REPORT

Norfolk Nutrient Budget Calculator

Technical Reference Report

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Table of Contents

Table of Tables

Table of Figures

1.1 Introduction

1.1.1 Evidence-based approach

The Norfolk nutrient budget calculator is a regional specific tool designed to rapidly calculate the nutrient loading from new residential development in the catchments of the River Wensum SAC and the Broads SAC. This report presents the methods, principles and key assumptions on which the calculator is based.

The Norfolk nutrient budget calculator utilises the best available scientific evidence and research alongside the latest nutrient neutrality guidance from Natural England (2022). The calculator adopts a regional specific and accurate approach. As a result, some of the calculator inputs and assumptions deviate from those advised in the published guidance. The evidence to support these deviations is presented within this report.

Whilst the best available evidence and research was used, some inputs are based on professional judgement and the values used are subject to a degree of uncertainty. As such, a precautionary approach was applied in line with existing legislation and case law. Furthermore, a precautionary buffer is added to the total nutrient loading values for developments. Applying a precautionary approach provides reasonable certainty to the local planning authority that the development, in combination with other developments, will avoid significant increases in nutrient loading to the designated sites.

Under the requirements of the Conservation of Habitats and Species Regulations 2017 (as amended) (herein referred to as the Habitats Regulations), a Habitats Regulations assessment must remove all reasonable scientific doubt as to the absence of adverse effects on a habitats site. However, absolute certainty is not required. In order to meet the requirements, scientific evidence was used instead of generic assumptions where possible.

1.1.2 Use of the calculator

The calculator is only applicable to developments that impact the River Wensum SAC and/or Broads SAC site or any water body that subsequently discharges into these sites. **Figure 1** presents the surface water catchment area that will impact nutrient contributions to the designated sites. **Appendix 1** provides a full list of the Water Recycling Centres (WRCs) that discharge into the surface drainage network upstream of the designated sites and could therefore supply nutrients to them. For any development proposals that would be located outside of the defined surface water catchment area, but would discharge effluent to a WRC within the surface water catchment, stages 2 and 3 do not apply. No assessment is necessary for any development proposals that would drain to a WRC that discharges outside of the surface water catchment.

The methodology applies to all developments that could result in a net increase in population, such as new homes, student accommodation, tourist attractions and tourist accommodation as these developments would have wastewater implications. Commercial developments are not typically included, as it is assumed that people working in a commercial building will live within the same catchment and the wastewater implications of the individuals are considered when assessing housing. Assessing both housing and commercial developments could therefore lead to ‘double-counting’.

Figure 2 presents a flow diagram for the application of the methodology used in the Norfolk nutrient budget calculator. Details of each stage are presented below.

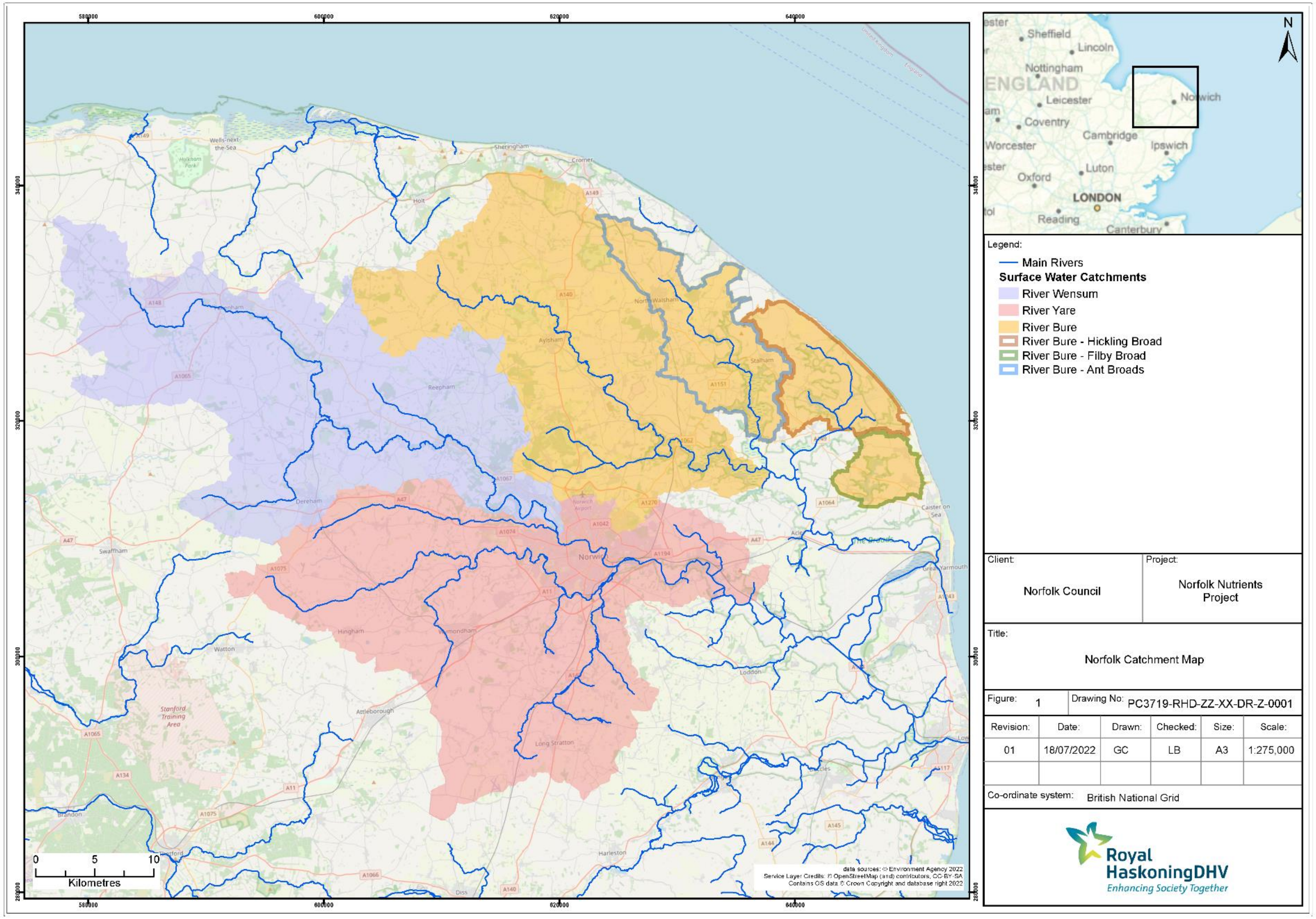

Figure 1: *Surface water catchment map*

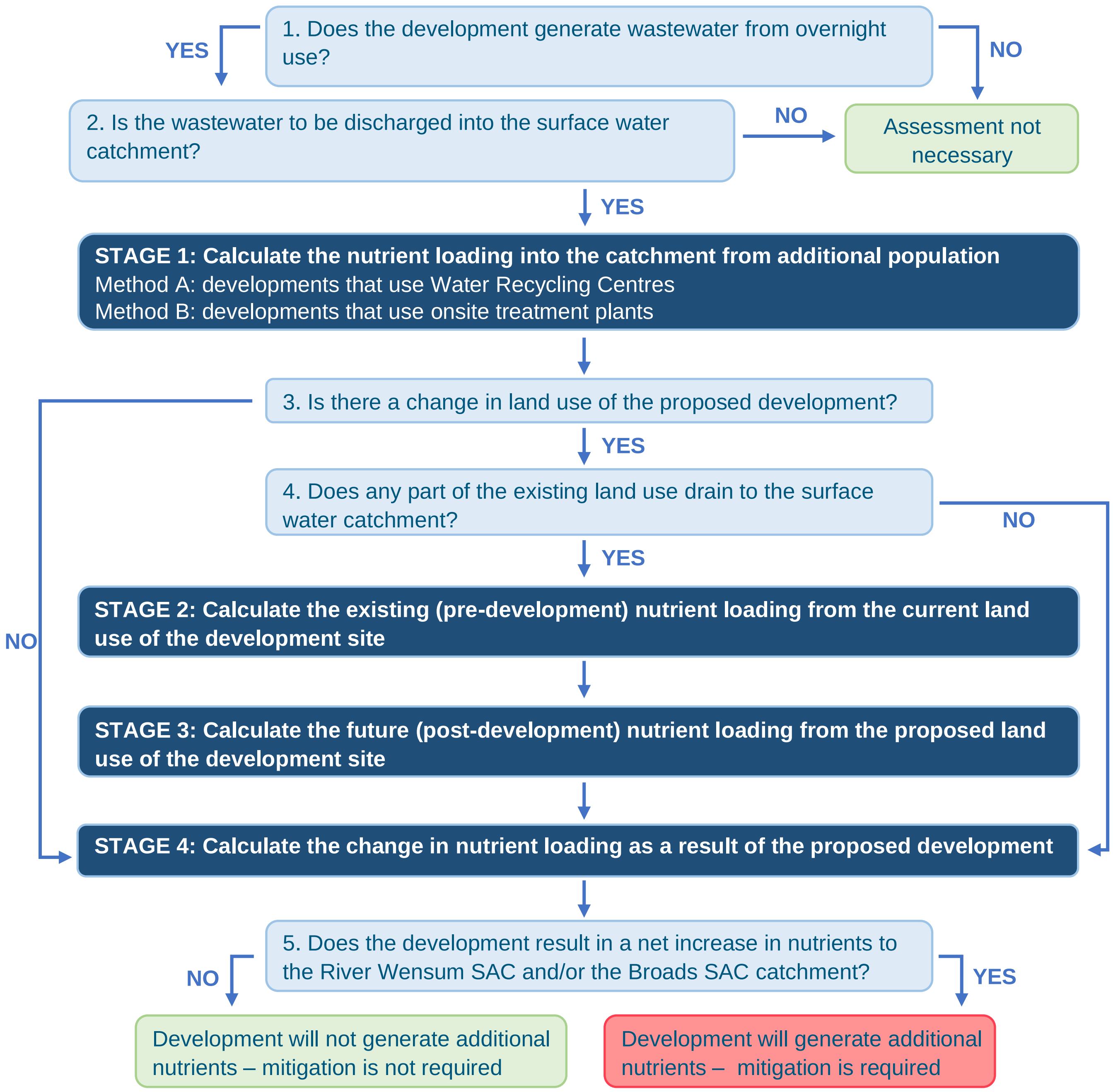

Figure 2: *Nutrient neutrality flow diagram*

1.2 Stage 1: Calculate nutrient loading from additional wastewater

1.2.1 Stage 1 methodology

Nutrient loading is calculated by multiplying the number of proposed dwellings by the assumed occupancy rate (persons/dwelling) to calculate the population increase from the development. This is then multiplied by the water usage (l/person/day) and the effluent discharge concentration (mg/l) to calculate the nutrient loading, which is converted into kg/yr.

$$\boldsymbol{No. of\ dwellings} \times \boldsymbol{Occupancy\ rate} = \boldsymbol{P_i} \qquad \text{Eq. 1}$$

Where $\boldsymbol{P_i}$ represents the population increase.

$$\boldsymbol{P_i} \times \boldsymbol{Water\ usage} = \boldsymbol{W}\ (\boldsymbol{Litres\ per\ day}) \qquad \text{Eq. 2}$$

Where $\boldsymbol{W}$ the wastewater volume generated.

$$\boldsymbol{W} \times (\boldsymbol{WRC\ discharge\ level}) = \boldsymbol{L_w}\ (\boldsymbol{mg\ per\ day}) \qquad \text{Eq. 3}$$

$$\frac{\boldsymbol{Nutrient\ load}}{\boldsymbol{1000000}} \times \boldsymbol{365} = \boldsymbol{L_w}(\boldsymbol{kg\ per\ year}) \qquad \text{Eq. 4}$$

Where L_w represents the loading from wastewater.

1.2.2 Average occupancy rates

The current Natural England nutrient neutrality guidance (2022) derives average housing occupancy rates by considering the total population within a catchment against the total number of dwellings. This housing rate is then applied to all new developments within the catchment. This approach assumes that all new dwellings will result in an increase in the population within the catchment and ignores the fact that new dwellings will often by occupied by people who are already living within the catchment (and therefore already contributing to wastewater).

A more robust method of calculating the actual population change from new developments was used and a Norfolk specific occupancy rate of 1.876 persons/dwelling was derived (ORS, 2022). This value accounts for people moving within catchments and the impact of second homes / holiday homes.

This Norfolk average occupancy rate is applied to all residential dwellings within the catchment, regardless of the number of bedrooms. This consistent approach reduces the risk of underestimating or overestimating the total occupancy levels across the catchment. However, the Norfolk average occupancy rate is not appropriate for development types such as student accommodation or houses in multiple occupation, which are not included in the ONS data. In this case, an average occupancy of 1.65 persons/dwelling, derived from the Dorset Heathlands SPD (Dorset Council, 2020), is applied to additional rooms above 6 residents. The Dorset Heathlands SPD provides the best alternative estimate and is considered to be appropriate for use outside of Dorset.

In the case of hotels or guest houses, an average occupancy of 1.65 persons/dwelling is also assumed, alongside estimations on the number of weeks open per year (1-52) and typical occupancy (1-100%) which are applied as multipliers. Accounting for the number of weeks open and typical occupancy allows for the most accurate determination of the wastewater volume that will be produced by the development.

In the case of single bedroom student halls, bespoke occupancy rates should be agreed with the relevant Local Planning Authority.

1.2.3 Water usage per person

The optional higher Building Regulations standard for water use per person of 110 litres/person/day is used within the calculator by default. When developments are built to 110 l/person/day, this value should be secured by the Local Planning Authority through a planning condition. However, the cells remains open and the user can choose to apply the Building Regulations legal maximum water use per person standard of 125 litres/person/day or a water use per person standard that is even greater than the optional higher standard.

Natural England nutrient neutrality guidance (2022) indicates that an additional 10 litres per person per day should be applied to the chosen water usage standard to account for potential changes to less water efficient fittings throughout the lifetime of the development. However, there is evidence in the literature to suggest that water usage per person per day does not increase over time. As such, this assumption was not adopted in the Norfolk nutrient budget calculator. For example, a recent report by Waterwise (2018) indicates that customer perception on water efficient fittings is positive, with 42% feeling that efficient showerheads and taps would perform the same and 39% thinking that they perform better than less efficient products. Furthermore, a recent Ofwat study found that it is possible to achieve average household consumptions of 50-70 litres per person per day in 50 years, without a reduction in the level of utility or quality of water use. Andrewartha and Scott (2018) found that the average water usage in properties built to a standard of 125 litres/person/day is actually 113.7 litres/person/day.

The Norfolk Nutrient budget calculator uses a default value of 110 l/person/day within the calculator and does not apply an additional 10 l/person/day as per Natural England guidance.

1.2.4 Wastewater discharge concentrations

1.2.4.1 Water Recycling Centre

In order to calculate the nutrient contribution from wastewater, an estimate is made on the nutrient concentrations in the treated wastewater generated by the new development. Wastewater from a new development is preferably treated at a mains water recycling centre (WRC), where nutrients are removed by treatment processes. Some WRCs have dedicated nutrient removal processes and the final effluent concentrations will comply with permitted concentrations. Other WRCs, usually more rural, will not have a permitted limit on the concentration of final effluent discharges.

Permitted WRCs are operated so that they have some headroom between the final effluent concentrations and the level that has to be met for compliance with the permit. This is to ensure that WRCs will remain compliant with their permits as well as to provide water quality benefits. Where a permit limit is set to decrease, water companies will sometimes operate at this lower concentration in advance of the permit changes. Natural England's guidance assumes that WRC discharge at 90% of their permit limit, and as such apply a multiplier of 0.9 to the permit limit. This makes a general assumption on the average discharge concentrations, which is likely to vary between each WRC, and typically represents an overestimation on the actual discharge concentrations in the final effluent from the WRCs.

A more catchment specific and evidence-based approach is to use measured discharge concentrations from the WRC within the catchment that operate under permit limits. However, due to potential future changes (either increases or decreases) in the discharge concentration, a precautionary approach was adopted which assumes that the WRCs discharge at one standard deviation[1] from the mean.

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[1] *Standard deviation is a statistic that measures the dispersion of a dataset relative to its mean. This is calculated as the square root of the variance using the formula* $\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(X_i - \mu)^2}$ Where σ is the standard deviation, μ is the mean average, N is the sample size and X the observed values. A low standard deviation indicates the values tend to be close to the mean, while a high standard deviation indicates the values are spread out over a wider range. Under a normal distribution (i.e. bell-shaped curve), one standard deviation away from the mean in either direction account for 68.2% of the values.

The suitability of the standard deviation approach as a precautionary buffer was assessed by considering the % increase in flow (m^3/day) as a result of projected growth at each permitted WRC. Where a WRC will see a flow increase of greater than 10%, it was assumed that this was significant growth and a further buffer was required on top of the standard deviation. The WRCs in this case were therefore assumed to operate at 90% of their permit. This approach ensures that future growth is considered without underestimating the wastewater loading. For the WRCs without sufficient data, the typical standard deviation discharge of 76% was applied to the permitted concentration.

The discharge concentration data was supplied by Anglian Water Services and ranges from January 2019 to June 2022. In order to ensure the calculator remains up to date with measured concentrations, a review of the measured data should be conducted at regular intervals and the calculator updated to reflect any changes. The calculator, at the time of completing the Habitats Regulations Assessment will represent the best available evidence at that time. Regularly reviewing the discharge concentration data ensures that is still the case going forward.

The calculator also incorporates post 2025 (Asset Management Plan (AMP) 7) and Post 2030 (AMP 8) discharge concentrations. Where the permit limit is not changing post 2025, the same discharge concentrations were assumed. Where the permit limit is changing (Aylsham, Southrepps and Swardeston) it was assumed that the WRC would operate at 90% of its updated permit limit. This will be reviewed once there is sufficient evidence regarding the post-2025 performance.

A statement from the Department for Levelling Up, Housing & Communities (21st July 2022) indicates that there will be a statutory obligation on Anglian Water to operate WRCs at the Technically Achievable Limit (TAL) within the catchment by 2030. The TAL is 0.25mg/l for Total Phosphorus (TP) and 10mg/l for Total Nitrogen (TN). The government will table an amendment to the Levelling Up and Regeneration Bill (LURB) which gives confidence that the upgrades will be in place by 2030 and enabling the use of the lower permit limits as part of a Habitats Regulations Assessment. The calculator adopts these new lower permit limits. However, due to a lack of data on performance at these significantly reduced limits, the calculator assumes the discharge concentrations would be at 90% of the permits.

Natural England guidance indicates that standard concentrations of 8 mg/l for TP and 27 mg/l for TN should be assumed for unpermitted WRCs. However, catchment specific default values are used within the Norfolk nutrient budget calculator of 6 mg/l TP and 25 mg/l TN.. These are the values used in Environment Agency WRC modelling of nutrient inputs from WRCs in Norfolk and represent the most locally relevant default values.

Table 1 presents the WRC concentrations used within the Norfolk nutrient budget calculator for the permitted sites. A full list of WRCs and their assumed discharge concentrations are provided in **Appendix A1**.

Table 1: *Measured discharge concentrations of permitted WRCs*

WRC	Permitted P limit (mg/l)	Assumed P concentration (mg/l)	Discharge %	Assumption applied
Aldborough	2	1.57	79	STDEV
Aylsham	1	0.9	72	Significant growth
Aylsham (post 2025)	0.6	0.54	76	90% of future permit
Belaugh	1	1.05	105	STDEV
Briston	1	0.69	69	STDEV
Bylaugh	2.5	1.89	76	STDEV
Coltishall	1	0.86	86	STDEV

WRC	Permitted P limit (mg/l)	Assumed P concentration (mg/l)	Discharge %	Assumption applied
Dereham	1	0.76	76	STDEV
Fakenham	1	0.9	69	Significant growth
Foulsham	1	0.89	89	STDEV
Long Stratton	1	0.74	74	STDEV
Ludham	1	0.67	67	STDEV
North Elham	1	0.62	62	STDEV
Rackheath	2	1.8	75	Significant growth
Reepham	1	0.83	83	STDEV
Roughton	2	1.34	67	STDEV
Sculthorpe	1	0.65	65	STDEV
Southrepps	3	2.28	76	Average discharge applied
Southrepps (post 2025)	0.5	0.45	76	90% of future permit
Stalham	1	0.86	86	STDEV
Swanton Morley	2	1.52	76	Average discharge applied
Swardeston (post 2025)	0.4	0.36	76	90% of future permit
Whitlingham	1	0.9	76	Significant growth
Wymondham	0.8	0.61	76	STDEV

1.2.5 On-site treatment plant

The Norfolk nutrient budget calculator adopts default discharge concentrations for TP and TN from Package Treatment Plants (PTPs) and Septic Tanks (STs) from the Natural England nutrient neutrality guidance (Natural England, 2022). Additionally, the Norfolk nutrient budget calculator also includes the option to select a ST serving multiple properties with a discharge concentration of 7mg/l TP (May and Woods, 2016). The default values used within the calculator are presented in **Table 2**.

Table 2: *Default onsite treatment plants effluent concentrations*

Treatment type	P removal (mg/l)	N removal (mg/l)
Default package treatment plant	9.7	72.9
Default multi-source septic tank	7	96.3
Default single-source septic tank	11.6	96.3

1.3 Stage 2 & 3: Calculate nutrient loading from land use

1.3.1 Stage 2 & 3 methodology

In order to calculate the net change in land use, the existing nutrient input from the current land within the proposed development footprint needs to be calculated. The nutrient input is calculated by multiplying the runoff coefficient for each specific land use type by the relevant area of each land use.

$$(\boldsymbol{A_1} \times \boldsymbol{C_1}) + (\boldsymbol{A_2} \times \boldsymbol{C_2}) \ldots + (\boldsymbol{A_n} \times \boldsymbol{C_n}) = \boldsymbol{L_{current}} \qquad \textit{Eq. 5}$$

*Where **A** represents the Area in hectares, **C** the export coefficient and $L_{current}$ the nutrient load from the current land uses.*

Where land does not drain to the designated site surface water catchment it should be excluded from the calculation in Stages 2 and 3.

The nutrient load from the future land uses ($L_{proposed}$) utilises the same calculations as Equation 5.

1.3.2 Rainfall data

The rainfall data used within the Norfolk nutrient budget calculator differs from that used within the Natural England guidance. Rainfall data used within the Norfolk nutrient budget calculator for the catchment was derived from HadUK gridded which provided Standard Average Annual Rainfall (SAAR) for the period 2001-2021. This data provides the best available evidence for which to base the land use runoff coefficients. The HadUk data provides a more up to date dataset than the data proposed by Natural England which was collected between 1961 – 1990.

1.3.3 Agricultural runoff coefficients

The Norfolk nutrient budget calculator employs the same methodology for deriving agricultural runoff coefficients as the Natural England guidance. TP and TN runoff coefficients (in kg/ha/yr) were derived using Farmscoper V5 (ADAS, 2022). The Upscale tool was used which derived runoff coefficients specific to the operational catchments of the Wensum, Yare and Bure as well as the Broadland Rivers Management catchment. Operational catchment values were used where possible. In the absence of operational catchment values, management catchment data was used. The agricultural runoff coefficients were modified to account for pollution incidents and illegal operations. Agricultural runoff coefficients for each operational catchment are provided in **Appendix A2**.

The agricultural runoff rates are dependent on the following:

- Farm type
- Operational catchment
- Soil types
- Average annual rainfall
- Whether the development is in a Nitrate Vulnerable Zone (NVZ)

Soil types are derived from Soilscapes (Cranfield Soil and Agrifood Institute, 2022) and characterised into the following drainage categories to conform with the Farmscoper (**Table 3**). This is consistent with the approach outlined by Natural England (2022).

Table 3: Soil types by drainage category

Free draining			Impermeable - drained for arable			Impermeable - drained for arable and grassland		
Colour	ID	Name	Colour	ID	Name	Colour	ID	Name
	3	Shallow lime-rich soils over chalk or limestone		1	Saltmarsh soils		17	Slowly permeable seasonally wet acid loamy and clayey soils
	4	Sand dune soils		2	Shallow very acid peaty soils over rock		18	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils
	5	Freely draining lime-rich loamy soils		8	Slightly acid loamy and clayey soils with impeded drainage		19	Slowly permeable wet very acid upland soils with a peaty surface
	6	Freely draining slightly acid loamy soils		9	Lime-rich loamy and clayey soils with impeded drainage			
	7	Freely draining slightly acid but base-rich soils		15	Naturally wet very acid sandy and loamy soils			
	10	Freely draining slightly acid sandy soils		16	Very acid loamy upland soils with a wet peaty surface			
	11	Freely draining sandy Breckland soils		20	Loamy and clayey floodplain soils with naturally high groundwater			
	12	Freely draining floodplain soils		21	Loamy and clayey soils of coastal flats with naturally high groundwater			
	13	Freely draining acid loamy soils over rock		22	Loamy soils with naturally high groundwater			
	14	Freely draining very acid sandy and loamy soils		23	Loamy and sandy soils with naturally high groundwater and a peaty surface			
				24	Restored soils mostly from quarry and opencast spoil			
				25	Blanket bog peat soils			
				26	Raised bog peat soils			
				27	Fen peat soils			

The Farmscoper Upscale tool uses existing data on operating farms within a catchment to predict the average runoff coefficients. The Farmscoper upscale tool does not contain data on farms within the catchment with a rainfall of less than 600 mm/yr. As a result, runoff coefficients derived for 600 – 700 mm/yr rainfall were also applied to the runoff coefficients between 500 – 600 mm/yr.

Allotments and community food growing land are derived using agricultural land export coefficients in line with the Natural England guidance (2022).

1.3.4 Non-agricultural land runoff coefficients

Non-agricultural land use coefficients were adopted from Natural England's nutrient neutrality guidance (2022) (**Table 4**). The Norfolk nutrient budget calculator also includes the option not select constructed wetlands as a land use. The Norfolk nutrient budget calculator uses default values for constructed wetlands that is intended to be used for guidance proposes only to provide the user with an indication of the likely area required. The default values were derived from expert opinion and literature (Land et al., 2016).

***Table 4**: Non-agricultural land runoff coefficients*

Land Use classification	P runoff coefficient (kg/ha/yr)	N runoff coefficient (kg/ha/yr)
Greenspace	0.02	3
Woodland	0.02	3
Shrub / heathland / bracken / bog	0.02	3
Water	0.00	0
Constructed wetland	-8.00	-930
Set aside Land	0.02	3

1.3.5 Urban land runoff coefficients

The derivation of urban land use runoff coefficients is primarily based on Natural England's nutrient neutrality guidance (2022) and does not deviate from the proposed method (HR Wallingford Modified Rational Method). The urban land is categorised into residential, open urban and commercial/industrial land. The Norfolk nutrient budget calculator further sub-divides residential land into high-density, medium-density and low-density.. This allows for more specific land use types to be selected, increasing the accuracy of the calculator and limits the potential for overestimations or underestimations. The following definitions are used:

- High density residential - applies to urban cores (e.g. city centres)
- Medium density residential - applies to development in larger towns where there is a high percentage of development, but outside of core cities.
- Low density residential – rural developments

The HR Wallingford Modified Rational Method was used to calculate the nutrient loading:

$$L = R \times P_r \qquad \text{Eq. 6}$$

Where L is the average runoff (mm/yr), R is the average rainfall (mm/yr) and P_r is the percentage runoff (%)

The percentage runoff was calculated using the following equation:

$$P_r = 0.829 \times PIMP + 0.078 \times U - 20.7 \qquad \text{Eq. 7}$$

Where $PIMP$ is the percentage of land that is impervious (%) and U is the catchment wetness index.

The catchment wetness index is calculated using the following equation:

$$U = -129.5 + (0.424 \times R) - (2.28 \times 10^{-4} \times R^2) - (4.56 \times 10^{-8} \times R^3) \qquad \text{Eq. 8}$$

Eq. 6 is combined with Event Mean Concentrations (EMCs) to calculate the urban runoff coefficients. The EMCs outlined in the Natural England nutrient neutrality guidance (2022) were adopted and are derived from Mitchel (2005). The EMCs used within calculations are presented in **Table 5**.

Table 5: *EMCs for urban land use*

Land use	P EMC (mg/l)	N EMC (mg/l)
Residential	2.85	0.41
Commercial / Industrial	1.52	0.30
Open urban land	1.68	0.22

The percentage of land that is impervious in selected urban land uses was derived from the available literature[2], and represents the average of reported mean values stated. Where a range of values was provided, the upper limits were taken in order to adopt a precautionary approach. To account for how nitrogen is more readily transported in the environment, an additional 20% was added to the TN impervious values. **Table 6** presents the impervious percentages used to derive urban land use runoff coefficients.

Table 6: *Impervious percentages used for the various land use types*

Land use	TP imperviousness (%)	TN imperviousness (%)
High density residential	61	81
Medium density residential	38	58
Low density residential	30	50
Commercial / Industrial	84	100
Open space urban	22	42

The literature values are further supported by measured data from ongoing projects within the catchment, which shows that land classified as either high density or medium density urban has a typical impervious cover of 45-50%.

Table 7 presents the urban runoff coefficients used with the calculator.

[2] Exum et al., (2005); Cappiela & Brown (2001); Chormanski et al., (2008); Lu & Weng (2006); Yancey (2008); Yang & Liu (2005); Wu & Murray (2003); Xu et al., (2018); Ferguson (1998); Jiang & Fu (2015); Boyd et al., (1993); New York State Department of Environmental Conservation (2015); Tilley & Slonecker (2006); ENSR (2005); Shahtahmassebi et al., (2018); National Land Cover Data (1992)

Table 7: Urban runoff coefficients derived for the Norfolk nutrient budget calculator

Rainfall band (mm/yr)	Midpoint (mm/yr)	Catchment wetness (U)	High density residential		Medium density residential		Low density residential		Commercial / Industrial		Urban open space	
			TP	TN	TP	TN	TP	TN	TP	TN	TP	TN
550-575	562.55	28.75	0.74	7.81	0.30	4.75	0.15	3.69	0.86	5.51	0.00	1.55
575-600	587.55	31.66	0.78	8.19	0.32	5.00	0.16	3.89	0.91	5.78	0.00	1.64
600-625	612.55	34.19	0.82	8.57	0.34	5.25	0.17	4.09	0.95	6.04	0.00	1.73
625-650	637.55	36.33	0.85	8.95	0.36	5.49	0.18	4.29	0.99	6.30	0.01	1.82
650-675	662.55	38.07	0.89	9.33	0.37	5.73	0.19	4.48	1.03	6.56	0.01	1.90
675-700	687.55	39.42	0.93	9.70	0.39	5.97	0.20	4.67	1.07	6.82	0.01	1.99
700-750	725.05	40.68	0.98	10.25	0.42	6.31	0.22	4.94	1.13	7.20	0.01	2.11
750-800	775.05	41.00	1.05	10.97	0.44	6.75	0.23	5.29	1.21	7.70	0.01	2.25
800-850	825.05	41.00	1.12	11.67	0.47	7.19	0.25	5.63	1.29	8.20	0.01	2.40
850-900	875.05	41.00	1.19	12.38	0.50	7.63	0.26	5.97	1.37	8.70	0.01	2.55

1.4 Stage 4: Calculating the nutrient budget

1.4.1 Stage 4 methodology

Stage 4 calculates the net change in the nutrient loading to the catchment as a whole due to the proposed development. This is calculated by summing the additional nutrients from wastewater (stage 1) and the difference between the nutrient load for the future (stage 3) and current land uses (stage 2). A precautionary buffer is then applied.

$$\boldsymbol{Total\ nutrient\ loading} = \mathbf{1.2} \times (\boldsymbol{L_W} + (\boldsymbol{L_{Proposed}} - \boldsymbol{L_{Current}})) \qquad Eq.\ 9$$

1.4.2 Precautionary buffer

Whilst the figures used throughout this model are based on scientific research and evidence and represent the best available evidence, there is some inherent uncertainty remaining. A precautionary buffer is used to recognise the uncertainty and provide, with reasonable certainty, that there will be no adverse effect on the integrity of the designated sites. As per Natural England guidance (2022), a 20% precautionary buffer is added to the total loading value.

1.5 Mitigation

The Norfolk nutrient budget calculator goes beyond the Natural England guidance and provides an indication of potential mitigation options. The mitigation tabs offer guidance on the change in land use that is required in order to achieve nutrient neutrality. The stages only apply to developments that will generate additional nutrients as outlined in Stage 4. The different tabs reflect the different mitigation requirements from reduction in permit limits. The mitigation tabs offer the option to implement either on-site or off-site.

1.5.1 Mitigation methodology

In the case of off-site mitigation, the excess nutrients as a result of the proposed development must equal the change in land use of the mitigation area.

$$\boldsymbol{Total\ nutrient\ loading} = (\boldsymbol{L_{Mitigationproposed}} - \boldsymbol{L_{mitigationCurrent}}) \qquad Eq.\ 10$$

Where $\boldsymbol{L_{Mitigationproposed}}$ is the total nutrient loading from the proposed land use of the mitigation area and $\boldsymbol{L_{Mitigationcurrent}}$ is the total nutrient loading from the current land use of the mitigation area.

Only land that is currently within the surface water catchment and may affect the designated sites, either by draining directly and draining to upstream locations, can be selected for mitigation land.

1.6 Zero-value calculator

The zero-value calculator is an additional feature included within the Norfolk nutrient budget calculator. The zero-value calculator shows the number of developments that can be built and occupied as a result of taking the entire development site out of agricultural use and partly into low-input use (e.g. semi-natural grassland) and a small part of the future use. This allows part of the development to progress and prevents delays while mitigation solutions are implemented. The calculator generates the number of properties that can be built for both TP and TN. Unless the difference in short-term mitigation can be sourced off-site, the lower number of dwellings applies.

1.6.1 Zero-value calculator methodology

The development will be ‘zero value’ or nutrient neutral when the wastewater contribution from the development is equal to the nutrient load from the land use change. In this case the precautionary buffer is not required because the value is not above zero.

$$L_W = ((L_{Proposed} + L_{low-input}) - L_{Current})) \qquad Eq.\ 11$$

In order to calculate the maximum number of dwellings that could be permitted whilst remaining nutrient neutral, the permitted nutrient loading from wastewater that is neutral follows the opposite calculations to those in Stage 1.

$$\frac{L_W}{365} \times 1000000 = L_w \qquad Eq.\ 12$$

$$\frac{L_w}{WRC\ discharge\ level} = W \qquad Eq.\ 13$$

$$\frac{W}{water\ usage} = P_i \qquad Eq.\ 14$$

$$\frac{P_i}{occupancy\ rate} = No.\ of\ dwellings \qquad Eq.\ 15$$

1.7 Summary

Table 8 below provides a summary of the key inputs and how these differ between the Natural England guidance and the Norfolk nutrient budget calculator.

Table 8: *Summary comparison of key inputs*

Calculator input	Natural England guidance	Norfolk nutrient budget calculator	Comment
Occupancy rate	2.4 persons/dwelling	1.89 persons/dwelling residential development	Use of regional specific value for Norfolk that accounts for movement of people already living within the catchment.
	Not included	1.65 persons/dwelling for houses in multiple occupation and hotels.	Provides more accurate estimation of wastewater volume from specific development types
Water usage	120 l/person/day	110 l/person/day	Use of 110/l/person/day as this is secured through policy
WRC P discharge concentrations	At 90% of permit limit for permitted sites 8 mg/l for unpermitted sites	Use of one standard deviation from the mean. WRC with significant growth use 90% of permit. 6 mg/l for unpermitted sites	Use of measured data rather than generalised assumptions for permitted sites. Use of regional specific default values used by Environment Agency.
WRC N discharge concentrations	27 mg/l	25 mg/l	Use of regional specific default values used by Environment Agency.
Onsite treatment plants	Default values used for PTP and ST from literature review	Default values used for PTP and ST from literature review. Addition of option to include STs serving multiple dwellings.	No difference in default values.
Rainfall	1961 – 1990 SAAR data	2001 – 2021 SAAR data	Use of more up to date data
Agricultural runoff rates	Derived using Farmscoper upscale model	Derived using Farmscoper upscale model	No difference in approach
Non-agricultural runoff rates	Default values derived from literature review	Default values derived from literature review	No difference in approach

Urban runoff coefficients	Derived using HR Wallingford Modified Rational Method. Default EMCs used from Mitchell (2005) and generic impervious values of 80% for P and 100% for N. Option of only residential land use.	Derived using HR Wallingford Modified Rational Method. Default EMCs used from Mitchell (2005) and impervious values derived from detailed literature review and catchment specific data. Option of high, medium and low density residential land use types.	Use of catchment specific data and adoption of values following detailed literature review, as opposed to generic assumptions. Use of more detailed land use types to improve accuracy of urban runoff coefficients.
Precautionary buffer	20%	20%	No difference in approach
Mitigation	Not included	Included	N/A
Zero-value calculator	Not included	Included	N/A

1.8 References

Agricultural Development and Advisory Service. (2022). Farmscoper Version 5.

Andrewartha, T. and Scott, R. (2018). Building Regulations Part G Analysis of Water Consumption, Essex and Suffolk Water

Boyd, M.J., Bufill, m.C., Knee, R.M. (1993). Pervious and impervious runoff in urban catchments, Hydrological Sciences Journal, 38:6, 463-478.

Cappiela, K. & Brown, K. (2001). Impervious Cover and Land Use in the Chesapeake Bay Watershed.

Chormanski, J., Van de Voorde, T., De Roeck, T., Batelaan, O., Canters, F. (2008). Improving Distributed Runoff Prediction in Urbanized Catchments with Remote Sensing based Estimates of Impervious Surface Cover.

Cranfield Soil and Agri-food Institute (2022). Soilscapes.

Dorset Council. (2020). The Dorset Heathlands Planning Framework 2020-2025: Supplementary Planning Document.

ENSR (2005). Pilot TMDL Applications using the Impervious Cover Method.

Exum, L., Bird, S., Harrison, J., Perkins, C.A. (2005). Estimating and Projecting Impervious Cover in the Southeastern United States. US Environmental Protection Agency.

Ferguson, B.K. (1998). Introduction to Stormwater: Concept, Purpose, Design. New York: John Wiley & Sons.

Jiang, Y. & Fu, P. (2015). Assessing the Impacts of Urbanization-Associated Land Use/Cover Change on Land Surface Temperature and Surface Moisture: A Case Study in the Midwestern United States. *Remote Sensing*.

Land, M., Graneli, W., Grimvall, A., Hoffman, C., Mitsch, W., Tonderski, K., Verhoeven, J. (2016). How effective are created or restored freshwater wetlands for nitrogen and phosphorus removal? A systematic review. *Environ Evid*, 5:9

Lu, D. & Weng, Q. (2006). Use of impervious surface in urban land-use classification. *Remote Sensing of Environment*, 102, 146-160.

May, L. & Woods, H. (2016). Phosphorous in Package Treatment Plant effluents. *Natural England Commissioned Reports*, Number221.

Mitchell, G. (2005). Mapping hazard from urban non-point pollution: A screening model to support sustainable urban drainage planning. Journal of Environmental Management, 74(1), pp. 1-9.

National Land Cover Data (1992)

Natural England. (2020). Advice on Nutrient Neutrality for New Development in the Stour Catchment in Relation to Stodmarsh Designated Sites – For Local Planning Authorities. Final Version Report.

Natural England. (2022). Nutrient Neutrality Generic Methodology.

New York State Department of Environmental Conservation. (2015). The New York State Stormwater Management Design Manual: Appendix A.1 Pollutant Concentrations.

Shahtahmassebi, A, R., Wu, C., Blackburn, G.A,. Zheng, Q., Huang, L., Shortridge, A., Shahtahmassebi, G., Jiang, R., He, S., Wang, K., Lin, Y., Clarke, K.C., Su, Y., Lin, L., Wu, J., Zheng, Q., Xu, H., Xue, X., Shen, Z. (2018). How do modern transportation projects impact on development of impervious surfaces via new urban area and urban intensification? Evidence from Hangzhou Bay Bridge, China. *Land Use Policy*, Volume 77, 479-497.

Tilley, J.S., & Slonecker, E.T. (2006). Quantifying the Components of Impervious Surfaces: U.S. Geological Survey Open-File Report 2006-1008, 33.

Waterwise. (2018) Advice on water efficient new homes for England.

Wu, C. & Murray, A.T. (2003). Estimating impervious surface distribution by spectral mixture analysis. *Remote Sensing of Environment*, 84, 493 – 505.

Xu, R., Liu, J., Xu, J. (2018). Extraction of High-Precision Urban Impervious Surfaces from Sentinel-2 Multispectral Imagery via Modified Linear Spectral Mixture Analysis. *Sensors*, 18, 2873.

Yancey, K. (2008). Impervious Surface Coefficients: A tool for environmental analysis and management.

Yang, X. & Liu, Z. (2005). Use of satellite-derived landscape imperviousness index to characterize urban spatial growth. *Computers, Environment and Urban Systems*, 29, 524–540

A1 Appendix A1: Water Recycling Centre discharge concentrations

Water Recycling centres	Current TP discharge concentration (mg/l)	Post-2025 TP discharge concentration (mg/l)	Post-2030 TP discharge concentration (mg/l)	Current TN discharge concentration (mg/l)	Post-2030 TN permit limit (mg/l)
Aldborough Water Recycling Centre	1.57	1.57	0.23	25.0	9.00
Ashmanaugh	6.00	6.00	0.23	25.0	9.00
Ashwellthorpe Water Recycling Centre	6.00	6.00	0.23	25.0	9.00
Aylsham Water Recycling Centre	0.90	0.54	0.23	25.0	9.00
Barford Water Recycling Centre	6.00	6.00	0.23	25.0	9.00
Barnham Broom Water Recycling Centre	6.00	6.00	0.23	25.0	9.00
Barton Turf	6.00	6.00	0.23	25.0	9.00
Belaugh Water Recycling Centre	1.05	1.05	0.23	25.0	9.00
Billingford STW	6.00	6.00	0.23	25.0	9.00
Bircham Newton (Monks Close) WRC	6.00	6.00	0.23	25.0	9.00
Brisley	6.00	6.00	0.23	25.0	9.00
Briston Water Recycling Centre	0.69	0.69	0.23	25.0	9.00
Bunwell STW	6.00	6.00	0.23	25.0	9.00
Bylaugh Water Recycling Centre	1.89	1.89	0.23	25.0	9.00
Carleton Rode Church Road	6.00	6.00	0.23	25.0	9.00
Carleton Rode STW	6.00	6.00	0.23	25.0	9.00
Coltishall STW	0.86	0.86	0.23	25.0	9.00
Corpusty STW	6.00	6.00	0.23	25.0	9.00
Cranworth STW	6.00	6.00	0.23	25.0	9.00

Water Recycling centres	Current TP discharge concentration (mg/l)	Post-2025 TP discharge concentration (mg/l)	Post-2030 TP discharge concentration (mg/l)	Current TN discharge concentration (mg/l)	Post-2030 TN permit limit (mg/l)
Deopham STW	6.00	6.00	0.23	25.0	9.00
Dereham WRC	0.76	0.76	0.23	25.0	9.00
East Bilney STW	6.00	6.00	0.23	25.0	9.00
East Carleton - Wymondham Road STW	6.00	6.00	0.23	25.0	9.00
East Ruston STW	6.00	6.00	0.23	25.0	9.00
Fakenham (Old And New) WRC	0.90	0.90	0.23	25.0	9.00
Felmingham Water Recycling Centre	6.00	6.00	0.23	25.0	9.00
Forncett End STW	6.00	6.00	0.23	25.0	9.00
Forncett St. Peter STW	6.00	6.00	0.23	25.0	9.00
Foulsham Water Recycling Centre	0.89	0.89	0.23	25.0	9.00
Fritton School Lane STW	6.00	6.00	0.23	25.0	9.00
Fundenhall STW	6.00	6.00	0.23	25.0	9.00
Garvestone Reymerston Road STW	6.00	6.00	0.23	25.0	9.00
Garvestone, Dereham Road	6.00	6.00	0.23	25.0	9.00
Gateley STW	6.00	6.00	0.23	25.0	9.00
Great Melton STW	6.00	6.00	0.23	25.0	9.00
Gresham STW	6.00	6.00	0.23	25.0	9.00
Hardwick STW	6.00	6.00	0.23	25.0	9.00
Hempnall Water Recycling Centre	6.00	6.00	0.23	25.0	9.00
Hempnell - Silver Green STW	6.00	6.00	0.23	25.0	9.00
Hindolveston Church Lane	6.00	6.00	0.23	25.0	9.00

Water Recycling centres	Current TP discharge concentration (mg/l)	Post-2025 TP discharge concentration (mg/l)	Post-2030 TP discharge concentration (mg/l)	Current TN discharge concentration (mg/l)	Post-2030 TN permit limit (mg/l)
Hindolveston STW	6.00	6.00	0.23	25.0	9.00
Hockering STW	6.00	6.00	0.23	25.0	9.00
Horningtoft	6.00	6.00	0.23	25.0	9.00
Horsey - Bensleys Close STW	6.00	6.00	0.23	25.0	9.00
Honing STW	6.00	6.00	0.23	25.0	9.00
Little Fransham Crown Lane STW	6.00	6.00	0.23	25.0	9.00
Little Fransham Glebe STW	6.00	6.00	0.23	25.0	9.00
Long Stratton WRC	0.74	0.74	0.23	25.0	9.00
Mattishall STW	6.00	6.00	0.23	25.0	9.00
North Elmham STW	0.62	0.62	0.23	25.0	9.00
North Tuddenham STW	6.00	6.00	0.23	25.0	9.00
Rackheath Water Recycling Centre	1.80	1.80	0.23	25.0	9.00
Reepham Water Recycling Centre	0.83	0.83	0.23	25.0	9.00
Ridlington(Norfolk) STW	6.00	6.00	0.23	25.0	9.00
Roughton Water Recycling Centre	1.34	1.34	0.23	25.0	9.00
Saxlingham STW	6.00	6.00	0.23	25.0	9.00
Spooner Row School Lane STW	6.00	6.00	0.23	25.0	9.00
Sculthorpe STW	0.65	0.65	0.23	25.0	9.00
Shipdham STW	6.00	6.00	0.23	25.0	9.00
Shotesham The Grove STW	6.00	6.00	0.23	25.0	9.00
Skeyton STW	6.00	6.00	0.23	25.0	9.00

Water Recycling centres	Current TP discharge concentration (mg/l)	Post-2025 TP discharge concentration (mg/l)	Post-2030 TP discharge concentration (mg/l)	Current TN discharge concentration (mg/l)	Post-2030 TN permit limit (mg/l)
Sloley STW	6.00	6.00	0.23	25.0	9.00
Smallburgh STW	6.00	6.00	0.23	25.0	9.00
South Raynham	6.00	6.00	0.23	25.0	9.00
Southrepps STW	2.28	0.45	0.23	25.0	9.00
Sparham Norwich Road WRC	6.00	6.00	0.23	25.0	9.00
Sparham(Wells Close)	6.00	6.00	0.23	25.0	9.00
Stalham Water Recycling Centre	0.86	0.86	0.23	25.0	9.00
Stanfield STW	6.00	6.00	0.23	25.0	9.00
Stibbard Moor End STW	6.00	6.00	0.23	25.0	9.00
Stoke Holy Cross STW	6.00	6.00	0.23	25.0	9.00
Swanton Abbott STW	6.00	6.00	0.23	25.0	9.00
Swanton Morley Water Recycling Centre	1.52	1.52	0.23	25.0	9.00
Swanton Novers STW	6.00	6.00	0.23	25.0	9.00
Swardeston STW	6.00	0.36	0.23	25.0	9.00
Tibenham The Street STW	6.00	6.00	0.23	25.0	9.00
Weasenham All Saints STW	6.00	6.00	0.23	25.0	9.00
Weasenham St.Peter STW	6.00	6.00	0.23	25.0	9.00
Wendling STW	6.00	6.00	0.23	25.0	9.00
West Raynham STW	6.00	6.00	0.23	25.0	9.00
Whinburgh	6.00	6.00	0.23	25.0	9.00
Whitlingham Water Recycling Centre	6.00	6.00	0.23	25.0	9.00

Water Recycling centres	Current TP discharge concentration (mg/l)	Post-2025 TP discharge concentration (mg/l)	Post-2030 TP discharge concentration (mg/l)	Current TN discharge concentration (mg/l)	Post-2030 TN permit limit (mg/l)
Wymondham Water Recycling Centre	0.90	0.90	0.23	25.0	9.00

A2 Appendix A2: Agricultural runoff coefficients

Wensum – P runoff coefficients

	500-600 mm/yr						600-700 mm/yr						700-900 mm/yr					
Land Use	**Free draining**		**Impermeable (Drained for Arable)**		**Impermeable (Drained for Arable + Grassland)**		**Free draining**		**Impermeable (Drained for Arable)**		**Impermeable (Drained for Arable + Grassland)**		**Free draining**		**Impermeable (Drained for Arable)**		**Impermeable (Drained for Arable + Grassland)**	
Dairy	0.14	0.14	0.19	0.19	0.50	0.51	0.14	0.14	0.19	0.19	0.50	0.51	1.31	0.98	0.41	0.41	0.83	0.84
Lowland grazing	0.06	0.06	0.11	0.11	0.43	0.50	0.06	0.06	0.11	0.11	0.43	0.50	0.11	0.16	0.22	0.22	0.68	0.68
Mixed Livestock	0.06	0.06	0.28	0.29	0.55	0.60	0.06	0.06	0.28	0.29	0.55	0.60	0.14	0.18	0.60	0.60	0.94	0.95
Poultry	0.17	0.12	0.35	0.38	0.71	0.68	0.17	0.12	0.35	0.38	0.71	0.68	0.26	0.37	0.70	0.74	1.08	1.14
Pig	0.07	0.07	0.35	0.38	0.58	0.68	0.07	0.07	0.35	0.38	0.58	0.68	0.17	0.23	0.72	0.76	1.00	1.05
Horticulture	0.05	0.05	0.33	0.33	0.52	0.53	0.05	0.05	0.33	0.33	0.52	0.53	0.14	0.15	0.66	0.70	0.92	0.97
Cereals	0.05	0.05	0.34	0.34	0.56	0.56	0.05	0.05	0.34	0.34	0.56	0.56	0.15	0.15	0.73	0.73	0.98	0.98
General Arable	0.05	0.05	0.31	0.31	0.53	0.50	0.05	0.05	0.31	0.31	0.53	0.50	0.13	0.13	0.64	0.64	0.90	0.90
Allotment	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.13	0.13	0.13	0.13	0.13	0.13

Yare – P runoff coefficients

	500-600 mm/yr						600-700 mm/yr						700-900 mm/yr					
Land Use	**Free draining**		**Impermeable (Drained for Arable)**		**Impermeable (Drained for Arable + Grassland)**		**Free draining**		**Impermeable (Drained for Arable)**		**Impermeable (Drained for Arable + Grassland)**		**Free draining**		**Impermeable (Drained for Arable)**		**Impermeable (Drained for Arable + Grassland)**	
Dairy	0.14	0.14	0.27	0.28	0.83	0.85	0.14	0.14	0.27	0.28	0.83	0.85	1.31	0.98	1.31	0.98	1.31	1.31
Lowland grazing	0.09	0.09	0.15	0.15	0.51	0.51	0.09	0.09	0.15	0.15	0.51	0.51	0.16	0.16	0.26	0.25	0.80	0.78
Mixed Livestock	0.07	0.08	0.29	0.30	0.59	0.59	0.07	0.08	0.29	0.30	0.59	0.59	0.18	0.18	0.61	0.62	1.00	1.01
Poultry	0.16	0.18	0.39	0.43	0.60	0.65	0.16	0.18	0.39	0.43	0.60	0.65	0.37	0.37	0.80	0.85	1.06	1.26
Pig	0.08	0.10	0.35	0.38	0.58	0.62	0.08	0.10	0.35	0.38	0.58	0.62	0.23	0.23	0.77	0.82	1.00	1.12
Horticulture	0.05	0.05	0.31	0.31	0.52	0.52	0.05	0.05	0.31	0.31	0.52	0.52	0.15	0.15	0.64	0.66	0.92	0.92
Cereals	0.06	0.06	0.34	0.34	0.56	0.56	0.06	0.06	0.34	0.34	0.56	0.56	0.17	0.18	0.73	0.74	0.98	0.99
General Arable	0.05	0.05	0.29	0.29	0.49	0.49	0.05	0.05	0.29	0.29	0.49	0.49	0.15	0.15	0.61	0.62	0.85	0.86
Allotment	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.62	0.62	0.62	0.62	0.62	0.62

Bure – P runoff coefficients

Bure	500-600 mm/yr						600-700 mm/yr						700-900 mm/yr					
Land Use	**Free draining**		**Impermeable (Drained for Arable)**		**Impermeable (Drained for Arable + Grassland)**		**Free draining**		**Impermeable (Drained for Arable)**		**Impermeable (Drained for Arable + Grassland)**		**Free draining**		**Impermeable (Drained for Arable)**		**Impermeable (Drained for Arable + Grassland)**	
Dairy	0.14	0.14	0.28	0.28	0.88	0.90	0.14	0.14	0.28	0.28	0.88	0.90	1.31	0.98	1.31	0.98	1.31	1.31
Lowland grazing	0.10	0.10	0.16	0.16	0.50	0.50	0.10	0.10	0.16	0.16	0.50	0.50	0.17	0.16	0.28	0.25	0.85	0.78
Mixed Livestock	0.09	0.09	0.33	0.33	0.60	0.60	0.09	0.09	0.33	0.33	0.60	0.60	0.20	0.18	0.67	0.62	1.00	1.01
Poultry	0.16	0.16	0.41	0.44	0.71	0.75	0.16	0.16	0.41	0.44	0.71	0.75	0.34	0.37	0.80	0.85	1.20	1.26
Pig	0.08	0.08	0.38	0.42	0.62	0.68	0.08	0.08	0.38	0.42	0.62	0.68	0.21	0.23	0.77	0.82	1.06	1.12
Horticulture	0.05	0.05	0.33	0.33	0.53	0.53	0.05	0.05	0.33	0.33	0.53	0.53	0.16	0.15	0.66	0.66	0.96	0.92
Cereals	0.06	0.06	0.36	0.36	0.56	0.56	0.06	0.06	0.36	0.36	0.56	0.56	0.18	0.18	0.77	0.74	1.04	0.99
General Arable	0.05	0.05	0.32	0.32	0.50	0.50	0.05	0.05	0.32	0.32	0.50	0.50	0.15	0.15	0.65	0.62	0.91	0.86
Allotment	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.62	0.62	0.62	0.62	0.62	0.62

Wensum – N runoff coefficients

	500-600 mm/yr						600-700 mm/yr						700-900 mm/yr					
Land Use	**Free draining**		**Impermeable (Drained for Arable)**		**Impermeable (Drained for Arable + Grassland)**		**Free draining**		**Impermeable (Drained for Arable)**		**Impermeable (Drained for Arable + Grassland)**		**Free draining**		**Impermeable (Drained for Arable)**		**Impermeable (Drained for Arable + Grassland)**	
Dairy	35.87	35.87	12.05	12.15	11.17	11.30	35.87	35.87	12.05	12.15	11.17	11.30	22.54	18.10	17.17	17.32	12.96	13.11
Lowland grazing	12.94	13.02	8.87	8.93	7.97	9.68	12.94	13.02	8.87	8.93	7.97	9.68	17.55	22.39	13.66	13.75	9.62	9.65
Mixed Livestock	27.33	27.39	18.76	18.96	18.83	21.55	27.33	27.39	18.76	18.96	18.83	21.55	33.11	38.38	24.06	24.32	20.64	20.98
Poultry	244.30	231.58	144.04	149.96	138.11	140.47	244.30	231.58	144.04	149.96	138.11	140.47	273.57	287.23	177.92	185.52	141.39	152.82
Pig	93.57	93.25	59.54	61.69	56.34	79.38	93.57	93.25	59.54	61.69	56.34	79.38	109.91	147.90	73.20	75.97	60.56	64.79
Horticulture	22.09	22.39	15.49	15.52	15.97	16.00	22.09	22.39	15.49	15.52	15.97	16.00	26.42	26.19	19.08	19.09	17.12	17.02
Cereals	26.47	26.54	19.11	19.16	20.20	20.25	26.47	26.54	19.11	19.16	20.20	20.25	31.52	31.61	23.75	23.82	21.97	22.03
General Arable	25.28	25.35	17.62	17.67	18.23	19.17	25.28	25.35	17.62	17.67	18.23	19.17	29.97	30.05	21.72	21.77	19.48	19.52
Allotment	25.35	25.35	25.35	25.35	25.35	25.35	25.35	25.35	25.35	25.35	25.35	25.35	30.05	30.05	30.05	30.05	30.05	30.05

Yare – N runoff coefficients

Yare	500-600 mm/yr						600-700 mm/yr						700-900 mm/yr					
Land Use	Free draining		Impermeable (Drained for Arable)		Impermeable (Drained for Arable + Grassland)		Free draining		Impermeable (Drained for Arable)		Impermeable (Drained for Arable + Grassland)		Free draining		Impermeable (Drained for Arable)		Impermeable (Drained for Arable + Grassland)	
Dairy	35.87	35.87	22.72	24.35	18.31	18.64	35.87	35.87	22.72	24.35	18.31	18.64	22.54	18.10	22.54	18.10	22.54	22.54
Lowland grazing	16.52	16.42	11.24	11.32	9.85	9.87	16.52	16.42	11.24	11.32	9.85	9.87	22.39	22.39	17.62	17.59	11.91	11.76
Mixed Livestock	30.56	31.47	20.94	21.21	20.84	21.19	30.56	31.47	20.94	21.21	20.84	21.19	38.38	38.38	27.25	28.27	23.37	23.83
Poultry	257.38	243.03	158.74	165.42	146.43	156.49	257.38	243.03	158.74	165.42	146.43	156.49	287.23	287.23	187.03	195.03	157.06	160.54
Pig	101.74	125.44	64.59	67.00	60.94	64.61	101.74	125.44	64.59	67.00	60.94	64.61	147.90	147.90	97.81	101.80	65.71	86.47
Horticulture	21.86	22.15	15.39	15.50	15.96	15.99	21.86	22.15	15.39	15.50	15.96	15.99	26.19	26.19	19.05	19.13	17.12	17.15
Cereals	26.13	26.21	19.23	19.29	20.56	20.62	26.13	26.21	19.23	19.29	20.56	20.62	31.21	31.51	23.99	24.03	22.55	22.42
General Arable	24.70	24.77	17.41	17.46	18.16	18.20	24.70	24.77	17.41	17.46	18.16	18.20	31.17	31.25	21.56	22.76	19.53	20.53
Allotment	24.77	24.77	24.77	24.77	24.77	24.77	24.77	24.77	24.77	24.77	24.77	24.77	26.19	26.19	26.19	26.19	26.19	26.19

Bure – N runoff coefficients

Bure	500-600 mm/yr						600-700 mm/yr						700-900 mm/yr					
Land Use	**Free draining**		**Impermeable (Drained for Arable)**		**Impermeable (Drained for Arable + Grassland)**		**Free draining**		**Impermeable (Drained for Arable)**		**Impermeable (Drained for Arable + Grassland)**		**Free draining**		**Impermeable (Drained for Arable)**		**Impermeable (Drained for Arable + Grassland)**	
Dairy	35.87	35.80	24.09	24.35	19.06	19.43	35.87	35.80	24.09	24.35	19.06	19.43	22.54	18.10	22.54	18.10	22.54	22.54
Lowland grazing	18.15	18.29	12.39	12.48	9.65	9.68	18.15	18.29	12.39	12.48	9.65	9.68	25.00	22.39	19.50	17.59	13.14	11.76
Mixed Livestock	34.60	34.74	23.56	23.85	21.18	21.55	34.60	34.74	23.56	23.85	21.18	21.55	42.91	38.38	31.32	28.27	23.37	23.83
Poultry	228.65	227.66	141.90	147.63	138.11	147.41	228.65	227.66	141.90	147.63	138.11	147.41	268.72	287.23	175.37	195.03	148.53	160.54
Pig	89.80	89.51	57.34	82.66	74.68	79.38	89.80	89.51	57.34	82.66	74.68	79.38	105.49	147.90	97.81	101.80	80.36	86.47
Horticulture	22.63	22.69	15.78	15.82	15.97	16.00	22.63	22.69	15.78	15.82	15.97	16.00	26.79	26.19	19.08	19.13	17.34	17.15
Cereals	25.75	25.83	18.70	18.75	20.45	20.51	25.75	25.83	18.70	18.75	20.45	20.51	30.70	31.51	23.29	24.03	21.57	22.42
General Arable	27.73	2.80	19.36	19.40	19.12	19.17	27.73	2.80	19.36	19.40	19.12	19.17	32.90	31.25	23.83	22.76	21.38	20.53
Allotment	27.8	27.8	27.8	27.8	27.8	27.8	27.8	27.8	27.8	27.8	27.8	27.8	26.19	26.19	26.19	26.19	26.19	26.19