Appendix B

1 Water Quality Assessment

1.1 Introduction

The increased discharge of effluent due to a growth in population served by a Water Recycling Centre (WRC, more commonly called Waste Water Treatment Works - WwTW) may impact on the quality of the receiving water. The Water Framework Directive (WFD) does not allow a watercourse to deteriorate from its current class (either water body or element class).

It is Environment Agency (EA) policy to model the impact of increasing effluent volumes on the receiving watercourse. Where the scale of development is such that a deterioration is predicted, a new Environmental Permit (EP) may be required for the WRC to improve the quality of the final effluent, so that the extra pollution load will not result in a deterioration of the water quality in the watercourse. This is known as a "no deterioration" or "load standstill".

It is the objective of the WFD that all water bodies should achieve Good Ecological Status (GES), or where they have been highly modified achieve Good Ecological Potential (GEP). It is therefore also necessary to assess whether the proposed increase in effluent could prevent a watercourse from achieving GES or GEP.

If a watercourse fails to achieve the GES target, further investigations are needed to define the 'reasons for fail' and which actions could be implemented to reach such status in the future.

For each development site, the receiving WRC was identified. This has allowed for the total future DWF to be calculated for each WRC. This analysis identified twenty one WRCs to assess and takes into account demand from developments outside the East Cambridgeshire District Council (ECDC) area that use WRCs within the study area.

The EA reviewed the list of WRCs and suggested that an RQP assessment be undertaken on following WRCs:

- Bottisham
- Burwell
- Ely
- Ely (New)
- Newmarket
- Soham

All other WRCs receiving waste water from the new developments underwent a simpler initial assessment to assess whether 'load standstill' permit limits are achievable by conventional treatment methods (best available technology).

1.2 Study Objectives

This report assesses the potential water quality impacts on the receiving watercourses due to future growth in effluent flows. The aims of this assessment are to:

- Identify whether the increase in wastewater effluent discharged as a result of the proposed growth would lead to a deterioration of the water quality in the receiving watercourse.
- Where deterioration is predicted, test whether this could be prevented by the application of best available technology (BAT) and a tighter permit condition.
- Where the watercourse is not meeting the physico-chemical requirements of the Water Framework Directive Good Ecological Status or Potential, test whether the proposed growth would prevent that from being achieved.

1.3 Methodology

1.3.1 Growth scenarios

In order to undertake this assessment, the flows at each WRC have been calculated from the proposed developments provided by the ECDC. The Dry Weather Flow (DWF) was calculated for each WRC by using an occupancy rate of 2.3 persons per dwelling, a consumption of 133 l/p/d as outlined in the Water Resource Management Plan (WRMP) with 95% of flows reaching the WRC.

Table 1 shows the present day DWF, the forecast demand from proposed developments calculated from the method above, and the sum of these to make the future DWF.

Table 1: present-day and future scenario flow predictions for RQP assessment

WRC	Mean DWF - present day (Ml/d)	Demand from future growth (Ml/d)	Future DWF (Ml/d)	% Change
Bottisham	0.981	0.061	1.042	6%
Burwell	1.13	0.2	1.33	18%
Ely	3.56	0.36	3.92	10%
Ely (New)	1.57	1.71	3.28	109%
Newmarket	5.58	0.84	6.42	15%
Soham	2.86	0.9	3.76	31%

Table 2 Present day and future scenario flow predictions for load standstill assessment

WRC	90%ile DWF - Present day (Ml/d)	Demand from future growth (Ml/d)	Future flow (Ml/d)	% Change
Burrough Green	0.015	0.00	0.02	21%
Dullingham	0.153	0.00	0.16	3%
Haddenham	0.546	0.05	0.60	9%
Isleham	0.222	0.07	0.29	30%
Little Downham	0.276	0.01	0.28	3%
Littleport	0.716	0.95	1.67	133%
Mepal	0.14	0.01	0.15	10%
Stretham	0.229	0.03	0.26	13%
Swaffham Prior	0.066	0.02	0.09	34%
Wilburton	0.174	0.02	0.19	10%
Witcham	0.885	0.34	1.22	38%
Witchford	0.473	0.30	0.77	63%

It should be noted that the WRC data for the RQP assessment is from 2015 and uses mean flows. This data was only available for those WRCs identified to undergo the RQP assessment, the remaining WRC data is from 2014 which only includes a 90%ile DWF value.

1.3.2 Assessment of Deterioration

The study was required to assess changes to effluent flows as a result of the proposed development in order to assess the impact of the increased pollutant load on the receiving watercourses. Any increase in a pollutant load being discharged from a WRC could cause a deterioration and the EA set the following criteria to define significant deterioration, at which point a review of the Environmental Permit may be triggered:

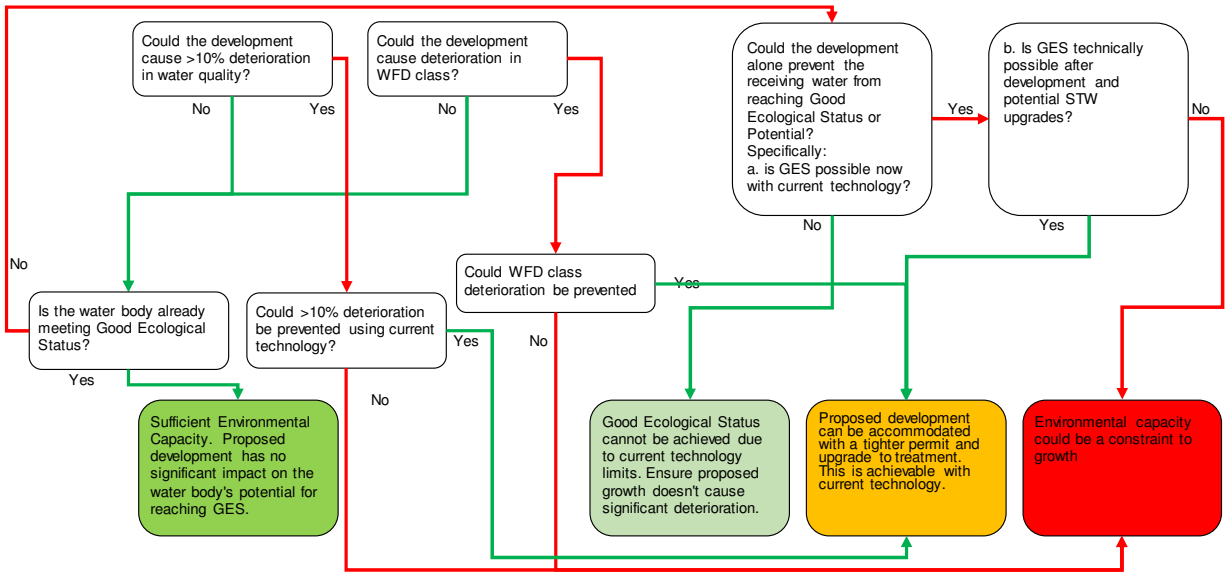
- A class deterioration. For example, if an increased load of ammonia from a WRC led to a water body currently defined as "Moderate" ecological status dropping down to "Poor" status.
- A deterioration of more than 10% in any determinand. For example, if the present-day 95 percentile BOD downstream of a WRC is 2.0mg/l, but as a result of an increased WRC discharge this rose to 2.3mg/l, this would be a deterioration of 15%.
- Any deterioration of a water body classed as "Bad". Where the water body is currently of "Bad" ecological status (the lowest WFD status), then no further deterioration is permitted.

Where a WRC is predicted to lead to a failure in one or more of these targets, it is necessary to determine a possible future permit value which would prevent this from occurring. The RQP tool can be used to do this by calculating the required discharge needed to achieve a downstream river target.

1.3.3 Best Available Technology (BAT) Assessment

Where river target failures were predicted, the models were rerun to test whether application of Best Available Technology (BAT) treatment processes could prevent deterioration and enable the receiving watercourse to meet the physico-chemical requirements to achieve Good Ecological Status or Potential. This assessment process has recently been set out in a guidance document by the Environment Agency's West Thames Area[1]. Whilst this document has no national status, it provides a useful summary of how to interpret the results of the water quality assessment. This guidance is summarised in the flow chart below:

Figure 1: Water quality assessment flow chart



The EA advised that the following permit values are achievable using BAT, and that these values should be used for modelling all WRC potential capacity irrespective of the existing treatment technology and size of the works:

- BOD (95%ile) = 5mg/l
- Ammonia (95%ile) = 1mg/l
- Phosphate (mean) = 0.5mg/l

Note that phosphate removal is the subject of ongoing national trials investigating novel techniques and the optimisation of existing methods. This major study, which involves all UK water companies, is not due to report until 2017, therefore this assessment is based on the current assumption of BAT for phosphate. AW are assuming a 0.5mg/l as BAT until the study's results are available.

This assessment did not take into consideration the feasibility of upgrading each existing WRC to such technology after constraints of costs, timing, space, carbon costs etc are applied.

1 Environment Agency West Thames Area (2015) Water Cycle Study Guidance and Requirements - West Thames Area.

1.3.4 River Quality Planning Tool

Where data was available, the Environment Agency RQP tool was the selected approach for this assessment in conjunction with the recommended guidance document; "Water Quality Planning: no deterioration and the Water Framework Directive[2]". The tool uses a state Monte Carlo Mass Balance approach which allows the user to calculate permit values needed to achieve a particular river quality standard. The tool can also predict the discharge quality required to achieve a downstream water quality target.

RQP models were set up and run for each WRC to determine the current impact of the treatment works as well as the future impact.

Where failure was predicted in any of the scenarios, and the upstream river quality did not achieve 'good status' the model was re-run assuming that the upstream river had 'good status'. This allows the actual impact of the future effluent discharge to be assessed if upstream point and/or diffuse sources were to be resolved.

The data required to run the RQP software were:

Upstream river data (received from the EA):

- Mean flow
- 95% exceedance flow
- Mean for each contaminant
- Standard deviation for each contaminant

Discharge data (received from the EA):

- Mean flow
- Standard deviation for the flow
- Mean for each contaminant
- Standard deviation for each contaminant

River quality target data (received from the EA):

- No deterioration target
- 'Good status' target

The above data inputs should be based on observations where available. In the absence of observed data EA guidance require that the following values were used:

- Flow mean: 1.25*DWF
- Flow SD: 1/3*mean
- Quality data: permit values or assumed values
- If observed river flows were not available these were obtained from an existing model or a low-flows estimation software.
- If observed water quality data were not available these were obtained from an existing model or a neighbouring catchment with similar characteristics, or the mid-point of the WFD class.
- Dry Weather Flow (DWF) permits and the measured Q90 flows were also provided by the EA

1.3.5 Determinants

The determinands assessed at each WRC were Biological Oxygen Demand (BOD), Ammonia (NH_4) and Phosphate (P). No dilution data has been provided from AW for the future dilution of the pollutants, therefore it is assumed the dilution will be the same as the present day dilution.

1.3.6 Good Ecological Status

The WFD targets for Good Ecological Status (GES) for Biological Oxygen Demand (BOD), Ammonia (NH_4) and Phosphate (P) set by the EA for lowland and high alkalinity water bodies are shown in Table 3 below.

2 Environment Agency (2012) Water Quality Planning: no deterioration and the Water Framework Directive. Accessed online at: http://www.fwr.org/WQreg/Appendices/No_deterioration_and_the_WFD_50_12.pdf on: 17/10/2017

Table 3: WFD 'Good Status' Targets for lowland and high alkalinity water bodies

Determinand	Statistic	Target
BOD	90 percentile	5mg/l
NH_4	90 percentile	0.6mg/l
P	Mean	Site Specific

The EA has provided 2015 WFD catchment/reach specific 'Good Status' targets for phosphate. The following targets have been used in this assessment at each WRC:

Table 4: Phosphorus targets for 'Good Status' by WRC

WRC	P mean mg/l	Receiving Watercourse
Bottisham	0.095	Swaffham Bulbeck Lode
Burwell	0.100	Burwell Lode
Ely	0.099	Ely Ouse (South Level)
Ely (new)	0.120	Ely Ouse (South Level)
Soham	0.100	Ely Ouse (South Level)
Newmarket	0.097	Soham Lode

1.3.7 Assessing Compliance

Compliance against WFD targets for the scenarios modelled was calculated using the present day situation as the baseline. Compliance / or non-compliance is indicated on the results tables as follows:

Modelled water quality is within the WFD target for the determinand in question.	Modelled water quality does not meet the WFD target for the determinand in question.

The status of the receiving watercourse is reported using the same traffic light colour system used by the EA "Method statement for the classification of surface water bodies v3[3]" as shown in Figure 2. The WCS requires an assessment only based on the physico-chemical quality elements where each element is classified as bad, poor, moderate, good or high.

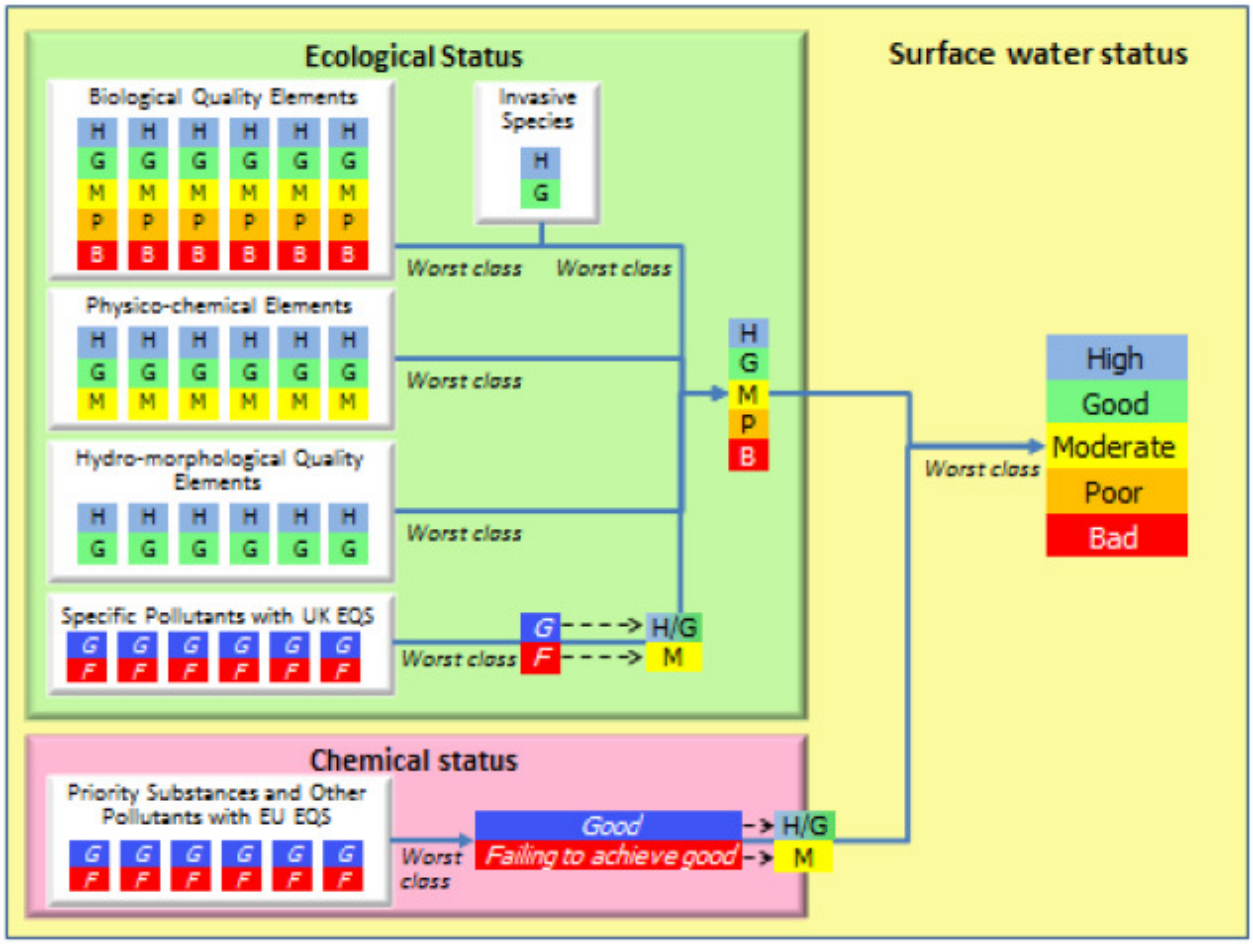
For each WRC a summary table is provided (based on Table 5) for the receiving watercourse, reporting the 2015 WFD status for BOD, NH_4 and P, the overall status for the watercourse and future objectives.

3 Environment Agency (2015) Rules for assessing Surface Water Body Status and Potential Version 2.0. Accessed online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/503282/RBMP_Guide_to_accessing_data_and_information.pdf on: 17/10/2017

Table 5: Summary table representing 2015 WFD status, watercourse status and its objectives

	Overall	BOD	Ammonia	Phosphorus
2015 WFD status	Overall watercourse's status	Watercourse's status for BOD	Watercourse's status for NH_4	Watercourse's status for P
Objective	Overall watercourse's objective	Watercourse's objective for BOD	Watercourse's objective for NH_4	Watercourse's objective for P

Figure 2: Classification of Surface Water from "Rules for assessing Surface Water Body Status and Potential v2.0"



1.3.8 Load standstill assessment

The load standstill assessment is a simpler mass balance assessment of water quality. The current, consented and future loads for each determinand are calculated using the observed, consented and future flows multiplied by the permit level for each determinand. The future load is then compared with the consented load to check if it is likely to exceed its permit.

Best available technology is then applied to each of the future loads to see whether it is possible to reduce the future load to the same as the current load.

1.4 Results - RQP Analysis

1.4.1 Bottisham WRC

Bottisham WRC discharges into the Swaffham Bulbeck Lode as shown in Figure 3. There are proposed developments containing 162 residential properties and 0.9ha of economic land that has been designated to connect to Bottisham WRC.

Figure 3: Bottisham WRC discharge location.

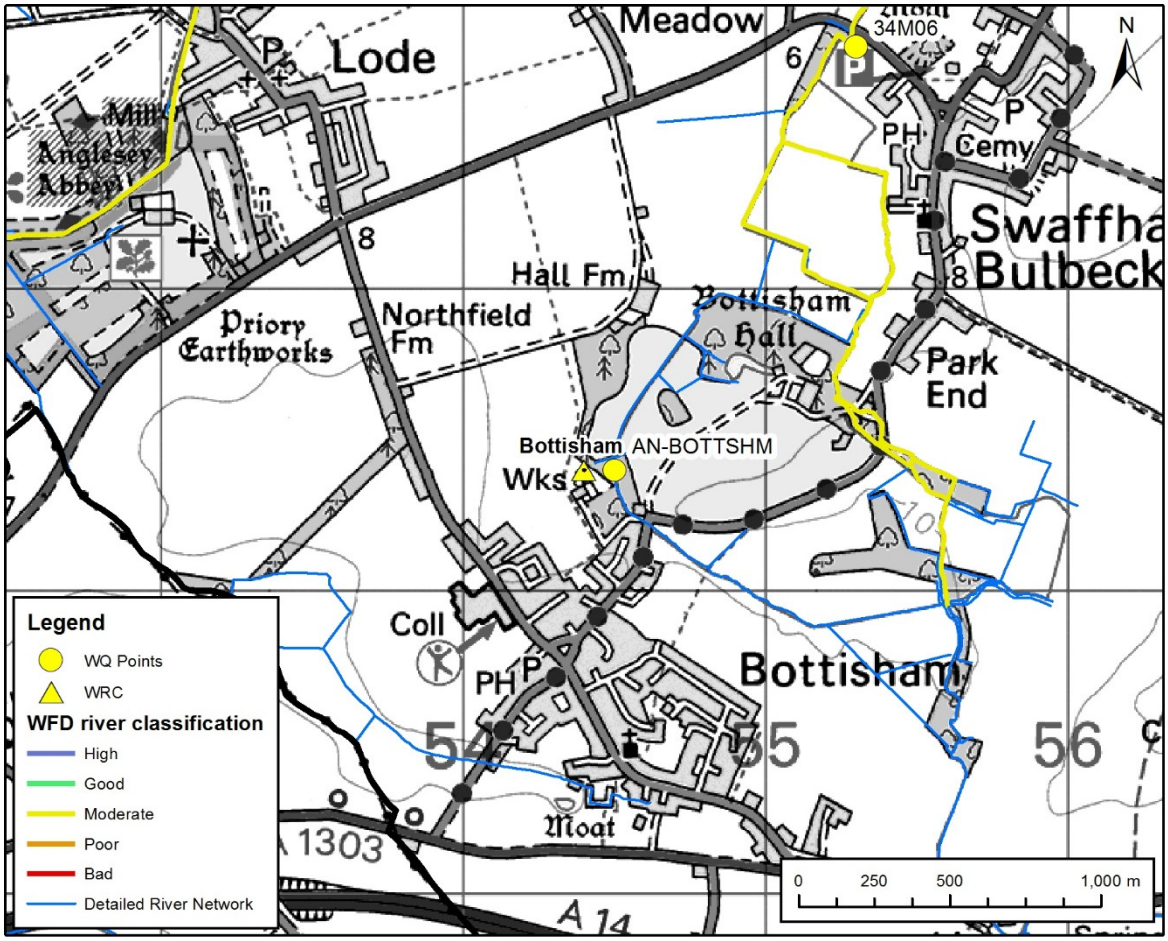


Table 6: Swaffham Bulbeck Lode 2015 WFD status and objectives.

	Overall	BOD	Ammonia	Phosphate
2015 status	Poor	High	High	Poor
Objective	Not available	High	High	Good

Table 6 shows the current WFD cycle 2 statuses of the receiving watercourse (both overall and individual status for BOD, NH_4 and P). The Swaffham Bulbeck Lode has a poor overall status due to the poor status for Phosphate, but both BOD and NH_4 have a high WFD status.

For both BOD and NH_4, the WFD status measured at the 34M06 WQ monitoring point (downstream of the WRC) is high. However, the data provided for the RQP assessment predates the 2016 WFD cycle data and therefore the RQP results predicts a "moderate" status for both these determinands in the present day scenario.

Table 7: Consent Values for DWF, BOD, NH_4 and P at Bottisham WRC

DWF (m3/d)		BOD (mg/l)		NH4 (mg/l)		P (mg/l)	
Permitted DWF	Measured Q90	95%ile consent value	Modelled 95%ile	95%ile consent value	Modelled 95%ile	Mean consent value	Modelled mean
820	708	20	9.25	5	2.22	Not available	

Table 7 shows the consent values for Bottisham WRC. The works has permitted values for 2015 DWF, BOD and NH_4 and is currently working within these limits. As no data has been given for the future dilution of the pollutants, it is assumed they will remain the same. In this case, the works will still be operating in the future within the consented values.

Table 8: Input data and RQP results for Bottisham WRC

Parameter	Statistic	River	Source	Present Day			Future growth		
				WRC	Source	RQP Result	WRC	Source	RQP Result
Flow (Ml/d)	Mean	0.60	Low Flow Softw are	0.981	Observed Data		1.04	Calculated using AW parameters	
	SD			0.222			0.236		
	5%ile	0.26							
BOD (mg/l)	Mean	1.15	Assumed Mid Class High	4.97	Observed Data	5.57	4.97	Observed Data	5.64
	SD	0.69		2.23			2.23		
	Target 90%ile	4.00	2015 WFD						
NH4 (mg/l)	Mean	0.09	Assumed Mid Class High	0.62	Observed Data	0.96	0.62	Observed Data	0.97
	SD	0.05		1.11			1.11		
	Target 90%ile	0.30	2015 WFD						
P (mg/l)	Mean	0.074	Assumed Mid Class Good	7.12	Observed Data	4.6	7.12	Observed Data	4.7
	SD	0.074		1.46			1.46		
	Target Mean	0.095	2015 WFD						

Table 8 shows the input data and RQP results for Bottisham. The model results indicate that there is no class deterioration for any of the determinands, however all three fail to meet the WFD target for "good" status.

The RQP function was used to calculate the required discharge quality for all pollutants to meet the river targets. The model results in Table 9 indicate that the "good" target can be achieved for both present day and future growth for BOD using BAT, whilst the targets cannot be achieved for NH_4 and P. A moderate target was calculated for P as the good target could not be reached, however this target also cannot be achieved using BAT.

Table 9: Discharge quality required to meet good WFD targets for P at Bottisham WRC

Pollutant	Target	Upstream river quality	Scenario	Mean	SD	95%ile	Comments
BOD	4.00 - High	Assumed Mid Class High	Future Growth	3.49	1.52	**6.38**	Achievable with BAT
BOD	4.00 - High	Assumed Mid Class High	Present Day	3.53	1.54	**6.44**	Achievable with BAT
NH4	0.3 - High	Assumed Mid Class High	Future Growth	0.18	0.26	**0.63**	Not achievable with BAT
NH4	0.3 - High	Assumed Mid Class High	Present Day	0.18	0.27	**0.64**	Not achievable with BAT
P	0.095 - Good	Assumed Mid Class Good	Future Growth	**0.11**	0.02	0.14	Not achievable with BAT
P	0.095 - Good	Assumed Mid Class Good	Present Day	**0.11**	0.02	0.15	Not achievable with BAT
P	0.222 - Moderate	Assumed Mid Class Good	Future Growth	**0.30**	0.06	0.41	Not achievable with BAT
P	0.222 - Moderate	Assumed Mid Class Good	Present Day	**0.31**	0.06	0.42	Not achievable with BAT

1.4.2 Burwell WRC

Burwell WRC discharges into the Burwell Lode as in Figure 4. There are proposed developments containing 511 residential properties and 3.3ha of economic land that has been designated to connect to Burwell WRC.

Figure 4: Burwell WRC discharge location.

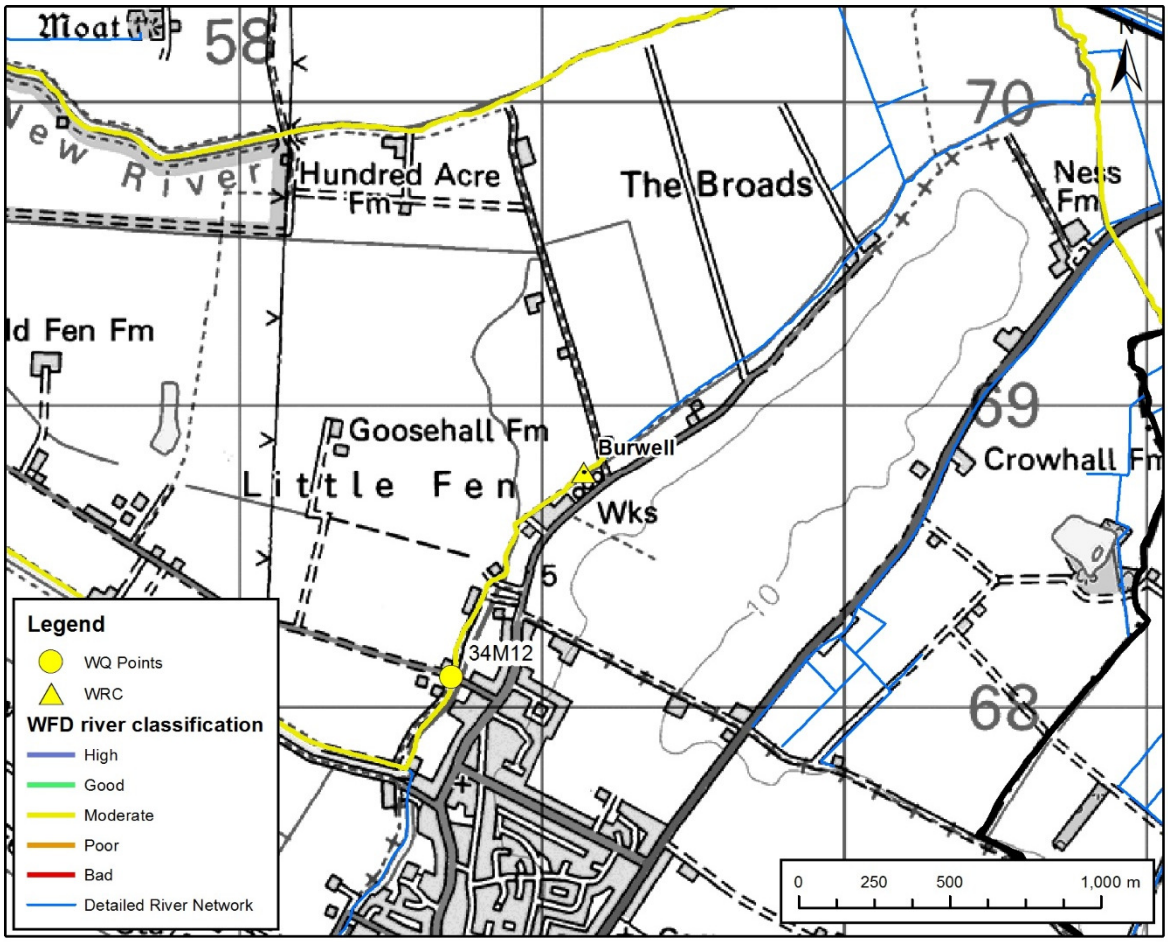


Table 10: Burwell Lode watercourse status and objectives.

	Overall	BOD	Ammonia	Phosphate
2015 status	Poor	High	Good	Moderate
Objective	Not available	High	Good	Good

Table 10 shows the current WFD cycle 2 status of the receiving watercourse including the overall status and the individual statuses for BOD, NH_4 and P. the Burwell Lode has a poor overall status, but BOD has a high WFD status and NH_4 has a good WFD status.

Table 11: Consent Values for DWF, BOD, NH_4 and P at Burwell WRC

DWF (m3/d)		BOD (mg/l)		NH4 (mg/l)		P (mg/l)	
Permitted DWF	Measured Q90	95%ile consent value	Modelled 95%ile	95%ile consent value	Modelled 95%ile	Mean consent value	Modelled mean
1373	897	14	4.62	9	3.7	1	0.49

Table 11 shows the consent values for Burwell WRC. The work has permitted values for 2015 DWF, BOD, NH_4 and P and is currently working within these limits. As no data has been given for the

future dilution of the pollutants, it is assumed they will remain the same. In this case, the works will still be operating in the future within the consented values.

Table 12: Input data and RQP results for Burwell WRC

Parameter	Statistic	River	Source	Present Day			Future growth		
				WRC	Source	RQP Result	WRC	Source	RQP Result
Flow (Ml/d)	Mean	9.90	Low Flow Softw are	1.13	Observed Data		1.33	Calculated using AW parameters	
	SD			0.29			0.34		
	5%ile	2.39							
BOD (mg/l)	Mean	1.15	Assumed Mid Class High	2.55	Observed Data	2.14	2.55	Observed Data	2.16
	SD	0.69		1.08			1.08		
	Target 90%ile	4.00	2015 WFD						
NH4 (mg/l)	Mean	0.09	Assumed Mid Class High	1.06	Observed Data	0.45	1.06	Observed Data	0.49
	SD	0.05		1.73			1.73		
	Target 90%ile	0.60	2015 WFD						
P (mg/l)	Mean	0.075	Assumed Mid Class Good	0.48	Observed Data	0.13	0.48	Observed Data	0.15
	SD	0.075		0.22			0.22		
	Target Mean	0.1	2015 WFD						

Table 12 shows the input data and RQP results for Burwell. The model results indicate that there are no class deteriorations for any of the determinands. However, there is a target failure for Phosphate, even when a good class upstream flow is assumed. There is also a 15% deterioration for this determinand.

The RQP function was used to calculate the required discharge quality for P to meet the river targets whilst assuming good quality upstream. The model results in Table 13 indicate that this cannot be achieved for both present day and future scenarios with BAT.

Table 13: Discharge quality required to meet good WFD targets for P at Burwell WRC

Pollutant	Target	Upstream river quality	Scenario	Mean	SD	95%ile	Comment
P	0.1 - Good	Assumed Mid Class Good	Future Grow th	**0.14**	0.06	0.26	Not achievable w ith BAT
P	0.1 - Good	Assumed Mid Class Good	Present	**0.20**	0.09	0.37	Not achievable w ith BAT

New permit values were calculated for the pollutants that present a deterioration of more than 10% or a class deterioration in the future growth scenario. These were calculated using the present day result from the RQP calculation to provide a permit value that would provide a future downstream deterioration of less 10% and no class deterioration. Table 14 shows the results for P which had deteriorated by 15% in the future growth scenario. Limiting the deterioration to less than 10% is not possible using BAT.

Table 14: WRC Discharge quality required to meet up to 10% or no class deterioration for Burwell

Parameter	Worst Case Scenario	Present Day + 10% (mg/l)	Values required to meet target (mg/l)		
			Mean	SD	95%ile
Phosphate	Future Growth	0.14	0.45	0.2	0.83

1.4.3 Ely

Ely WRC discharges into the Ely Ouse as shown in Figure 5. There are proposed developments with 273 residential properties and 18.5ha of economic land that has been designated to connect to Ely WRC.

Figure 5: Ely WRC discharge location.

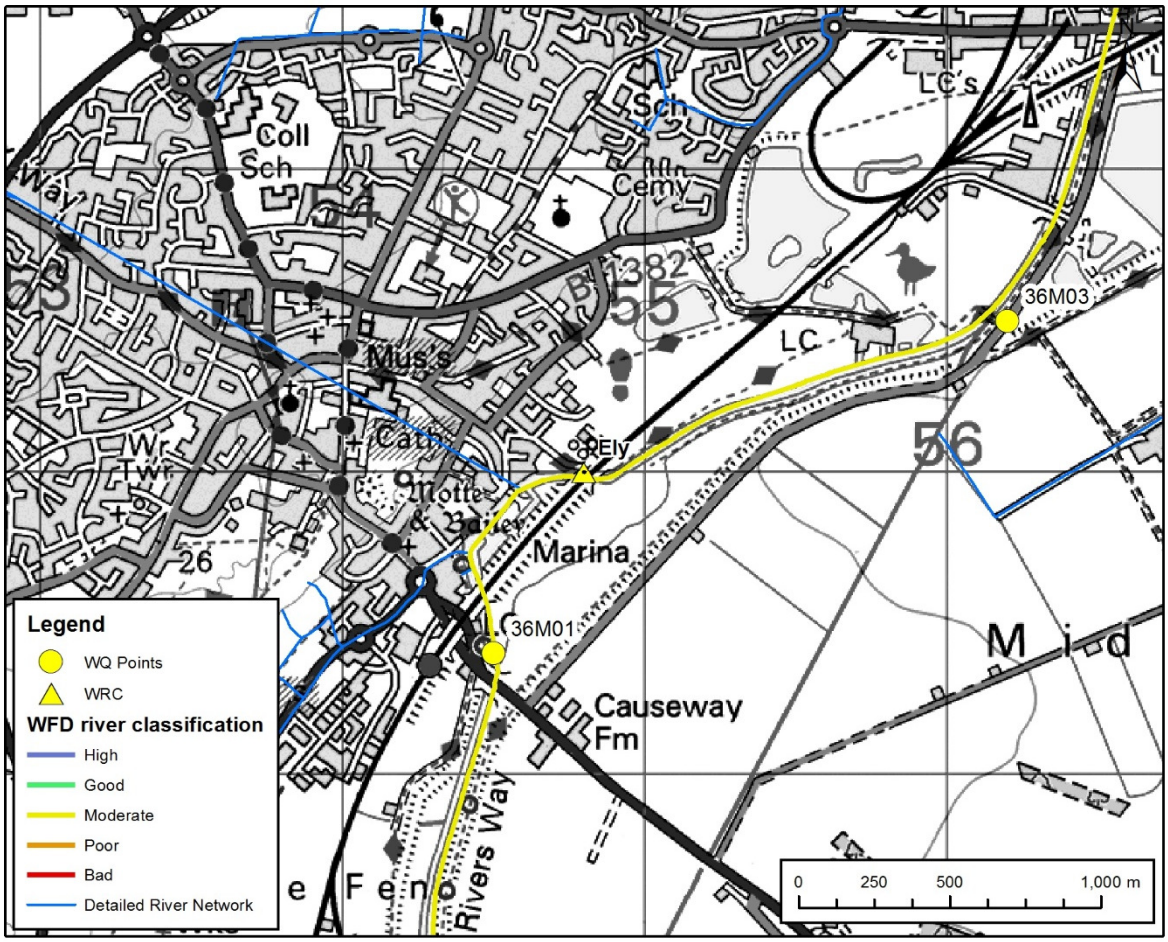


Table 15: Ely Ouse watercourse status and objectives.

	Overall	BOD	Ammonia	Phosphate
2015 status	Moderate	Good	Good	Moderate
Objective	Not available	Good	Good	Good

Table 15 shows the current WFD cycle 2 status of the receiving watercourse including the overall status as well as the individual statuses for BOD, NH_4 and P. The Ely Ouse has a moderate overall status, but both BOD and NH_4 have a good WFD status.

Table 16: Consent Values for DWF, BOD, NH_4 and P at Ely WRC

DWF (m3/d)		BOD (mg/l)		NH4 (mg/l)		P (mg/l)	
Permitted DWF	Measured Q90	95%ile consent value	Modelled 95%ile	95%ile consent value	Modelled 95%ile	Mean consent value	Modelled mean
4350	2934	25	14.59	15	6.83	2	0.98

Table 16 shows the consent values for Ely WRC. The work has permitted values for 2015 DWF, BOD, NH_4 and P and is currently working within these limits. As no data has been given for the

future dilution of the pollutants, it is assumed they will remain the same. In this case, the works will still be operating in the future within the consented values.

Table 17: Input data and RQP results for Ely WRC

Parameter	Statistic	River	Source	Present Day			Future growth		
				WRC	Source	RQP Result	WRC	Source	RQP Result
Flow (Ml/d)	Mean	466.99	Low Flow Software	3.57	Observed Data		3.93	Calculated using AW parameters	
	SD			0.64			0.71		
	5%ile	109.47							
BOD (mg/l)	Mean	1.94	Observed Data	7.66	Observed Data	3.37	7.66	Observed Data	3.37
	SD	1.13		3.60			3.60		
	Target 90%ile	5.00	2015 WFD						
NH4 (mg/l)	Mean	0.19	Observed Data	3.41	Observed Data	0.43	3.41	Observed Data	0.43
	SD	0.19		1.77			1.77		
	Target 90%ile	0.60	2015 WFD						
P (mg/l)	Mean	0.280	Observed Data	0.96	Observed Data	0.29	0.96	Observed Data	0.29
	SD	0.120		0.55			0.55		
	Target Mean	0.099	2015 WFD						

Table 17 shows the input data and RQP results for Ely. The model results indicate that there is no class deterioration for BOD or NH_4, and they achieve at least a "good" status post development. In the case of phosphate, the present day result is "poor" although this does not deteriorate further in the future growth scenario.

The application of BAT does not allow "good" or "moderate status to be achieved unless upstream water quality is improved. If a mid-class "good" status was achieved upstream, "good" status could be achieved for the future growth scenario.

Table 18 Input data and RQP results for Ely (Old) assuming "good" upstream flow

Parameter	Statistic	River	Source	Present Day			Future growth		
				WRC	Source	RQP Result	WRC	Source	RQP Result
P (mg/l)	Mean	0.078	Assumed mid class good	0.96	Observed Data	0.09	0.96	Observed Data	0.09
	SD	0.078		0.55			0.55		
	Target Mean	0.099	2015 WFD						

1.4.4 Ely (New)

Ely WRC discharges into the Ely Ouse as shown in Figure 6. There are proposed developments with 3019 residential properties and 55.1ha of economic land that has been designated to Ely (New) WRC.

Figure 6: Ely WRC discharge location.

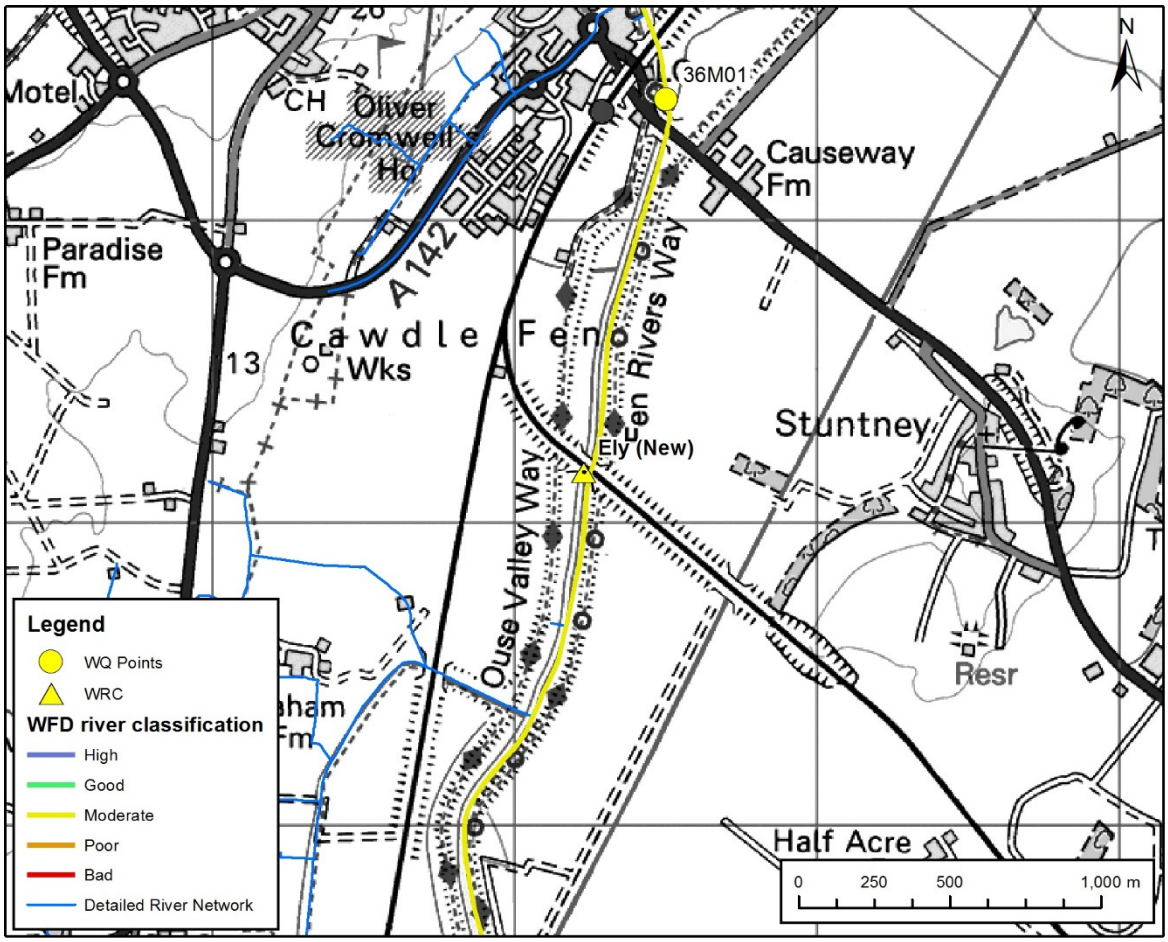


Table 19: Ely Ouse watercourse status and objectives.

	Overall	BOD	Ammonia	Phosphate
2015 status	Moderate	Good	Good	Moderate
Objective	Not available	Good	Good	Good

Table 19 shows the current WFD cycle 2 status of the receiving watercourse including the overall status as well as the individual statuses for BOD, NH_4 and P. The Ely Ouse has a moderate overall status, but both BOD and NH_4 have a good status.

Table 20: Consent Values for DWF, BOD, NH_4 and P at Ely (New) WRC

DWF (m3/d)		BOD (mg/l)		NH4 (mg/l)		P (mg/l)	
Permitted DWF	Measured Q90	95%ile consent value	Modelled 95%ile	95%ile consent value	Modelled 95%ile	Mean consent value	Modelled mean
1604	1175	25	10.3	10	2.82	2	5.23

Table 20 shows the consent values for Ely (New) WRC. The works has permitted values for 2015 DWF, BOD and NH_4 and is currently working within these limits. P is the only pollutant which

exceeds its current permit. As no data has been given for the future dilution of the pollutants, it is assumed they will remain the same. In this case, the works will still be operating in the future within the consented values, apart from P.

Table 21: Input data and RQP results for Ely (New) WRC.

Parameter	Statistic	River	Source	Present Day			Future growth		
				WRC	Source	RQP Result	WRC	Source	RQP Result
Flow (Ml/d)	Mean	486.00	Low Flow Software	1.57	Observed Data		3.28	Calculated using AW parameters	
	SD			0.41			0.86		
	5%ile	69.10							
BOD (mg/l)	Mean	1.86	Assumed Mid Class High	5.62	Observed Data	3.25	5.62	Observed Data	3.25
	SD	1.12		2.44			2.44		
	Target 90%ile	5.00	2015 WFD						
NH4 (mg/l)	Mean	0.07	Assumed Mid Class High	0.92	Observed Data	0.13	0.92	Observed Data	0.14
	SD	0.04		1.09			1.09		
	Target 90%ile	0.60	2015 WFD						
P (mg/l)	Mean	0.085	Assumed Mid Class Good	5.18	Observed Data	0.12	5.18	Observed Data	0.16
	SD	0.085		1.02			1.02		
	Target Mean	0.120	2015 WFD						

Table 21 shows the input data and RQP results for Ely (New). The model results indicate that for BOD and NH_4 the WFD target is being met, there is no deterioration in class, and less than 10% deterioration in discharge quality. In the case of Phosphate, a "good" status is currently being met, however a deterioration of 33% is predicted in the future growth scenario, dropping the class to "moderate".

The RQP function was used to calculate the required discharge quality for P to meet the river targets. The model results in Table 22 indicate that for P "good" status can be achieved using BAT.

Table 22: Discharge quality required to meet good WFD targets for P at Ely (New)

Pollutant	Target	Upstream river quality	Scenario	Mean	SD	95%ile	Comments
P	0.12 - Good	Assumed Mid Class Good	Future Growth	**2.22**	0.43	2.99	Achievable with BAT

The values above would also represent the new permit values required in order to ensure there is no deterioration in class in the future growth scenario.

1.4.5 Newmarket

Newmarket WRC discharges into the Newmarket No.1 Public Drain as shown in Figure 7. There are proposed developments containing 1480 residential properties and 27ha of economic land that has been designated to Newmarket WRC.

Figure 7: Newmarket WRC discharge location.

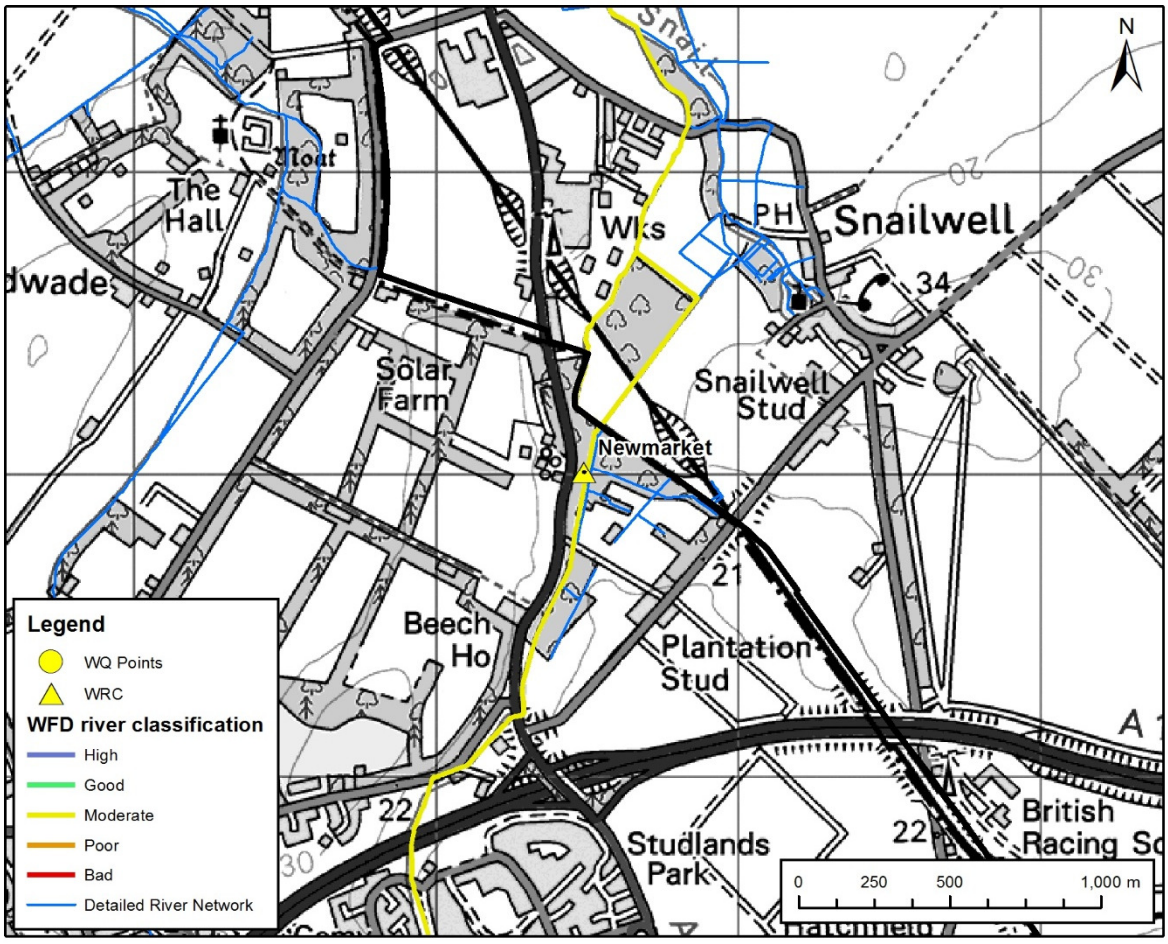


Table 23: Newmarket public drain status and objectives.

	Overall	BOD	Ammonia	Phosphate
2015 status	Moderate	High	High	Moderate
Objective	Not available	High	High	Good

Table 23 shows the current WFD cycle 2 status of the receiving watercourse including the overall status as well as the individual statuses for BOD, NH_4 and P. The Newmarket public drain has a moderate overall status, but both BOD and NH_4 have a high WFD status.

Table 24: Consent values for DWF, BOD, NH_4 and P at Newmarket WRC

DWF (m3/d)		BOD (mg/l)		NH4 (mg/l)		P (mg/l)	
Permitted DWF	Measured Q90	95%ile consent value	Modelled 95%ile	95%ile consent value	Modelled 95%ile	Mean consent value	Modelled mean
6100	4909	12	6.62	4	0.52	2	1.28

Table 24 shows the consent values for Newmarket WRC. The works has permitted values for 2015 DWF, BOD, NH_4 and P and is currently working within these limits. As no data has been given for

the future dilution of the pollutants, it is assumed they will remain the same. In this case, the works will still be operating in the future within the consented values.

Table 25: Input data and RQP results for Newmarket WRC.

Parameter	Statistic	River	Source	Present Day			Future growth		
				WRC	Source	RQP Result	WRC	Source	RQP Result
Flow (Ml/d)	Mean	19.01	Low Flow Software	5.59	Observed Data		6.43	Calculated using AW parameters	
	SD			2.28			2.62		
	5%ile	4.66							
BOD (mg/l)	Mean	3.41	Observed Data	3.69	Observed Data	6.31	3.69	Observed Data	6.2
	SD	3.64		1.53			1.53		
	Target 90%ile	4.00	2015 WFD						
NH4 (mg/l)	Mean	0.460	Observed Data	0.14	Observed Data	0.79	0.14	Observed Data	0.76
	SD	0.900		0.28			0.28		
	Target 90%ile	0.30	2015 WFD						
P (mg/l)	Mean	0.200	Observed Data	1.26	Observed Data	0.5	1.26	Observed Data	0.53
	SD	0.180		0.54			0.54		
	Target Mean	0.097	2015 WFD						

Table 25 shows the input data and RQP results for Newmarket. The model results indicate that all the determinands fail to achieve the WFD target in both the present day and future scenarios. Deterioration is less than 10% for all determinands and the there is no class deterioration. In the case of BOD and NH_4 there is a reduction in RQP result in the future scenario. This is due to the relative size of the standard deviation to the mean for the upstream water quality.

The RQP function was used to calculate the required discharge quality for all determinands to meet the river targets. The model results in Table 26 indicate that the WFD target is achievable for BOD using BAT, but not for NH4. A "good" status cannot be achieved for phosphate using BAT, however "moderate" status can be achieved.

Table 26: Discharge quality required to meet good WFD targets at Newmarket

Pollutant	Target	Upstream river quality	Scenario	Mean	SD	95%ile	Comments
BOD	4 - High	Mid Class High	Future Growth	5.29	2.14	**9.32**	Achievable with BAT
BOD	4 - High	Mid Class High	Present Day	5.47	2.21	**9.64**	Achievable with BAT
NH4	0.3 - High	Mid Class High	Future Growth	N/A	N/A	N/A	Not achievable with BAT
NH4	0.3 - High	Mid Class High	Present Day	N/A	N/A	N/A	Not achievable with BAT
P	0.097 - Good	Moderate	Future Growth	N/A	N/A	N/A	Not achievable with BAT
P	0.097 - Good	Moderate	Present Day	N/A	N/A	N/A	Not achievable with BAT
P	0.226 - Moderate	Moderate	Future Growth	**0.28**	0.12	0.51	Achievable with BAT
P	0.226 - Moderate	Moderate	Present Day	**0.29**	0.12	0.52	Achievable with BAT

If upstream water quality was improved, the RQP result would also improve but would still miss the WFD target.

Table 27 Input data and RQP result assuming "good" upstream water quality

Parameter	Statistic	River	Source	Present Day			Future growth		
				WRC	Source	RQP Result	WRC	Source	RQP Result
P (mg/l)	Mean	0.074	Assumed Mid Class Good	1.26	Observed Data	0.4	1.26	Observed Data	0.44
	SD	0.074		0.54			0.54		
	Target Mean	0.097	2015 WFD						

Best available technology in this scenario would allow a moderate status to be achieved.

Table 28 Discharge quality required to meet "good" or "moderate WFD targets for P

Pollutant	Target	Upstream river quality	Scenario	Mean	SD	95%ile	Comments
P	0.097 - Good	Assumed Mid Class Good	Future Growth	**0.16**	0.07	0.28	Not achievable with BAT
P	0.097 - Good	Assumed Mid Class Good	Present Day	**0.17**	0.07	0.30	Not achievable with BAT
P	0.226 - Moderate	Assumed Mid Class Good	Future Growth	**0.58**	0.24	1.05	Achievable with BAT
P	0.226 - Moderate	Assumed Mid Class Good	Present Day	**0.63**	0.27	1.14	Achievable with BAT

1.4.6 Soham

Soham WRC discharges into the Soham Lode as shown in Figure 8. There are proposed developments containing 2365 residential properties and 14.3ha of economic land that has been designated to connect to Soham WRC.

Figure 8: Soham WRC discharge location.

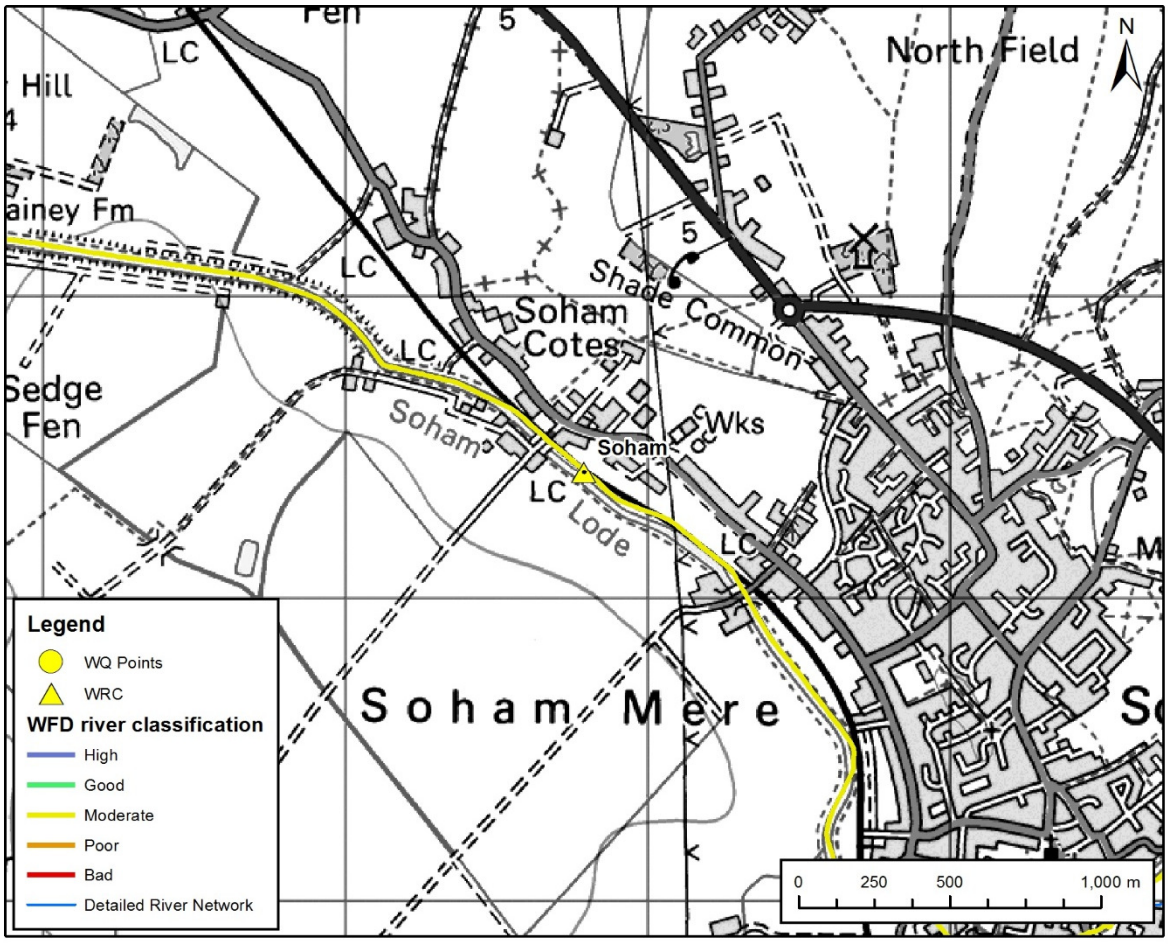


Table 29: Soham Lode watercourse status and objectives.

	Overall	BOD	Ammonia	Phosphate
2015 status	Moderate	High	Good	Moderate
Objective	Not available	Not available	Not available	Good

Table 29 shows the current WFD cycle 2 status of the receiving watercourse including the overall status as well as the individual statuses for Bod, NH_4 and P. The Soham Lode has a moderate overall status, but BOD has a high status and NH_4 has a good WFD status.

Table 30: Consent Values for DWF, BOD, NH_4 and P at Soham WRC

DWF (m3/d)		BOD (mg/l)		NH4 (mg/l)		P (mg/l)	
Permitted DWF	Measured Q90	95%ile consent value	Modelled 95%ile	95%ile consent value	Modelled 95%ile	Mean consent value	Modelled mean
2500	2280	17	11.01	8	4.2	2	1.22

Table 30 shows the consent values for Soham WRC. The work has permitted values for 2015 DWF, BOD and NH_4 and is currently working within these limits. As no data has been given for the future

dilution of the pollutants, it is assumed they will remain the same. In this case, the works will still be operating in the future within the consented values.

Table 31: Input data and RQP results for Soham WRC.

Parameter	Statistic	River	Source	Present Day			Future growth		
				WRC	Source	RQP Result	WRC	Source	RQP Result
Flow (Ml/d)	Mean	33.44	Low Flow Software	2.86	Observed Data		26.51	Calculated using AW parameters	
	SD			0.65			6.025		
	5%ile	12.27							
BOD (mg/l)	Mean	1.62	Observed Data	5.31	Observed Data	3.28	5.31	Observed Data	3.4
	SD	1.17		2.95			2.95		
	Target 90%ile	4.00	2015 WFD						
NH4 (mg/l)	Mean	0.26	Observed Data	1.26	Observed Data	0.73	1.26	Observed Data	0.80
	SD	0.88		1.82			1.82		
	Target 90%ile	0.60	2015 WFD						
P (mg/l)	Mean	0.220	Observed Data	1.20	Observed Data	0.32	1.20	Observed Data	0.34
	SD	0.160		0.40			0.40		
	Target Mean	0.100	2015 WFD						

Table 31 shows the input data and RQP results for Soham. The model results indicate that for BOD the WFD target is met with a 4% deterioration in the future growth scenario. For NH_4, the "good" status target is missed and a 10% deterioration is predicted in the future growth scenario. For phosphate, "good" status is missed, and a deterioration of 6% is predicted.

The RQP function was used to calculate the required discharge quality for all pollutants to meet the river targets. The model results in Table 32 indicate that the NH_4 target can be achieved using BAT. The "good" P target cannot be achieved using BAT, although the "moderate" target can be achieved for the present day flow.

Table 32: discharge quality required to meet good WFD targets for all pollutants at Soham

Pollutant	Target	Upstream river quality	Scenario	Mean	SD	95%ile	Comments
NH4	0.6 - Good	Mid Class Good	Future Growth	1.61	0.53	**2.59**	Achievable with BAT
NH4	0.6 - Good	Mid Class Good	Present Day	0.80	1.01	**2.61**	Achievable with BAT
P	0.1 - Good	Moderate	Future Growth	**0.12**	0.04	0.20	Not achievable with Bat
P	0.1 - Good	Moderate	Present Day	**0.27**	0.09	0.43	Not achievable with Bat
P	0.232 - Moderate	Moderate	Future Growth	**0.31**	0.10	0.49	Not achievable with Bat
P	0.232 - Moderate	Moderate	Present Day	**0.33**	0.11	0.53	Not achievable with Bat

If upstream water quality were improved to a mid-good status the predicted phosphate result would allow a "moderate status to be achieved (see Table 33).

Table 33 Input data and RQP result if upstream water quality was improved

Parameter	Statistic	River	Source	Present Day			Future growth		
				WRC	Source	RQP Result	WRC	Source	RQP Result
P (mg/l)	Mean	0.074	Observed Data	1.20	Observed Data	0.18	1.20	Observed Data	0.21
	SD	0.074		0.40			0.40		
	Target Mean	0.100	2015 WFD						

A "good" status then becomes achievable using BAT for the present day scenario, but is not possible for the future growth scenario.

Table 34 Discharge quality required to meet "good" WFD targets with improved upstream water quality

Pollutant	Target	Upstream river quality	Scenario	Mean	SD	95%ile	Comments
P	0.1 - Good	Assumed Mid Class Good	Future Growth	**0.30**	0.10	0.49	Not achievable with Bat
P	0.1 - Good	Assumed Mid Class Good	Present Day	**0.38**	0.12	0.61	Not achievable with Bat
P	0.232 - Moderate	Assumed Mid Class Good	Future Growth	**1.40**	0.46	2.24	Achievable with BAT
P	0.232 - Moderate	Assumed Mid Class Good	Present Day	**1.78**	0.58	2.85	Achievable with BAT

1.5 Results - Load standstill assessment

Table 35 shows the results of the load stand still assessment. It can be seen that future waste water demand from growth may cause Witcham and Witchford WRCs to exceed their permit value for all three determinands.

The application of best available technology to each of the WRCs could allow the load from the future growth scenario to return to the same level as the present day load in all cases except Littleport WRC which may give an increased load for BOD and P. It should be noted that permit levels are not predicted to be exceeded for this WRC.

Table 35 Load standstill assessment results

	Permit Level			Future Growth		Within permitted value after future growth			"No deterioration" achieved after application of BAT		
WRC	**BOD 95%ile (mg/l)**	**NH_4 95%ile (mg/l)**	**P Annual Mean (Mg/l)**	**Additional flow (m3/d)**	**Total flow (m3/d)**	**BOD**	**NH_4**	**P**	**BOD**	**NH_4**	**P**
Burrough Green	20	20	1	3.20	18.20	Y	Y	Y	OK	OK	OK
Dullingham	20	15	1	4.36	157.36	Y	Y	Y	OK	OK	OK
Haddenham	20	5	1	50.72	596.72	Y	Y	Y	OK	OK	OK
Isleham	45	8	1	66.70	288.70	Y	Y	Y	OK	OK	OK
Little Downham	15	10	1	7.27	283.27	Y	Y	Y	OK	OK	OK
Littleport	10	3	1	950.90	1666.90	Y	Y	Y	NOT ACHIEVABLE	OK	NOT ACHIEVABLE
Mepal	40	25	1	14.53	154.53	Y	Y	Y	OK	OK	OK
Stretham	20	20	1	29.06	258.06	Y	Y	Y	OK	OK	OK
Swaffham Prior	25	30	1	22.44	88.44	Y	Y	Y	OK	OK	OK
Wilburton	20	N/A	1	17.44	191.44	Y	N/A	Y	OK	N/A	OK
Witcham	12	6	1	339.80	1224.80	N	N	N	OK	OK	OK
Witchford	20	12	1	298.74	771.74	N	N	N	OK	OK	OK

1.6 Summary and Conclusions

1.6.1 Results

Table 36 summaries the modelling results for the following targets:

- 'Good status';
- 'No 10% deterioration';
- 'No class deterioration'.

Table 36: RQP results summaries for passing or failing targets of: 'Good Status', 'No >10% Deterioration' and 'No Class Deterioration'.

WRC	Scenario	Achieves 'Good status' target?			Achieves 'No > 10% deterioration' target?			Achieves No 'Class deterioration' target?		
		BOD	NH4	P	BOD	NH4	P	BOD	NH4	P
Key		Achieves good status			No deterioration			No class deterioration		
		NA			Up to 10% deterioration			NA		
		Fails to achieve good status			More than 10% deterioration			Class deterioration		
Bottisham	Present day	no	no	no	N/A	N/A	N/A	N/A	N/A	N/A
	Future growth	no	no	no	1%	1%	2%	yes	yes	yes
Burwell	Present day	yes	yes	no	N/A	N/A	N/A	N/A	N/A	N/A
	Future growth	yes	yes	no	1%	9%	15%	yes	yes	yes
Ely (Old)	Present day	yes	yes	no	N/A	N/A	N/A	N/A	N/A	N/A
	Future growth	yes	yes	no	0%	0%	0%	yes	yes	yes
Ely (New)	Present day	yes	yes	yes	N/A	N/A	N/A	N/A	N/A	N/A
	Future growth	yes	yes	no	0%	8%	33%	yes	yes	no
Newmarket	Present day	no	no	no	N/A	N/A	N/A	N/A	N/A	N/A
	Future growth	no	no	no	-2%	-4%	6%	yes	yes	yes
Soham	Present day	yes	no	no	N/A	N/A	N/A	N/A	N/A	N/A
	Future growth	yes	no	no	4%	10%	6%	yes	yes	yes

1.6.2 Best Available Technology (BAT) assessment

Table 37 summarises the results assuming BAT is applied for each WRC.

Table 37: Summary of results assuming BAT is applied.

Key	Sufficient Environmental Capacity. Proposed development has no significant impact on the water body's potential for reaching GES	Good Ecological Status cannot be achieved due to current technology limits. Ensure proposed growth doesn't cause significant deterioration.	Proposed development can be accommodated with a tighter permit and upgrade to the treatment. This is achievable with current technology.	Environmental capacity could be a constraint to growth.

WRC	Could the development cause a greater than 10% deterioration in WQ?	Could the development cause a deterioration in WFD class of any element?	Could the development prevent the water body from reaching GES?
Bottisham	Less than 10% deterioration for each determinand.	No class deterioration is predicted.	Good Ecological Status cannot be achieved due to individual status of NH4 and P which cannot be improved due to current technology limits. Ensure proposed growth doesn't cause significant deterioration.
Burwell	The development causes greater than 10% deterioration in P which cannot be mitigated with BAT. Environmental capacity could be a constraint to growth.	No class deterioration predicted.	Good Ecological Status cannot be achieved due to individual status of P which cannot be improved due to current technology limits. Ensure proposed growth doesn't cause significant deterioration.
Ely (Old)	Less than 10% deterioration for each determinand.	No class deterioration predicted.	Good Ecological status cannot be achieved due to the individual status for P which cannot be improved due to current technological limits. If "good" status could be achieved upstream then P status could be improved in both present and future scenarios and GES would be achievable.
Ely (New)	A 33% deterioration is predicted for P. Proposed development can be accommodated with a tighter permit and upgrade to the WRC and is achievable using BAT.	Class deterioration has been predicted P. Class could be maintained through application of BAT.	Good Ecological Status can be achieved if individual status of P is maintained in future scenario through application of BAT.
Newmarket	Less than 10% deterioration for each determinand.	No class deterioration predicted.	Good Ecological Status is not achievable due to individual status for NH4 and P which cannot be improved due to current technology limits. Ensure proposed growth doesn't cause significant deterioration.
Soham	Predicted deterioration is more than 10% for NH4. Proposed development can be accommodated with a tighter permit and upgrade to the WRC. This is achievable with BAT.	No class deterioration predicted.	Good Ecological Status is not achievable due to individual status for NH4 and P which cannot be improved due to current technology limits. Ensure proposed growth doesn't cause significant deterioration.

1.6.3 Conclusions

The following conclusions are drawn from this water quality impact assessment:

RQP Assessment

- All WRCs are currently working within their DWF permits, with the exception of Ely (New) which exceeds its permit for phosphate.
- The proposed growth is predicted to lead to deterioration greater than 10% and/or class deterioration at Burwell, Ely (New) and Soham WRCs. In the case of Ely (New) and Soham this can be accommodated through an upgrade to the WRC (application of BAT) and a tightening of permits, however for Burwell, the deterioration in phosphate cannot be reduced to less than 10% using BAT. In this case environmental capacity is considered to be a constraint to growth.
- All receiving watercourses at all WRCs with the exception of Ely (New) fail to meet their targets for Phosphate in the present day situation. Bottisham and Newmarket also fail to achieve the WFD target for BOD and NH4 in the present day scenario.
- At Ely (Old) Good Ecological Status (GES) could be achieved in the receiving watercourse if the upstream water quality could be improved to GES, and if the treatment works is upgraded to BAT.
- At Ely (New) Good Ecological Status (GES) could be achieved for the future growth scenario in the receiving watercourse if the individual status of P were improved through application of BAT.
- At all other works assessed by RQP, modelling predicts that GES cannot be achieved due to current technology limits for treatment of Phosphate at Burwell and phosphate and ammonia at Bottisham, Newmarket and Soham. In these cases, the technology is considered to be the reason for not achieving GES, not the proposed growth.

Load standstill assessment

- At WRCs assessed using the load standstill method, the future demand may cause the permit level for the three assessed determinands to be exceeded at Witcham and Witchford WRCs. Application of BAT would reduce these values within the permitted levels. All other WRCs are predicted to operate within their permits.
- Application of BAT may allow future loads to return to the present day levels for all WRCs with the exception of Littleport.