PROFORMA FOR STAGE 3 APPROPRIATE ASSESSMENT

PART A: SITE DETAILS

1 Site Details:

Name, Legal Status, and Priority of the European site:	BROADLANDS/ THE BROADS	SPA/ SAC & Ramsar	**Medium**
	Ant Broads and Marshes	SSSI	

This Appendix 21 form covers the SAC/SPA features only of Ant broads and marshes SSSI and is consistent with the scope for the Appropriate Assessment as agreed with you at the beginning of Stage 3.

Current Environment Agency policy, as endorsed by the Habitats Directive Project Board, states that we will not at this time consider Ramsar features that are not also designated as SAC/SPA features on coincident/overlapping sites in the Review of Consents. For this site we consider that the Ramsar features and boundary overlap with the SAC/SPA features.

2 Features List:

2.1 Designated features present:

- Natural Eutrophic Lakes **REF: APP 13 – Groups – 1.5**
- Hard Oligo-mesotrophic waters **REF: APP 13 – Groups – 1.5**
- Molina meadows **REF: APP 13 – Groups – 1.1**
- Alluvial Forests **REF: APP 13 – Groups – 1.1**
- Calcareous Fens **REF: APP 13 – Groups – 1.2**
- Transition Mires and Quaking Bogs **REF: APP 13 – Groups – 1.2**
- Fen Orchid **REF: APP 13 – Groups – 2.2**
- Otter **REF: APP 13 – Groups –2.9**
- Desmoulin's Whorl Snail **REF: APP 13 – Groups – 2.2**
- **Bittern** **REF: APP 13 – Groups – 3.6**
- **Marsh Harrier** **REF: APP 13 – Groups – 3.6,3.7**
- **Hen Harrier** **REF: APP 13 – Groups – 3.4,3.6,3.7**
- Gadwall **REF: APP 13 – Groups – 3.6**
- Shoveler **REF: APP 13 – Groups – 3.6,**
- **Great Crested Grebe** **REF: APP 13 – Groups – 3.6,**
- **Cormorant** **REF: APP 13 – Groups – 3.6**
- **Teal** **REF: APP 13 – Groups – 3.4,3.6,**
- **Pochard** **REF: APP 13 – Groups – 3.4,3.8**
- **Tufted Duck** **REF: APP 13 – Groups – 3.6**
- **Coot** **REF: APP 13 – Groups – 3.4,3.6**

- **Assemblage** **REF: APP 13 – Groups – 3.6**

***Those highlighted in bold are additions respective of the SPA review July 2001**

3 Summary Table of the Number of Permissions going to Stage 3:

Function	Proforma Stage 1	Proforma Stage 2
WQ	123	123
WR	109	109 (27 alone and in combination, 82 in combination only)
WASTE	0	0
IPC	0	0
RAS	0	0

4 Review of Consents Group Members:

Water Quality	Sue Hogarth /Daniel Bastreri
Water Resources	Christine Kuettner
Area Habitats Directive	Amanda Elliott
Regional Habitats Directive	Rob Pilcher
EN RoC Officer	David Fraser
EN Conservation Officer(s)	Clive Doarks

5 Site Characterisation

Ant Broads and Marshes SSSI (TG 362213) consists of areas on the east and west banks of the River Ant and extends for approximately 5.5 km down the River, from the southern edge of Stalham and finishing 2 km to the north of Ludham Bridge.

The habitats on site include dykes, fen, reedbeds, carr woodland and open Broads which include Barton Broad. The water levels on the site are dependent almost entirely on river levels and the quality of the water on site is also related to varying degrees to the quality of the river water. However, water levels in the eastern half of Catfield Fen and the area surrounding Crome's Broad are controlled by the Smallburgh Internal Drainage Board.

Much of the site is managed by conservation organisations.

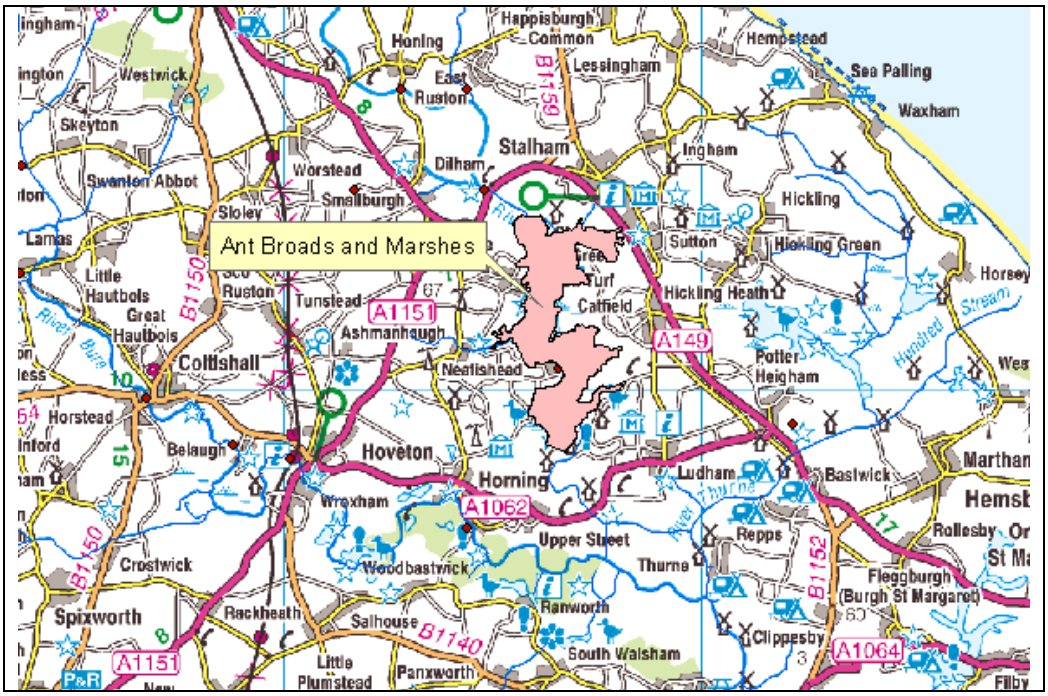

Fig. A1 Ant Broads and Marshes SSSI

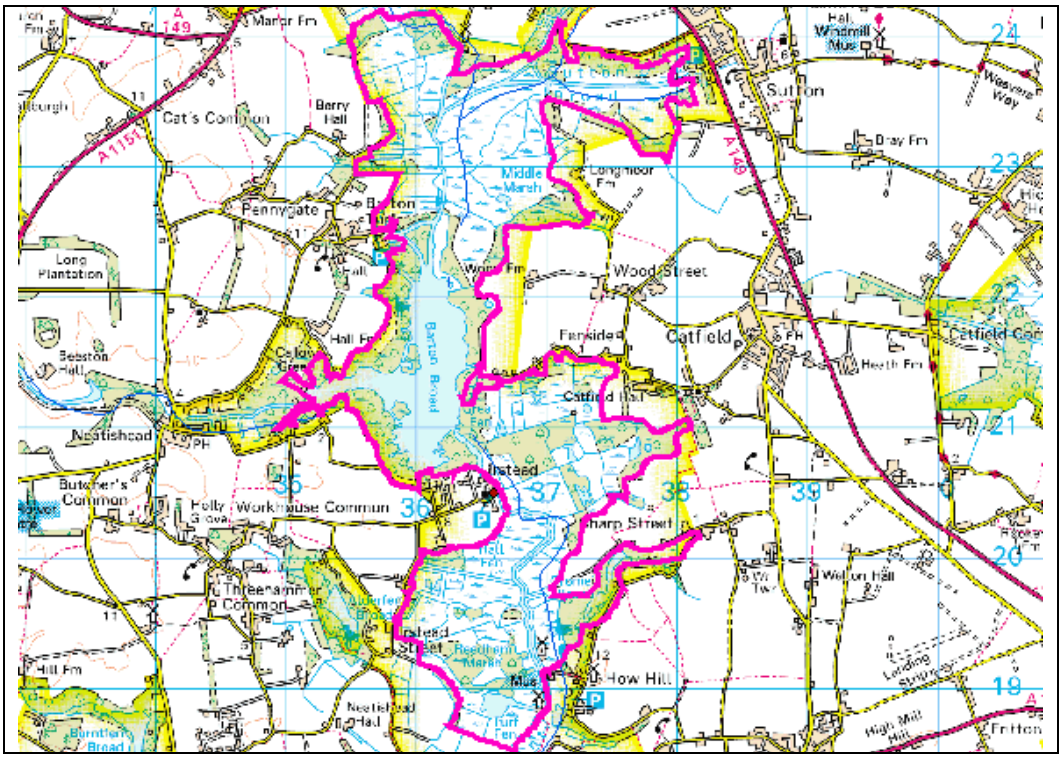

Fig A2 Ant Broads and Marshes SSSI

Summary of Issues, taken from Initial Scoping Proforma

ISSUE	FEATURES	RESPONSIBILITIES
1. Reduction in water table. Groundwater abstraction will effect a reduction in the water table below the fen communities as well as within the broads. All of the interest features have a specific freshwater requirement. However, none has a specific requirement for groundwater. Fen orchid require permanently high water levels whilst the naturally nutrient rich lakes and chara features are vulnerable to a reduction in water supply and/or quality.	Calcareous fen (S2, S24 & S25) Molinia meadows (M24, M25) Transition mires and quaking bogs (M5, M9, S27) Alluvial forests (W2, W5, W6) Hard-oligo-mesotrophic waters with Chara sp. Naturally nutrient rich lakes Fen orchid *Liparis loeselii* Otter *Lutra lutra* Desmoulins whorl snail *Vertigo moulinsiana* *A*nnex 1 species (Bittern, Marsh Harrier and Hen Harrier) Migratory species of international importance (Gadwall & Shoveler) Species that contribute to the wintering waterfowl assemblage	EA water abstraction licences will affect the freshwater inflow to the site. Part of site, Catfield Fen, is presently an AMP3 site with the whole of the Ant Broads and Marshes site included on the list of proposed sites for AMP4.
2. Flow through the site Levels within the River Ant and other watercourses heavily influence the majority of water levels within the site. A reduction of flows will cause a reduction in water quality.	As above	EA water abstraction licences (gw and sw) may reduce surface water flows into and through the site, effecting a reduction in water quality within the site.
3.Water levels within the broads Otter require good water quality to support prey; naturally nutrient rich lakes and chara features are vulnerable to a reduction in water supply and/or quality. A prolonged significant reduction in broad levels would result in a reduction in water table levels below the fen, mire and wet grassland communities which may result in a transition from the calcareous fen community to wet grassland community.	As above	A reduction in freshwater inflow (due to EA abstraction licences) to the site will result in a reduction in water levels and quality that may affect a number of the interest features.
4. Water level management IDB management	As above	IDB impact on the Crome's Broad unit. Supposedly managed with conservation objectives. Need to investigate whether this is ~~beeing~~being undertaken correctly. IDB management may encourage drainage out of the site. Other responsibilities lie with the FD function of the EA who maintain a sluice at the downstream end of the site.

5.Water quality -Floodwater Nutrients / siltation / pH / oxygen demand	Calcareous fens Naturally eutrophic lakes Hard oligo-mesotrophic lakes Otter Desmoulins	Agency – discharge consents Diffuse/agricultural land use – farms/DEFRA
6. Water quality river water – non flooding	Calcareous fens Naturally eutrophic lakes Hard oligo-mesotrophic lakes Otter Desmoulins	Agency – discharge consents Diffuse/agricultural land use – farms/MAFF
7. Water quality Navigation and recreational Boating activities has the ability to stir up the mud and hence nutrients could be re-suspended. It will have an in-combination effect with all Agency consents and diffuse sources.	As above	Non-Agency
8. Water quality (surface and groundwater quality) Landfills, transfer stations Leachate will affect groundwater and surface water quality, and therefore will potentially affect features that require good water quality, low nutrient conditions etc		There are no waste sites relevant to Ant Broads and Marshes
9. Air quality?	As above	Agency authorisations Non-consented air emissions sources such as small livestock units
10. Habitat management Inappropriate or lack of management	As above	The site is managed by Conservation organisations and therefore the risk is considered to be very low.

PART B: FUNCTIONAL ASSESSMENTS

1 Water Quality Assessment

B.1.1 Introduction

A general description of the site and a map can be found in section A of the present proforma and the Entec reports (2001 and 2005).

In general, the River Ant is only weakly tidal upstream of Ludham Bridge. Water levels in Barton Broad may rise and fall under normal tidal conditions though saline water coming up-river only rarely reaches this area. Freshwater flooding as a result of heavy rain in the area also occurs from time to time.

In common with many other Broadland sites, water quality improves (i.e. becomes less eutrophic) with distance away from the river. Near to the upland margins the water quality is commonly much better (although agricultural runoff can cause enrichment in certain areas) as is the water quality in areas not directly connected to the river.

Prior to the late 1970s, phosphate levels in the system were much higher than present day levels due to the operation of several large sewage treatment works in the catchment. Since this time, large works such as Stalham have been installed with phosphate stripping equipment which has significantly reduced phosphate loading of the system. Monitored phosphate levels still fluctuate as phosphate laid down prior to phosphate stripping is released from river/broad sediments. The mud pumping of Barton Broad is one method of removing this 'relic' phosphate from the system.

Across the majority of the site the water supply to the features is dominated by the surface water component, supplied by the river, and hence, any water level fluctuations and changes in water quality experienced by the features in the Ant Broads and Marshes are likely to originate from changes in river level and quality.

Ant Broads and Marshes is a complex site and consists of nine main hydrological areas, listed below and shown in figure B1.1:

- Reedham Marshes;
- Crome's Broad;
- Sharp Street;
- Hall Fen;
- Barton Broad (including Heater Swamp, Catfield Great and Little Fens, and Irstead Fen);
- Catfield Internal Fen (area to the east of the rond and the Ant Dyke);
- Barton Fen;
- Sutton Broad;
- Sutton Fen.

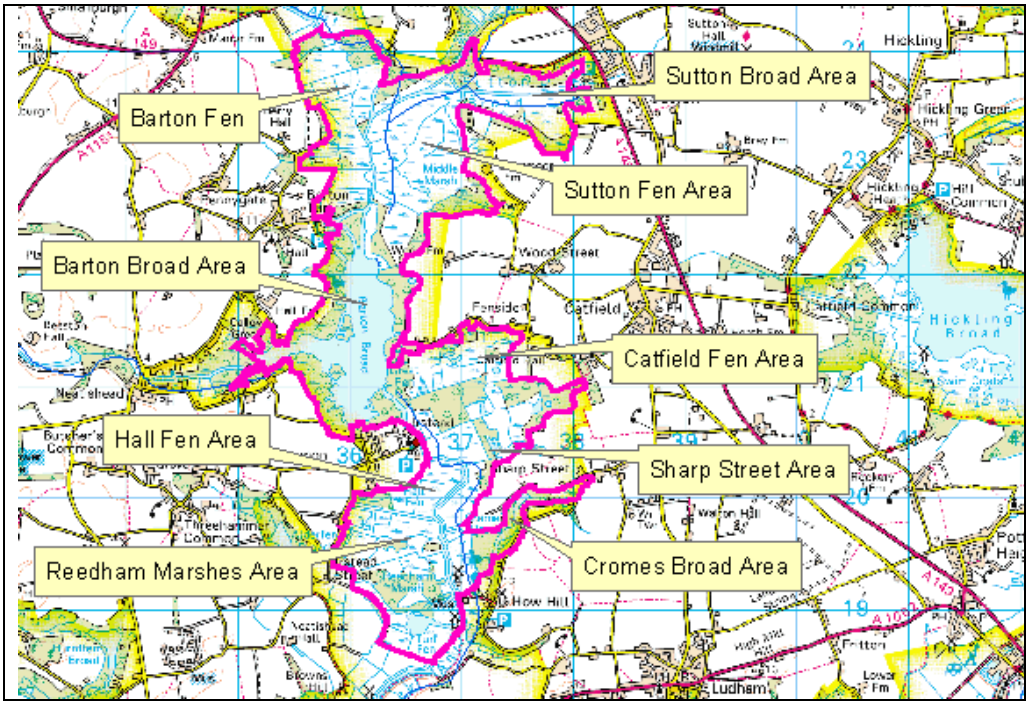

Fig B1.1 – hydrological areas of Ant Broads and Marshes SSSI

Reedham Marshes and Reedham Water

Reedham Marsh comprises undrained fen connected directly to the river. Reedham Water is a very shallow water body that is semi-isolated from the river by a series of bunds. The area also receives runoff water from the upland to the west. Water levels in this area may rise in response to higher levels in the river from IDB pumping in the upstream catchment, ~~though there~~though there are only four small IDB pumps upstream of this area, Sutton, Chapelfield, Wayford Bridge and Tonnage Bridge, and generally the water is gravitational.

Crome's Broad

Crome's Broad is a deep excavation that was originally dug for peat. The Broad has subsequently become infilled with mud and silt. The site is fed by precipitation and drainage inputs primarily, though water can enter the system from the river either by overtopping the embankment or by being let in through the sluice structures. Crome's Broad has recently been mud-pumped.

Hall Fen

Hall Fen to the north of Reedham Marshes is embanked and there is no permanent connection with the river. The embankment is frequently overtopped by river water.

Sharp Street Area

This area is semi-isolated from the river but is flooded when river levels rise due to poor condition of the river banks.

Barton Broad (including Catfield Great and Little Fens)

The main channel of the River Ant flows directly through Barton Broad. The Broad also receives runoff from the west. Catfield Great Fen also receives a surface water input from Catfield 'Internal' Fen.

Catfield Fen (area to the east of the rond and the Ant Dyke)
Catfield 'Internal' Fen is fed primarily by precipitation and drainage inputs from the upland. There is a potential for groundwater to be reaching the area either by upwelling or by throughflow being intercepted by drainage dykes. The Fen is semi-isolated from the rest of the SSSI by an impermeable rond. There is a sluice to the north which allows water to exit into Catfield Great Fen (and vice versa) and a flapped culvert to the south where the Ant Dyke flows southwards from Catfield Fen to Irstead Fen.

Barton Fen (Berry Hall Fens)
Barton Fen is embanked, with water levels controlled by the damming of the Hundred Stream that flows through the site towards the Ant. The site is fed by land drainage inputs, precipitation and by episodic flooding when the water levels in the adjacent River Ant are high.

Sutton Broad
This area is in a side arm valley of the Ant and comprises a large area of fen, swamp and water. The site covers the area of the former Sutton Broad which has been almost entirely re-vegetated with the exception of a central channel to the River Ant. The site is fed primarily by precipitation and river water (by flow either over or under the vegetation mat).

Sutton Fen
Sutton Fen is linked to the river, precipitation also provides an input. Flooding of the area occurs episodically.

B.1.2 List of features sensitive to water quality permissions from the HD Handbook

Conservation Objectives

The conservation objectives for the European interest on the SSSI are:

to maintain*, in favourable condition, the:

- Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior*.
- Calcareous fens with *Cladium mariscus* and species of the *Carex davallianae.*
- Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition*-type vegetation.
- Transition mires and quaking bogs.
- Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp..
- *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*).

to maintain*, in favourable condition, the habitats for the population of:

- Fen orchid (*Liparis loeselii*).
- Desmoulin's whorl snail (*Vertigo moulinsiana*).
- Otter (*Lutra lutra*).

to maintain*, in favourable condition, the habitats for the populations of Annex1 bird species[+] of European importance with particular reference to:

- open water
- swamp
- fen
- reedbed
- fen meadow with ditches and water bodies.

+Bittern, Marsh harrier, Hen harrier.

to maintain*, in favourable condition, the habitats for the populations of migratory bird species+ of European importance with particular reference to:

- open water
- swamp
- fen
- reedbed
- fen meadow with ditches and water bodies.

+ Gadwall and Shoveler.

to maintain*, in favourable condition, the habitats of the populations of waterfowl that contribute to the wintering waterfowl assemblage of European importance, with particular reference to,

- open water
- wet woodland
- swamp and fen
- fen meadow with ditches and water bodies.

* maintenance implies restoration if the feature is not currently in favourable condition.

B.1.3 Summary of targets

According to the favourable condition tables drawn up by English Nature the following designated SAC features have a requirement for good water quality and have specific targets:

Feature	**Target**
Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition*-type vegetation	For southern systems 0.1mg/l or below
Hard oligomesotrophic waters with benthic vegetation of *Chara* formations	For *Chara* lake 0.03 mg/l total phosphorus or below.
Otter (*Lutra lutra*)	'Good', with no pollution incidents
Desmoulin's whorl snail (*Vertigo moulinsiana*)	GQA biology class >='b' River Ecosystem classification >='RE3'

English Nature have indicated that if the site is delivering the targets for the eutrophic lakes or oligomesotrophic waters features it will be delivering the water quality targets for all the features. (Clive Doarks, Entec meeting 3.2.05).

In addition to targets in the Favourable Condition Tables, targets for SAC and SPA lakes have been given in WQTAG111c 'Guidance on the assessment of Phosphorus in SAC/SPA Lakes under the Review of Consents'. The target for SAC lakes in the Broads is 0.05mg/l P. The target of 0.1 mg/l however remains where the natural eutrophic feature consists of ditches/dykes. The target for SPA lakes is 0.1mg/l P.

The eutrophic lakes features are Barton Broad and dykes throughout the site. Two turf ~~ponds in~~ponds in Catfield Fen comprise the oligo-mesotrophic feature, these ~~ponds are~~ponds are isolated from the river under normal conditions. Dykes and open areas of water are considered to provide the habitats for otters. Desmoulins whorl snail has been recorded along dykes in the north of the site. The areas of open water, fen and drains are the habitats of value to the SPA interest features, with Crome's Broad and Reedham Water identified as particular importance to SPA birds

Eutrophic waters
Eutrophic standing waters are highly productive because plant nutrients are plentiful, either naturally or as a result of artificial enrichment. These water bodies are characterised by having a diverse and luxuriant growth of pondweeds.

Oligomesotrophic waters
Oligomesotrophic lakes are characterised by having a narrow range of nutrients, the main indicative ones being inorganic nitrogen and total phosphorus, with virtually all available nutrients `locked up` in algae during the growing season. Mesotrophic lakes potentially have the highest macrophyte diversity of any lake type and contain a high proportion of nationally scarce and rare aquatic plants and animals.

Alluvial forest
These woodlands occur on a range of soil types. They are an important habitat for a number of priority species including otter.

Fens and Molinia meadows
Other "wet" SAC features such as *Molinia* meadows do not have water quality mentioned in their favourable condition tables. However, it is realised they will also be susceptible to the effects of excessive nutrient enrichment and will be considered in a similar way to those features listed above under the Review of Consents.

There is currently little information available to suggest which factors influencing fen communities could be related to point source discharges. Harding (1999) reviewed some published work on nutrients and other factors affecting fen communities and concluded that either nitrogen or phosphorus could be the controlling nutrient. Wheeler and Shaw (2000) looked specifically at Redgrave and Lopham Fens and although concluding that they are particularly liable to enrichment from agricultural activities within the catchment, found less evidence that this was actually occurring. They did not provide any nutrient targets for the plant communities, although they suggested that phosphorus is more important than nitrogen.

SPA features
SPA features requiring wet habitats require suitable conditions for proliferation of plant or animal food sources. Although no specific water quality requirements are listed in the favourable condition tables, it is understood that good water quality will be necessary for many of the plant and animal communities supporting the SPA features. Where these are supported by SAC features with identified nutrient requirements protection of the SAC feature will automatically protect the SPA feature. For the Broads that have been identified by EN as of importance to SPA birds a target of 0.1mg/l P will be used.

B.1.4 Discussion of permissions: Discharges put forward to Stage 3 of the RoC

123 discharge consents were brought forward from stage 2. In addition PR4NF751X which was originally thought to be in the Bure catchment has now been identified as in the Ant catchment and will now be added to this list. These consents include all from the River Ant catchment upstream and downstream of the site which have the potential of affecting the site. The list of consents was put together using precautionary principles and in the absence of detailed guidance. Guidance is now available as part of Appendix 3 of the Habitats Directive Handbook and WQ TAG papers and will be used in sections B.1.4.1 to B.1.4.4 below to carry out further screening on the list of consents. Consents in the re-screened list will be assessed in sections B.1.4.5 onwards.

The Habitats Directive Handbook identifies possible hazards for this type of site as changes to thermal regime, salinity or pH, physical damage, siltation, toxic contamination and nutrient enrichment. There are no discharges in the stage 2 list that are expected to alter the thermal regime, or pH; or lead to ~~physical damage~~physical damage or siltation; or discharge sodium chloride. Toxic contamination and nutrient enrichment will be considered, as effluents may contain toxic substances and are a major source of phosphate.

B.1.4.1 Discharges to land
38 consents to discharge to land were brought forward from Stage 2 of the Review of Consents. PR4LF127 and PR4LF1560 have been identified as revoked, all others are shown in table B1 below and plotted in fig B1.2.

Table B1.1: Discharges to land.

Number	Type/Receiving water	Volume. m3/d	NGR
PRELF1463	land	3*	TG3295025000
PR4LF11	soakaway	1*	TG3320025100
PR4LF112	Soakaway	1*	TG3050028300
PR4LF1183	Soakaway	1*	TG3320024700
PR4LF1240	soakaway	1*	TG3270023400
PR4LF126	Soakaway	1*	TG3300027700
PR4LF176	Soakaway	1*	TG3580019500
PR4LF2053	soakaway	1*	TG3070031500
PR4LF236	Soakaway	1*	TG3470020300
PR4LF245	Soakaway	1*	TG3480022800
PR4LF248	Soakaway	1*	TG3320027200

PR4LF286	Soakaway	1*	TG3530018700
PR4LF290	Soakaway	1*	TG2980027200
PR4LF311	Soakaway	1*	TG3340024500
PR4LF333	soakaway	1*	TG2860032200
PR4LF479	soakaway	1*	TG3890022600
PR4LF541	Soakaway	1*	TG3180027000
PR4LF576	Soakaway	1*	TG3450031700
PR4LF619	Soakaway	1*	TG3490022700
PR4LF710	soakaway	1*	TG2960030300
PR4LF82549	land	1*	TG3420021000
PR4LF83571	land	1*	TG3490028100
PR4LF83630	land	1*	TG3280020000
PR4LF84430	land	1*	TG3650030600
PR4LF97	Soakaway	1*	TG3440023700
PRELF1035	land	1*	TG3466027170
PRELF119	land	1*	TG3459028270
PRELF189	land	1*	TG3452028150
PRELF191	land	1*	TG3452028150
PRELF3063	land	1*	TG3011029410
PRELF3706	land	1*	TG3296027800
PRELF372	land	1*	TG3486022820
PRELF784	land	1*	TG2984031580
PR4LF79796	land	<5*	TG3560027300
PRELF3180	land	1*	TG3263027490
PRELF3524	land	1*	TG2965025500

***Maximum daily flow**

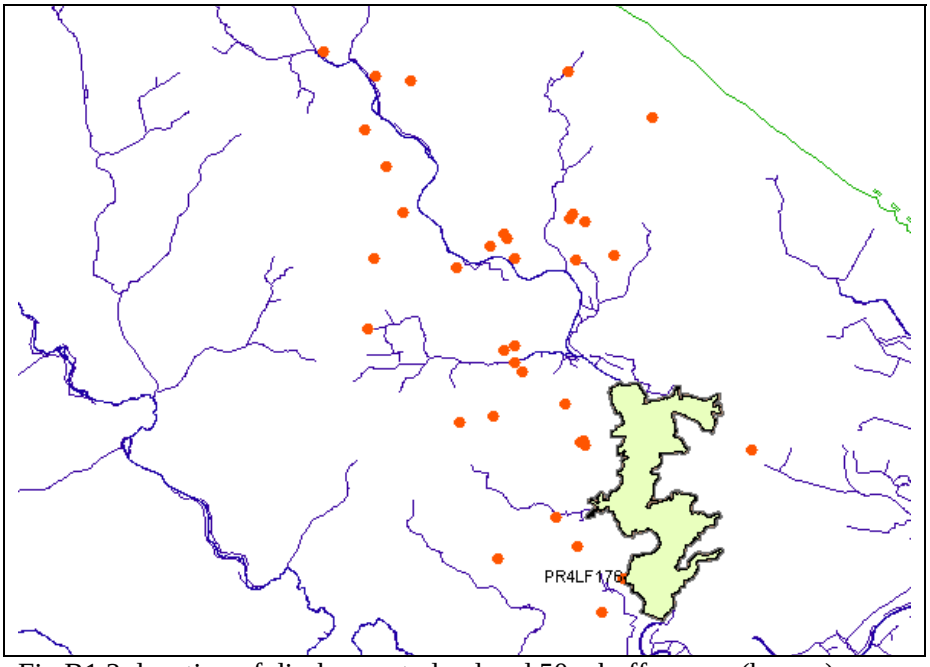

Fig B1.2: location of discharges to land and 50m buffer zone (brown)

The Water Quality TAG paper "Policy on Habitats Regulations 48 and 50 for Small Discharges to Ground (WQTAG060e)" states that:

> "Small domestic discharges to ground' – i.e. discharges of less than $5m^3$/day of domestic effluent to ground will not normally be considered as having a likely significant effect under Regulation 48 of the Habitats Regulations, provided they are more than 50m from a Natura 2000 site."

As can be seen in Figures B1.1 and Table B1.1 above, all discharge points except for PR4LF176 are further than 50m from the site and are less than 5 m^3/day. Therefore all consents to discharge to land (except for PR4LF176) shown in table B1.1 above will not cause an adverse impact on the interest features of Ant Broads and Marshes SSSI alone or in combination under the above guidance.

PR4LF176 will be taken forward to section B.1.4.5 onwards for further assessment with the other discharges

All current discharges to land shown in Table B1, except PR4LF176, will be affirmed at stage 4

B.1.4.2 Discharges to Water

The River Ant and tributaries are directly linked to the site at many points, and additional areas of the site are affected by flooding therefore discharges into these watercourses need to be considered as they have a potential to impact on the interest features of the site.

The discharges to water are shown in tables B1.2 (private) and B1.5 (Water Company) and discussed below.

B.1.4.3 Private discharges to water

65 private discharges have been brought forward from stage 2 (plus PR4NF751X). PR4NF1112X and PR4NF571 have been identified as being revoked. All others are shown in table B1.2 below and plotted in fig B1.3.

Table B1.2: private discharges to water

Number	Type/Receiving water	Volume. m3/d	NGR
PR4NF660X	Sewage effluent/trib R Ant	2046*	TG2990025200
PR4NF751X	sewage effluent/trib R Ant	23*	TG3000020000
PRENF3708	Sewage effluent/N Walsham	5.8*	TG3437027360
PR4NF270	Sewage effluent/trib R Ant	15*	TG3410029700
PR4NF1560	Sewage effluent/trib R Ant	10*	TG3187023270
PR4NF568	Sewage effluent/trib R Ant	10*	TG3270027600
PRENF327	Sewage effluent/trib R Ant	8*	TG3543032000
PR4NF1446	Sewage effluent/land	6*	TG3480021400
PR4NF1682	Trib River Ant	5*	TG3820024600
PRENF2562	Trib Dilhan Canal	5*	TG3030029250
PRETF8563	River Ant	5*	TG3482024830
PR4NF2084	Trib River Ant	4*	TG2580033900

PR4NF284	Trib River Ant	4*	TG3302024600
PRENF127	Trib Dilham Canal	4*	TG3228026420
PR4NF162	Limekiln Dyke River Ant	3*	TG3442021090
PRENF63	Trib River Ant	3*	TG3439020130
PRENF755	Trib River Ant	3*	TG3306027710
PR4NF1084	Trib River Ant	2*	TG3482027660
PR4NF1095X	Trib River Ant	2*	TG3520019100
PR4NF1871	Trib River Ant	2*	TG3270027500
PR4NF1952	Trib River Ant	2*	TG2870031900
PR4NF309	Limekiln Dyke Barton Broad	2*	TG3230021000
PR4NF426	Limekiln Dyke	2*	TG3442021090
PR4NF678X	Trib River Ant	2*	TG3110029700
PR4NF886	Trib River Ant	2*	TG2720031600
PR4NF913	Trib River Ant	2*	TG3640026300
PRENF10334	Trib River Ant	2*	TG3675026250
PRENF10863	a ditch in the catchment	2*	TG3060028400
PRENF11334	tributary North Walsham &	2*	TG3300026700
PRENF11640	Trib River Ant	2*	TM3420020180
PRENF11669	limekiln dyke	2*	TG3437021020
PRENF2238	Trib North Walsham & Dilh	2*	TG3340027270
PRENF3426	Trib Dilham Canal	2*	TG3295026650
PRENF8736	Trib River Ant	2*	TG2962025880
PRENF8857	Trib River Ant	2*	TG3261027660
PR4NF1657	Unknown Trib River Ant	1*	TG2711033480
PR4NF1966	Trib River Ant	1*	TG3260027600
PR4NF1976	Trib River Ant	1*	TG3430021000
PR4NF1978	Trib River Ant	1*	TG2730033500
PRENF10135	Trib River Ant	1*	TG3150027400
PRENF10136	Trib River Ant	1*	TG3455024180
PRENF10224	Trib River Ant	1*	TG3000028500
PRENF10379	North Walsham & Dilham Canal	1*	TG3000030650
PRENF10617	tributary North Walsham & Dilham Canal	1*	TG3141027400
PRENF10854	Trib River Ant	1*	TG3409021110
PRENF11408	Trib River Ant	1*	TG3450024220
PRENF11750	north walsham & dilham canal	1*	TG3300027700
PRENF11812	Trib River Ant	1*	TG3320025300
PRENF11813	Trib River Ant	1*	TG3320025301
PRENF13199	barton broad	1*	TG3500021310
PRENF13371	tributary hickling broad	1*	TG3392022120
PRENF152	Trib Dilham Canal	1*	TG3269027680
PRENF1534	Trib River Ant	1*	TG3154027330
PRENF155	Trib Dilham Canal	1*	TG3269027680
PRENF179	Trib River Ant	1*	TG3428020940
PRENF180	Trib River Ant	1*	TG3428020940
PRENF209	Trib Smallburgh Stream	1*	TG3285024450
PRENF220	Trib River Ant	1*	TG3262027600
PRENF4089	Trib River Ant	1*	TG3432020180
PRENF8347	Trib River Ant	1*	TG3392024090
PRENF8468	Trib River Ant	1*	TG3273024800

PRENF8714	Trib River Ant	1*	TG3411021090
PRENF952	Trib River Ant	1*	TG3480030180
PR4NF756	TE to land	0.22*	TG2870030400

*Maximum daily flow/**Dry weather flow

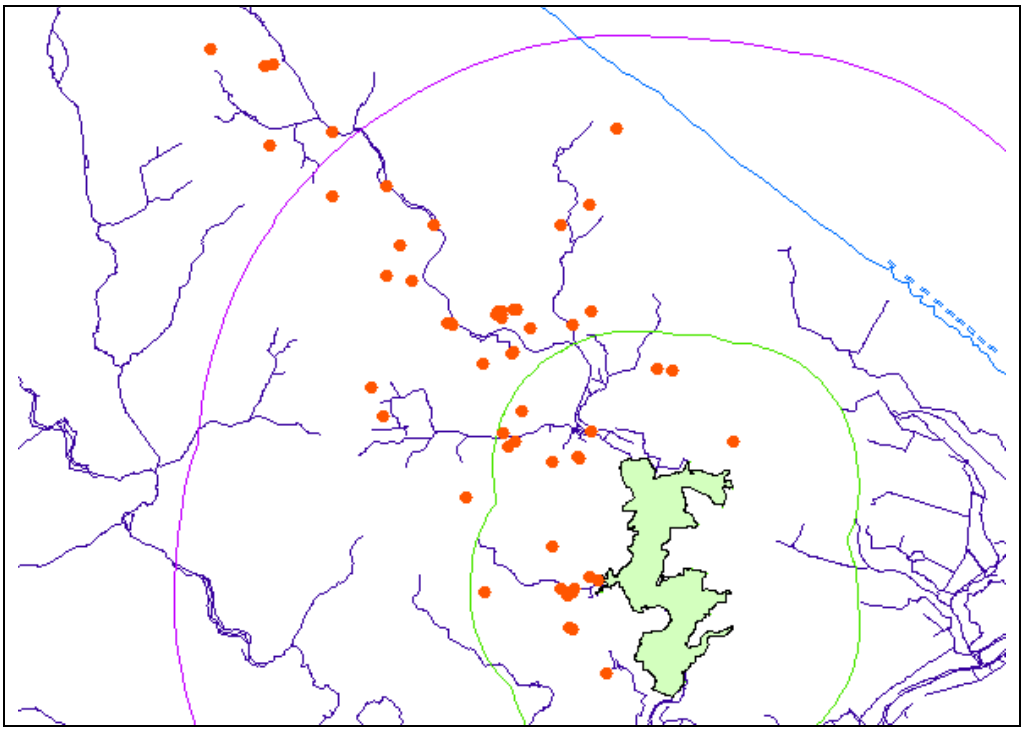

Fig B1.3 location of private discharges to water – all shown, with 3km and 10 km buffer zones

The following screening criteria –from Habitats Directive: Work Instruction: (Appendix 3) can be applied, to identify which discharges are likely to have an impact on the site and require assessment:

Discharges to assess -

- Within site - all discharges
- Within 3 km - all discharges
- Within 10km - all sewage or trade discharge greater than 5 m^3/day
- Within 50 km - all discharges in Bands A and B and all discharges greater than 1000 m^3/day.

Beyond 50 km - there may be special cases to take into account but generally discount discharges beyond this distance

Content bands A or B of the Environment Agency's scheme of "Charges for Discharges" indicates that they are higher risk discharges containing dangerous substances. None in table B1.2 above are in content bands A or B, though PR4NF660X is liable to have dangerous substances (pesticides) present in the effluent.

Therefore within the site and within 3km of the site all discharges are required to be assessed – these 28 are shown in table B1.3 below:

Table B1.3: private discharges to water within 3km buffer zone

Number	Type/Receiving water	Volume. m3/d	NGR
PR4NF751X	sewage effluent/trib R Ant	23*	TG3000020000
PR4NF1446	Sewage effluent/land	6*	TG3480021400
PR4NF1682	Trib River Ant	5*	TG3820024600
PRETF8563	River Ant	5*	TG3482024830
PR4NF284	Trib River Ant	4*	TG3302024600
PR4NF162	Limekiln Dyke River Ant	3*	TG3442021090
PRENF63	Trib River Ant	3*	TG3439020130
PR4NF1095X	Trib River Ant	2*	TG3520019100
PR4NF309	Limekiln Dyke Barton Broad	2*	TG3230021000
PR4NF426	Limekiln Dyke	2*	TG3442021090
PR4NF913	Trib River Ant	2*	TG3640026300
PRENF10334	Trib River Ant	2*	TG3675026250
PRENF11669	limekiln dyke	2*	TG3437021020
PR4NF1976	Trib River Ant	1*	TG3430021000
PRENF10136	Trib River Ant	1*	TG3455024180
PRENF10854	Trib River Ant	1*	TG3409021110
PRENF11408	Trib River Ant	1*	TG3450024220
PRENF11812	Trib River Ant	1*	TG3320025300
PRENF11813	Trib River Ant	1*	TG3320025301
PRENF13199	barton broad	1*	TG3500021310
PRENF13371	tributary hickling broad	1*	TG3392022120
PRENF179	Trib River Ant	1*	TG3428020940
PRENF180	Trib River Ant	1*	TG3428020940
PRENF209	Trib Smallburgh Stream	1*	TG3285024450
PRENF4089	Trib River Ant	1*	TG3432020180
PRENF8347	Trib River Ant	1*	TG3392024090
PRENF8468	Trib River Ant	1*	TG3273024800
PRENF8714	Trib River Ant	1*	TG3411021090

Between 3km – 10km all sewage or trade discharge greater than 5 m^3/day or any in band A and B. In this distance criteria there were 6 additional discharges of greater than 5 m^3/day and none in bands A or B:

Table B1.4: private discharges to water additional within 10km buffer zone

Number	**Type/receiving**	**Volume m^3/day**	**NGR**
PR4NF660X	TE/Trib River Ant	2046*	TG2990025200
PRENF3708	Sewage effluent/N Walsham	5.8*	TG3437027360
PR4NF270	Sewage effluent/trib River Ant	15*	TG3410029700
PR4NF1560	Sewage effluent/trib R Ant	10*	TG3187023270
PR4NF568	Sewage effluent/trib R Ant	10*	TG3270027600
PRENF327	Sewage effluent/trib River Ant	8*	TG3543032000

Between 10-50km sewage or trade discharge greater than 1000 m^3/day or any in band A and B. In this distance criteria there were no additional discharge of greater than 1000 m^3/day and none in Bands A or B:

There are no discharges greater than 50km away so no further assessments to be carried out here.

Therefore current private discharges to water other than those in tables B1.3 and B1.4 above will be affirmed at stage 4

B.1.4.4 Water company discharges to water

20 water company discharges have been brought forward from stage 2. AW4NF41, AW4NF41X, AW4NF174X, AW4NF521X and AW4NF868 have been identified as revoked, the remainder are listed in table B1.5 below and plotted in fig B1.4.

Table B1.5 – water company discharges to water

Number	**Type/Receiving water**	**Volume m^3/day**	**NGR**
AEENF1312	Sewage effluent/R Ant	6618*	TG3585025130
AEENF2011	TE/East Ruston Marsh	65*	TG3410027900
AEENF12002	Sewage effluent/Hundred stream	45*	TG3389027870
AW4NF704X	TE/Richam Canal	34*	TG2900031000
AEENF1202	Sewage effluent/Foxes beck	160**	TG2654034850
AW4NF807	Sewage effluent/trib Ant	330**	TG3560017900
AWENF103	Sewage effluent	9*	TG3461030770
AW4NF637X	Sewage effluent/trib Ant	15**	TG3300024500
AW4NF1082X	Sewage effluent/ditch to R Ant	6*	TG3280027700
AW4NF1091X	Sewage effluent/trib Smallburgh wc	9**	TG3010024600
AW4NF12216	PS		TG3725024740
AEENF12104	CSO		TG2913030770
AEENF2454	PS		TG2960030800
AW4NF937X	SPS		TG2950030800
AEENF2474	PS		TG3720024700

*****Maximum daily flow/**Dry weather flow

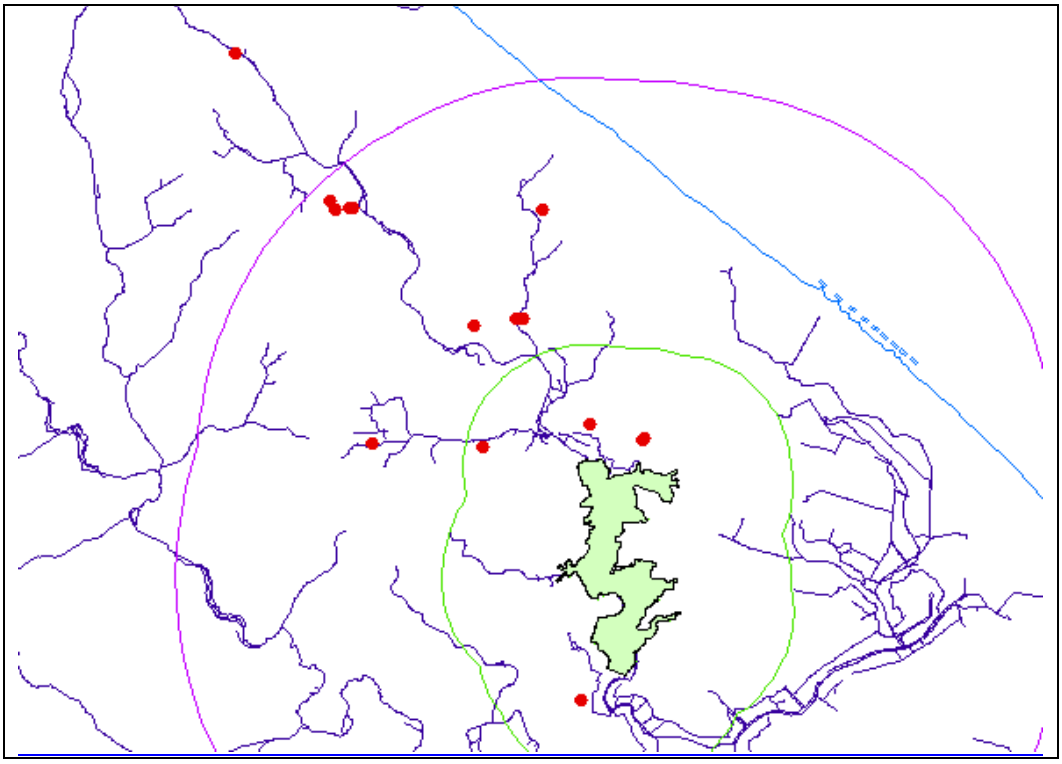

Figure B1.4 water company discharges with 3 and 10 km buffers

Intermittent discharges have been screened out using the approach outlined in WQ TAG papers "WQTAG36c Intermittent (Combined Sewer Overflows/Storm Tank) discharges and RoC" and "WQTAG058b Consideration of Emergency Discharges under the Habitats Directive".

These papers recommend checking that the discharges have not been identified as unsatisfactory during the AMP process, and that they do not operate frequently, and if these criteria are met then screening them out because by their nature and frequency of discharge they represent a low risk to the environment.

The intermittent discharges in table B1.4 above have not been identified as unsatisfactory and requiring work under AMP4. Records have been checked back to 2000 and these discharges have not operated, except for one at Main road in Stalham. This did operate in 2002, work has since been carried out and there have been no records of it operating since then~~.~~. Therefore these discharges will not cause an adverse impact on the interest features of the Ant Broads and Marshes SSSI alone or in combination under the above guidance.

There have been issues at Sutton where an AMP scheme has been ~~identified~~identified. A consent for a new CSO here was not agreed with and the water company is instead working on removing surface water from the foul system which will prevent backing up and overflowing.

Therefore the intermittent discharges AEENF12104, AEENF2454, AW4NF12216, AEENF2474 and AW4NF937X will be affirmed at stage 4.

For the non intermittent discharges the screening criteria from Habitats Directive: Work Instruction (Appendix 3) used above for private discharges can be applied.

Therefore within the site and within 3km of the site all discharges are required to be assessed – these are shown in table B6 below (AEENF1312 is in band B):

Table B1.6: water company discharges to water within 3km buffer zone

Number	**Type/receiving**	**Volume m^3/day**	**NGR**
AEENF1312	Sewage effluent/R Ant	6618*	TG3585025130
AW4NF637X	Sewage effluent/trib R Ant	15**	TG3300024500
AW4NF807	Sewage effluent/trib Ant	330**	TG3560017900

*****Maximum daily flow/**Dry weather flow

Between 3 – 10km all sewage or trade discharge greater than 5 m^3/day or any in band A and B. In this distance criteria there were 5 additional discharges of greater than 5 m^3/day, none in bands A or B:

Table B1.7: water company discharges to water additional within 10km buffer zone

Number	**Type/receiving**	**Volume m^3/day**	**NGR**
AW4NF704X	TE/Richam Canal	34*	TG2900031000
AW4NF1091X	Sewage effluent/trib smallburgh wc	9**	TG3010024600
AEENF2011	TE/East Ruston Marsh	65*	TG3410027900
AEENF12002	Sewage effluent/Hundred stream	45*	TG3389027870
AW4NF1082X	Sewage effluent/ditch to R Ant	6*	TG3280027700
AWENF103	Sewage effluent	9*	TG3461030770

Between 10-50km sewage or trade discharge greater than 1000 m^3/day or any in band A and B. In this distance criteria there were no additional discharge of greater than 1000 m^3/day and none additional in bands A or B.

There are no discharges greater than 50km away so no further assessments need to be carried out here.

Therefore AEENF1202 will be affirmed at stage 4

B.1.4.5 Discharges remaining after screening carried out in B.1.4.3 and B.1.4.4

As a result of screening carries out in B.1.4.3 and B.1.4.4 above the following discharges shown in Table B1.8 are carried forward to be assessed and shown in fig B1.5.

Table B1.8: consents remaining after re-screening

Number	Type/Receiving water	Volume. m3/d	NGR
PR4NF751X	sewage effluent/trib R Ant	23*	TG3000020000
PR4NF1446	Sewage effluent/land	6*	TG3480021400
PR4NF1682	Trib River Ant	5*	TG3820024600

PRETF8563	River Ant	5*	TG3482024830
PR4NF284	Trib River Ant	4*	TG3302024600
PR4NF162	Limekiln Dyke River Ant	3*	TG3442021090
PRENF63	Trib River Ant	3*	TG3439020130
PR4NF1095X	Trib River Ant	2*	TG3520019100
PR4NF309	Limekiln Dyke Barton Broad	2*	TG3230021000
PR4NF426	Limekiln Dyke	2*	TG3442021090
PR4NF913	Trib River Ant	2*	TG3640026300
PRENF10334	Trib River Ant	2*	TG3675026250
PRENF11669	Limekiln dyke	2*	TG3437021020
PR4NF1976	Trib River Ant	1*	TG3430021000
PRENF10136	Trib River Ant	1*	TG3455024180
PRENF10854	Trib River Ant	1*	TG3409021110
PRENF11408	Trib River Ant	1*	TG3450024220
PRENF11812	Trib River Ant	1*	TG3320025300
PRENF11813	Trib River Ant	1*	TG3320025301
PRENF13199	Barton broad	1*	TG3500021310
PRENF13371	Tributary hickling broad	1*	TG3392022120
PRENF179	Trib River Ant	1*	TG3428020940
PRENF180	Trib River Ant	1*	TG3428020940
PRENF209	Trib Smallburgh Stream	1*	TG3285024450
PRENF4089	Trib River Ant	1*	TG3432020180
PRENF8347	Trib River Ant	1*	TG3392024090
PRENF8468	Trib River Ant	1*	TG3273024800
PRENF8714	Trib River Ant	1*	TG3411021090
PR4NF660X	TE/Trib River Ant	2046*	TG2990025200
PRENF3708	Sewage effluent/N Walsham	5.8*	TG3437027360
PR4NF270	Sewage effluent/trib River Ant	15*	TG3410029700
PR4NF1560	Sewage effluent/trib R Ant	10*	TG3187023270
PR4NF568	Sewage effluent/trib R Ant	10*	TG3270027600
PRENF327	Sewage effluent/trib River Ant	8*	TG3543032000
AEENF1312	Sewage effluent/R Ant	6618*	TG3585025130
AW4NF637X	Sewage effluent/trib R Ant	15**	TG3300024500
AW4NF807	Sewage effluent/trib Ant	330**	TG3560017900
AW4NF704X	TE/Richam Canal	34*	TG2900031000
AW4NF1091X	Sewage effluent/trib smallburgh wc	9**	TG3010024600
AEENF2011	TE/East Ruston Marsh	65*	TG3410027900
AEENF12002	Sewage effluent/Hundred stream	45*	TG3389027870
AW4NF1082X	Sewage effluent/ditch to R Ant	6*	TG3280027700
PR4LF176	Soakaway	1*	TG3580019500
AWENF103	Sewage effluent	9*	TG3461030770

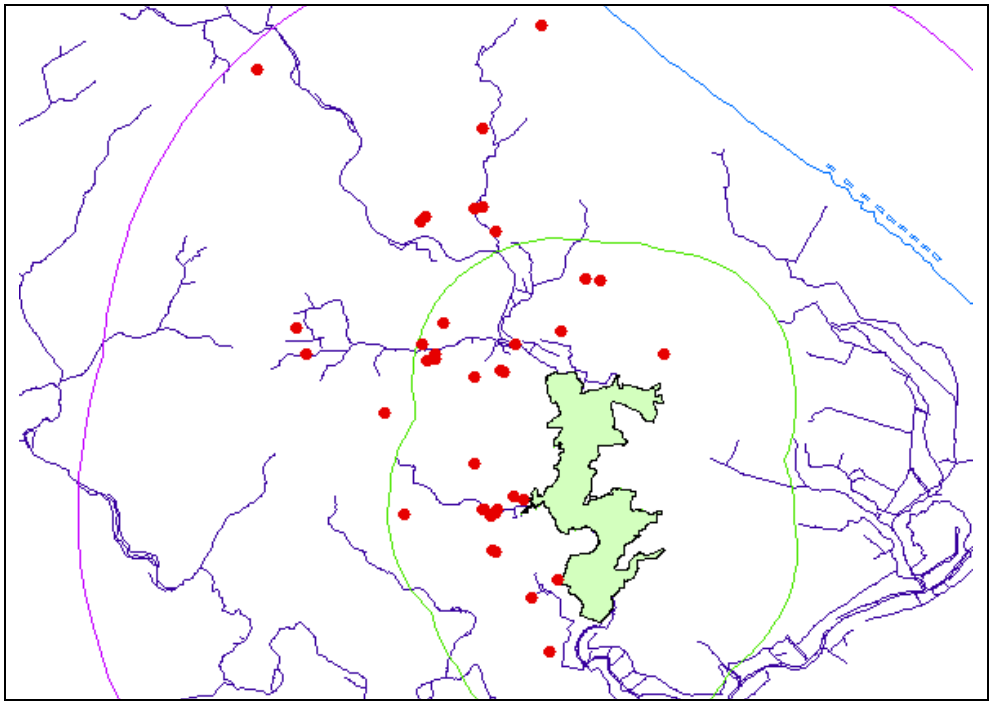

Fig B1.5 remaining discharge consents for assessment

Consent PR4NF660X appears in the above list and original list from stage 2, however this consent has been assessed previously under Regulation 48 (appendix 12) so will not be assessed here again in section B1.5, only in-combination with other discharges in section B1.6.3 and B1.7

B.1.5 Current results

The location of routine sample points in or near Ant Broads and Marshes SSSI is shown in figure B1.6

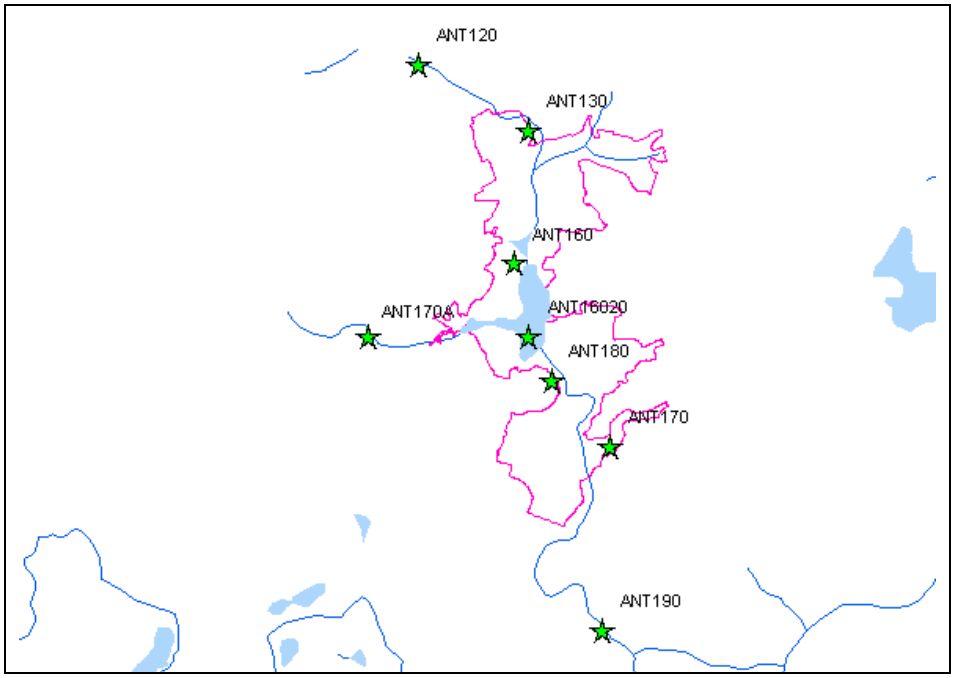

Fig B1.6 – location of sample points

B.1.5.1 Toxic substances

The discharge in table B1.8 which is in band B (there were none in band A) is AEENF1312 (Stalham STW), this was checked to see if it had failed its consent conditions over the past year, it had not.

There are two sample points on the River Ant at Irstead (ANT180) and Ludham (ANT190) which are tested for a wide range of substances including some pesticides. Results from these sites, over a 3 year period, for all toxic substances tested are shown in appendix B1.2 attached. There were no exceedences of EQSs over this time period.

There are routine monitoring points on the River Ant that are sampled for many substances for the Dangerous Substances and Surface Water Abstraction Directives. Reports show that there were no failures for any substances sampled for in these directives on the River Ant in 2004.

Therefore the consents remaining after screening will have no toxic impact on the interest features of the Ant Broads and Marshes SSSI.

B.1.5.2 routine water quality and nutrient results

The Environment Agency's method for classifying the water quality of rivers and canals is known as the General Quality Assessment scheme (GQA). It is designed to provide an accurate and consistent assessment of the state of water quality using measures of Biochemical Oxygen Demand (BOD), Dissolved Oxygen (DO), Ammonia and river invertebrates. The scheme allocates one of six grades A to F indicating 'very good' to 'bad' for chemical and biological water quality to each stretch of river.

The River Ecosystem (RE) Classification comprises five classes in order of decreasing quality that are used as planned targets for water quality. RE1 is defined as "water of very good quality and suitable for all fish species" and RE5 as "water of poor quality which is likely to limit coarse fish

populations". River samples collected are checked against the standards associated with the appropriate RE target. The standards include those for Ammonia, BOD, DO, pH and some metals.

Water quality results are available at 7 of the points shown in figure B1.8 above. These are the River Ant at Wayford Bridge (ANT120), Hunsett Mill (ANT130) and Irstead (ANT180); Barton Broad (ANT160) and the outflow (ANT16020); Cromes Broad (ANT170), and the Neatishead Stream tributary (ANT170A).

Table B1.9 – water quality results

Site	**Total Phosphate Result (mg/l)**		
	2003	**2004**	**2005**
ANT120 (Ant upstream of site)	0.056	0.047	0.040
ANT130 (Ant at upstream edge of site)	0.078	0.047	0.044
ANT160 (Barton Broad)	0.074	0.064	0.037
ANT16020 (Barton Broad outflow)	0.075	0.072	0.039
ANT170 (Cromes Broad)	0.186	0.130	0.077
ANT170A (Neatishead Stream tributary)	0.148	0.171	0.087

	Biological GQA	**Chemical GQA**	**River Ecosystem class**	**Number of pollution incidents**
ANT180 (Ant within site)	B	C	RE3	One incident in river in 2004, of oil, categorised as of minimal impact.

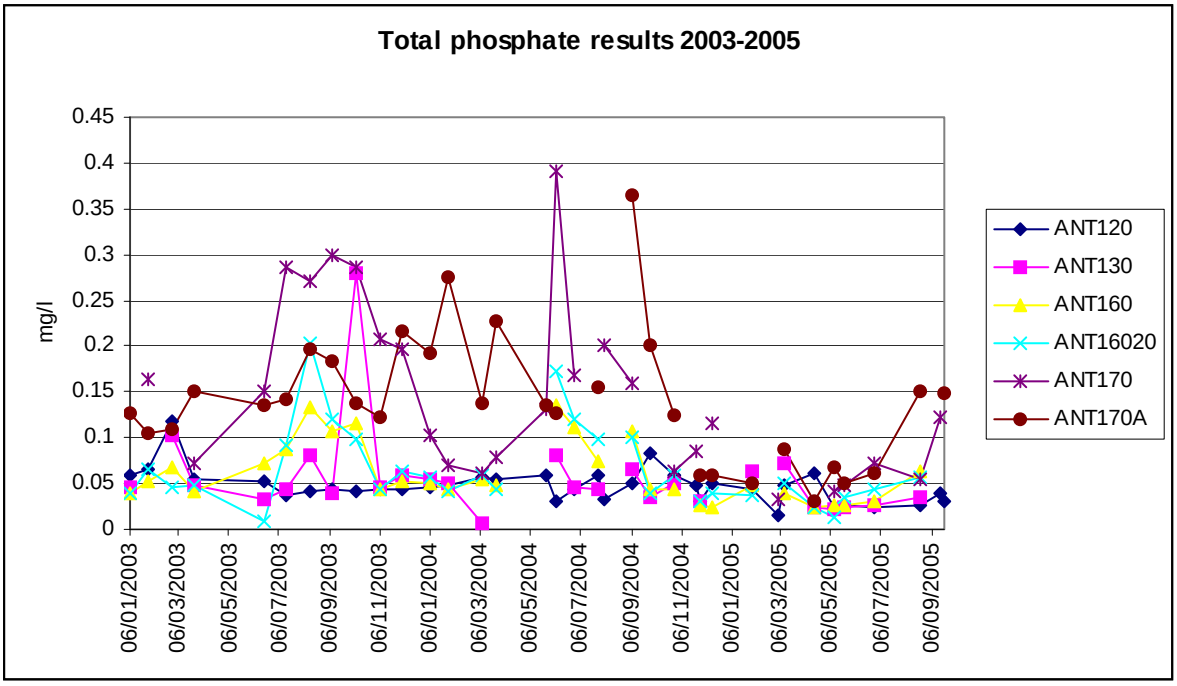

Fig B1.7 – phosphate results

The GQA point at ANT180 represents the stretch of the River Ant throughout the Ant Broads and Marshes SSSI. The river at this point complies with the targets for otters and Desmoulins whorl snail. The RE target for this stretch of watercourse is class RE3 and it is compliant with this. Compliance with the RE3 standards should ensure that no adverse effect will occur to the site's European features during flooding episodes. RE3 indicates water of fair quality and suitable for high class coarse fish populations.

There are total phosphate results from several points upstream and within the Ant Broads and Marshes including Barton Broad which is designated as a natural eutrophic SAC lake, and Crome's Broad an SPA lake. Most of the site is linked to the ~~watercourses ,including~~watercourses, including Barton Broad and many dykes designated as natural eutrophic lakes, ~~therefore results~~therefore results from the watercourses will give a good indication of results in eutrophic designated features within the site itself.

Results show that the results from the River Ant and from Barton Broad comply with the total phosphate target of up to 0.1 mg/l P for eutrophic waters from the FCT. The SAC lake target of 0.05 mg/l has been complied with in Barton Broad and the River Ant in 2005 but not in years prior to 2005.

Cromes Broad has complied with the SPA lake target in 2005 but not in years prior to this.

None of the results comply with the oligomesotrophic target of up to 0.03mg/l total phosphate.

Further investigation has been carried out to look at ecological status of the broads using Water Framework Directive methodology (work in progress). A summary of the results is shown below in table B1.10.

Table B1.10 - ecological status results for Barton Broad and Cromes Broad

Site	Status according to macrophytes	Status according to phytoplankton	Status according to transparency	Status according to phosphorus	Overall status and comments
Barton Broad	Poor	Moderate	Moderate	Moderate	Plankton biomass and transparency indicate impact and Moderate status. Macrophytes clearly indicate impact. Site subject to P removal for 25 years, showing signs of recovery and both P and Chlorophyll are clearly improving. Conclude an adverse impact, but suggest site is recovering.
Cromes Broad	Poor	Poor	Moderate	Moderate	P target exceeded. Poor status

Connectivity and results

Most of the site is linked to the River Ant and other watercourses, including Barton Broad and many dykes which are designated as natural eutrophic lakes. Therefore the eutrophic lakes feature in dykes on the site will comply with the target as they are linked to the River. The River also frequently overtops the banks into the site as shown in figure B1.8 below, and this water will enter the eutrophic

lake feature in any isolated ponds. The Entec report (2005) states that in general the water quality in the dykes improves with distance away from the river. So using the results in the river to indicate results in the dykes will tend to be a precautionary view.

The oligomesotrophic water feature is in turf ponds on the site which are generally isolated from the watercourses. However water exchange with the external system is possible via sluices and the River frequently overtop the banks into the site and so this feature will be affected by the quality of water in the river also.

Therefore discharges entering the watercourses need to be considered as to their nutrient input, as they affect the nutrient quality of water in features on the site, and modelling is required to assess if the natural eutrophic target in watercourses and dykes will still be met under fully consented conditions.

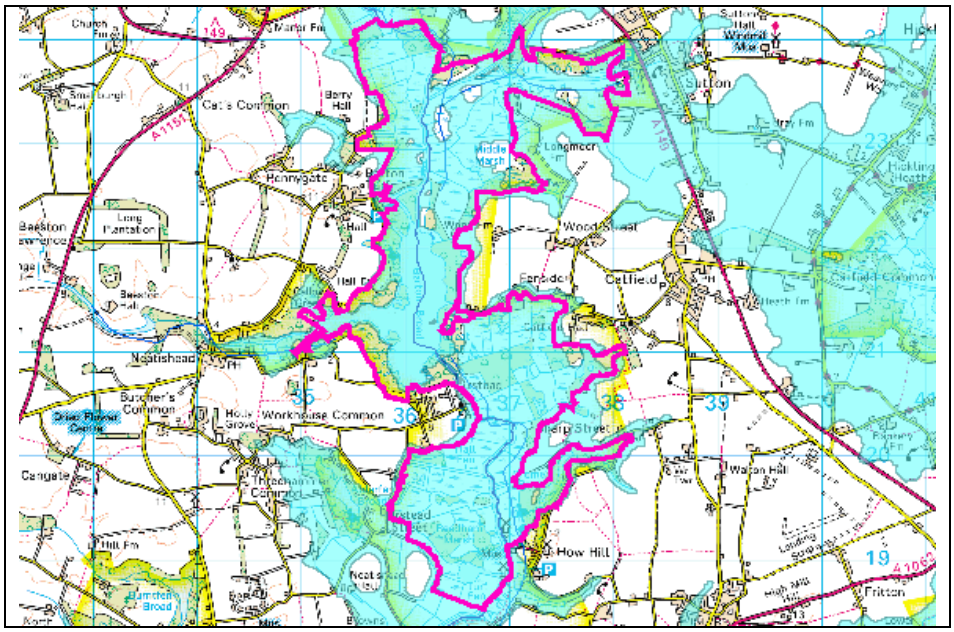

Figure B1.8 – frequently flooded area at Ant Broads and Marshes

B.1.6 River Modelling of nutrient loads and concentrations

B.1.6.1 SIMCAT modelling

SIMCAT modelling has been carried out on the River Ant and tributaries upstream of the tidally-influenced section. It includes all major water company STWs, some smaller ones and some trade discharges. Some consents screened out using joint Agency / EN guidance have however been kept in SIMCAT to enable a more realistic assessment of the others to be made. Smaller discharges are not in the model but the phosphate they input to the system is included as part of the 'diffuse and background' source because the model uses data from monitoring of the watercourses. The model was set up in 2005.

The model is calibrated using current water quality and effluent data. Different scenarios can then be run to see what the effects on phosphate concentrations in the river would be. These scenarios include

setting all discharges with numeric consents to discharge at those consent maxima, setting these discharges to discharge at 1mg/l phosphate or to discharge no phosphate, to obtain a value for background and diffuse inputs only. The results from different scenarios are shown in Table B1.11.

Table B1.11 – results of SIMCAT scenarios

Scenario	ANT120 (u/s site)	Ant130 at u/s edge of site
At current conditions	0.06	0.07
At fully consented conditions	0.07	0.11
All numeric consents set to 1 mg/l	0.06	0.11
All numeric consents set to 0 mg/l	0.05	0.05

Modelled results indicate a change between current conditions and the scenarios for the River Ant at the closest point (ANT 130) but little change at the more upstream point (ANT120) this is due to larger discharges between the two points.

Therefore discharges to the river have an effect either alone or incombination.

At fully licensed conditions the natural eutrophic target is just exceeded in the river Ant at the upstream edge of the site, and it is expected it will just be borderline or exceeded in eutrophic features within the site. At fully licensed conditions the SAC lake target is exceeded in the River Ant at the upstream edge of the site and it is expected it will be exceeded in Barton Broad also.

SIMCAT modelling is of the freshwater / non-tidally influenced part of the Ant catchment, for the tidally influenced section of the river an ISIS model has been used. Ant Broads and Marshes is close to the boundary of the tidally influenced area and both SIMCAT and ISIS models are appropriate to be used to model nutrient concentrations at the site.

B.1.6.2 ISIS modelling

The Halcrow Group Ltd have produced a report (2004) on phosphate in the ~~tidally-influenced~~tidally influenced Broadland catchment using an ISIS model. This identifies inputs to and distribution of phosphate within the catchment, and gives predicted concentrations of phosphate in rivers in component SSSIs.

Details of all consented water company sewage treatment works and industrial discharges within the tidally influenced Broads catchment were used to calculate the total point source load and their contributions were identified. For both the post-AMP3 and post-AMP4 scenarios, 24 discharges accounted for at least 95% of the total point source load with remaining discharges each accounting for <0.2% of the total point source load. Since the top 24 point source discharges account for such a large proportion of the total point source load, only these were used as inputs to the ISIS water quality model. The remaining proportion of the total point source load is included in the diffuse source load in the model.

For the River Ant at Irstead, in the centre of the site, there was a reasonable correlation between the model and "real" measured results as shown in Fig B1.8 (small red diamonds are measured ortho-P and blue columns are modelled orthoP from the model in 1999).

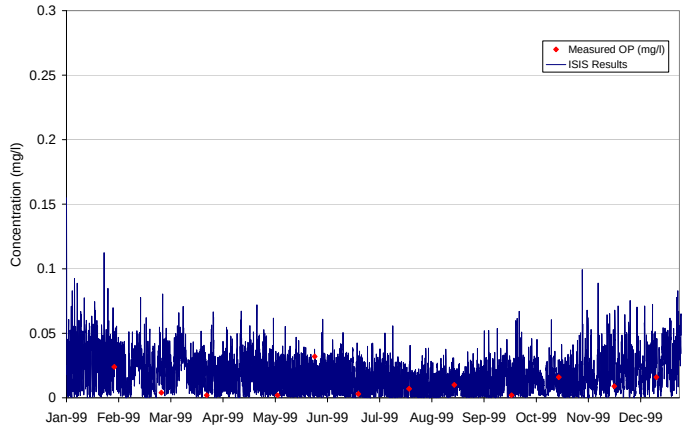

Fig B1.9 – ISIS model results and monitored results River Ant at Irstead in 1999

The model predicts that orthophosphate concentrations in the River Ant at the centre of Ant Broads and Marshes SSSI will be between 0.05 and 0.1 mg/l under fully consented conditions, and will remain the same after AMP 4 improvements are in effect. This correlates to a total phosphate concentration of between 0.056 to 0.13 using the ratios of ortho to total phosphate of between 0.75 and 0.9 for the tidally influenced broadland given in Halcrow (2004). Therefore at fully consented conditions the target of 0.1 mg/l total phosphate for natural eutrophic lakes may be met in the site but not the target of 0.05mg/l for SAC lakes or 0.03mg/l for oligomesotrophic waters.

The ISIS model predicts that less than 1 % of phosphate affecting the site comes from two of the large point sources within the tidally influenced river (AEENF1312 and PR4NF660X); 46% from upstream (as modelled in the SIMCAT model); and 53% from diffuse inputs to the tidally influenced River Ant and tributaries (includes inputs from agriculture, background loads, septic tanks and minor point sources). These percentages are for one point in the centre of the site to give a general estimate of relative contributions of P from the different sources. For other points within the Ant Broads and Marshes these percentages will be different and there will be higher proportions from certain discharges at points nearer to those discharges.

B.1.6.3 Phosphate Loadings from point sources

Likely effluent loads from discharges can be estimated to give relative contributions of phosphate loadings to the catchment assuming that all phosphate exported from the discharges reaches the European site. Consent PR4NF660X is used in these calculations also as background, to provide a more accurate assessment of phosphate loadings, as it is a large discharge.

Likely effluent loads from discharges can be estimated to give relative contributions of phosphate loadings to the catchment assuming that all phosphate exported from the discharges reaches the European site. Likely effluent loads can be estimated from the population equivalent with the assumption of a phosphorus load to the works of 1.08kg P/pe/yr. This figure is provided in Halcrow 2004 using up to date data and assumed to be a reasonable representation of the P export. Due to the nature of STWs some P is retained in the plant, and Halcrow have suggested P retention may be up to 35%. If phosphate stripping is in place then P retention is up to 90%.

Small private discharges are usually small package treatment plants serving a private dwelling. They afford basic treatment to sewage and discharge effluent directly to a watercourse. The volume of effluent consented is based on the number of people likely to be using the plant and it is usually

assumed 180 l per person per day of effluent is treated and discharged although the volumes tend to be rounded up to 1 to 5 m^3 per day.

Halcrow has addressed this issue in the tidally influenced Broadland catchment and have suggested that for daily flows of up to 10 m^3 a conversion ratio of 3.5 people m^{-3} is more appropriate than 180 l per person per day. For values of >10, 5 people per m3 is more appropriate. These values have been used in the calculations in Table B1.12.

Small package treatment plants probably have less P retention within the plant than STWs although some retention will occur as sludge is removed periodically from these plants. Halcrow have assumed no P retention which provides a precautionary scenario. Septic tanks have a retention of 31%.

Table B1.12 – phosphate loadings to catchment

Number	Type/Receiving water	Volume (m3/day)	name	Pe	P load to catchment (kg/year)
PR4NF751X	sewage effluent/trib R Ant	23*		115	124
PR4NF1446	Sewage effluent/land	6*		21	22.68
PR4NF1682	Trib River Ant	5*		17.5	18.9
PRETF8563	River Ant	5*		17.5	18.9
PR4NF284	Trib River Ant	4*		14	15.1
PR4NF162	Limekiln Dyke River Ant	3*		10.5	11.34
PRENF63	Trib River Ant	3*		10.5	11.34
PR4NF1095X	Trib River Ant	2*		7	7.56
PR4NF309	Limekiln Dyke Barton Broad	2*		7	7.56
PR4NF426	Limekiln Dyke	2*		7	7.56
PR4NF913	Trib River Ant	2*		7	7.56
PRENF10334	Trib River Ant	2*		7	7.56
PRENF11669	limekiln dyke	2*		7	7.56
PR4NF1976	Trib River Ant	1*		3.5	3.78
PRENF10136	Trib River Ant	1*		3.5	3.78
PRENF10854	Trib River Ant	1*		3.5	3.78
PRENF11408	Trib River Ant	1*		3.5	3.78
PRENF11812	Trib River Ant	1*		3.5	3.78
PRENF11813	Trib River Ant	1*		3.5	3.78
PRENF13199	barton broad	1*		3.5	3.78
PRENF13371	tributary hickling broad	1*		3.5	3.78
PRENF179	Trib River Ant	1*		3.5	3.78
PRENF180	Trib River Ant	1*		3.5	3.78
PRENF209	Trib Smallburgh Stream	1*		3.5	3.78
PRENF4089	Trib River Ant	1*		3.5	3.78
PRENF8347	Trib River Ant	1*		3.5	3.78
PRENF8468	Trib River Ant	1*		3.5	3.78
PRENF8714	Trib River Ant	1*		3.5	3.78
PR4NF660X	TE/Trib River Ant	2046*	Private discharge at Westwick		769
PRENF3708	Sewage effluent/N Walsham	5.8*		20.3	21.9

PR4NF1560	Sewage effluent/trib River Ant	10*		35	37.8
PR4NF568	Sewage effluent/trib River Ant	10*		35	37.8
PRENF327	Sewage effluent/trib River Ant	8*		28	30.24
AEENF1312	Sewage effluent/R Ant	6618*	Stalham STW	9920	1071.4
PR4NF270	Sewage effluent/trib River Ant	15*		75	81
AW4NF807	Sewage effluent/trib Ant	330**	Horning STW	1354	146.2
AW4NF704X	TE/Richam Canal	34*	N. Walsham wash water		None
AW4NF1091X	sewage effluent/trib smallburgh wc	9**	Sloley	55	59.4
AEENF2011	TE/East Ruston Marsh	65*	Wash water		None
AEENF12002	Sewage effluent/Hundred stream	45*	East Ruston STW	51	35.8
AW4NF1082X	sewage effluent/ditch to R Ant	6*	Honing	30	21.1
PR4LF176	Soakaway	1*		3.5	2.61
AW4NF637X	sewage effluent/trib R Ant	15**	Smallburgh	75	82.1
AWENF103	sewage effluent	9*	Ridlington	51	55.1
					2762.8

The results show that 92% of phosphorus comes from just 12 of the above discharges in total – the STWs and private discharges of 8 m^3/day or greater. 8% comes from the other smaller discharges in total.

B1.6.4 Comparison of diffuse and point source inputs of P
Point sources can be compared against inputs form diffuse sources to identify the relative contributions of each.

Under any land-use regime some nutrients will be lost from the catchment to the watercourses. However, where the land-use is intensive, including agriculture, nutrient loss from the catchment can be considerably increased over natural conditions. Land-management including land drainage, ploughing, spreading of phosphorous rich fertiliser (particularly fertiliser imported to the catchment) and pollution associated with run-off from certain farming activities are particularly likely to increase nutrient export from the catchment to watercourses supplying the site and interest features.

Export coefficients can be used in conjunction with land-use data to provide a "best guess" as to the amount of phosphorus which could be exported from the catchment to the watercourses, based on land-use and associated likely phosphorus input. This method has been used by Johnes (1996) on the River Bure catchment.

Land-use data obtained from the 2000 agricultural census is held by the Agency and available for 25km^2 (2500ha) blocks. The information provides the areas under a wide range of land-uses and also the number of livestock present although poultry and horses are not included. Fig B1.9 shows the catchment draining to the Ant Broads and Marshes, the square symbols are the centres of agricultural 2500ha squares used to provide an estimate of landuse. Table B1.13 shows the export coefficients used for different types of land use and livestock. Table B1.14 gives the results for the Ant Broads and Marshes catchment (14006.8ha).

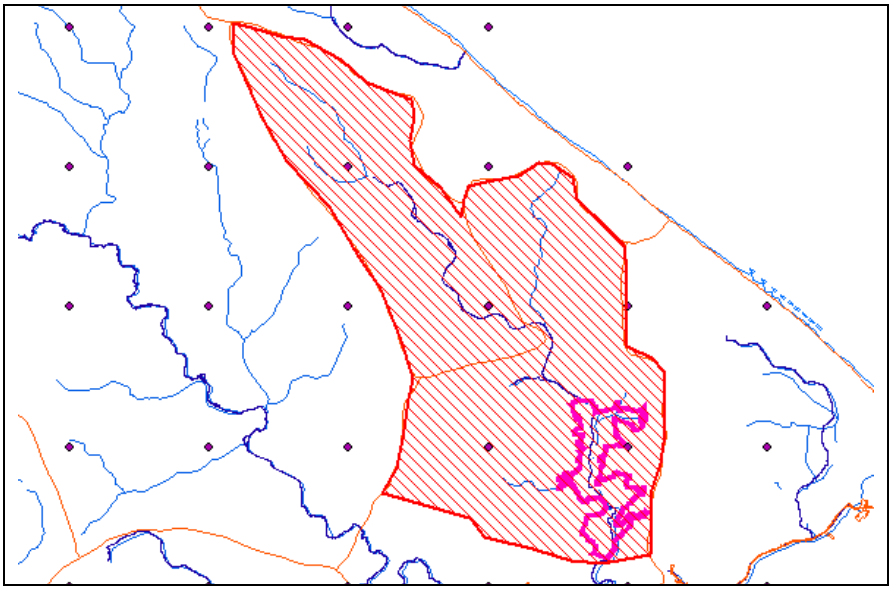

Fig B1.9 – Ant broads and marshes catchment

Table B1.13 – phosphorus export coefficients for land use and livestock types

Agricultural category	Phosphorus input to area	Phosphorus export coefficient
Temporary grassland	1.84kg /ha /year	0.2% of input
Permanent grassland	8.52 kg / ha / year	0.2% of input
Rough grazing	0 kg / ha / year	0 % of input
Orchard and woodland	0 kg / ha / year	0 % of input
Bare fallow and set aside	0 kg / ha / year	0 % of input
Cereal crops	22.5 kg / ha / year	0.4 % of input
Other arable	52.8 kg / ha / year	0.6 % of input
Cattle	17.6 kg / animal / year	1.7 % of input
Pigs	5.63 kg / animal / year	1.7 % of input
Sheep + goats	1.50 kg / animal / year	1.7 % of input

Table B1.14 – loads calculation for diffuse/background loads in Ant Broads and Marshes catchment

Agricultural category	ha or number of animals in 2,500 ha census square (average)	Area or number in 14007 ha catchment	P input to catchment (kg per year in 14007 ha catchment)	Calculated P export
Temp grassland	27.65	154.8	284.8	0.57
Permanent grassland	187.87	1052.1	8963.9	17.9
Rough grazing	37.13	207.9	0	0
Woodland	55.3	309.7	0	0
Bare fallow and set aside	147.25	824.6	0	0
Cereal crops	1030.01	5768.1	129782.3	519.1
Other arable	683.95	3830.1	202229.3	1213.4
Cattle	35	196	3449.6	58.6
Pigs	1595	8932	50287.2	854.9
Sheep + goats	88	493	739.5	12.6
Total				2677.07

Therefore in the ant Broads and Marshes catchment 51% of P comes from consented discharges and 49% from agricultural/background inputs.

Therefore the point discharges in the Ant Broads and Marshes catchment affect the site either alone or in combination

B1.6.5 Conclusion from modelling work

Loadings show that the sewage works and private discharges greater than or equal to 8m^3/day in table B1.12 above contribute 92% of the phosphorus from point sources and 46% of phosphorus from total diffuse and point sources. Therefore it cannot be concluded that these discharges will not cause an adverse impact on the interest features of Ant Broads and Marshes SSSI alone or in combination. These consents will be taken to stage 4 for further assessment and options appraisal.

The other smaller discharges in table B1.12 contribute 8 of point source phosphorus and 4% of total point and diffuse. Therefore these smaller consents are concluded to have only a trivial effect in comparison and will be affirmed in stage 4.

Therefore the consents in table B1.15 below will be taken to stage 4 for further assessment and options appraisal.

Table B15 – consents for further assessment and options appraisal at stage 4

Number	Type/Receiving water	Volume (m3/day)	name
PR4NF1560	Sewage effluent/trib River Ant	10*	
PR4NF568	Sewage effluent/trib River Ant	10*	
PRENF327	Sewage effluent/trib River Ant	8*	
AEENF1312	Sewage effluent/R Ant	6618*	Stalham STW
PR4NF270	Sewage effluent/trib River Ant	15*	
AW4NF807	Sewage effluent/trib Ant	330**	Horning STW
AW4NF1091X	sewage effluent/trib smallburgh wc	9**	Sloley
AEENF12002	Sewage effluent/Hundred stream	45*	East Ruston STW
AW4NF637X	sewage effluent/trib R Ant	15**	Smallburgh
PR4NF751X	sewage effluent/trib R Ant	23*	
AWENF103	sewage effluent	9*	Ridlington

Consent PR4NF660X will be discussed below in section B1.7.

B.1.7 In-combination

Since stage 2 was completed 26 new consents have been assessed via appendices 11 and 12 and within the 3 km buffer zone. 3 are for treated sewage to land, all the rest are for treated domestic sewage effluent to water and are less than 5 m^3/day to the River Ant and tributaries. These discharges to the River Ant and tributaries will have only a trivial impact in combination with the discharges already assessed. These discharges therefore will not cause an adverse impact on the interest features of the Ant Broads and Marshes SSSI in combination.

The discharges to land are for treated sewage between 1 to 2 km from the site. Details are shown in table B1.16.

Table B1.16 -

Number	Location	Max consented volume (m3/day)	NGR
AEELF12300	Barton Turf	44.4	TG3492022490
AEELF12298	Neatishead	25.4	TG3466420130
AEELF12296	Neatishead	38.0	TG3392020380

Groundwater risk assessments have been carried out for these discharges, as prior to the Groundwater Regulations coming into effect they were exempt from having a consent. The assessments concluded that groundwater is in hydraulic continuity with the River Ant so there is a possibility of nutrients from the discharges reaching the river. Calculations showed that phosphate concentrations reaching the River Ant tended to be less than 0.1mg/l depending on the dilution factors used and were not considered to pose a risk to the conservation sites. However assessments were carried out using discharge volumes derived from actual populations equivalents, and these volumes were many times less than the maximum consented volume. Because maximum consented volumes will result in higher concentrations of nutrients potentially reaching the River Ant it therefore cannot be concluded that they will not affect the interest features of Ant Broads and Marshes SSSI in combination with other nutrient inputs and therefore they will be considered in the in-combination at stage 4 options appraisal. Any modifications needed will be taken through Regulation 48.

Consent PR4NF660X has been assessed previously under Regulation 48 (appendix 12) when an application was put forward to increase the flow of the discharge. The assessment concluded that the increase in flow may adversely affect SSSIs in the River Ant catchment. However because the effluent quality had recently been improved a consent was issued, as the SSSIs would not be adversely affected over a short period of time, and it would be assessed in-combination with information gathered under the Review of Consents.

PR4NF660X is not consented for dangerous substances and these are not monitored routinely in the effluent, but it has been monitored for some pesticides from 2002 to date. The results from this monitoring have been checked against Environmental Quality Standards (EQS). EQSs reflect the concentration of a chemical in a watercourse above which there may be an adverse effect on aquatic life. They are used as a way of determining consent limits to ensure protection of riverine ecosystems. The results are shown in Appendix B1.1 attached and show that no pesticides monitored exceeded their EQS. The consent is now being modified and pesticide limits will be put in the new consent to ensure that EQSs will not be exceeded in the receiving water. The company has recently installed a granulated activated carbon system to remove pesticides from the effluent.

PR4NF660X has been assessed in-combination with other consents in section B1.6.3 for phosphate loadings and it will be considered in the in-combination at stage 4 options appraisal. Any modifications needed will be taken through Regulation 48.

B.1.8 Summary Conclusions

123 consents were brought forward from stage 2. The discharges to water together with new Appendix 11 and 12 consents have been screened and assessed using new guidance and modelling and will contribute – in combination with diffuse sources - to the loads in the River Ant and tributaries. Most have been deemed of only trivial effect and will not cause an adverse impact on the interest features of the Ant Broads and Marshes SSSI alone or in combination. These will be affirmed at stage 4.

The 11 consents shown in table B1.15 cannot be shown not to cause an adverse impact on the interest features of Ant Broads and Marshes SSSI alone or in combination, and will be taken forward to stage

4 for further assessment and options appraisal. In addition PR4NF660X will also be considered in the in-combination as part of the stage 4 options appraisal. Any modifications needed will be taken through Regulation 48.

Discharges to land in the stage 2 list were assessed and due to their small volumes, their nature and location it has been concluded that they will not cause an adverse impact on the interest features of the Ant Broads and Marshes SSSI alone or in combination. These will be affirmed at stage 4.

There were also 3 discharges to land previously assessed under the groundwater regulations these will be considered in the in-combination at stage 4 options appraisal. Any modifications needed will be taken through Regulation 48.

B.1.9 References

English Nature (2005) http://www.natureonthemap.org.uk/map.aspx?map=sssi

Entec UK Ltd (2001) Hydro-ecological Review of European Sites within the Yare & North Norfolk Groundwater Resource Investigation Area (Ant Broads and Marshes SSSI) Environment Agency report

Entec UK Ltd (2005) Habitats Directive Review of Consents Stage 3 Water Resources Impact Assessment: Ant Broads and Marshes SSSI. Environment Agency, Anglian Region report

Environment Agency (2005) effluent performance report for period ending May 2005 (issued August 2005)

Environment Agency (2005) List I, List II and SWAD returns 2005 (issued May-June 2005)

Halcrow (2004) Investigation of the flows and phosphorus fluxes relevant to the Habitats Directive Review of Consents in tidally influenced Broadland Rivers. Phosphorus budget and source appointment modelling study of the tidally-influenced Broadland catchment. Environment Agency report.

Harding, M (1999) Nutrients in Fens: Published studies relevant to planned work at Redgrave and Lopham Fen. Unpublished review

JNCC (2004) *http://www.jncc.gov.uk/protectedsites/sacselection/habitat.asp?FeatureIntCode=H6410*

Wheeler, B.D. & S.C. Shaw (2000). Redgrave and Lopham Fens. The effect of increased fertility through surface water and seepage on EC Habitats Directive Annex 1 Plant Communities (draft). Report to English Nature, no. NE/08/09

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2 WATER RESOURCES ASSESSMENT

The assessment has considered data available at June 2005. Documents considered during this water resources assessment comprise the following:

- Habitats Directive Handbook. Appendix 4 – Applying the Habitats Regulations to Water Resources Permissions and Activities (Environment Agency, 2003).
- Broads Characterisation (CD, English Nature).
- A Wetland Framework for Impact Assessment at Statutory Sites in Eastern England (Environment Agency, Research and Development Technical Report W6-068/TR2; Wheeler and Shaw, 2001).
- Hydrological Impact to Ecological Effect for Fens & Wet Grassland (Entec/ EA, Technical Note, 2004).
- Stage 1 and Stage 2 Proformas (Appendix 18) for Ant Broads and Marshes (Environment Agency, 2001).
- Initial Scoping Pro-forma for Ant Broads and Marshes (Environment Agency, 2002).
- Favourable Condition Table for Ant Broads and Marshes SSSI (English Nature, 2004).
- Ecohydrological Guidelines for Lowland Wetland Plant Communities (Wheeler B D, Shaw S C, Gowing D J G, Mountford J O and Money R P, 2004).
- Eco-hydrological Guidelines for Wet Woodland – Phase 1. (Barsoum, N, Anderson, R, Broadmeadow, S, Bishop, H, and Nisbet, T, 2005).
- Habitats Directive Review of Consents Stage 3: Water Resources Impact Assessment: Ant Broads and Marshes SSSI. Issue 1 (Entec, June 2005).
- Hydro-ecological Review of European Sites within the Yare and North Norfolk Groundwater Investigation Area: Ant Broads and Marshes SSSI (The Broads cSAC. Broadland SPA), (Entec, 2001).
- Connectivity on Floodplain SSSIs - explanatory notes for the Ant Broads and Marshes (Entec, 2004).
- Investigation of the flows and phosphorus fluxes relevant to the Habitats Directive Review of Consents in tidally-influenced Broadland rivers. Phosphorus budget and source apportionment modelling study of the tidally-influenced Broadland catchment (Halcrow Group Ltd, 2004).
- Anglian Water AMP3 investigations on Ludham PWS (Atkins/HSI, 2003 and 2004).

METHODOLOGY

This appropriate assessment for the water resources function has been structured in three sections: 'Ecological and Hydrological Target Setting', 'Assessment of Hydrological Impacts' and 'Assessment of Ecological Effects'. The following briefly outlines the methodologies employed in each section, after which the results for each section are discussed in detail. The document is designed to set up a 'test' or series of tests to assess whether the water resources consents are causing, or could potentially cause an adverse effect on the integrity of the site.

Ecological and Hydrological Target Setting

Generic approach:

Ecological targets are identified by reference to the most appropriate NVC survey and by reference to the features that have been designated as European features. These are highlighted on a map clearly indicating type, extent and location.

Seasonal target water level regimes have been evaluated for the designated European features by reference to the Eco-hydrological Guidelines for Lowland Wetland Plant Communities, Favourable Condition Tables, the Hydrology to Ecology Technical Note and other relevant scientific literature. In the first instance, generic regimes are presented. If site specific data are available the generic regimes may be modified to reflect the conditions existing at the site.

Site Specific Approach:

It was agreed with English Nature that it would be appropriate to set target regimes for the features considered most sensitive to water resources permissions rather than for all features. English Nature has agreed that assigning targets to the most sensitive features for the assessment would adequately cover the requirements of the other, less sensitive, features for the purposes of assessing effects resulting from hydrological impacts caused by water resources permissions.

Although there are monitoring data for this site, absence of field data for the majority of the features has resulted in the need to define seasonal target water level regimes and river flows for the agreed list of features using the generic approach identified above.

Assessment of Hydrological Impacts

Generic Approach:

The generic approach to assessing the impacts of water resources consents has included the following (Local Models Technical Note):

- Site characterisation and conceptual modelling including; schematic maps and cross sections, conceptual model review and site classification, vulnerability mechanisms and preliminary natural water balance;
- Initial assessment of possible flow reduction impact (by consideration of natural site water balances and comparison of abstraction source equivalent recharge circles with wetland recharge catchments);
- Application of simple, conservative drawdown calculations (e.g. one layer leaky or unconfined analytic) and review of licensed abstraction impacts;
- If desirable, application of more sophisticated layered radial flow model drawdown calculations and review of licensed abstraction impacts;
- If necessary, development of a simple two layer distributed groundwater flow model representing the wetland and abstractions in the context of simple transient recharge assumptions, regional groundwater flow patterns and interaction between groundwater and surface water features. Simple comparisons with observed levels and flows to confirm that the representation is 'reasonable' and that any simplifications are conservative with regard to hydrological impact assessment.

Site Specific Approach:

The approach to the assessment of hydrological impact followed for Ant Broads and Marshes has included the following:

- Consideration of site conceptual model and connectivity.

- Application of layered radial MODFLOW model to assess cumulative impact of all licences within 5km of Ant Broads and Marshes and within the hydrometric area draining to the marshes, providing an insight into the relative contribution of licences to the cumulative drawdown at the site.
- Application of the Yare & North Norfolk regional groundwater model to assess the in-combination drawdown/impact on river flows of all licences from both the 5km radius area surrounding the site, and from the upstream catchment.. Groundwater flow to the drains on Ant Broads and Marshes has been assessed indirectly via estimating the net-upward flow of groundwater into the drains by using the Yare and North Norfolk Regional Groundwater Model.
- Detailed descriptions of the findings of these analyses are presented in Habitats Directive RoC Stage 3: Water Resources Impact Assessment: Ant Broads and Marshes SSSI, Issue 1 (Entec, 2005).

Assessment of Ecological Effects

Generic Approach:

The methodology adopted is to calculate a predicted water level change for the feature location using techniques appropriate to the site, the data available and the risk. Seasonal target water levels, target water turnover rates for waterbodies on site, targets for water quality and target flows for rivers have been evaluated for the designated European features using available information including the Eco-hydrological Guidelines for Lowland Wetland Plant Communities and liaison with English Nature. The predicted water level changes are compared with the seasonal target water level envelopes in order to isolate the probable significance of impact if present.

Site Specific Approach:

In addition to the assessment of water level changes referred to in the generic approach described above, the presence of a wide range of features, and associated hydrological regime target type means that the predicted changes in groundwater influx rates into site waterbodies and flows in the river are compared with the target seasonal groundwater influx rates, water quality and/or river flows as appropriate in order to isolate the probable significance of impact if present.

ECOLOGICAL TARGET SETTING

Features Sensitive to Water Resources Permissions

The features present on site that are sensitive to water resources permissions (taken from the EA HD Handbook Appendix 4[1]), are detailed below.

The features (SAC and SPA) present on site that are sensitive to water resources permissions (taken from the EA HD Handbook Appendix 4[1]), are detailed below:

- Fens and wet habitats (not sensitive to acidification);
- Bogs and wet habitats

[1] Technical and Procedural Issues Specific to Water Resources Permissions and Activities

- Standing waters (not sensitive to acidification);
- Vascular plants, lower plants and invertebrates of wet habitats;
- Mammals of riverine habitats;
- Birds of lowland freshwaters and their margins;
- Birds of lowland wet grassland.

These are represented on site by the European features identified below.

Broads SAC:

- Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition* type vegetation (present in ditches and waterbodies on site);
- Molinia Meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*) (represented on site by M24 (*Molinia caerulea – Cirsium dissectum*) and M25 (*Molinia caerulea - Potentilla erecta*) fen meadow communities);
- Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (represented on site by parts of W2 (*Salix cinerea - Betula pubescens - Phragmites australis*), W5 (*Alnus glutinosa - Carex paniculata*) and W6 (*Alnus glutinosa - Urtica dioica*) woodland NVC communities);
- Calcareous fens with *Cladium mariscus* and species of the *Carex davallianae* (represented by S24 (*Phragmites australis-Peucedanum palustre)* tall herb fen and S25 (*Phragmites australis - Eupatorium cannabinum*) tall herb fen);
- Transition mires and quaking bogs (represented on site by S27 (*Carex rostrata-Potentilla palustris*) tall herb fen and M5 (*Carex rostrata-Sphagnum squarrosum)* and M9 (*Carex rostrata - Calliergon cuspidatum*/*giganteum*) mire communities*);*
- Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp (represented almost exclusively by type'4' of the GB Standing Waters Classification, rarely types '5' and '10');
- Desmoulin's whorl snail (*Vertigo moulinsiana*);
- Fen orchid (*Liparis loeselii*); and
- Otter (*Lutra lutra*).

Broadland SPA:

- Habitats for the populations of Annexe 1 bird species (bittern *Botaurus stellaris*, marsh harrier *Circus aeruginosus,* and hen harrier *Circus cyaneus).*These are*:*
    - Open water
    - Swamp
    - Fen;
    - Reedbed; and
    - Fen meadow with ditches and waterbodies;
    -
- Habitats for the populations of migratory bird species (shoveler *Anas clypeata* and gadwall *Anas strepera*). These are:
    - Open water
    - Swamp
    - Fen;
    - Reedbed; and

- Fen meadow with ditches and waterbodies

- Habitats of the populations of waterfowl that contribute to the wintering waterfowl assemblage of European importance. These are:
  - Open water
  - Wet woodland
  - Swamp and Fen
  - Fen meadow with ditches and water bodies;

Licensed abstraction may affect the features by (taken from the EA HD Handbook Appendix 4[1]):

- change in water levels or table
- change in flow or velocity regime
- change in surface flooding
- changed water chemistry
- change in salinity regime
- reduced dilution capacity,
- habitat loss, and
- Entrapment.

In the context of this site it is considered that entrapment is not relevant. However there remains the potential for the other changes to take place on this site as a result of abstraction and hence these have been considered in the assessment.

Summary of Targets

During the development of targets for the site, discussions were held with English Nature on which features should be used in the assessment, and hence which need to have hydrological regime targets set.

It has been agreed with English Nature that the following features require targets to be set:

- Alluvial forests (W2, W5 and W6);
- Calcareous fens (S24, S25);
- Hard oligo-mesotrophic water with benthic vegetation of *Chara* spp.;
- Natural eutrophic lakes (macrophyte communities present in ditches and waterbodies);
- Transition mires (S27, M5 and M9);
- *Molinia* meadows (M24 and M25);
- Fen orchid; and

It was also agreed that otter, and the habitats for Desmoulin's whorl snail and the habitats for the SPA species do not need to have targets set as these will be adequately covered by the targets to be set for the SAC features indicated above.

Figure B2.1a and Figure B2.1b indicate the locations of the European features on site and their hydrological target regime respectively. Table 1 lists the locations of the features by hydrological sub-unit of the site, which are indicated on Figure B2.2. Additionally, Figure B2.2 illustrates the connectivity of the hydrological sub-units to the River Ant.

Table 1 Distribution of European Features within Ant Broads and Marshes

SAC Feature	Reedham Marshes	Crome's Broad	Sharp Street	Hall Fen	Barton Broad	Catfield Fen	Barton Fen	Sutton Broad
Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior*	3	3	3		3	3	3	3
Calcareous fens with *Cladium mariscus* and species of the *Carex davallianae*	3		3		3	3		
Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition*-type vegetation	3	3	3	3		3	3	
Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp						3		
Transition mires and quaking bogs	3			3	3	3		
Molinia meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*)		3					3	3
Desmoulin's whorl snail (*Vertigo moulinsiana*)						3		3
Fen Orchid (*Liparis loeselii*)					3			3
Otter (*Lutra lutra*)	3	3			3	3		3

The distribution of the vegetation communities are based on the locations given by English Nature's Broads Characterisation CD and subsequent discussions with English Nature.

Hydrological regime targets have been formulated for the features based on the following:

- English Nature's favourable condition tables for the site;
- The 'Eco-hydrological Guidelines for Lowland Wetland Plant Communities';

- Eco-hydrological Guidelines for Wet Woodland – Phase 1; and
- Discussions with English Nature.

Considering the information gathered from these sources the following hydrological targets are considered appropriate.

Site Specific Targets for the Features on Ant Broads and Marshes

Natural Eutrophic Lakes in Fen Drain Systems

For the natural eutrophic lakes feature, English Nature's favourable condition tables indicate that hydrology involves not only ditch levels but flushing rates and the prevention of lowering or rising of ditch levels through modification of outfalls. The ditch system should have a constant high water table throughout the year. For this feature targets have been developed related both to flushing flows and levels.

With respect to flushing flows the proposed target is that the monthly flow through the ditch system should be twice the volume of system (i.e. flushing rate of 2 weeks) in summer. However, where the flushing rate drops below 6 weeks, it is considered that there is a greater potential for changes is water level , which are otherwise considered likely to be maintained at, or exceed, the level of an outfall when the flushing period is shorter than 6 weeks. Therefore after this period, assessment of the effects on ditch water levels is also undertaken. No target has been set for winter. With respect to water level, English Nature recommend a water level regime that retains high water levels, not more than 45cm below marsh level, year round.

With respect to the magnitude of effect that would be considered potentially adverse, whilst it is considered that plants are not highly sensitive to fluctuations in water level, it is suggested that the potential to affect species rooted in the ditch banks means that a conservative target is required to ensure that variation does not result in adverse effect. Therefore it is suggested that mean reductions in level of up to 10% of ditch depth are acceptable in the spring and summer months (March – September) although the 45cm below marsh level is the threshold below which EN would indicate that targets are not being met irrespective of the level of abstraction. To this end a 10% reduction will be allowed unless reductions of 10% would breach the 45cm threshold.
The ditches are thought to be around 1.0 m deep (actual depths have not been measured).

The hydrological regime target defined above normally applies to grazing marsh systems however here it is applied to fen drain systems in areas isolated from the river.

Natural Eutrophic Lakes in the Broads and Ditches Linked to the River

Unlike for the drained grazing marsh ditch systems, no generic targets have been agreed with English Nature for these types of waters.

It is not considered reasonable to define a level target in tidally influenced waterbodies. It is therefore considered that the target should relate to river flows, noting that the flow rate will also influence level. It has not been possible at this stage to define a robust stage discharge relationship between river flow and river level. The target that has been set therefore is precautionary and is that

abstraction should not reduce river flow by an amount equivalent to more than 10% of the naturalised Q95.

Transition Mires and quaking bogs

The transition mire communities occur in a combination of locations floating and non-floating on site and is thus potentially sensitive to water level fluctuations. The EN favourable condition tables for this feature indicate that water levels should not fluctuate more than 30 cm annually and this is the target that has been adopted for the feature.

Hard oligo-mesotrophic waters (in Drainage Systems)

With respect to water level the EN favourable condition tables indicate that '*water level change downwards is acceptable only in dry years. If lake level lowers due to outside water demands such as aquifer abstraction then counter measures need to be instigated'*. As a precautionary approach it is suggested that an effect will be considered adverse if it results in a change in level of more than 10% of the waterbody depth.

Alluvial Woodland

The proposed generic target hydrological regime for alluvial woodland W5 and W6 comprises winter water-levels at or very near the ground surface, being maintained within 5 cm of the ground surface through the spring establishment period. Summer maximum and minimum levels should be between 5 and 45 cm below the ground surface, accepting that optimal seedling growth occurs with water levels between 10 and 30 cm below ground level. This should maintain the typical canopy and under-storey species. Since antecedent fen composition and within-stand environmental variation influence the composition and distribution of the field layer, and little information on its hydrological requirements is readily available, the above regime is also considered suitable for maintaining the community as a whole.

No data are available on the requirements of W2 woodland, which also contributes to the European feature. It is therefore proposed that the target regime described above applies to this community also.

Molinia Meadows

For the M24, the target, which is derived from the 'Eco-hydrological Guidelines', in the absence of information in the Favourable Condition Tables, is that the summer water table should be between 10 and 41 cm below ground level in the summer months (July-Sept). This is the mean water level for M24 on a number of sites across East Anglia (as presented above) ±1SD (but curtailing the maximum water table to water at 10 cm below ground level as measured)[2].

Note that the target for M24 has been assumed to be acceptable for M25 also.

Calcareous fen with Cladium spp.

[2] For normally distributed data this range will pick up 70% of the occurrences of situations for M24.

For the S24, the target identified is that the summer water table should be between 3 cm above and 36 cm below ground level in the summer months (July-Sept). This is the mean water level for S24 on a number of sites across East Anglia ±1SD (but curtailing the maximum water table to water at 4 cm above ground level as measured). Winter water levels are expected to be at the surface.

Note that the target for S24 covers all the communities that contribute to the calcareous fen feature.

Fen Orchid
Fen orchid is associated with the calcareous fen and *Molinia* meadows features at Sutton Broad and Catfield Fen respectively. The targets for these features are therefore applied to the fen orchid in these locations.

Influence of the River Regime on Levels

The majority of the features on site have a water level regime target, as indicated above. However a number of features are located in areas directly influenced by river level but to be able to assess the effects of abstraction on river levels, and hence feature target levels, a stage relationship is required. As indicated for the natural eutrophic lakes and Desmoulin's whorl snail targets above, it has not been possible to robustly relate changes in river flow to river level and therefore, for the features located in areas that are directly influenced by river level, the precautionary river flow target will apply, rather than the specific water level targets.

In summary, different targets apply to the fen features, bog features, ditch communities, broads and features affected by river levels and therefore the assessment includes consideration of effects on all of these different target types.

Site Specific Ecological Uncertainties

No survey work has been undertaken to date during the RoC process to ground truth the locations or composition of these features.

ASSESSMENT OF HYDROLOGICAL IMPACTS

Hydrological Installations on Site

Hydrological monitoring on site has concentrated on Catfield Fen, reflecting the potential impact of the Ludham PWS abstraction on the site (see Figure B2.3) and information from Anglian Water's investigations on Catfield Fen was reviewed. Unfortunately there is difficulty with interpretation of site data and topographic information because of uncertainty with regard to ground levels on this site. A signal test was also performed at Ludham PWS to check for responses at Catfield Fen. Additional data sources have also been used in this assessment and these are summarised in Table 2 below.

Table 2 Sources of Information Used in this Report

Description of Information	Source	Comments
LIDAR data	Environment Agency	Discussed in Section 3.1.2 of Stage 3 HIA report.
Water levels in Barton Broad	Environment Agency	Discussed in Section 3.1.3 of Stage 3 HIA report.
Distribution of wetland features	English Nature	Additional maps provided with detailed information. Discussed in Section 3.2 of Stage 3 HIA report.
Ecological conditions	English Nature Condition Tables	Discussed in Section 3.2 of Stage 3 HIA report.
River Flow at Horning Lock	Environment Agency	Discussed in Section 4.3.2 of Stage 3 HIA report.
Water quality data (River Ant and Barton Broad)	Environment Agency	Discussed in Section 4.3.2 of Stage 3 HIA report.
Abstraction data for Ludham PWS	Anglian Water	Discussed in Section 4.3.2 of Stage 3 HIA report.
Water level data for Catfield Fen	Anglian Water	Discussed in Section 4.3.2 of Stage 3 HIA report.

Water Supply to the Features

The main hydrological inputs to the site are:

- Direct rainfall;
- Breydon Formation/Crag groundwater
- Surface water fluxes through areas of the Ant Broads and Marshes SSSI With an open connection to the River Ant
- Surface water flows during periods of winter flooding.

Hydrological outputs include:

- Evapotranspiration;
- Ditches flowing/being pumped;

Barton Broad receives water from the River Ant and is 'turned over' relatively rapidly by inflows from the upstream catchment. Tidal fluctuations in level 'back up' river flow and generally do not involve ingress of saline water although water quality data shows that saline water can enter Barton Broad during tidal surges. Hydrological variations in flow in the river and tidal fluctuations in water levels in Barton Broad, however, will result in a 'backward and forward' flux of water into surface drains that feed the openly connected areas of the surrounding marshes and fens.

In semi-isolated parts of the system, the water balance will be dominated by surface water flows during periods of winter flooding but in areas where water levels are controlled by sluices in the summer, water balances and levels will be controlled by the local balance between rainfall and evaporation, groundwater inputs and subsurface inflow from drains. The extent of the influence of surface drains on water levels on surrounding marshes is dependent on horizontal permeability through the upper layers.

In areas of low connectivity, IDB pumping, operation of sluices, the local balance between rainfall and evaporation, sub-surface drainage and groundwater inflows will control water levels. Groundwater inflows are likely to have a greater influence on water fluxes and levels in these areas.

Discussion of Permissions

Figure B2.4a indicates the permissions within 5 km of Ant Broads and Marshes that were identified as having a likely significant effect in the Appendix 18 (Stage 2) for the site. In total, 16 surface water abstraction licences and 70 groundwater abstraction licences were considered during Stage 2. However 8 groundwater licences, included in Stage 2, have now expired.

Additionally, the Appendix 18 did not include an assessment of the potential effects of groundwater and surface water licences in the river catchment on river flows, and subsequently on the site. This is recognised as an omission at Stage 2 and relevant licences in the catchment have been identified for this Stage 3 Appropriate Assessment. As a result an additional 2 surface water licences and 65 groundwater licences were identified within the catchment upstream of Ant Broads and Marshes that could potentially affect the flows of the River Ant (see Figure B2.4b). Changes to flows, and any subsequent changes in water quality, of the River Ant can impact on the fen habitats and associated features present in sub-units of the site with a high connectivity to the river. . As indicated above, the extra surface water and groundwater abstraction licences identified within the catchment upstream of the Ant Broads and Marshes have not been included previously in Stages 1 and 2.

Overall therefore, a total of 127 groundwater licences and 18 surface water licences are assessed in this Stage 3 Appropriate Assessment.

Note that 56 of the licences mentioned above have recently gone through the deregulation process of the Water Act 2003. These are highlighted in Column 3 in Appendix 1. To date, a decision as to whether to deregulate an abstraction licence or not has been made for licences permitting water abstraction of less than $15m^3$/day, whilst decisions are pending for licences of between 15 and $20m^3$/day.

Of the licences considered in this Appropriate Assessment, 3 groundwater licence abstractions and 6 surface water licence abstractions are known to have been considered under Regulation 48 of the Habitats Directive. These are highlighted in Column 2 in Appendix 1.

Hydrological Impact of Permissions (Alone and In Combination)

Surface Water licences
There are 18 current surface water licences in the catchment of Ant Broads and Marshes.

Groundwater licences

In total, 129 groundwater licences have been assessed under Stage 3 of RoC for Ant Broads and Marshes. Of these, most abstractions are from the Chalk. The remaining abstractions are from the Crag and Glacial Gravels.

The main sources of groundwater recharge are the Breydon Formation (Drift) aquifer/aquitards and the Crag aquifer. Surface water flows contribute to the wetness of this site where connectivity exists between the sub-units and the River Ant (see Figure B2.2). Barton Broad receives water from the River Ant and is 'turned over' relatively rapidly by inflows from the upstream catchment. In semi-isolated parts of the system, the water balance will be dominated by surface water flows during periods of winter flooding but in areas where water levels are controlled by sluices in the summer, water balances and levels will be controlled by the local balance between rainfall and evaporation, groundwater inputs and subsurface inflow from drains.

The shallow geology at the site comprises complex Holocene drift deposits of the Breydon Formation (diamict of peats, clays and silts, which are highly variable both laterally and vertically). The formation is believed to be split into a lower fen/brushwood peat and an upper peat, separated by a clay aquitard of variable thickness. The connectivity between the surface peat and the deeper peat and underlying crag aquifer is believed to be spatially variable and affected by peat digging and surface drains.

Underlying these drift deposits in the valley bottom are rocks of the Pliocene/Pleistocene Crag Group. The Crag consists mainly of sand though many discontinuous layers of silt and clay have been identified in local borehole logs. The Crag outcrops at the edge of the Breydon Formation and marks the beginning of the upland in many localities. The semi-confined aquifer is directly below the lower peat layer and outcrops at the upland break in slope. The Crag is in hydraulic continuity with the lower peat and overlying sands and gravels of the Kesgrave formation in the uplands.

The Eocene boundary is believed to run through the SSSI. To the west of this point, the Crag is directly overlying the Upper Cretaceous Chalk whilst to east the Crag is separated from the Chalk by the Eocene Clay. Detailed information on boundary of the Clay is not available but it may provide a zone of variable connectivity between the Crag and underlying Chalk in the central area of the site.

The Chalk is a deep major aquifer which is in continuity with the Crag over much of the site but confined in areas where the Eocene Clay is present.

Two approaches have been undertaken to evaluate the potential impact of licensed abstractions on the hydrology of Ant Broads and Marshes:

1. Three radial flow models were developed, centred on the Barton Fen, Catfield Fen and Reedham Marshes (see sub-units indicated on Figure B2.2). Groundwater abstractions in the area include Crag and Chalk boreholes. Separate radial flow models with abstraction from Crag at the bottom layer and Chalk as the bottom layer were, therefore, created, and drawdown associated with the Crag and Chalk licences assessed separately. Results, however, have been combined into superimposed LAD diagrams for the 3 sites (see Entec, 2005). The hydrogeological conditions for the three areas were represented using the parameters from the Yare and North Norfolk Regional Groundwater Model. The radial flow models do not take into account the impact of the Eocene clay layer on the eastern end of the SSSI because inclusion of this impermeable layer would greatly reduce the impact of all

abstractions including those to the west of the clay. In reality, the Eocene clay layer will reduce the impact of abstractions to the eastern end of the site.

2. The Yare and North Norfolk Regional Groundwater Model has been used to investigate the effects of abstraction on groundwater levels and groundwater flow into the ditch network on the site, as well as effects on flows in the River Ant. The aim of this is to investigate whether abstractions could affect level targets set for features like alluvial forests and *Molinia* meadows, calcareous fen, and transitional mires and flow targets relating to the natural eutrophic lakes feature.

By agreement with English Nature (23rd September 2004) licences which have a predicted individual impact of less than 1 mm and which contribute to a predicted cumulative drawdown of less than 1 mm (i.e. they fall below the 1 mm line on the relevant LAD in the Water resources Assessment report for the site) are deemed to be trivial. However, where an impact of >1mm is predicted it has also been agreed that a measurable hydrological impact will be taking place. This does not mean that an 'adverse impact' has occurred. This is assessed in relation to the hydrological regime targets identified above.

In respect of licences affecting river flows, the effects of all licences are included in the overall assessment. A pragmatic approach has then been taken to identifying which licences contribute to the hydrological impact that takes the river flow out of regime, based on the magnitude of the individual licences in the catchment. The results of the assessment are summarised in the following sub-sections.

Assessment

(1) **Radial Flow Modelling** - Nine licences are predicted to contribute to an in-combination effect above the 0.001 m cumulative threshold at Barton Fen, whilst at Catfield Fen, 7 licences contribute to an in-combination effect above the 0.001 m cumulative threshold and at Reedham Marsh 7 licences contribute to an in-combination effect above the 0.001 m cumulative threshold. Ludham PWS (7/34/15/*G/0091) has the greatest impact and is the only abstraction with an individual impact greater than 10 cm. At Catfield Fen, Ludham accounts for 82% of the combined drawdown but the impact is greatly reduced at Barton Fen and Reedham Marsh. The only other licenses with an estimated drawdown of greater than 1 cm were 7/34/09/*G/0059, 7/34/09/*G/0091, 7/34/09/*G/0141A and 7/34/09/*G/0138A.

NB The radial MODFLOW model was used mainly to apportion abstraction impact to individual abstraction licences. The results of the Yare and North Norfolk regional groundwater model are used to assess predicted groundwater levels against ecological targets.

(2) **Regional Groundwater Model Assessment of Effects on Near-surface Water Levels** - The Yare and North Norfolk regional groundwater model was used to assess the fully licensed in-combination impact of groundwater abstraction on near surface groundwater levels at Ant Broads and Marshes.
In order to assess the impact, three groundwater abstraction scenarios were run on the regional model:

- Naturalised (no abstraction or discharge);

- Historic (abstraction based on returns data);
- Fully licensed (abstraction at fully licensed rate).

The assessment was undertaken for a dry year and for an average year.

Modelled 'in-combination' impacts of fully licensed abstractions compared to naturalised conditions on groundwater levels were plotted (Figure B2.5a-k) for key assessment points (Figure B2.1a). Substantial drawdown is associated with the Ludham PWS source to the east of the Cromes Broad hydrological sub-unit although the largest drawdowns are mostly outside the boundary of the SSSI. Drawdowns associated with abstraction 7/34/*g/0147 also extend into the western side of the site. Drawdowns at the model assessment points (see Figure B2.1a) are summarised in Table 3. Generally vertical gradients on the site are downward for the fully licensed and naturalised model runs. The largest head difference between the fully licensed and naturalised model runs is simulated at the eastern end of Cromes Broad (0.738 m). Head differences tend to decline with increasing distance from Ludham PWS (drawdown in Catfield Fen and Sharp Street are the next highest) between. Estimated drawdowns from the Regional Model compare fairly well cumulative drawdown produced by the radial flow model which were 0.053 m at Reedham Marsh, 0.159 m at Catfield Fen and 0.023 m at Barton Fen.

Table 3 Summary of 'In Combination' Impacts of Licensed Abstractions of Groundwater Levels beneath the site (Comparing Naturalised, Historical and Fully Licensed Model Runs)

Assessment Point	Difference Between Groundwater Levels in Upper Layer (m)		
	Point No	Average	Maximum (1976)
Comparison Between Naturalised and Fully Licensed			
Barton Fen	1	0.042	0.051
Sutton Broad	2	0.052	0.059
Sutton Fen	3	0.043	0.046
West of Barton Broad	4	0.129	0.149
SE of Barton Broad	5	0.082	0.084
Catfield Fen (Outer)	6	0.14	0.139
Catfield Fen (Outer South)	7	0.134	0.138
Sharp Street	8	0.126	0.132
Cromes Broad (East)	13	0.704	0.721
Cromes Broad (West)	10	0.14	0.142

Reedham Marsh	9	0.09	-0.08
Reedham Marsh 2	11	0.08	0.084
Hall Fen	12	0.06	0.06
Comparison Between Historical and Naturalised			
Barton Fen	1	0.012	0.013
Sutton Broad	2	0.016	0.021
Sutton Fen	3	0.012	0.009
West of Barton Broad	4	0.028	0.016
SE of Barton Broad	5	0.039	0.038
Catfield Fen (Outer)	6	0.055	0.049
Catfield Fen (Outer South)	7	0.062	0.061
Sharp Street	8	0.067	0.070
Cromes Broad (East)	13	0.41	0.447
Cromes Broad (West)	10	0.073	0.075
Reedham Marsh	9	0.037	0.037
Reedham Marsh 2	11	0.028	0.026
Hall Fen	12	0.026	0.025

(3) **Comparison of radial flow model results with regional groundwater model results**

In the light of the large discrepancies (more than tenfold) between drawdown predictions of the radial flow model and the regional groundwater model, it was considered appropriate to also regard the following licences as potential contributors to the cumulative drawdown predicted by the regional groundwater model, on a precautionary basis: 7/34/09/*g/0008, 7/34/09/*g/0034, 7/34/09/*g/0087, 7/34/09/*g/0106, 7/34/10/*g/0011, 7/34/10/*g/0009, 7/34/09/*g/0004, 7/34/09/*g/0033, 7/34/09/*g/0058 and 7/34/10/*g/0125 .

(4) Regional Groundwater Model Assessment of Effects on Flows in Low Connectivity Fen Drain Areas - The Yare and North Norfolk regional groundwater model was also used to assess the fully licensed in-combination impact of groundwater abstraction on flows in the drains at Ant Broads and Marshes. For this it is assumed that the net upward flow of groundwater to a modelled near-surface layer represents groundwater flow to the drains. The same three scenarios and years were assessed as described previously.

Regional Groundwater Model output for groundwater flows and other water balance components for the hydrological sub-units (Figure B2.2 shows the model nodes) are presented in Table 4 for the naturalised, historical and fully licensed runs. Stream cell inflows are substantially reduced in Cromes Broad and Catfield Fen (no stream cells are present in the Sharp Street Unit).

Changes in water flux are lower in units further away from the Ludham PWS abstraction. Figure B2.6 shows groundwater inflows to the model stream cells in the Catfield Fen and Cromes Broad hydrological sub-units. Table 4 summarises results with regard to turnover of water in the drains.

Table 4 Estimated Turnover Times in the Drains in Catfield Fen and Cromes Broad

	Naturalised	**Fully Licensed**	**Historical**
Catfield Fen			
Estimated volume of surface drains	15 900 m^3	15 900 m^3	15 900 m^3
Average groundwater inflow	376.2 m^3/day	287.2 m^3/day	345.9 m^3/day
Average turnover time	42.3 days	55.4 days	46 days
Groundwater inflow 1976 stress period	66.9 m^3/day	13.5 m^3/day	43.5 m^3/day
Turnover time during stress period	237 days	1178 days	366 days
Cromes Broad			
Estimated volume of surface drains	7900 m^3	7900 m^3	7900 m^3
Average groundwater inflow	382.1 m^3/day	255.9 m^3/day	317.6 m^3/day
Average turnover time	20.7 days	30.9 days	22.8days

Table 4 (continued) Estimated Turnover Times in the Drains in Catfield Fen and Cromes Broad

	Naturalised	**Fully Licensed**	**Historical**
Cromes Broad			
Groundwater inflow 1976 stress period	200 m^3/day	110.6 m^3/day	131.4 m^3/day
Turnover time during stress period	39.5 days	71.4 days	60.1 days

As indicated in hydrological regime targets for the the natural eutrophic lakes features, where the turnover rate in the drains extends beyond 6 weeks, it is considered that water level becomes more important. This is the case at both Cromes Broad and Catfield Fen. In relation to water depth, Cromes Broad (0.7 m) and Catfield Fen (0.14 m) are predicted to experience the greatest drawdown effects under fully licensed conditions. This would reduce water levels by approximately 20% in shallow fen drains at Catfield Fen (calculated by adding the modelled drawdown to the minimum water level allowed in field dranis, i.e. 55cm, and then calculating the percentage impact of the drawdown on the sum total; in this case 69cm) and 12% in deeper IDB drains (calculated as for field drains but minimum allowed depth is 105cm). The predicted impact at Cromes Broad reduces water levels by 0.7m so it is likely to dry out the ditches.

(4) **River Flows Predicted by the Regional Groundwater Model -** Abstractions and discharges in the upstream catchment of the River Ant may impact on the Ant Broads and Marshes by modifying flow in the River Ant around Ant Broads and Marshes. Modifications to flows in the River Ant may impact on the site by reducing surface water levels within the marshes and fens. Predicted flows from the Yare and North Norfolk regional groundwater model were used to assess the fully licensed in-combination impact of groundwater abstraction on flows in River Ant upstream of Ant Broads and Marshes. The same three scenarios and years were assessed as described previously.

Using model output for the period 1971-2003, Table 5 compares average, drought year (lowest monthly simulated flow in 1976) and percentile flows (i.e. flow in the river for that percentage of time e.g. Q95 is 95%) at various locations in the river for the naturalised, fully licensed and historical model runs for the assessment points shown in Figure B2.1a.

A reduction in flow equivalent to 8.9% of the Qn_{95} is predicted in the River Ant downstream of Ant Broads and Marshes during a fully licensed abstraction scenario.

Reductions in upstream inflows of approximately 5.9% of the Qn95 are predicted as a result of fully licensed abstractions and discharges compared to naturalised flows. Reductions in river flow are greatest in the summer when river flows are low. In contrast, average upstream inflows to the site are modified by less that 1% as a result of historical abstractions and discharges compared to naturalised flows. Under drought conditions (1976) flows increase under the historical model run, suggesting that overall wastewater discharges to the upstream catchment exceed abstractions during drought periods because water is imported from adjacent catchments via the water distribution and sewerage systems. Reductions in flow associated with fully licensed abstractions increase as the river passes through the Ant Broads and Marshes, presumably due to a reduction in inflows to the SSSI from the external catchment as a result of interception of water by abstraction boreholes, particularly Ludham PWS.

Table 5 Summary of 'In Combination' Impacts of Licensed Abstractions of River Flows (comparing naturalised, historical and fully licensed model runs). Assessment Points Shown in Figure B2.2

Assessment Point	River Flow - m^3/day (% reduction in flow from naturalised flows)			
	Point No	Average	1976	Q95
Naturalised				
Upstream of SSSI	3	52257	22461	30212
Upstream Barton Broad	4	59195	23705	32922
Tributary Barton Broad	2	1715	971	1127
Downstream Barton Broad	5	64378	26311	36397
Downstream of SSSI	1	69752	26527	38300
Fully Licensed				
Upstream of SSSI	3	49864 (4.6%)	21281 (5.3%)	28417 (5.9%)
Upstream Barton Broad	4	56324 (4.85%)	22289 (6.0%)	30862 (6.3%)
Tributary Barton Broad	2	1504 (12%)	833 (14%)	1003 (11%)
Downstream Barton Broad	5	60881 (5.43%)	24325 (7.55%)	33772 (7.2%)
Downstream of SSSI	1	65277 (6.4%)	23753 (10.5%)	34880 (8.9%)
Historical				
Upstream of SSSI	3	52355 (-0.2%)	23752 (-5.7%)	28726 (4.9%)
Upstream Barton Broad	4	59164 (0.05%)	24931 (-5.2%)	31505 (4.3%)
Tributary Barton Broad	2	1668 (3%)	952 (2%)	1118 (0.8%)
Downstream Barton Broad	5	64210 (0.26%)	27303 (-3.8%)	34442 (5.4%)
Downstream of SSSI	1	69501 (0.34%)	27628 (-4.15%)	36318 (5.2%)

Site Specific Hydrological Uncertainties

- Limited availability of information on the hydraulic conductivity of the surface layers creates significant uncertainty in the analysis because the behaviour of the surface layers determines the degree to which impacts on deep groundwater levels are translated into impacts on the water table at the surface. Confining clay layers and breaks in the confining layer associated with peat digging or surface drains

may control the influx of groundwater into the site. Hydraulic conductivity in the upper layers also determines the influence of surface water levels on water table levels within adjacent marshes and fens.

- The complex nature of surface water movements within the Ant Broads and Marshes make it difficult to assess impacts on flows in surface drains (including those designated as natural eutrophic lakes and hard oligo-mesotrophic waters). Detailed survey work on the drains and hydraulic modelling of the drainage system would be required to estimate flows in the drains.
- The degree of subsurface flow in areas of hover would also need to be quantified.
- The location of stream leakage cells in the Regional Model are broadly based on the distribution of streams and drains so may not correspond to actual locations of groundwater inflows, which will have a significant bearing on the validity of the estimates of turnover times in the surface drainage system.
- Estimates of the volume of the surface drainage system may also be inaccurate as they are based on assumptions regarding the width and depth of the drains.
- Impacts of salinity on the site are likely to be affected by climate change because rising sea levels will increase the penetration of salinity up the River Ant. In these circumstances maintaining flows in the river may become more important.
- Uncertainties related to the impact of upstream abstractions and discharges on river flow are large because accurate information on the return of abstracted water to groundwater and the river is not available.

Assessment of Ecological Effects

An 8.9% reduction in the naturalised Qn_{95} flow is predicted in the River Ant downstream of Ant Broads and Marshes during a fully licensed abstraction scenario, as indicated in Table 5. Table 3 indicates the drawdown on Ant Broads and Marshes associated with fully licensed conditions compared with naturalised conditions and Table 4 indicates the effects of abstraction on turnover rate in the assessed ditches on some of the hydrological units.

From the hydrological assessment presented in the previous sections it is considered that the mechanisms presented in the EA HD Handbook Appendix 4 likely to affect the features on this site are:

1. Change in water levels or table;
2. Changes in flow velocity or volume;
3. Changed water chemistry;
4. Change in salinity regime;
5. Reduced dilution capacity;
6. Habitat loss.

The following assessment considers these potential effects.

Abstraction may result in features going out of hydrological regime. It should be noted that it is not only the magnitude of the abstraction impact (in terms of centimetres of drawdown) that is considered important for the communities. Communities may be able to withstand relatively sizeable drawdown effects for short periods without being compromised. Where data permit, the duration and frequency of periods out of regime should be determined for the feature at the site under naturalised and under different abstraction scenarios. This allows an estimate of the additional time that the regime is breached given the abstraction scenarios and a determination as to whether there is any increase in frequency out of regime. It has been proposed that where an abstraction scenario results in the feature going out of regime when it would not naturally have done so, then an adverse effect can be predicted. Where a feature naturally goes out of regime an adverse effect can be predicted if the particular abstraction scenario extends the out of regime duration by more than 10% of the growing season (taken as April to September), equating to approximately 18 days in any one growing season. Unfortunately the paucity of monitoring data for the majority of the features on this site prevents this approach being taken to the assessment, which is therefore based solely on the magnitude of predicted impact.

The mechanism for determining an adverse ecological effect on features reliant on flushing flows is as described in the regime target text.

Effects of abstraction on groundwater level have been assessed. It was concluded that abstraction may result in features going out of hydrological regime. However it is not only the magnitude of the abstraction impact in terms of centimetres of drawdown, that is considered important for the communities, as communities may be able to withstand relatively sizeable effects for short periods without being compromised. Therefore it is also considered that, where data permit, the additional duration and frequency of excursions out of regime resulting from abstraction should be assessed. Unfortunately the difficulty with interpretation of site data and topographic information because of uncertainty with regard to ground levels on this site prevents this approach being taken to the assessment, which is therefore based solely on the magnitude of predicted impact.
Predicted impacts are greatest in the Cromes Broad unit (up to 72 cm), with lower impacts predicted for Sharp Street (13.2 cm) and Catfield Fen (13.8 cm). Additionally to the west of Barton Broad there is a predicted impact of 14.9 cm. Surface water levels would exert considerable control over fen water levels near to ditches and where hydrological sub-units have a high connectivity to the river but further away from the river and ditches, effects on groundwater may become more apparent. Additionally, the units mentioned above have low connectivity to the river and hence effects on water levels would not be mitigated by river water levels.

Alluvial woodland is the only non-aquatic feature present in the Cromes Broad unit. The predicted impact of 72 cm is greater than the maximum annual optimum water regime range. Whilst it is unlikely that variations of that magnitude would actually be experienced on site, the absence of monitoring data in the feature and the mitigating effect of links with the river, adds to the uncertainty of the impact. As a result it is not possible to conclude that abstraction at fully licensed rates would not result in an adverse effect on the European feature.
Calcareous fen is the main non-aquatic feature in the Sharp Street unit. The predicted impact of 13.2 cm is just over 33% of the maximum annual optimum water regime range. Calcareous fen, alluvial woodland and transition mires are present in the Catfield Fen unit. 13.8 cm is approaching 50% of the maximum expected water regime range for transition mires but is less of the range for the other two features. As indicated above, the absence of monitoring data in the feature and the mitigating effect of links with the river, adds to the uncertainty of the impact. As a result it is not possible to conclude that abstraction at fully licensed rates would not result in an adverse effect on the European features in these sub-units.

Alluvial woodland is the main feature at the assessment point to the west of Barton Broad. Although the predicted impact here is 14.9 cm it is most likely that the water levels in the Broads would mitigate against this effect being experienced.

The mechanism of effect as a result of groundwater drawdown would be reduced water levels, potentially leading to habitat loss.

The effect of abstraction on river flows is predicted to amount to a reduction equivalent to 8.9% of the Q95 flow at the downstream end of the SSSI. Note that, although there is a prediction of 11% effect on the tributary that enters Barton Broad from the west, it is not thought that this would affect water levels in the Alluvial Woodland as reductions from the tributary that enters Barton Broad would be mitigated for by levels on the Broad itself due to the small proportion this tributary flow contributes to the Broad Hence, it is considered that the overall impact is within threshold and therefore abstraction licenses in the catchment upstream of the SSSI that affect river flows are not predicted to result in an adverse effect on the European features.

In relation effects on turnover rates of ditches supporting the natural eutrophic lakes feature, assessment was only possible for two sub-units, Catfield Fen and Cromes Broad. The assessment indicates that turnover of the both ditch systems naturally takes longer than 6 weeks. In case of Catfield Fen it is predicted to be

around 7.5 months. Therefore an assessment of effect on water level was made. This indicates that drawdown of greater than 10% of the ditch depth would be expected for both areas and the ditches are therefore considered to be out of regime.

In relation to reduced dilution capacity, change in water chemistry and change in salinity regime, the effect of abstraction on river flow is below the threshold of change lower than 10% of Q95, and therefore the potential consequent effects on water chemistry etc. are not considered likely to result in an adverse effect.

In summary therefore, it is not possible to conclude that, under fully licensed conditions, abstraction local to the SSSI would not result in an adverse effect on the European features present. Notably this assessment applies to Cromes Broad, Sharp Street and Catfield Fen. However it is considered that the effects of abstraction in the upstream catchment do not result in an effect on river flows of sufficient magnitude to result in an adverse effect on the site.

A summary of the water resources assessment based on the hydrological impact and assessment of ecological effect is provided in Appendix 1.

SUMMARY CONCLUSIONS RELATING TO THE EFFECTS OF WATER RESOURCES PERMISSIONS ON THE INTEGRITY OF THE INTEREST FEATURES ON SITE

In summary, of the licences considered in this assessment, 18 surface water licences and 99 groundwater licences can be shown to have no adverse effect on the European features of Ant Broads and Marshes either alone or in-combination. Of these licences 45 licences have undergone recent deregulation and 2 licences have been assessed under Regulation 48 of the Habitats Directive; thus these licences cannot be assessed under the Review of Consents.

However, 28 groundwater licences cannot be shown to have no adverse effect on the European features of Ant Broads and Marshes, in-combination and are listed in Column 5 of Appendix 1. Of these 28 licences, 11 have been deregulated and can therefore not be assessed further under the Review of Consents. In addition, for one of these licences (7/34/09/*G/0091) has also been assessed under Regulation 48 and can therefore not be assessed herein.

In total, therefore, no adverse impact can be shown for 70 licences, whilst no adverse impact cannot be shown for 16 licences in –combination and zero licences alone.

The effects of abstraction on the European features on site are considered to be adverse. The effect would be predominantly caused by:

- change in water levels or table, and
- change in flow or velocity regime;

These mechanisms may also lead to:

- reduced dilution capacity
- change in water chemistry, and
- Habitat loss.

Therefore: there is potential for adverse effect on the integrity of the site alone and in-combination from water resource permissions.

Authors: Karina Bray, Peter Daldorph and Andy Brooks
Date: August 2005, updated August 2006 (C. Küttner)

PART C: MULTIFUNCTIONAL IN COMBINATION ASSESSMENT

The multi-functional in-combination assessment considers the impact of the sum of all influences on a site from all plans and projects in the context of prevailing environmental conditions, on each feature of the site. This assessment is based on best available information and follows the joint guidance. However, the assessment has been tailored to reflect significant potential interactions between different plans, projects and features on this site.

Relevant influences on Ant Broad and Marshes SSSI are:

Plans and projects - Appendix 22 consultation aims to identify other plans or projects which could act in-combination with Agency permissions to have an impact on the site.

Internal multifunctional impacts - Agency permissions may have combined impacts that modify and, in some cases, exceed impacts identified in the functional assessments (Part B). Interactions between all permissions, therefore, need to be considered to assess the overall impact on the site.

Prevailing conditions - Background influences on the site such as diffuse pollution and water level management may influence or modify impacts of Agency permissions on the site.

C1 – Plans and Projects (Appendix 22).

English Nature were initially consulted to identify which competent authorities to contact, and to identify relevant plans or projects. As part of the Appendix 22 consultation the following organisations were contacted:

- Internal Drainage Boards
- English Nature
- Anglian Water Services
- Norfolk County Council
- BESL
- Broadland District Council
- Broads Authority

Of these only the IDB, and Norfolk County Council replied to confirm they had no plans or projects for this site that needed considering in any "in combination assessment".

The other organisations provided a “nil return” in the specified period and therefore this is taken as meaning they had no plans or projects that needed including.

EN provided the following information:

International Site Name	SSSI Name	Consent Description	Date Consent Given	Date Reviewed	Further Action	Comments
Broadland	ANT BROADS AND MARSHES	A consent type letter that does not follow the standard formats	26/11/1987	02/05/2002	MAYBE	
Broadland	ANT BROADS AND MARSHES	A consent type letter that does not follow the standard formats	13/01/1988	02/05/2002	MAYBE	
Broadland	ANT BROADS AND MARSHES	A consent type letter that does not follow the standard formats	01/06/1995	02/05/2002	NO	
Broadland	ANT BROADS AND MARSHES	A consent type letter that does not follow the standard formats	20/01/1988	02/05/2002	MAYBE	
Broadland	ANT BROADS AND MARSHES	Formal EN Consent letter following format in Lands Manual/Habitats Regulations Manual	04/07/1990	02/05/2002	NO	
Broadland	ANT BROADS AND MARSHES	Formal EN Consent letter following format in Lands Manual/Habitats Regulations Manual	25/05/1989	02/05/2002	MAYBE	
Broadland	ANT BROADS AND MARSHES	Formal EN Consent letter following format in Lands Manual/Habitats Regulations Manual	01/08/1989	02/05/2002	MAYBE	
Broadland	ANT BROADS AND MARSHES	Formal EN Consent letter following format in Lands Manual/Habitats Regulations Manual	07/12/1987	02/05/2002	MAYBE	

Broadland	ANT BROADS AND MARSHES	Formal EN Consent letter following format in Lands Manual/Habitats Regulations Manual	02/06/1989	02/05/2002	MAYBE
Broadland	ANT BROADS AND MARSHES	Formal EN Consent letter following format in Lands Manual/Habitats Regulations Manual	06/01/1988	02/05/2002	NO
Broadland	ANT BROADS AND MARSHES	Formal EN Consent letter following format in Lands Manual/Habitats Regulations Manual	16/12/1987	02/05/2002	NO
Broadland	ANT BROADS AND MARSHES	Formal EN Consent letter following format in Lands Manual/Habitats Regulations Manual	09/10/1989	02/05/2002	MAYBE
Broadland	ANT BROADS AND MARSHES	Formal EN Consent letter following format in Lands Manual/Habitats Regulations Manual	02/06/1990	02/05/2002	NO
Broadland	ANT BROADS AND MARSHES	Management Agreement S15	01/04/1993	08/05/2002	MAYBE
Broadland	ANT BROADS AND MARSHES	Formal EN Notice and Consent Form following format in the Lands Manual/Habitats Regulations Manual	01/02/1988	02/05/2002	MAYBE

Broadland	ANT BROADS AND MARSHES	Formal EN Notice and Consent Form following format in the Lands Manual/Habitats Regulations Manual	13/10/1989	02/05/2002	MAYBE
Broadland	ANT BROADS AND MARSHES	Formal EN Notice and Consent Form following format in the Lands Manual/Habitats Regulations Manual	24/05/1989	02/05/2002	NO
Broadland	ANT BROADS AND MARSHES	Formal EN Notice and Consent Form following format in the Lands Manual/Habitats Regulations Manual	22/05/1989	02/05/2002	NO
Broadland	ANT BROADS AND MARSHES	Formal EN Notice and Consent Form following format in the Lands Manual/Habitats Regulations Manual	29/07/1989	02/05/2002	MAYBE
Broadland	ANT BROADS AND MARSHES	Formal EN Notice and Consent Form following format in the Lands Manual/Habitats Regulations Manual	02/08/1990	02/05/2002	NO

Broadland	ANT BROADS AND MARSHES	Formal EN Notice and Consent Form following format in the Lands Manual/Habitats Regulations Manual	29/03/1988	02/05/2002	MAYBE
Broadland	ANT BROADS AND MARSHES	Formal EN Notice and Consent Form following format in the Lands Manual/Habitats Regulations Manual	08/12/1987	02/05/2002	MAYBE
Broadland	ANT BROADS AND MARSHES	Formal EN Notice and Consent Form following format in the Lands Manual/Habitats Regulations Manual	12/01/1988	02/05/2002	MAYBE
Broadland	ANT BROADS AND MARSHES	Formal EN Notice and Consent Form following format in the Lands Manual/Habitats Regulations Manual	06/06/1989	02/05/2002	NO
Broadland	ANT BROADS AND MARSHES	Formal EN Notice and Consent Form following format in the Lands Manual/Habitats Regulations Manual	13/10/1989	02/05/2002	MAYBE

Broadland	ANT BROADS AND MARSHES	Formal EN Notice and Consent Form following format in the Lands Manual/Habitats Regulations Manual	20/06/1990	02/05/2002	NO
Broadland	ANT BROADS AND MARSHES	Formal EN Notice and Consent Form following format in the Lands Manual/Habitats Regulations Manual	12/06/1989	02/05/2002	MAYBE
Broadland	ANT BROADS AND MARSHES	Formal EN Notice and Consent Form following format in the Lands Manual/Habitats Regulations Manual	02/08/1990	02/05/2002	NO
Broadland	ANT BROADS AND MARSHES	Formal EN Notice and Consent Form following format in the Lands Manual/Habitats Regulations Manual	02/08/1990	02/05/2002	NO
Broadland	ANT BROADS AND MARSHES	Formal EN Notice and Consent Form following format in the Lands Manual/Habitats Regulations Manual	24/05/1989	02/05/2002	NO

Broadland	ANT BROADS AND MARSHES	Formal EN Notice and Consent Form following format in the Lands Manual/Habitats Regulations Manual	30/06/1990	02/05/2002	NO
Broadland	ANT BROADS AND MARSHES	Formal EN Notice and Consent Form following format in the Lands Manual/Habitats Regulations Manual	27/07/1989	02/05/2002	MAYBE
Broadland	ANT BROADS AND MARSHES	Formal EN Notice and Consent Form following format in the Lands Manual/Habitats Regulations Manual	02/08/1990	02/05/2002	NO
Broadland	ANT BROADS AND MARSHES	Formal EN Notice and Consent Form following format in the Lands Manual/Habitats Regulations Manual	02/08/1990	02/05/2002	NO
Broadland	ANT BROADS AND MARSHES	Site Mangement Statement	01/03/1997	02/05/2002	NO
Broadland	ANT BROADS AND MARSHES	Site Mangement Statement	01/09/1996	02/05/2002	NO
Broadland	ANT BROADS AND MARSHES	Site Mangement Statement **Could not**	01/03/1997	02/05/2002	NO

Broadland	ANT BROADS AND MARSHES	Site Mangement Statement **sort out these**	01/11/1997	02/05/2002	NO
Broadland	ANT BROADS AND MARSHES	Site Mangement Statement **SMS's but no**	01/11/1999	02/05/2002	NO
Broadland	ANT BROADS AND MARSHES	Site Mangement Statement **problems with them**	01/04/1999	02/05/2002	NO
Broadland	ANT BROADS AND MARSHES	Site Mangement Statement	01/11/1996	02/05/2002	NO
Broadland	ANT BROADS AND MARSHES	Site Mangement Statement	01/03/1997	02/05/2002	NO

The activities listed by English Nature relate to ongoing management of the site. Although these influence the distribution and ecological status of the European features in the long term, they do not modify compliance with ecological targets for the current features and, therefore, do not act in combination with Agency permissions to affect the site.

C2 Internal multifunctional impacts

Potential interactions between different types of influence on the site are listed in the hazard matrix (modified from the HD handbook; Table C1). Potentially significant interactions are highlighted in red. This in-combination assessment will therefore focus on these.

Impacts of air pollution on the site are primarily related to acidification and nutrient enrichment. Acidification is unlikely to be important for the Ant Broads and Marshes because of base rich nature of the water. Nutrient enrichment associated with air pollution is related to nitrogen rather than phosphorus so is not relevant to the ecological targets for the site.

There are no waste licences relevant to the Ant Broads and Marshes.

Impacts of water resources permissions on the hydrology of the site which, in turn, affect water quality are the likely to be the most important in-combination impacts on the site. The critical European Features in this respect are, therefore, those with water quality targets; namely Natural Eutrophic Lakes and Hard Oligo-Mesotrophic Waters with benthic vegetation of *Chara* spp (referred to as Hard Oligo-Mesotrophic Waters in the rest of this Section).

Reduced dilution (RD) – Surface and groundwater abstractions can impact on the site by modifying flows in the River Ant and, therefore, modifying dilution of wastewater discharges. Generally this will result in deterioration in river quality, unless effluent quality is better than river water quality.

Impacts of licensed abstractions on river water quality were assessed by combining the modelling tools, developed for the functional assessments (Yare and North Norfolk Regional Groundwater Model for water resources and SIMCAT for water quality). The Yare and North Norfolk Regional Groundwater Model was used to estimate impacts of groundwater abstractions on diffuse inflows (additional Regional Groundwater Model runs were carried out with groundwater abstractions but without surface water abstractions and wastewater discharges to estimate diffuse inflows). Information on diffuse inflows was then input to SIMCAT (headwaters, tributaries and diffuse inflows along the reaches) to assess impacts of groundwater abstractions on water quality in the river (SIMCAT models surface water abstractions). Following the approach used for water resources and water quality functional assessment, the following scenarios were completed to assess the impact of abstractions on water quality.

1) Naturalised: No groundwater and surface water abstractions or discharges (i.e. pollutant inputs only from diffuse sources).
2) Historical: Groundwater and surface water abstractions and discharges at historical rates. Effluent discharges with historical water quality.
3) Fully Licensed (historical effluent water quality): Groundwater and surface water abstractions fully licensed rates. Effluent discharges at historical consented water quality.
4) Fully Licensed (maximum consented effluent water quality): Groundwater and surface water abstractions and discharges at fully licensed rates.

	WASTE	PIR	RSR	WATER QUALITY	WATER RESOURCES	FLOOD DEFENCE & WATER LEVEL MANAGEMENT	AGRICULTURAL RUN-OFF	NATURAL NUTRIENTS SOURCES (AIR AND WATER)	BACKGROUND SOURCES (AIR)	LONG RANGE AIR EMISSIONS
WASTE										
PIR PERMISSIONS				TC NE			NE	TC NE	TC NE A	TC NE A
RSR PERMISSIONS										
WATER QUALITY PERMISSIONS		TC NE			**RD** **TR**	**NE** **TR**	**NE**	**NE**	NE	NE
WATER RESOURCES PERMISSIONS				**RD** **TR**			RD			
FLOOD DEFENCE				**NE, TR**						
AGRICULTURAL RUN-OFF		NE		**NE**	RD					
NATURAL NUTRIENTS SOURCES (AIR AND WATER)		TC NE		**NE**					NE	NE
BACKGROUND SOURCES (AIR)		TC, NE, A		NE				NE		NE
LONG RANGE AIR EMISSIONS		TC, NE, A		NE				NE	NE	

TC	Toxic contamination
NE	Nutrient enrichment
A	Acidification
RD	Reduced Dilution
TR	Transport

Table C1 Matrix of in-combination influences

Figure C1 shows the Regional Model River Stream Nodes that correspond to the Reaches in the SIMCAT model. Table C2 compares water quality and flows at the downstream end of the SIMCAT model (Hunsett Mill) for the four scenarios. Results from the original SIMCAT model (historical discharges and abstractions), developed for the functional water quality assessment are shown for comparison.

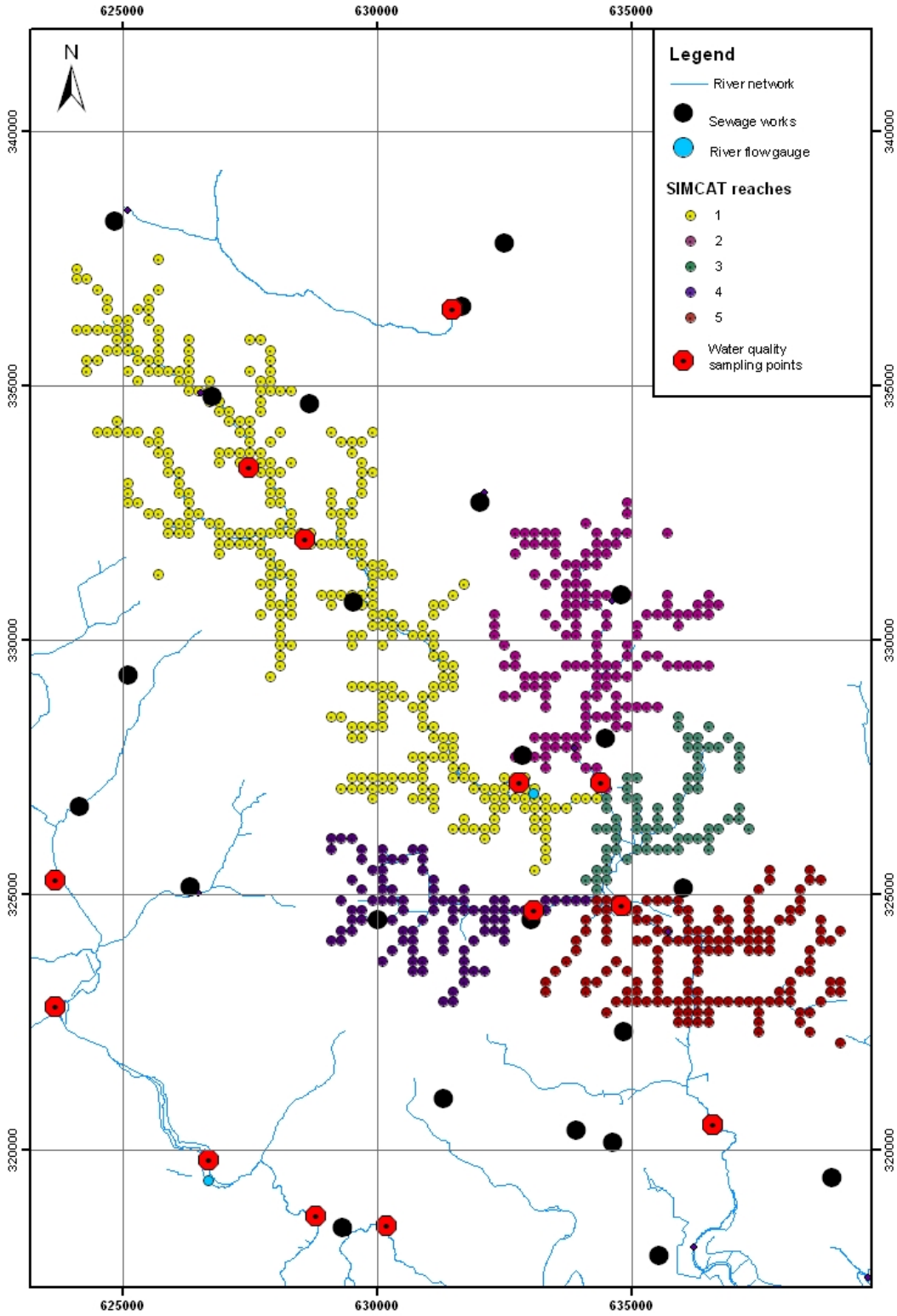

Figure C1 YNN Regional Model stream nodes corresponding to SIMCAT reaches

Scenario	Total phosphorus – mg/l P		River flow – Ml/day	
	Mean	90%ile	Mean	Q95
1 – Naturalised	0.05	0.06	57.87	32.6
2 – Historical abstractions and discharges	0.08	0.11	56.28	29.76
3- Fully licensed abstractions and historical discharges	0.08	0.11	50.09	25.05
4 – Fully licensed abstractions and discharges	0.15	0.22	52.21	26.49
Original SIMCAT model	0.07	0.1	57.06	33.07

Table C2 SIMCAT model results for the River Ant at Hunsett Mill

Results for the original SIMCAT model (historical discharges and flows) and version using YNN model flows are similar with regard to phosphorus and river flows, indicating that the combined model results can be compared directly to the analysis presented in the functional water quality assessment. Increasing abstractions to the fully licensed rate results in no increase in average total phosphorus, indicating that abstractions upstream of Hunsett Mill do not have a significant impact on water quality in the River Ant. Although there are a number of groundwater abstractions downstream of Hunsett Mill (surrounding the Ant Broads and Marshes), no discharges are in this area that were not screened out in the functional assessment on the basis of size and location using jointly agreed guidance. Consequently, the interaction between licensed abstractions and discharges, related to reduced dilution, does not modify the conclusions of the functional water quality assessment or the number of consented discharges taken forward to Stage 4.

Transport (TR) – Substantial areas of the Ant Broads and Marshes are highly connected with the River Ant and/or Barton Broad. Pollutants derived from upstream discharges can, therefore, be transported from the river into connected drains and surrounding wetlands. During the winter, the wetlands are subject to prolonged flooding providing a further pathway for the transport of pollutants into the site.

Licensed abstractions and discharges may modify impacts of consented discharges on the site:

1. Upstream abstractions will reduce river stage levels (Section B2 – Water Resources Assessment) and, therefore, tend to reduce inputs of river water and pollutants into the site. This impact is beneficial with regards to water quality and will, therefore, not result in further consented discharges being identified as impacting on the site (i.e. additional to those identified in the functional water quality assessment). The functional water resources assessment showed that during drought years discharges can exceed abstractions and, therefore, increase river levels and transport of pollutants into the site. However, under these circumstances, the beneficial influence on surface water levels is likely to 'outweigh' the minor detrimental impact on water quality.

2. Abstractions close to the broads and marshes may reduce groundwater and local surface water influxes and, therefore, increase inputs of river water and reduce flushing out of river water. This impact is detrimental with regard to water quality. Impacts of licensed abstractions on water fluxes within the site were assessed as part of the water resources functional assessment (Section B.2) which indicated that groundwater inflows to surface water drains in parts of the Ant Broads and Marshes (e.g. Catfield Fen and Cromes Broad) may be substantially reduced as a result of local groundwater abstractions (Table B2.4). This increases the risk that the water quality targets will be exceeded in the lakes and ditch features. However, the water quality functional assessment assumed that there is a high level of connectivity between the river and the surrounding marshes and, therefore, used phosphorus concentrations in the River Ant as the basis for taking consents forward to Stage 4. Following this approach, changes in flushing of the drains do not result in further consented discharges being identified as impacting on the site (i.e. additional to those identified in

the functional water quality assessment).). These issues may, however, require further consideration at Stage 4 as part of the options appraisal work.

In conclusion, impacts of abstractions and discharges on transport processes do not modify the conclusions of the functional assessments with regard to the permissions that cannot be shown to have no adverse effect on the site. Generally, targets for water fluxes that were applied in the water resources assessment will identify abstraction licenses that have a significant impact on transport processes so the conclusions of the water resources assessment also remain unchanged.

C3 Prevailing conditions

Prevailing background conditions are the cumulative result of all historic influences upon a European site feature that are currently exerting that influence and will continue to do so, irrespective of changes in permissions that result from the Review of Consents process. Potential interactions between different types of influence on the site are listed in the hazard matrix (modified from the HD handbook; Table C1). Potentially significant interactions are highlighted in blue.

Water Level Management - Structures that control surface water level (e.g. flood defences, weirs and sluices) and transfers of water via pumps (e.g. IDB activities) will affect water table levels within wetland European features and, therefore, influence whether they meet ecological targets. Substantial areas of Ant Broads and Marshes are influenced by water level management:

Summer water levels controlled by sluices: Barton Fen, Hall Fen, Sharp Street. Normally these areas flood in the winter.

Water levels controlled by sluices throughout the year (separated from the river by rond). Catfield Internal Fen.

Water levels controlled by pumps. Cromes Broad and surrounding marshes.

Management of these activities by local site managers (e.g. Norfolk Wildlife Trust) and IDBs (e.g. following Water Level Management Plans) will have an affect in combination with water resource permissions. These include impacts on water table levels and turnover rates in surface drains. They will, therefore, need to be considered in Stage 4 as part of the options appraisal work.

Some areas e.g. Sharp Street Fen is currently embanked providing protection to European features. There can be issues associated with maintenance liability for such embankments. Any proposals to continue to maintain or to withdraw form maintenance may well be needed to be considered within stage 4.

Transport Processes – Transport of pollutants across the site is influenced by management of control structures, flood defences and surface drains. Operation of sluices will influence movement of water from the river to the marshes and fens. Management of flood defences will influence inputs of pollutants during floods. Maintaining open drains by weed-cutting and dredging will increase movement of river water into the site, which is, therefore, detrimental with regards to achieving the total phosphorus targets for Natural Eutrophic Lakes and Hard Oligo-Mesotrophic Waters. These activities are, however, an essential part of management of the ditch features so the detrimental impact of increased nutrients are likely to be 'outweighed' by other ecological benefits.

Nutrient Enrichment (Diffuse Pollution) – Inputs of phosphorus derived from agricultural sources to the site will influence whether ecological targets for total phosphorus for Natural Eutrophic Lakes and Hard Oligotrophic Lakes are met. A high background level of phosphorus associated

with diffuse pollution will make it more likely that upstream discharges result in exceedance of the targets. Assessment of diffuse sources of phosphorus was included in the water quality functional assessment which indicated that 50% of phosphorus loads to the River Ant are derived from diffuse sources (this number will be smaller when phosphorus concentrations are at their highest in the summer). SIMCAT modelling indicated that background ortho-phosphate concentrations associated with diffuse pollution were approximately 0.05 mg/l P. This indicates that at current levels of diffuse pollution, it may be impossible to achieve the ecological target for Hard Oligo-Mesotrophic Waters for features that are heavily influenced by river water. These issues were taken into account in the water quality functional assessment (Section B1) so the conclusions regarding Agency permissions are not changed.

C4 Conclusions

It is concluded that multifunctional in-combination interaction between permissions, do not modify the conclusions of the 'within function' (Section B) assessments. The number of consented discharges taken forward to Stage 4 is, therefore, not changed.

Although influences of prevailing conditions do not modify the conclusions of the 'within function' assessments, they may require further consideration in Stage 4 as part of the options appraisal work.

PART D: APPROPRIATE ASSESSMENT OVERALL CONCLUSIONS

1 Water Quality conclusions with reference to Interest Features –

123 consents were brought forward from stage 2. The discharges to water together with new Appendix 11 and 12 consents have been screened and assessed using new guidance and modelling and will contribute – in combination with diffuse sources - to the loads in the River Ant and tributaries. Most have been deemed of only trivial effect and will not cause an adverse impact on the interest features of the Ant Broads and Marshes SSSI alone or in combination. These will be affirmed at stage 4.
The 10 consents shown in table B15 cannot be shown not to cause an adverse impact on the interest features of Ant Broads and Marshes SSSI alone or in combination, and will be taken forward to stage 4 for further assessment and options appraisal. In addition PR4NF660X will also be considered in the in-combination as part of the stage 4 options appraisal. Any modifications needed will be taken through Regulation 48.

Discharges to land in the stage 2 list were assessed and due to their small volumes, their nature and location it has been concluded that they will not cause an adverse impact on the interest features of the Ant Broads and Marshes SSSI alone or in combination. These will be affirmed at stage 4.
There were also 3 discharges to land previously assessed under the groundwater regulations these will be considered in the in-combination at stage 4 options appraisal. Any modifications needed will be taken through Regulation 48.

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2 Water Resources conclusions with reference to Interest Features –

In summary, of the licences considered in this assessment, 18 surface water licences and 99 groundwater licences can be shown to have no adverse effect on the European features of Ant Broads and Marshes either alone or in-combination. Of these licences 45 licences have undergone recent deregulation and 2 licences have been assessed under Regulation 48 of the Habitats Directive; thus these licences cannot be assessed under the Review of Consents. Please see Column 4 of Appendix 1.

However, 28 groundwater licences cannot be shown to have no adverse effect on the European features of Ant Broads and Marshes, in-combination and are listed in Column 5 of Appendix 1. Of these 28 licences, 11 have been deregulated and can therefore not be assessed further under the Review of Consents. In addition, for one of these licences (7/34/09/*G/0091) has been assessed under Regulation 48 and can therefore not be assessed herein.

In total, therefore, no adverse impact can be shown for 70 licences, whilst no adverse impact cannot be shown for 16 licences in –combination and zero licences alone.

The effects of abstraction on the European features on site are considered to be adverse. The effect would be predominantly caused by:

- change in water levels or table, and
- change in flow or velocity regime;

These mechanisms may also lead to:

- reduced dilution capacity
- change in water chemistry, and
- Habitat loss.

Therefore: there is potential for adverse effect on the integrity of the site alone and in-combination from water resource permissions.

PART E: FINAL APPROPRIATE ASSESSMENT RECORD

1 Summary Table of all permissions

Enter the final numbers of permissions into the table below:

Function	No adverse effect on site integrity **can** be shown	No adverse effect on site integrity **cannot** be shown
Water Quality	113	10
Water Resources	70 (excluding deregulated and Reg 48 licences)	16 (excluding deregulated and Reg 48 licences)

The information contained in this document and used for decision-making purposes has been produced using 'best available information' and current understanding of the site as of June 2005.

2 Conclusion

The following statements must be included:

"This is a record of the appropriate assessment required by Regulation 50 and/or 3(4) of the Conservation (Natural Habitats, &c) Regulations ("Habitats Regulations") 1994, undertaken by the Environment Agency in respect of the Review of Existing Consents, in accordance with the Habitats Directive (Council Directive 92/43/EEC). Having considered that the existing permissions would be likely to have a significant effect on the **Ant Broads and Marshes SSSI part of Broadlands/The Broads /SPA/SAC** *and that the existing permissions were not directly connected with or necessary to the management of the site for nature conservation, an appropriate assessment has been undertaken of the implications of the plans/projects in view of the site's conservation objectives.*

"The site's nature conservation objectives have been taken into account, including consideration of the citation for the site and information supplied by EN/CCW. The likely effects of the existing permissions on the international nature conservation interests for which the site was classified or designated may be summarised as impact of abstraction licences on seepage flows

- *The existing permissions are a combination of those which **can** be shown to adversely effect the site integrity and those which **cannot**. Permissions which cannot be shown to not adversely effect the site will be taken forward for consideration in Stage 4 of the Agency's Review of Consents process; those which can be shown to have no adverse effect will be affirmed in Stage 4.*

Name of Agency officer signing on behalf of Review of Consents group members:

Signed: **Date:**

Name of relevant Agency Area Manager:

Signed: **Date:**

EN/CCW comments on appropriate assessment:

Is there agreement with the conclusion? **YES/NO**

Signed: (EN local team manager/ CCW area officer) **Date:**

APPENDIX 1

1 Example of Table of Decisions as to Adverse Effect

APPENDIX TABLE 1: Water Quality permissions

1 Table of decisions as to adverse effect included as Appendix 1

Permission Number	No adverse effect on site integrity can be shown (both alone and in-combination).	No adverse effect on site integrity cannot be shown	
		Alone	In-combination
AEENF1312			4
AEENF2011	4		
AEENF12002			4
AW4NF704X	4		
AEENF1202	4		
AEENF12104	4		
AEENF2454	4		
AEENF2474	4		
AW4NF1082X	4		
AW4NF1091X			4
AW4NF12216	4		
AW4NF637X			4
AW4NF937X	4		
AWENF103			4
AW4NF807			4
AW4NF174X	revoked		
AW4NF521X	revoked		
AW4NF41	revoked		
AW4NF41X	revoked		
AW4NF868	revoked		
PRENF3708	4		
PR4NF270			4
PR4NF1560		4	
PR4NF568		4	
PRENF327		4	
PR4NF1446	4		
PR4NF1682	4		
PRENF2562	4		
PRETF8563	4		
PR4NF2084	4		
PR4NF284	4		
PRENF127	4		
PR4NF162	4		
PRENF63	4		
PRENF755	4		
PR4NF1084	4		
PR4NF1095X	4		
PR4NF1871	4		

PR4NF1952		4
PR4NF309		4
PR4NF426		4
PR4NF678X		4
PR4NF886		4
PR4NF913		4
PRENF10334		4
PRENF10863		4
PRENF11334		4
PRENF11640		4
PRENF11669		4
PRENF2238		4
PRENF3426		4
PRENF8736		4
PRENF8857		4
PR4NF1657		4
PR4NF1966		4
PR4NF1976		4
PR4NF1978		4
PRENF10135		4
PRENF10136		4
PRENF10224		4
PRENF10379		4
PRENF10617		4
PRENF10854		4
PRENF11408		4
PRENF11750		4
PRENF11812		4
PRENF11813		4
PRENF13199		4
PRENF13371		4
PRENF152		4
PRENF1534		4
PRENF155		4
PRENF179		4
PRENF180		4
PRENF209		4
PRENF220		4
PRENF4089		4
PRENF8347		4
PRENF8468		4
PRENF8714		4
PRENF952		4
PR4NF756		4
PR4NF571	Revoked	
PR4NF1112X	Revoked	
PRELF1463		4
PR4LF11		4

PR4LF112	4
PR4LF1183	4
PR4LF1240	4
PR4LF126	4
PR4LF176	4
PR4LF2053	4
PR4LF236	4
PR4LF245	4
PR4LF248	4
PR4LF286	4
PR4LF290	4
PR4LF311	4
PR4LF333	4
PR4LF479	4
PR4LF541	4
PR4LF576	4
PR4LF619	4
PR4LF710	4
PR4LF82549	4
PR4LF83571	4
PR4LF83630	4
PR4LF84430	4
PR4LF97	4
PRELF1035	4
PRELF119	4
PRELF189	4
PRELF191	4
PRELF3063	4
PRELF3706	4
PRELF372	4
PRELF784	4
PR4LF79796	4
PRELF3180	4
PRELF3524	4
PR4LF127	Revoked
PR4LF1560	revoked
PR4NF660X	Reg 48
AEELF12300	Reg 48
AEELF12298	Reg 48
AEELF12296	Reg 48

APPENDIX TABLE 2: Water Resources permissions

Licence_No	No Adverse Effect on Site Integrity Can be Shown	No Adverse Effect on Site Integrity Cannot be Shown	
		Alone	In combination
7/34/05/*G/0001	Deregulated		
7/34/05/*G/0011	Deregulated		

7/34/08/*G/0002	Deregulated
7/34/08/*G/0009	Deregulated
7/34/08/*G/0015	Deregulated
7/34/08/*G/0016	Deregulated
7/34/08/*G/0017	√
7/34/08/*G/0019	Deregulated
7/34/08/*G/0021	Deregulated
7/34/08/*G/0024	Deregulated
7/34/08/*G/0030	√
7/34/08/*G/0031	√
7/34/08/*G/0032	√
7/34/08/*G/0033	√
7/34/08/*G/0034	Deregulated
7/34/08/*G/0036	Deregulated
7/34/08/*G/0036	Deregulated
7/34/08/*G/0037	√
7/34/08/*G/0038	√
7/34/08/*G/0039	√
7/34/08/*G/0039	√
7/34/08/*G/0041	√
7/34/08/*G/0043	Deregulated
7/34/08/*G/0045	Deregulated
7/34/08/*G/0049	√
7/34/08/*G/0050	Reg 48
7/34/08/*G/0051	Deregulated
7/34/08/*G/0053	√
7/34/08/*G/0057	√
7/34/08/*G/0058	Deregulated
7/34/08/*G/0059	Deregulated
7/34/08/*G/0093	√

7/34/08/*G/0094	√
7/34/08/*G/0095	√
7/34/08/*G/0096	√
7/34/08/*G/0097	√
7/34/08/*G/0098	√
7/34/08/*G/0099	√
7/34/08/*G/0101	Deregulated
7/34/08/*G/0103	√
7/34/08/*G/0106	√
7/34/08/*G/0107	Deregulated
7/34/08/*G/0109	Deregulated
7/34/08/*G/0110	Deregulated
7/34/08/*G/0111	√
7/34/08/*G/0112	√
7/34/08/*G/0114	√
7/34/08/*G/0115	√
7/34/08/*G/0116	√
7/34/08/*S/0036	√
7/34/08/*S/0036	√
7/34/08/*S/0040	√
7/34/08/*S/0042	√
7/34/08/*S/0044	√
7/34/08/*S/0045	√
7/34/08/*S/0048	√
7/34/08/*S/0050	√
7/34/08/*S/0051	√
7/34/08/*S/0055	√
7/34/08/*S/0108	√
7/34/09/*G/0001	√
7/34/09/*G/0004	deregulated

7/34/09/*G/0006	Deregulated		
7/34/09/*G/0007	Deregulated		
7/34/09/*G/0008	Deregulated		
7/34/09/*G/0011	Deregulated		
7/34/09/*G/0016	Deregulated		
7/34/09/*G/0017	Deregulated		
7/34/09/*G/0020	Deregulated		
7/34/09/*G/0022	Deregulated		
7/34/09/*G/0025	Deregulated		
7/34/09/*G/0027	Deregulated		
7/34/09/*G/0033	Deregulated		
7/34/09/*G/0034	Deregulated		
7/34/09/*G/0035	Deregulated		
7/34/09/*G/0039	Deregulated		
7/34/09/*G/0043	√		
7/34/09/*G/0045	√		
7/34/09/*G/0048	Deregulated		
7/34/09/*G/0049	Deregulated		
7/34/09/*G/0050	√		
7/34/09/*G/0051	√		
7/34/09/*G/0053	Deregulated		
7/34/09/*G/0058			√
7/34/09/*G/0059			√
7/34/09/*G/0060	Deregulated		
7/34/09/*G/0063	Deregulated		
7/34/09/*G/0065	Deregulated		
7/34/09/*G/0066	Deregulated		
7/34/09/*G/0069	√		
7/34/09/*G/0073			√
7/34/09/*G/0080	Deregulated		

7/34/09/*G/0082	√		
7/34/09/*G/0086	√		
7/34/09/*G/0087	Deregulated		
7/34/09/*G/0088			√
7/34/09/*G/0091	Reg 48		
7/34/09/*G/0092			√
7/34/09/*G/0094			√
7/34/09/*G/0095	√		
7/34/09/*G/0096	√		
7/34/09/*G/0097	√		
7/34/09/*G/0101	Reg 48		
7/34/09/*G/0102	√		
7/34/09/*G/0106			√
7/34/09/*G/0113			√
7/34/09/*G/0114	√		
7/34/09/*G/0125	√		
7/34/09/*G/0128	√		
7/34/09/*G/0129	√		
7/34/09/*G/0131	√		
7/34/09/*G/0136	√		
7/34/09/*G/0138A			√
7/34/09/*G/0139			√
7/34/09/*G/0141A			√
7/34/09/*G/0143	√		
7/34/09/*G/0144			√
7/34/09/*G/0146			√
7/34/09/*G/0147			√
7/34/09/*S/0059	√		
7/34/09/*S/0070	√		
7/34/09/*S/0074	√		

7/34/09/*S/0076	√	
7/34/09/*S/0084	√	
7/34/09/*S/0099	√	
7/34/09/*S/0149	√	
7/34/10/*G/0001	Deregulated	
7/34/10/*G/0006	Deregulated	
7/34/10/*G/0009		√
7/34/10/*G/0011	Deregulated	
7/34/10/*G/0015	Deregulated	
7/34/10/*G/0021	Deregulated	
7/34/10/*G/0035	Deregulated	
7/34/10/*G/0041	Deregulated	
7/34/10/*G/0046	Deregulated	
7/34/10/*G/0073	Deregulated	
7/34/10/*G/0102	√	
7/34/10/*G/0108	√	
7/34/10/*G/0111		√
7/34/10/*G/0114	√	
7/34/10/*G/0120	Deregulated	
7/34/10/*G/0124	√	
7/34/10/*G/0125	Deregulated	
7/34/10/*G/0126	√	
7/34/10/*G/0144A	√	

2 Example of Table of Multifunctional Decisions as to Adverse Effect In Combination

APPENDIX TABLE 2: Water Quality permissions and Abstraction Licenses

Permission Number	No adverse effect on site integrity in combination can be shown	No adverse effect on site integrity in combination **cannot** be shown
WATER QUALITY PERMISSIONS		
AEENF1312		
AEENF2011	4	
AEENF12002		
AW4NF704X	4	
AEENF1202	4	
AEENF12104	4	
AEENF2454	4	
AEENF2474	4	
AW4NF1082X	4	
AW4NF1091X		
AW4NF12216	4	
AW4NF637X		
AW4NF937X	4	
AWENF103		
AW4NF807		
AW4NF174X	revoked	
AW4NF521X	revoked	
AW4NF41	revoked	
AW4NF41X	revoked	
AW4NF868	revoked	
PRENF3708	4	
PR4NF270		
PR4NF1560		
PR4NF568		
PRENF327		
PR4NF1446	4	
PR4NF1682	4	
PRENF2562	4	
PRETF8563	4	
PR4NF2084	4	
PR4NF284	4	
PRENF127	4	
PR4NF162	4	
PRENF63	4	
PRENF755	4	

PR4NF1084	4	
PR4NF1095X	4	
PR4NF1871	4	
PR4NF1952	4	
PR4NF309	4	
PR4NF426	4	
PR4NF678X	4	
PR4NF886	4	
PR4NF913	4	
PRENF10334	4	
PRENF10863	4	
PRENF11334	4	
PRENF11640	4	
PRENF11669	4	
PRENF2238	4	
PRENF3426	4	
PRENF8736	4	
PRENF8857	4	
PR4NF1657	4	
PR4NF1966	4	
PR4NF1976	4	
PR4NF1978	4	
PRENF10135	4	
PRENF10136	4	
PRENF10224	4	
PRENF10379	4	
PRENF10617	4	
PRENF10854	4	
PRENF11408	4	
PRENF11750	4	
PRENF11812	4	
PRENF11813	4	
PRENF13199	4	
PRENF13371	4	
PRENF152	4	
PRENF1534	4	
PRENF155	4	
PRENF179	4	
PRENF180	4	
PRENF209	4	
PRENF220	4	
PRENF4089	4	

PRENF8347	4	
PRENF8468	4	
PRENF8714	4	
PRENF952	4	
PR4NF756	4	
PR4NF571	Revoked	
PR4NF1112X	Revoked	
PRELF1463	4	
PR4LF11	4	
PR4LF112	4	
PR4LF1183	4	
PR4LF1240	4	
PR4LF126	4	
PR4LF176	4	
PR4LF2053	4	
PR4LF236	4	
PR4LF245	4	
PR4LF248	4	
PR4LF286	4	
PR4LF290	4	
PR4LF311	4	
PR4LF333	4	
PR4LF479	4	
PR4LF541	4	
PR4LF576	4	
PR4LF619	4	
PR4LF710	4	
PR4LF82549	4	
PR4LF83571	4	
PR4LF83630	4	
PR4LF84430	4	
PR4LF97	4	
PRELF1035	4	
PRELF119	4	
PRELF189	4	
PRELF191	4	
PRELF3063	4	
PRELF3706	4	
PRELF372	4	
PRELF784	4	
PR4LF79796	4	
PRELF3180	4	

PRELF3524	4	
PR4LF127	Revoked	
PR4LF1560	revoked	
PR4NF660X		
AEELF12300		
AEELF12298		
AEELF12296		

APPENDIX TABLE 2: Water Resources permissions

Licence_No	No Adverse Effect on Site Integrity Can be Shown	No Adverse Effect on Site Integrity Cannot be Shown	
		Alone	In combination
7/34/05/*G/0001	Deregulated		
7/34/05/*G/0011	Deregulated		
7/34/08/*G/0002	Deregulated		
7/34/08/*G/0009	Deregulated		
7/34/08/*G/0015	Deregulated		
7/34/08/*G/0016	Deregulated		
7/34/08/*G/0017	√		
7/34/08/*G/0019	Deregulated		
7/34/08/*G/0021	Deregulated		
7/34/08/*G/0024	Deregulated		
7/34/08/*G/0030	√		
7/34/08/*G/0031	√		
7/34/08/*G/0032	√		
7/34/08/*G/0033	√		
7/34/08/*G/0034	Deregulated		
7/34/08/*G/0036	Deregulated		
7/34/08/*G/0036	Deregulated		
7/34/08/*G/0037	√		
7/34/08/*G/0038	√		
7/34/08/*G/0039	√		
7/34/08/*G/0039	√		

7/34/08/*G/0041	√
7/34/08/*G/0043	Deregulated
7/34/08/*G/0045	Deregulated
7/34/08/*G/0049	√
7/34/08/*G/0050	Reg 48
7/34/08/*G/0051	Deregulated
7/34/08/*G/0053	√
7/34/08/*G/0057	√
7/34/08/*G/0058	Deregulated
7/34/08/*G/0059	Deregulated
7/34/08/*G/0093	√
7/34/08/*G/0094	√
7/34/08/*G/0095	√
7/34/08/*G/0096	√
7/34/08/*G/0097	√
7/34/08/*G/0098	√
7/34/08/*G/0099	√
7/34/08/*G/0101	Deregulated
7/34/08/*G/0103	√
7/34/08/*G/0106	√
7/34/08/*G/0107	Deregulated
7/34/08/*G/0109	Deregulated
7/34/08/*G/0110	Deregulated
7/34/08/*G/0111	√
7/34/08/*G/0112	√
7/34/08/*G/0114	√
7/34/08/*G/0115	√
7/34/08/*G/0116	√
7/34/08/*S/0036	√
7/34/08/*S/0036	√

7/34/08/*S/0040	√
7/34/08/*S/0042	√
7/34/08/*S/0044	√
7/34/08/*S/0045	√
7/34/08/*S/0048	√
7/34/08/*S/0050	√
7/34/08/*S/0051	√
7/34/08/*S/0055	√
7/34/08/*S/0108	√
7/34/09/*G/0001	√
7/34/09/*G/0004	Deregulated
7/34/09/*G/0006	Deregulated
7/34/09/*G/0007	Deregulated
7/34/09/*G/0008	Deregulated
7/34/09/*G/0011	Deregulated
7/34/09/*G/0016	Deregulated
7/34/09/*G/0017	Deregulated
7/34/09/*G/0020	Deregulated
7/34/09/*G/0022	Deregulated
7/34/09/*G/0025	Deregulated
7/34/09/*G/0027	Deregulated
7/34/09/*G/0033	Deregulated
7/34/09/*G/0034	Deregulated
7/34/09/*G/0035	Deregulated
7/34/09/*G/0039	Deregulated
7/34/09/*G/0043	√
7/34/09/*G/0045	√
7/34/09/*G/0048	Deregulated
7/34/09/*G/0049	Deregulated
7/34/09/*G/0050	√

7/34/09/*G/0051	√	
7/34/09/*G/0053	Deregulated	
7/34/09/*G/0058		√
7/34/09/*G/0059		√
7/34/09/*G/0060	Deregulated	Deregulated
7/34/09/*G/0063	Deregulated	
7/34/09/*G/0065	Deregulated	
7/34/09/*G/0066	Deregulated	
7/34/09/*G/0069	√	
7/34/09/*G/0073		√
7/34/09/*G/0080	Deregulated	
7/34/09/*G/0082	√	
7/34/09/*G/0086	√	
7/34/09/*G/0087	Deregulated	
7/34/09/*G/0088		√
7/34/09/*G/0091	Reg 48	
7/34/09/*G/0092		√
7/34/09/*G/0094		√
7/34/09/*G/0095	√	
7/34/09/*G/0096	√	
7/34/09/*G/0097	√	
7/34/09/*G/0101	Reg 48	
7/34/09/*G/0102	√	
7/34/09/*G/0106		√
7/34/09/*G/0113		√
7/34/09/*G/0114	√	
7/34/09/*G/0125	√	
7/34/09/*G/0128	√	
7/34/09/*G/0129	√	
7/34/09/*G/0131	√	

7/34/09/*G/0136	√		
7/34/09/*G/0138A			√
7/34/09/*G/0139			√
7/34/09/*G/0141A			√
7/34/09/*G/0143	√		
7/34/09/*G/0144			√
7/34/09/*G/0146			√
7/34/09/*G/0147			√
7/34/09/*S/0059	√		
7/34/09/*S/0070	√		
7/34/09/*S/0074	√		
7/34/09/*S/0076	√		
7/34/09/*S/0084	√		
7/34/09/*S/0099	√		
7/34/09/*S/0149	√		
7/34/10/*G/0001	Deregulated		
7/34/10/*G/0006	Deregulated		
7/34/10/*G/0009			√
7/34/10/*G/0011	Deregulated		
7/34/10/*G/0015	Deregulated		
7/34/10/*G/0021	Deregulated		
7/34/10/*G/0035	Deregulated		
7/34/10/*G/0041	Deregulated		
7/34/10/*G/0046	Deregulated		
7/34/10/*G/0073	Deregulated		
7/34/10/*G/0102	√		
7/34/10/*G/0108	√		
7/34/10/*G/0111			√
7/34/10/*G/0114	√		
7/34/10/*G/0120	Deregulated		

7/34/10/*G/0124	√
7/34/10/*G/0125	Deregulated
7/34/10/*G/0126	√
7/34/10/*G/0144A	√