and adjustments beyond any particular developments completion. Consideration of the long term security of facilities and their adoption at an early stage is advisable.

There are a number of publications which advise about constructed wetlands. For example, Kadlec and Wallace (2009) is a comprehensive source of information covering all stages related to the implementation of different types of constructed wetland. The many papers relating the results from detailed monitoring over many years of the performance of two constructed wetlands in Ohio, USA are also instructive (eg Mitsch et al 2005, 2006, 2014).

Stormwater wetlands

These are what is termed event-driven precipitation wetlands with intermittent flows. There will normally be baseflow and stormwater components to the inputs.

For such wetlands Kadlec and Wallace state that:-

'*A typical configuration consists of a sedimentation basin as a forebay followed by some combination of marshes and deeper pools'*

However, ponds are usually less effective at removing N (Newman et al 2015) than shallow FWS wetlands so the emphasis here should be on the latter although a small initial sedimentation basin is desirable since is likely to reduce the maintenance requirement for sediment removal in the FWS wetland. One advantage of this type of wetland is that it can be designed as an integral part of SUDs for the development and therefore is subject to fewer constraints.

Some wetlands with intermittent flows are prone to drying out and may need provisions for a supplemental water source. In some circumstances, this may be possible through positioning the wetland bottom so that there is some connection to groundwater. However many varieties of wetland vegetation can withstand drying out although there may be a small reduction in water quality improvement (Kadlec and Wallace 2009). Nevertheless base and stormwater flows to each wetland should be worked out to ensure that it is viable.

Wetlands need to be appropriately sized taking into account the HLR and N loading rates. To give a general idea of the areas involved, a wetland 1ha in area would serve a development area of about 50ha.

Calculating the potential N retention in such wetlands involves first determining the proportion of the HER that will pass through the wetland because a percentage of the water carrying N will go directly into groundwater, bypassing storm drains and SUDs and the constructed wetlands. This percentage will depend on such factors as the proportion of hard surface within the development and the geology. Then, assuming the inlet TN concentration is 3mg/l, a proportionate reduction of 37% can be used to work out the amount of N retained.

Provision is needed to control tree and scrub invasion, for wetlands with emergent vegetation medium height such as Typha and reed had higher rates of denitrification than those dominated by trees and woody shrubs (Alldred and Baines 2016).

Other critical aspects of design are the water control structures - inflow and outflow arrangements with water level control – and the need or otherwise for a liner. This last issue is related to soil permeability. A variety of emergent wetland plants, not only reed, can be effective within wetlands. Wetlands with a number of different plant species, rather than monocultures, are desirable both for biodiversity reasons and because they are more resilient against changes in environmental conditions; different species will have different tolerances. Guidance concerning planting can be found in Kadlec and Wallace (2009); allowance should be made in planting ratios and densities for different rates of expansion of different species. Another approach is to use material containing wetland plant seeds from a nearby wetland with a species composition similar to the one preferred. However, unless the donor site is carefully monitored, this would obviously increase the risk of importing unwanted alien plants.

Sedimentation will eventually compromise some aspects of the wetland's function and rejuvenation measures will be necessary (Kadlec and Wallace 2009). The same authors indicate a sediment accretion rate in the order of 1 or 2cm/yr and give examples of rejuvenation after 15 and 18 years but other wetlands have not needed any significant restoration in similar timespans. Various different options for the management of sediment accumulation are given by Qualls and Heyvaert (2017). There of course needs to be provisions to ensure that appropriate maintenance and restoration measures, guided by monitoring, are periodically carried out.

Other sources of information about stormwater wetlands include Wong et al (1999, available on line). The papers about a stormwater wetland in the Lake Tahoe Basin in California are also useful (Heyvaert et al 2006, Qualls and Heyvaert 2017).

Constructed wetlands taking discharges from STW

Many of the considerations discussed above for stormwater wetlands apply equally here. There will obviously be constraints on the location and size of such a wetland because of land availability in the area of the STW. The flow from the STW together with the N concentration in the discharge are needed to determine the approximate size of a wetland. We would recommend a wetland area that gives an N loading of about 500 $g/m^2/yr$ or lower. Because many of the discharges from STW have a high N concentration the potential for N retention in such wetlands is also high. The concentration of N in the outflow will be variable but the purpose of such wetlands is to retain N overall rather than to provide a specific constant standard of water quality in the outflow.

Wetlands associated with streams and rivers

Diverting part of the flow of a stream or river through a wetland, with the outflow returning to the watercourse, provides another opportunity for N saving. For obvious reasons such wetlands would mostly need to be located on the river floodplain. The inlet flow rate can be controlled so it is appropriate for the size of the wetland created and so that the ecology of the watercourse is not compromised in the section affected.

There can be other concerns in relation to the potential effects on the stream or river. An abstraction licence will almost certainly be required.

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Appendix B Nitrogen budget calculation for Site 26

Table 5: Breakdown of detailed steps taken to calculate the nitrogen budget for Site 26 (Land adjacent to the Parish Hall). The methodology follows Natural England's Advice Note on the issue (dated June 2020).

Stage	Detailed Calculation Steps				
Stage 1 – Nitrogen load in future treated wastewater effluent (kg/TN/yr)	Step 1 – Additional population[15]	Step 2 – Wastewater generation (l/d)[16]	Step 3 – WwTW permit limit (or average for catchment; mg/l)	Step 4 – TN discharge (kg/TN/yr)	
	48	5,280	27	48.18	
Stage 2 – Loss of nitrogen input due to the conversion of existing land uses (kg/TN/yr)	Step 1 – Total Area of Agricultural Land (ha)	Step 2 – Identifying current land use and nitrogen loss (kg/ha/yr)	Step 3 – Total Nitrogen loss from current land use (kg/TN/yr)		
	1.1	Cereal cropping (31.2 kg/TN/ha/yr)	34.32		
Stage 3 – Nitrogen leachate from future types of land use (kg/TN/yr)	Step 1 – Total area of urban surface (ha)[17]	Step 2 – Nitrogen leachate from urban areas (kg/TN/yr)[18]	Step 3 – Total area of open space (ha)	Step 4 – Nitrogen leachate from open space (kg/TN/yr)[19]	Step 5 – Combined leachate from all future surfaces (kg/TN/yr)
	0.9	12.87	0.2	1	13.87
Stage 4 – Overall nitrogen budget for Site 26 (kg/TN/yr; values taken from stages 1-3 above)	Step 1 – Treated WwTW Effluent (Stage 1 above)	Step 2 – Nitrogen leachate from future surfaces (Stage 3 above)	Step 3 – Nitrogen loss from conversion of existing land use (Stage 2 above)	Stage 4 – Total nitrogen budget [Step 1 + (Step 2 – Step 3)]	Step 5 – Total nitrogen budget with 20% precautionary buffer
	48.18 kg/TN/yr	13.87 kg/TN/yr	34.32 kg/TN/yr	27.73 kg/TN/yr	33.28 kg/TN/yr

[15] Based on 20 residential dwellings to be delivered at an average occupancy rate of 2.4.
[16] Assumes wastewater generation of 110l per person per day.
[17] Measurements of future urban surface and open space have been done in MAGIC and are approximate.
[18] Urban land has been shown to have a nitrogen leachate value of 14.3 kg/ha/yr.
[19] Open space is predicted to have a nitrogen leachate value of 5 kg/ha/yr.