Fenland District Council
Water Cycle Study
Detailed Study: Stage 2a Report

Final Report
September 2011




Prepared for

Fenland District Council

Revision Schedule

Stage 2a Detailed Water Cycle Study
Sept 2011

Rev	Date	Details	Prepared by	Reviewed by	Approved by
01	Feb 2011	Draft Structure for comment	**Clare Postlethwaite** Senior Consultant	**Carl Pelling** Principal Consultant	**Carl Pelling** Principal Consultant
02	May 2011	Draft v1	**Clare Postlethwaite** Senior Consultant **Amy Ruocco** Graduate Water Specialist	**Carl Pelling** Principal Consultant	**Carl Pelling** Principal Consultant
03	July 2011	Draft_V3_re-issue	**Clare Postlethwaite** Senior Consultant **Amy Ruocco** Graduate Water Specialist	**Carl Pelling** Principal Consultant	**Jon Robinson** Technical Director
04	Aug 2011	Final Drfat (V4)	**Clare Postlethwaite** Senior Consultant **Amy Ruocco** Graduate Water Specialist	**Carl Pelling** Principal Consultant	**Carl Pelling** Principal Consultant
05	Sept 2011	Final Report	**Clare Postlethwaite** Senior Consultant **Amy Ruocco** Graduate Water Specialist **Dr James Riley** Principal Biodiversity Consultant	**Carl Pelling** Principal Consultant	**Jon Robinson** Technical Director

URS/Scott Wilson
Scott House
Alençon Link
Basingstoke
RG21 7PP

Tel 01256 310200
Fax 01256 310201

www.urs-scottwilson.com

Table of Contents

Executive Summary

The district of Fenland is expected to experience a significant increase in housing and employment provision over the period to 2031. This growth represents a challenge in ensuring that both the water environment and water services infrastructure has the capacity to sustain this level of growth and development proposed.

A joint Outline Water Cycle Study (WCS) was completed with East Cambridgeshire District to determine constraints that may be imposed by the water cycle in both districts. A further Detailed Stage 2a WCS has been completed for Fenland using initial growth locations and numbers from the development of the Neighbourhood Planning Vision Study for the District.

This information has been used to determine how the water cycle constraints identified in the Outline WCS may relate to potential settlement growth areas, if and how the constraints can be resolved and how they may impact on phasing of development over the plan period. Furthermore, it provides a more detailed suggested approach to the management and use of water which demonstrates ways to ensure that the sustainability of the water environment in the study area is not compromised by growth. The Stage 2a study has been undertaken in acknowledgement that a full Stage 2 Detailed WCS could not be completed without preferred development locations being identified in the District; but that further detailed assessment work was required to inform the development of the Council's emerging Local Development Framework and the potential locations for growth identified therein.

Three levels of growth were considered in the detailed study based on projected growth figures and on the development of various 'opportunity zones' in the main settlements in the District and how these zones may be developed out over the planning period to 2031.

The Wastewater Strategy

Wastewater Treatment

The Stage 2a study has shown that several Wastewater Treatment Works (WwTWs) have capacity to accept wastewater flow from all three levels of growth without need for improvements to treatment infrastructure. This is the case for Manea Town, Chatteris, Parsons Drove and Benwick. Growth is not constrained by wastewater treatment in these locations.

At the remaining WwTWs of Doddington, March, West Walton and Whittlesey, improvements are required in order to accommodate the growth to ensure that the increased wastewater flow discharged does not impact on the current quality of the receiving watercourses, their associated ecological sites and also to ensure that the watercourses can still meet with legislative requirements.

The improvements required at West Walton WwTW and Doddington WwTW are achievable over the plan period within the limits of conventionally applied technology and hence, a solution can be implemented to allow growth in these catchments to proceed.

However, the Stage 2a assessments have shown that improvements beyond conventionally applied technology are required at both March WwTW (due to water quality) and Whittlesey (due to physical constraints in the Middle Level drainage area). Early phasing of development in these locations may need to be restricted until solutions are developed. The WCS has concluded that the study partners, including Fenland District Council, the Environment Agency, the Middle Level Commissioners and Anglian Water should work together to determine if any of the potential solutions proposed in the Stage 2a study are acceptable and hence conclude when and how much development can be accomodated in Whittlesey and March.

In all cases, the assessments have shown that the ability of watercourses to meet future water quality targets (Good Status or Potential) under the Water Framework Directive will not be compromised by growth alone and hence growth should not be seen as a barrier to watercourses in the District meeting 'Good Status' in the future.

Ecological impacts on designated sites

There is one statutory designated site and one County Wildlife Site which were identified in the outline WCS as being connected to WwTW discharges in Fenland – Nene Washes SAC/SPA/Ramsar site/SSSI and Forty Foot Drain (East) County Wildlife Site. It has been identified that the new development in Chatteris (which drains to Forty Foot Drain) can be accommodated within the remaining headroom of the existing consent. Impacts will therefore have been assessed when the initial consent was granted and have not been considered further as part of the detailed WCS. At the time of the Outline WCS it was considered that there was a hydraulic link enabling WwTW discharges into the Whittlesey Dyke to reach Morton's Leam. However, correspondence with the Mid-Level Commissioners has now confirmed that Whittlesey Dyke is in fact part of the Mid-Level Commissioners pumped drainage system and despite the proximity of its western end to Morton's Leam is pumped north-east (away from the SAC/SPA/Ramsar site/SSSI) into the Middle Level Main Drain, which is in turn pumped into the Great Ouse at Wiggenhall St Germans, 12km downstream of the Ouse Washes. Based on this information, it can be concluded that there is unlikely to be a significant effect on the interest features of the Nene Washes SAC/SPA/Ramsar site/SSSI due to discharges from Whittlesey WwTW.

The Nene Washes SAC is vulnerable to (and already suffering from) excessive flooding. However, it has now been established that Whittlsey WwTW is not hydrologically connected to Morton's Leam and a conceptual plan to potentially discharge effluent from the WwTW directly into Morton's Leam is not to be taken forward. As such, there is no mechanism for discharges from Whittlesey WwTW to exacerbate flooding in the Nene Washes.

Ecology outside designated sites

In addition to impacts on designated sites, a range of other UK or Cambridgeshire BAP species or otherwise protected/notable species that are found in Cambridgeshire can be affected by wastewater discharge. Of the four WwTWs in Fenland which will require a change to their consents in order to comply with the Water Framework Directive requirements, March will require novel treatment solutions. These will need to take into account ecological impacts on these species and others using the receiving watercourses as part of any planning application associated with expansion proposals.

Sewer Capacity

In order to ensure wastewater from growth can be drained to the WwTWs, a high level assessment of sewer capacity constraints on potential growth opportunity zones was undertaken. This assessment has been based on the opportunity zones within the 'Neighbourhood Planning Vision Study' for the District.

The Stage 2a assessment concluded that several growth zones will require significant developer contribution towards sewerage upgrades and new sewerage infrastructure before growth can proceed; this is largely due to the existing system already being at capacity and that sewer flooding is an existing issue in several key settlements in the District.

Significant investment from developers and Anglian Water Services will be required in the following locations before growth can be served:

- Wisbech;
- growth zones to the south of March;

- growth zones to the south of Chatteris; and
- growth zones to the north of Whittlesey.

The Water Supply Strategy

The Outline WCS concluded that Fenland would have adequate water supply to cater for all levels of growth in the plan period; however there is a drive to ensure the delivery of sustainable development for Cambridgeshire as a whole and hence there are key drivers requiring that water demand is managed in the study area to achieve long term sustainability in terms of water resources. The study area is in the driest part of the UK and key sources of water (rivers and aquifers) are considered to be at their limits of abstraction before ecosystems reliant on them would be adversely affected. It is also predicted that climate change will further reduce available water resources.

In order to reduce reliance on raw water supplies from rivers and aquifers, the Detailed WCS has set out ways in which demand for water as a result of development can be minimised without incurring excessive costs or resulting in unacceptable increases in energy use. In addition. the assessment has considered how far District can be moved towards achieving a theoretical 'water neutral' position i.e. that there is no net increase in water demand between the current use and after development has taken place. A pathway for achieving neutrality as far as practicable has been set out, including advice on:

- what measures need to be taken technologically to deliver more water efficient development;
- what local policies need to be developed to set the framework for reduced water use through development control;
- how measures to achieve reduced water use in existing and new development can be funded; and
- where parties with a shared interest in reducing water demand need to work together to provide education and awareness initiatives to local communities to ensure that people and business in the District understand the importance of using water wisely.

Four water neutrality scenarios have been proposed and assessed to demonstrate what is required to achieve different levels of neutrality in the District. Total neutrality would only be achieved with very high-specification fittings being retrofitted into existing properties as well as rainwater harvesting and greywater recycling in new properties. These features can add significantly to build costs and energy use, particularly greywater recycling. Achieving this scenario would require significant uptake of retrofitted devices in existing homes and businesses.

The assessment concluded that measures should be taken to deliver the first step on the neutrality pathway by implementing the low scenario, which is generally considered to require a small scale level of funding and partnership working. Depending on the success of the first step, higher scenarios could then be aspired to. The following initial measures are therefore suggested by the WCS;

- new housing development must go beyond the minimum requirements of Building Regulations;
- carry out a programme of retrofitting and water audits of existing dwellings and non domestic buildings. Aim to move towards delivery of 10% of the existing housing stock with easy fit water savings devices; and
- establish a programme of water efficiency promotion and consumer education, with the aim of behavioural change with regards to water use.

Agriculture in the study area has a high demand for irrigation water and it is important that public water supply is balanced against the requirements for agriculture as well as navigational requirements to maintain water levels in the Internal Drainage Board's systems.

It has been suggested that storage of winter river flows when water is more abundant could be a potential solution to provide water for irrigation and navigation in the summer months when water entering the Middle Level system is low. The Middle Level Commissioners have a long term plan to locate a suitable storage area which could be used to store excess winter water for use during the summer. The study has concluded that storage of runoff from urban areas could be used at all sites at March, Wisbech and Chatteris and that several sites at Whittlesey could also be suitable.

Ecological impacts

AWS are predicting a supply surplus of available water in 2035 within the water resources zones located within Fenland which would provide sufficient water supply to supply the levels of growth within Fenland through the plan period. Therefore, there will be no impact that hasn't already been covered in the WRMP approval process. There is thus no need to consider water supply issues in this detailed WCS.

Surface Water Drainage Management

Conventional surface water drainage systems for new development were designed to convey rainwater and surface water run-off away as quickly as possible. This helps to prevent flooding of the drained area, but may cause flooding of downstream areas. In addition to the increased flood risk, conventional drainage systems can cause pollution of the receiving watercourses as impermeable surfaces accumulate pollutants such as hydrocarbons, tyre fragments and debris, detergents and grit and particulates.

Sustainable Drainage Systems (SuDS) can be used to both hold back and treat surface water run-off thereby reduce downstream flood risk and protect or improve water quality in the water environment.

The vision for sustainable surface water management in the proposed new growth in Fenland is based on the following key aims:

- 100% separation of surface and foul water drainage;
- linkage to green infrastructure giving multiple benefits to users and ecology;
- linkage to water efficiency measures, including rainwater harvesting; and,
- linkage to the Cambridgeshire wide Surface Water Management Plan (SWMP).

The ultimate vision for Fenland is to achieve 100% above ground drainage for all future developments, where feasible. In addition, above ground drainage should include environmental enhancement and should provide amenity, social and recreational value.

Although SuDS are an important tool in managing surface water drainage in the District, at a site specific level, the requirements of any discharge of surface water from a site are dictated by the specifics of the water level management system operated by the Internal Drainage Board receiving that discharge as they may have a preference for surface water to be discharged from a site more quickly, rather than holding it back. Therefore, the assessment provides advice on how SuDS should be developed to mimic the rate and volume of runoff that would occur from the site prior to development taking place; however the study concludes that a second step should occur whereby developers or development control officers seek the advice of the relevant Internal Drainage Board to determine whether retention of surface water is preferable to a faster (but controlled) rate of runoff.

Each of the potential growth zones has been assessed for SuDS suitability and advised provided to inform the Neighbourhood Planning Vision Study for the District.

Ecological Opportunities

There may be opportunities for treated effluent to be used at a greater distance to supplement wetland habitat creation initiatives such as the Great Fen Project, although this would be subject to confirmation of acceptable water quality standards and non-prohibitive costs of infrastructure delivery.

None of March, Wisbech and Whittlesey settlements are identified as being near any corridors or strategic greenspace identified within the Cambridgeshire Green Infrastructure Strategy, but the development areas around these settlements all have potential for the enhancement of ecological value through new SuDS opportunities linked to the new development which could provide habitat for Cambridgeshire BAP species and habitats. Chatteris is linked to several green corridors identified within the Cambridgeshire Green Infrastructure Strategy and development proposals at this settlement could therefore help to enhance these corridors.

Water Cycle Strategy Recommendations and Policy

In order to support the further development of the Fenland Neighbourhood Planning Vision Study with respect to water services infrastructure and the water environment, the detailed WCS reports a high level assessment of the potential constraints on each of the growth areas (or towns) where the majority of development within Fenland is likely to take place.

The following policies are also recommended to deliver the Water Cycle Strategy:

WW1 – Development Phasing March

Development in March will need to be restricted to a minimal annual completion rate to be agreed with AWS and EA until a new solution for the WwTW (water quality) is in place, likely to be post 2015.

WW2 – Development Phasing Whittlesey

Development in Whittlesey will need to be restricted to a minimal annual completion rate to be agreed with AWS and EA until a new solution for the WwTW (physical constraints in the Middle Level) is in place, likely to be post 2015.

WW3 – Wastewater Discharge permission

Middle Level Commissioner's consent should be sought for any discharges resulting in an increase in rate or volume to the Middle Level drainage system.

WS1 – Water Efficiency in New Homes

Ensure all housing is water efficient, new housing development must go beyond Building Regulations and as a minimum reach Code for Sustainable Homes Level 1 or 2

WS2 – Water Efficiency Retrofitting

Carry out a programme of retrofitting and water audits of existing dwellings and non-domestic buildings. Aim to move towards delivery of 10% of the existing housing stock with easy fit water savings devices

WS3 – Water Efficiency Promotion

Establish a programme of water efficiency promotion and consumer education, with the aim of behavioural change with regards to water use.

SWM1 – Sewer Separation

Developers should ensure foul and surface water from new development and redevelopment are kept separate where possible. Where sites which are currently connected to combined sewers are redeveloped, the opportunity to disconnect surface water and highway drainage from combined sewers must be taken.

SWM2 – Above Ground Drainage

Developers should aspire to achieve 100% above ground drainage for all future developments, where feasible. Where this is not feasible due to for example housing densities, land take, ground conditions, topography, or other circumstances, the development proposals should maximise opportunities to use SuDS measures which require no additional land take, i.e. green roofs, permeable surfaces and water butts.

SWM3 – SuDS and Green Infrastructure

Where SuDS are considered appropriate by the appropriate IDB, developers should ensure linkage of SuDS to green infrastructure to provide environmental enhancement and amenity, social and recreational value. SuDS design should maximise opportunities to create amenity, enhance biodiversity, and contribute to a network of green (and blue) open space.

SWM4 – SuDS and Water Efficiency

Where SuDS are considered appropriate by the appropriate IDB, developers should ensure linkage of SuDS to water efficiency measures, including rainwater harvesting.

SWM5 – Linkages to SWMP and SFRA

Where SuDS are considered appropriate by the appropriate IDB, developers should ensure SuDS design supports the findings and recommendations of the Cambridgeshire wide Surface Water Management Plan (SWMP) and the Fenland District Wide Level 1 SFRA and Wisbech Level 2 SFRA).

SWM6 – Water Quality Improvements

Developers should ensure that discharges of surface water are designed to deliver water quality improvements in the receiving watercourse or aquifer where possible to help meet the objectives of the Water Framework Directive.

ECO2 – Biodiversity enhancement

It is recommended that the Council include a policy in its Core Strategy which commits to seeking and securing (through planning permissions etc) enhancements to aquatic biodiversity in Fenland through the use of SuDS and other means as outlined in this WCS (subject to appropriate project-level studies to confirm feasibility including environmental risk and discussion with relevant authorities) in keeping with the Cambridgeshire Green Infrastructure Strategy.

Other recommendations include:

- key partners in the WCS maintain regular consultation with each other as development proposals progress;
- The WCS should remain a living document, and be reviewed on an annual basis as development progresses and appropriate changes are made to the various studies and plans that support it;
- consider the change to Planning Policy Statements that will occur as a result of consolidation of national planning policy into a single National Planning Policy Framework and how this may affect the overall water cycle strategy; and

- consider how policies may need to change as the Localism Bill takes effect through 2011 into 2012;
- Natural England have also requested that detailed studies to evaluate the impacts of increased discharges on wider biodiversity;
- The conclusions of the ecological assessments contained within this Stage 2a will need to be re-examined in more detail to confirm their validity;
- Where the proposed development figures are significantly different to those assessed in this Stage 2a Detailed WCS, review the findings of the Stage 2a Detailed WCS assessment to see if further screening of sites is required or conclusions need to be altered; and
- Consider opportunities for sites to link with Green Infrastructure; and
- a Stage 2b (complete WCS) should be considered once preferred development sites are known. A potential scope is provided as part of the Stage 2a WCS report.

Glossary of Acronyms and Abbreviations

Abbreviation	Description
AMP	Asset Management Plan
AWS	Anglian Water Services
BAP	Biodiversity Action Plan
BGS	British Geological Society
BOD	Biochemical Oxygen Demand
BREEAM	Building Research Establishment Environmental Assessment Method
CAMS	Catchment Abstraction Management Strategy
CBA	Cost Benefit Analysis
CFMP	Catchment Flood Management Plan
CIL	Community Infrastructure Levy
CIRIA	Construction Industry Research and Information Association
CLG	Communities and Local Government
CRC	Carbon Reduction Commitment
CSH	Code for Sustainable Homes
CSO	Combined Sewer Overflow
CWS	County Wildlife Sites
DDC	District Drainage Commissioner
DEFRA	Department for Environment, Food and Rural Affairs
DO	Dissolved Oxygen
DPD	Development Plan Document
DG2	Register of pressure of water mains
DWF	Dry Weather Flow
DWI	Drinking Water Inspectorate
EA	Environment Agency
ECDC	East Cambridgeshire District Council
EEP	East of England Plan (the RSS for the East of England)
EGDB	Ely Group of Drainage Boards
EIB	European Investment Bank
FDC	Fenland District Council
FEH	Flood Estimation Handbook
FFT	Flow to Full Treatment
FMfSW	Flood Maps for Surface Water
GHG	Greenhouse Gas
GI	Green Infrastructure
GQA	General Quality Assessment
GWMU	Groundwater Management Unit

Abbreviation	Description
GWR	Greywater Recycling
HA	Highways Agency
HMWB	Heavily Modified Water Body (under the Water Framework Directive)
IDB	Internal Drainage Board
JNCC	Joint Nature Conservation Committee
l/h/d	Litres/head/day (a water consumption measurement)
LCT	Limits of Conventional Treatment
LDDs	Local Development Documents
LDF	Local Development Framework
LFE	Low Flow Enterprise (model)
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority
MCA	Multi-Criteria Analysis
MLC	Middle Level Commissioners
Ml	Mega Litre (a million litres)
NE	Natural England
NH4	Ammonium
NRD	National Receptor Database (Environment Agency)
NWA	No Water Available (in relation to CAMS)
OFWAT	The Water Services Regulation Authority (formerly the Office of Water Services)
OR	Occupancy Rate
O-A	Over Abstracted (in relation to CAMS)
O-L	Over Licensed (in relation to CAMS)
P	Phosphorous
PE	Population Equivalent
PPS	Planning Policy Statement
PR	Periodic Review
PS	Pumping Station
p/d	Persons per dwelling
Q95	The river flow exceeded 95% of the time
Ramsar	Site designated under the International Convention on Wetlands of International Importance especially as Waterfowl Habitat
RAG	Red/Amber/Green Assessment
RBMP	River Basin Management Plan
RSS	Regional Spatial Strategy (East of England Plan)
RoC	Review of Consents
RQO	River Quality Objective
RQP	River Quality Planning

Abbreviation	Description
RTPI	Royal Town Planning Institute
RWH	Rainwater Harvesting
SAB	SuDS Approval Body
SAC	Special Area for Conservation
SFRA	Strategic Flood Risk Assessment
SPA	Special Protection Area
SPD	Supplementary Planning Document
SPZ	Source Protection Zone
SS	Suspended Solids
SSSI	Site of Special Scientific Interest
STW	Sewage treatment Works
SUDS	Sustainable Drainage Systems
SWMP	Surface Water Management Plan
SWMS	Sustainable Water Management Study
UKCIP02	United Kingdom Climate Impacts Programme 2002
UKCP09	United Kingdom Climate Projections 2009
UKTAG	United Kingdom Technical Advisory Group (to the WFD)
UKWIR	United Kingdom Water Industry Research group
UPM	Urban Pollution Management
UWWTD	Urban Wastewater Treatment Directive
WCS	Water Cycle Study
WFD	Water Framework Directive
WN	Water Neutrality
WRMP	Water Resource Management Plan
WRMU	Water Resource Management Unit (in relation to CAMS)
WRZ	Water Resource Zone (in relation to a water company's WRMP)
WTW	Water Treatment Works
WwTW	Waste Water Treatment Works

1 Introduction

1.1 Water Cycle Study Need

The district of Fenland is expected to experience a significant increase in housing and employment provision over the period to 2031. This growth represents a challenge to the district in ensuring that both the water environment and water services infrastructure has the capacity to sustain this level of growth and development proposed.

A Water Cycle Study (WCS) has therefore been undertaken to determine what impact this growth might have on the water environment and existing water services infrastructure (WSI). The objective of the WCS is to identify any constraints on housing and employment growth planned for the Fenland district area up to 2031 that may be imposed by the water cycle, and how these can be resolved i.e. by ensuring that appropriate WSI is provided to support the proposed development. Furthermore, it should provide a strategic approach to the management and use of water which ensures that the sustainability of the water environment in the district is not compromised.

1.2 WCS Reporting

The Fenland Water Cycle Study (WCS) has thus far been reported in 3 stages. A joint Scoping Study was produced jointly with East Cambridgeshire District Council, and reported in 2009[1]. Proceeding this, a Stage 1 Outline WCS was undertaken, also as a joint study with East Cambridgeshire and was completed in May 2011[2].

The Stage 1 Outline WCS assessed the baseline conditions of various elements of the water cycle in Fenland and East Cambridgeshire, including the natural water environment and the capacity of the water services infrastructure that would be used to support growth. In addition, the Stage 1 Outline WCS undertook a high level assessment of the likely growth town locations and the proposed levels of growth within in the districts, and determined where growth would be achievable within the existing capacity of both the infrastructure and the water environment at a strategic level. This information has been used in the production of the draft 'Fenland Neighbourhood Planning Vision Study.

A full Stage 2 Detailed WCS would usually follow a Stage 1 Outline WCS to determine the detailed infrastructure and required mitigation solutions required to mitigate any adverse effects or infrastructure capacity shortfalls determined in the Stage 1 Outline WCS. It would provide this information at a level suitable to ensure that there are solutions to deliver growth for the specific identified preferred development allocations, including detailed information regarding infrastructures and the policy required to deliver it. The outcome would be the development of a *water cycle strategy* for the district which informs site specific and other DPDs of the water environment and water services infrastructure issues that need to be considered in bringing growth forward at various sites, including guidance for developers in conforming with the requirements of the strategy.

However, at the time of completion of the joint Stage 1 Outline WCS, it was agreed that insufficient detail was available on potential or preferred options for housing and employment sites within Fenland to enable a full Stage 2 Detailed WCS to be completed; but that there were key strategic issues that required further detailed assessment to inform the development of a

[1] Entec (2009), Cambridgeshire Horizons, East Cambridgeshire and Fenland District Councils: Water Cycle Study and Strategic Flood Risk Assessment Scoping Report
[2] Scott Wilson (2011) – East Cambridgeshire & Fenland Water Cycle Study: Outline Study – Main Planning Report

revised Core Strategy. It was therefore agreed that the Stage 2 Detailed WCS would be split into two stages (2a and 2b) as follows:

- Stage 2a – detailed assessment of the strategic (town specific) infrastructure and mitigation required to deliver growth to further support the development of the Core Strategy; and
- Stage 2b – once sufficient information is available on preferred allocation options, there is the potential to develop a detailed assessment of the site specific infrastructure and mitigation required to deliver growth and complete the Fenland 'water cycle strategy'.

The Stage 2a study has taken the assessment as far as possible with the level of detail on housing and employment locations available and a decision on whether a stage 2b is commenced will be determined by development of the LDF at a later stage in the process.

The requirement to undertake the Stage 2 Detailed WCS for Fenland in two distinct stages also necessitated the requirement for the Stage 2 WCS for East Cambridgeshire to be reported separately. A separate full Stage 2 Detailed WCS has been undertaken for East Cambridgeshire[3].

1.3 Stage 2a Detailed WCS - Study Governance

This Stage 2a Detailed WCS has been carried out with the guidance of the Steering Group established for both the scoping and Stage 1 Outline WCS, comprising the following organisations:

- Cambridgeshire Horizons;
- East Cambridgeshire District Council;
- Fenland District Council;
- Cambridgeshire County Council;
- Anglian Water Services Ltd;
- Environment Agency;
- Natural England;
- Middle Level Commissioners and associated drainage boards; and
- North Level District Internal Drainage Board.

The Steering Group met on a regular basis throughout the completion of the study to both guide and feedback to the assessments undertaken in support of the study. It was also necessary on occasions to hold additional meetings with different Steering Group meetings to agree specific assessment details.

All Steering Group members have reviewed the draft study findings and approved the Stage 2a Draft WCS report for publication.

[3] URS/Scott Wilson (2011): East Cambridgeshire District Council Water Cycle Study - Detailed Study: Stage 2 Report

1.4 Stage 1 Outline WCS – Key Findings

1.4.1 Wastewater and Water Quality

The Stage 1 study concluded that whilst several Wastewater Treatment Works (WwTW) have capacity to accept and treat wastewater flow from growth without any changes, the following did not:

- Whittlesey WwTW;
- Doddington WwTW; and
- West Walton WwTW (serving Wisbech and surrounds).

The above WwTW will require upgrades in order to service the maximum growth levels proposed in the district whilst meeting the water quality targets of the watercourses receiving the discharges and solutions are to be identified through the Stage 2a Detailed WCS.

A high level assessment of capacity in the sewer network determined whether there is likely to be sufficient capacity to transmit additional wastewater flow generated by growth to the various treatment works within existing infrastructure. Several locations are likely to require upgrades to (or new) infrastructure including sewer mains and pumping stations when development locations are known, these locations include:

- Chatteris;
- Wisbech;
- Doddington (& Wimblington); and
- March.

This high level assessment is used in the Stage 2a Detailed WCS to determine preferential growth sectors within the major growth towns.

1.4.2 Water Supply Strategy

The Environment Agency's assessment of water availability[4] suggests that the principal sources of raw water supplying the main towns in Fenland are at their limit of available capacity without causing adverse impact on rivers and ecosystems that rely on them; hence further abstraction and transfer in the future to support growth is unlikely to be available.

However, the Stage 1 Outline WCS concluded that there are adequate demand control measures proposed, and sufficient capacity in current water resource options managed by AWS within Fenland, to cater for the demand for water created by growth.

An outline assessment of the likelihood of achieving water neutrality at the end of the plan period (2031) was undertaken for Fenland. Water Neutrality is theoretically feasible in Fenland for all housing growth scenarios; but, it will require significant intervention (and costs) in existing housing and employment stock to reduce existing demand.

A detailed water efficiency and water neutrality policy pathway has been developed in the Stage 2a Detailed WCS to determine how Fenland can move as close to achieving neutrality as possible.

[4] The Catchment Abstraction Management Strategies (CAMS)

1.4.3 Ecological Assessment

Manea Town Lots WwTW was identified in the outline WCS as potentially having a pathway linking it to the Ouse Washes SAC/SPA/Ramsar site/SSSI.

There is one statutory designated site which was identified in the outline WCS as being connected to WwTW discharges in Fenland – Nene Washes SAC/SPA/Ramsar site/SSSI. Of the eight non-statutory County Wildlife Sites in Fenland which are fluvial systems and therefore potentially vulnerable to water quality changes due to treated effluent discharged upstream, four were identified in the outline WCS as being linked to wastewater treatment works:

- Forty Foot Drain (East) – this feature is linked to Nightlayer Fen and may therefore be influenced by discharges from Chatteris - Nightlayer Fen WwTW
- Goosetree Heronry – This site is linked to the River Nene and therefore possibly be influenced by discharges from Whittlesey WwTW
- Guyhirn Reedbed – This site is linked to the River Nene and therefore possibly be influenced by discharges from Whittlesey WwTW

1.4.4 Flood Risk and Surface Water Management

In terms of fluvial and tidal flood risk, the study area has significant areas which lie within the fluvial and/or tidal flood zone, with only the settlements of Wisbech, March, Whittlesey, and Chatteris, located on 'islands' of high ground above the surrounding area and hence in the lower flood risk category for fluvial and tidal sources. .

The study area is mostly pump drained and hence the greatest flood risk is the lack of appropriate and adequate surface water drainage systems. The area is therefore reliant on flood defences to minimise flood risk to the existing development both from fluvial and tidal flood risk and surface water drainage channels. Due to the historical drainage of the area, the majority of the land lies below the levels of the arterial watercourses, creating a significant residual risk if defences were to be breached or overtopped. Surface water flooding from the managed drainage system is a key flood risk that needs to be considered as capacity of this pumped system is finite.

This high level assessment is used in the Stage 2a Detailed WCS to determine preferential growth sectors within the major growth towns.

Surface water management is a key flood risk consideration in the study area due to the fact that the majority of land put forward for development will be within areas where surface water runoff is managed via complex pumping systems. In order to prevent flooding of land from accumulating surface water, rainwater falling in the Middle Level system has to be actively managed via a network of pumped and gravity drainage channels, in order to move water out of the catchments in a controlled way. These systems are designed to ensure that surface water flooding does not inundate generally low lying urban areas and high grade agricultural land.

The majority of the study area is not suitable for infiltration SuDS and therefore development will be reliant on other types of SuDS such as surface attenuation and runoff restriction, which will require sites to make land provision for this mitigation.

This high level assessment of SuDS suitability is used in the Stage 2a Detailed WCS to determine preferential growth sectors within the major growth towns. Further policy advice has been developed for the Stage 2a Detailed WCS to aid in the delivery of sustainable surface water management. It is acknowledged however that due to the operating requirements of the various IDBs in the district that SuDS are not the most preferred solution in all cases. This is explained further in section 4.6.

1.5 Stage 2a Detailed WCS Scope

The key aims of the Fenland Stage 2a Detailed WCS are to:

- provide an indication as to which of the broad location options in each growth town are preferable with respect to each water cycle issue - and where constraints exist for each site. In conjunction with the findings of the Stage 1 Outline WCS, this will aid in supporting the selection of a preferred spatial strategy for growth;
- determine the required solutions to wastewater treatment for each growth town and how this might impact phasing of development within (and around) each town;
- provide a pathway to achievement of water neutrality;
- provide an interim study-wide water services infrastructure programme to inform phasing based on infrastructure serving growth towns (not site specific locations);
- provide interim developer guidance; and
- provide initial detailed policy recommendations.

1.6 Study Visions and Drivers

For each water cycle 'topic', this Stage 2a Detailed WCS report lists the specific visions and drivers relevant to that topic within the relevant report section and sets out how these specific visions and drivers have shaped the assessment of capacity and solutions required to facilitate sustainable growth. There are however, several key overarching study visions and drivers that are described subsequently given their importance in shaping the direction of the study as a whole:

- Deliver sustainable water management - the overall vision that underpins the WCS is the requirement to ensure that provision of water services infrastructure and mitigation is sustainable and contributes to the overall delivery of sustainable growth and development as set out in the Cambridgeshire Quality Charter for Growth;
- Aspire to achieve water neutrality – determine what is required in order to get as close as possible to ensuring that water demand in Fenland at the end of the plan period is no greater than it is now; and
- Water Framework Directive compliance – to ensure that growth, through abstraction of water for supply and discharge of treated wastewater, does not prevent waterbodies in Fenland (and more widely) from achieving the standards required of them as set out in the Water Framework Directive (WFD) Anglian River Basin Management Plan (RBMP);

A full list of the key legislative drivers shaping the study is detailed in the Stage 1 Outline WCS, and a summary table is included in Appendix 1 for reference.

The joint East Cambridgeshire and Fenland WCS Outline report defined other relevant studies that have a bearing on the provision of water services infrastructure for development. This list includes (but is not limited to the following key documents:

- Level 1 Strategic Flood Risk Assessment for Fenland;
- Level 2 Strategic Flood Risk Assessment for Wisbech;

- Surface Water Management Plan for Cambridgeshire (May 2011);
- The Cambridgeshire Biodiversity Action Plan; and
- The Cambridgeshire Green Infrastructure strategy; and
- The Minerals and Waste Core Strategy (adopted 19th July 2011).

1.6.1 Climate Change

One of the key drivers for delivering sustainable water management is the future uncertainty caused by the effects of climate change on water supplies, flood risk and wastewater management

Nationally, climate change is predicted to have the greatest effect on the East of England. The Stage 1 Outline WCS identified that, in the future, Fenland District is likely to experience hotter drier summers, warmer wetter winters and rising sea levels. This is likely to have a significant effect on environmental conditions and will increase the impact of human activity on the water environment. It is therefore essential that issues of water management and climate change should be viewed in a more holistic way to reflect the interdependency of services and resources that we receive from the natural environment, and plan for their future use accordingly.

Environmental sustainability and more efficient use of natural resources should be a key aspiration for Fenland District Council. In order to achieve these objectives, it is essential that development and water services infrastructure built today considers the future potential impacts of climate change and incorporates adaptive measures to improve future resilience. Investing in infrastructure to adapt to the likely impacts of climate change now could provide long-term cost savings and avoid having to deal with expected climate change impacts in the future, e.g. by providing more climate-resilient infrastructure and 'space for water' now, it is possible to protect societies and economies (to some extent) from its potential impacts such as surface water flooding[5].

1.6.2 Changing Planning Legislation and Policy

At the time of undertaking this detailed WCS, significant changes were being made to national planning policy and legislation governing land use change and development in the UK. The government have proposed the Localism Bill, the aim of which is to essentially decentralise power away from central government to individuals, communities and councils.

One of the key implications of the Localism Bill might be that communities take more control over land use and development decision making at a local level. District councils will need to support communities with this process and hence with understanding the implications of this WCS report with respect to potential impacts and effects of development on water services infrastructure and the water environment going forward.

A draft National Planning Policy Framework had also been produced for consultation; the aim of which is to replace and simplify the system of planning policy statements (PPS).

[5] The Stern Review on the Economics of Climate Change reported that the benefits of strong and early action outweigh the economic costs of not acting. *"Adaptation to climate change – that is, taking steps to build resilience and minimise costs – is essential. It is no longer possible to prevent the climate change that will take place over the next two to three decades, but it is still possible to protect our societies and economies from its impacts to some extent – for example, by providing better information, improved planning and more climate-resilient crops and infrastructure."*

1.7 Water Use – Key Assumption

For all wastewater and water supply assessments, an assumption was made on the likely use per new household going forward in the plan period. It was agreed with AWS that a starting assumption of 150l/h/d would be used to calculate wastewater generation and water use per person, and that this figure would also allow for estimated use in schools, hospitals and commercial property.

It is acknowledged that this figure is less stringent than the current Building Regulations requirement of 125l/h/d for all new homes. However, in their asset planning AWS will continue to assume a higher water use for new homes as their analysis has shown that even when homes are built to a standard of 125 l/h/d, the average household use increases over time due to various factors. AWS are required under their remit to the industry regulator Ofwat, to plan for the expected actual use and hence it is important that conclusions made on infrastructure capacity within this study are consistent with AWS' planning strategies.

This study has however considered the effect that achieving lower average per person consumption would have on infrastructure capacity and the water environment to assist in developing policy that supports and helps lead to a lower per capita consumption.

2 Proposed Growth

2.1 Preferred Growth Strategy

2.1.1 Stage 1 Outline WCS

For the Stage 1 Outline WCS, three possible growth scenarios were assessed in Fenland. The initial scenario (Scenario 1) was based on the growth targets as set out in the 2008 EEP[6]. Two further scenarios (Scenarios 2 and 3) were developed based on the additional growth requirements of the review of the EEP. Whilst the initial growth planning period was until 2026, all three scenarios were extended to 2031 to reflect the later review of the EEP, which examined growth up to 2031.

For each of the three growth scenarios, numbers of dwellings per settlement were assessed at a strategic level (as opposed to site specific) to identify capacity constraints in the water services infrastructure serving each settlement (i.e. trunk sewer capacity) and the impact this would have on the water environment.

2.1.2 Stage 2 Detailed WCS

As discussed, the housing scenarios assessed in the Stage 1 Outline WCS were based on the targets given by the EEP. In the absence of a replacement for the RSS, FDC has developed three further scenarios for assessment through its developing 'Fenland Neighbourhood Planning Vision Study'[7]. These scenarios have been based on bringing forward potential opportunity zones in different phases around each of the main growth of locations of Wisbech, Chatteris, March and Whittlesey (see Section 6 for locations) and each scenario has been assessed in this Stage 2a Detailed WCS.

It is important to note that in the absence of a replacement for the RSS, the authorities of Cambridgeshire issued a statement committing jointly to a continued strategy of growth in the county.

Housing

The total to be assessed in the Stage 2a Detailed WCS ranges from between 11,200 (low scenario) to 20,800 (high scenario). This has been broken down into:

- developments with extant permission;
- estimates volumes from urban capacity study;
- affordable exceptions;
- development in 'opportunity zones' around each growth area; and,
- windfalls (2011-2031).

Table 2-1 below gives a summary of the housing figures assessed in the Stage 2a Detailed WCS.

[6] East of England Plan – The Revision to the Regional Spatial strategy for the East of England, Government Office for the East of England, May 2008, http://www.gos.gov.uk/goee/docs/Planning/Regional_Planning/Regional_Spatial_Strategy/EE_Plan1.pdf
[7](2011) 'shaping Fenlands Future Stage 2 Report v0.1, AECOM 2011

Employment

Employment figures have also been taken from the Fenland Neighbourhood Planning Vision Study and give a total of between 1,510 and 9,443 new jobs spread mainly between Wisbech, Chatteris, Whittlesey and March. Further detail is given in Table 2-2.

At the time of commencing the assessments for this Stage 2a Detailed WCS, the Fenland Neighbourhood Planning Vision Study was at draft stage and hence further work was due to be undertaken on finalising the preferred strategy for growth in the district to feed into the emerging Core Strategy.

During the process of undertaking the detailed assessments, the housing figures for each of the main development towns have been revised downwards from the totals assessed in this Stage 2a Detailed WCS.

The implication of slightly lower housing totals coming forward has been considered within Section 6 of this report, where the water cycle strategy requirements of each of the development towns has been summarised.

Table 2-1: Summary of Housing Figures to be Assessed for Fenland taken from draft Fenland Neighbourhood Planning Vision Study)

Town	Opp zone total	Extant	UCS	Extra UCS	Windfall	Affordable exceptions	Growth outside of district	Scenario 1 total	Scenario 2 total	Scenario 3 total
Wisbech	6200	812	411	482	594	29	1134[8]	5462	6162	9662
Wisbech St Mary Cluster	0	150	0	0	130	29	0	309	309	309
March	5150	491	97	199	379	29	0	3395	5445	6345
Whittlesey	1700	340	20	0	341	29	0	1230	1930	2430
Chatteris	1750	301	79	28	184	29	0	1121	1621	2371
Manea	0	97	0	0	36	29	0	162	162	162
Doddington/Wimblington	0	48	0	0	93	29	0	170	170	170
TOTAL	**14800**	**2239**	**607**	**709**	**1757**	**203**	**1134**	**11849**	**15790**	**21449**

[8] Additional housing taken from Kings Lynn and West Norfolk Water Cycle Study (Entec 2009) and comments provided by the Environment Agency on version 3 (draft) of this WCS.

Table 2-2: Employment Total Breakdown taken from draft Fenland Neighbourhood Planning Vision Study)

	Scenario	Working age population change with housing growth	Rural district employment rate	Sub total	Those living and working in the town	Total projected jobs
Wisbech	1	1,282	75%	962	83%	798
	2	2,305	75%	1,728	83%	1,435
	3	7,416	75%	5,562	83%	4,617
March	1	1,577	75%	1,182	82%	970
	2	4,571	75%	3,428	82%	2,811
	3	5,885	75%	4,414	82%	3,619
Whittlesey	1	-764	75%	-573	50%	-286
	2	259	75%	194	50%	97
	3	989	75%	742	50%	371
Chatteris	1	64	75%	48	59%	28
	2	794	75%	596	59%	351
	3	1,889	75%	1,417	59%	836

3 Detailed Wastewater Strategy

3.1 Stage 1 Outline WCS Conclusions

The Stage 1 Outline WCS concluded that whilst several Wastewater Treatment Works (WwTW) have capacity to accept and treat wastewater flow from growth without any changes, the following did not:

- Whittlesey WwTW;
- Doddington WwTW; and,
- West Walton WwTW (serving Wisbech and surrounds).

The Stage 1 Outline WCS concluded that these WwTWs would require upgrades in order to service the maximum growth levels proposed in the district whilst meeting the water quality targets of the watercourses receiving the discharges. It concluded that solutions need to be investigated through this Stage 2a Detailed WCS..

A high level assessment of capacity in the sewer network determined whether there is likely to be sufficient capacity to transmit additional wastewater flow generated by growth to the various treatment works within existing infrastructure. Several locations are likely to require upgrades to (or new) infrastructure such as sewer mains and pumping stations when development locations are known, including:

- Chatteris;
- Wisbech;
- Doddington (& Wimblington); and,
- March.

This high level wastewater network assessment is used in the Stage 2a Detailed WCS to determine preferential growth sectors within the major growth towns.

The Stage 2a Detailed WCS wastewater treatment assessment has re-considered the conclusions of the Stage 1 Outline WCS assessment with respect to the changes in the growth targets proposed (as set out in Section 2 of this report).

3.2 Wastewater Treatment Options Assessment

3.2.1 Stage 2 Detailed Assessment Methodology

As with the Stage 1 Outline WCS, the volume of wastewater generated from growth in each catchment was re-calculated for the new growth figures and compared to the treatment capacity at each WwTW.

If there was sufficient headroom in the existing volumetric consent of a WwTW, then the growth can be accepted and a solution is feasible without the need for WwTW improvements. These WwTWs were assigned a ‘green’ coding under the Red/Amber/Green (RAG) assessment - see Table 3-1 and Figure 3-1 below which present findings for the higher growth scenario as worst case (all three growth scenarios are detailed in Appendix 2).

It should be noted that West Walton WwTW serving Wisbech can accept all growth for Scenarios 1 & 2 (including growth from West Norfolk – 1,134 new homes) and not exceed the flow consent. It is however exceeded for the higher growth scenario 3 and hence, on a worst case assumption, is assessed for water quality modelling and not included in Table 3-1.

Table 3-1: WwTW with Volumetric Capacity to Accept Growth without Significant WwTW Upgrades

Relevant WwTW	Current BOD 95%ile consent (mg/l)	Current Ammonia 95%ile consent (mg/l)	Current P consent mean (mg/l)	Current Consented DWF (m^3/d)	Future 2031 DWF after growth (scenario 3)[9] (m^3/d)	RAG assessment	
						2031 volumetric capacity (m^3/d)	Approximate residual housing capacity[10]
Manea Town Lots	15A	5	-	320	297	23	177
Chatteris	15A	6	2[11]	3,800	3696	104	335
Parsons Drove	15A	10	-	100	41	59	190
Benwick	15A	17	-	180	146	34	110

For the remaining WwTWs of Doddington, March, West Walton and Whittlesey where the flow consent is exceeded, a new flow consent application is required and as with the Stage 1 WCS, water quality modelling was undertaken to determine the new quality consent conditions which would have to be applied to protect downstream water quality, and whether the consents are realistically achievable. For West Walton WwTW, this was only undertaken for growth scenario 3 as there is sufficient volumetric capacity at the WwTW to serve growth proposed under scenarios 1 and 2. The modelling was undertaken to show what was required to meet the two key requirements of the WFD:

- to ensure no deterioration downstream from the current quality as a result of growth; and,
- where a receiving watercourse is currently less than the target of 'Good Status'[12]), to ensure attainment of future 'Good Status' is not compromised as a result of the growth.

Modelling Tools

Modelling of the quality consents required to meet the two WFD requirements has been undertaken with either one of two methods:

- the Environment Agency's software for calculating permit conditions - the version used is RQP 2.5 (River Quality Planning). The software is a statistical tool that determines what statistical quality is required from discharges in order to meet defined downstream targets,

[9] Scenario 3 has been presented as a worst case – Scenarios 1 and 2 are presented in Appendix 2.
[10] Based on an Occupancy rate of 2.1 and consumption rate of 150 l/h/d
[11] Chatteris WwTW has a PE greater than 10,000 and discharges to a 'Sensitive Areas (Eutrophic)' as designated under the UWWTD, it is therefore required that either: a) the effluent achieves 2 mg/l of P as an annual average; or b) 80% of influent P is removed by the treatment process. Although the WwTW does not have a formal P consent limit, it has been assumed for calculation purposes that a 2mg/l consent standard applies.
[12] Some watercourses are assessed through the WFD as being Heavily Modified waterbodies (HMWB) – these watercourses only need to meet good 'Potential' (as opposed to Status) as an acknowledgement that the existing modifications to the watercourse would in some cases inhibit the watercourse from achieving all of the ecological and water quality targets required of it under Good Status.

or to determine the impact of a discharge on downstream water quality compliance statistics; or

- Load Standstill Calculations – simplified calculations of the reduction required in the concentration of a discharge element to offset the increase in load that would otherwise be discharged as a result of increased flow volumes. The calculation determines what is required to ensure the overall load after increased discharge volumes is no greater than before growth.

The preference has been to use RQP where sufficient data is available to support its use as it provides a greater degree of confidence that downstream targets and consents required to achieve them can be met. However, the model requires detail on the flow data in the receiving watercourse upstream of the discharge and several of the watercourses in the study area do not have suitable flow information to use in the assessment. In these cases, Load Standstill Calculations have been used. Load Standstill has also been used for calculation of discharge consents to tidal waters, due to the highly managed nature of fenland drainage systems. A summary of which methodology has been used for each WwTW is provided in Table 3-2 below.

Table 3-2: Modelling Method Used – Summary

WwTW	RQP used	Load Standstill used
Whittlesey	✓	
March	✓	
Doddington		✓
West Walton[13]		✓

Modelling Steps

The first stage of the modelling exercise was to establish the discharge consent standards that would be required to meet 'No deterioration'; this would be the discharge consent limit that would need to be imposed on AWS immediately at the time that the growth causes the flow consent to be exceeded. No deterioration is an absolute requirement of the WFD and any development must not result in a decrease in quality downstream from the current status.

The second stage was to establish the discharge consent standards that would be required to meet future Good Status under the WFD classification in the downstream waterbody. This assessment was only carried out for WwTW discharging to waterbodies where the current status is less than Good (i.e. currently Moderate, Poor or Bad). This would be the discharge consent standard that may need to be applied in the future, subject to the assessments of 'technical feasibility' and 'disproportionate cost'. Such assessment would be carried out as part of the formal Periodic Review process overseen by OFWAT in order to confirm that the proposed improvement scheme is acceptable.

Modelling Assumptions and Input Data

Several key assumptions have been used in the water quality and consent modelling as follows:

[13] West Walton WwTW discharges to a tidal watercourse hence RQP is not appropriate for consent assessment

- wastewater generation per new household is based on an assumed Occupancy Rate (OR) of 2.1 people per house[14] and an average consumption ion of 150 l/h/d (as set out in water use assumptions – Section 1.7). The 150l/h/d figure makes an allowance for commercial use and use in schools and hospitals etc considered to represent increases in non-domestic use across the study area;
- WwTW current flows were taken as the current consented dry weather flow (DWF) multiplied b 1.25 to obtain a mean flow estimate. Future 2031 flows were calculated by adding the volume of additional wastewater generated by new dwellings (using an OR of 2.1, a consumption value of 150l/h/d and allowance for an increase in infiltration) to the current consented DWF value, with a multiplier of 1.25 to obtain mean flow;
- river flow data for the RQP modelling has been provided by the Environment Agency based on outputs from Low Flow Enterprise (LFE) models – data was provided as mean flow and Q95[15];
- following discussion with the Environment Agency[16] it was established that the waterbody classifications and targets as provided in the River Basin Management Plan, would not be appropriate for this detailed assessment. This is because the RBMPs report a waterbody classification on a large spatial scale, whereas the actual quality of a watercourse local to a discharge may be different and needs to be considered at a local scale. Base data for modelling has therefore been provided by Environment Agency water quality planners. The WFD 'no deterioration' targets for each WwTW are the downstream status for each water quality element, based on river monitoring data collected between 2006 and 2008. Where significant improvement has occurred since 2008, or is planned through confirmed RBMP measures, the 'no deterioration' target is the planned status. It was requested by the Environment Agency that the actual data provided was used in preference over the published status in the RBMP. Details are provided in the Appendix 2 along with the full results and outputs from the water quality modelling.
- WwTW effluent quality data was not available for use in this study, therefore assumptions were applied to the discharge quality statistics ensuring consistent ratios between mean and standard deviation (or co-efficient of variation[17]) for each parameter (see RQP print outs in Appendix 2 for details);
- in order to calculate Load Standstill values, where a P consent is not in place for a WwTW a starting assumption of a mean quality of discharge at 2mg/l was used[18]; and
- for the purposes of this study, the limits of conventionally applied treatment processes are considered to be :
  - 5mg/l for BOD;
  - 1mg/l for Ammoniacal-N; and,
  - 1mg/l for Phosphate.

[14] For modelling purposes AWS uses 2.3p/d (persons per dwelling) for new properties but factor in a declining occupancy in existing properties to balance, at a regional level, forecasts of population growth and housing targets. This brings it in line with the 2.1p/d use din this detailed study. AWS have confirmed (Rob Morris email, Thu 30/06/2011 09:41) that they consider the approach taken in this study as conservative and suitable for WCS purposes. It is the same approach that has been promoted in all the WCS in the AWS region

[15] Defined as the flow value exceeded 95% of the time i.e. a representation of low flows

[16] Steve Hopper, Senior Environment Planning Officer (Water Quality), personal communication, email "RE: East Cambs and Fenland WCS - WFD classes" - Thu 03/06/2010 14:11

[17] Approximately 1 for P, 0.5 for BOD and 0.33 for ammonia

[18] This is a worst case assumption on the basis that many of the WwTW will not treat to this high level of P removal – therefore, if the assessment shows the stricter standard is achievable then it can be assumed that a solution will be feasible

The water quality modelling was then undertaken for the new growth figures; but, using the following steps:

Step 1 – No Deterioration

A calculation was undertaken (using either RQP or Load Standstill) to determine if the receiving watercourse can maintain no deterioration downstream from the current quality with the proposed growth within limits of conventional treatment technology and what consent limits would be required. If no deterioration could be achieved, then a proposed discharge consent standard was calculated which will be needed as soon as the growth causes the WwTW flow consent to be exceeded. This consent has been given in Table 3-3 below and is described as what is required immediately; the results are presented geographically in Figure 3-1. This has presented for growth Scenario 3 to represent worst case; a full breakdown for Scenarios 1 and 2 are presented in Appendix 2 along with the target status of the receiving waterbody for each water quality element.

Table 3-3: Stage 2 Modelling Results for 'No Deterioration'

WwTW	Immediate consent requirement to achieve no deterioration as soon as flow consent is exceeded			Is no deterioration achievable?
	BOD	NH4	P	
Whittlesey	5	5	1	Yes
March	>current consent	>current consent	0.44	No (due to Phospate)
Doddington	17	N/A	N/A	Yes
West Walton	37	18	N/A[19]	Yes

Key

Green Value – no change to current consent required	Amber Value – consent tightening required, but within limits of conventionally applied treatment processes	Red Value – not achievable within limits of conventionally applied treatment processes

For March where no deterioration could not be achieved, a new solution is required for growth in this catchments as the absolute requirement of the WFD cannot be met (see Section on Results Discussion for further detail).

Step 2 – Meeting Future Good Status/

For all WwTW where the current downstream quality of the receiving watercourse *is less than good*, a calculation was undertaken to determine if the receiving watercourse could achieve future Good Status with the proposed growth within limits of conventional treatment technology and what consent limits would be required to achieve this.

The assessment of attainment of future Good Status assumed that other measures will be put in place to ensure Good Status upstream so the modelling assumed upstream water quality is

[19] West Walton discharges to a tidal watercourse where P is not a limiting nutrient – hence, no P consent would be applied.

at the mid point of the Good Status for each element and set the downstream target as the lower boundary of the Good Status for each element.

If Good could be achieved with growth with consents achievable within the limits of conventional treatment, then a proposed discharge consent standard which may be needed in the future has been given in Table 3-4 below.

If the modelling showed that the watercourse could not meet future Good Status with the proposed growth within limits of conventional treatment technology, a further assessment step three was undertaken.

Step 3 – Is Growth the Factor Causing Failure to Meet Future Good Status?

In order to determine if it is growth that is causing the failure to attain future Good Status downstream, the modelling in step 2 was repeated but without the growth in place (i.e. using current flows) as a comparison.

If the watercourse could not meet Good status without growth (assuming the treatment standard were improved to the limits of conventional treatment technology), then it is not the growth that would be preventing future Good status being achieved and the 'no deterioration' consent standard given in Table 3-3 (Step 1) above would be sufficient to allow the proposed growth to proceed.

If the watercourse could meet Good status without growth, then it is the growth that would be preventing future Good status being achieved. Therefore consideration needs to be given to whether there are alternative treatment options that would prevent the future failure to attain Good Status.

These outputs are summarised in Table 3-4 below for the high growth scenario (Scenario 3) as a worst case assumption. Full results for Scenarios 1 and 2 are presented in Appendix 2.

Table 3-4: Stage 2 Detailed modelling results for future Good Status (Scenario 3)

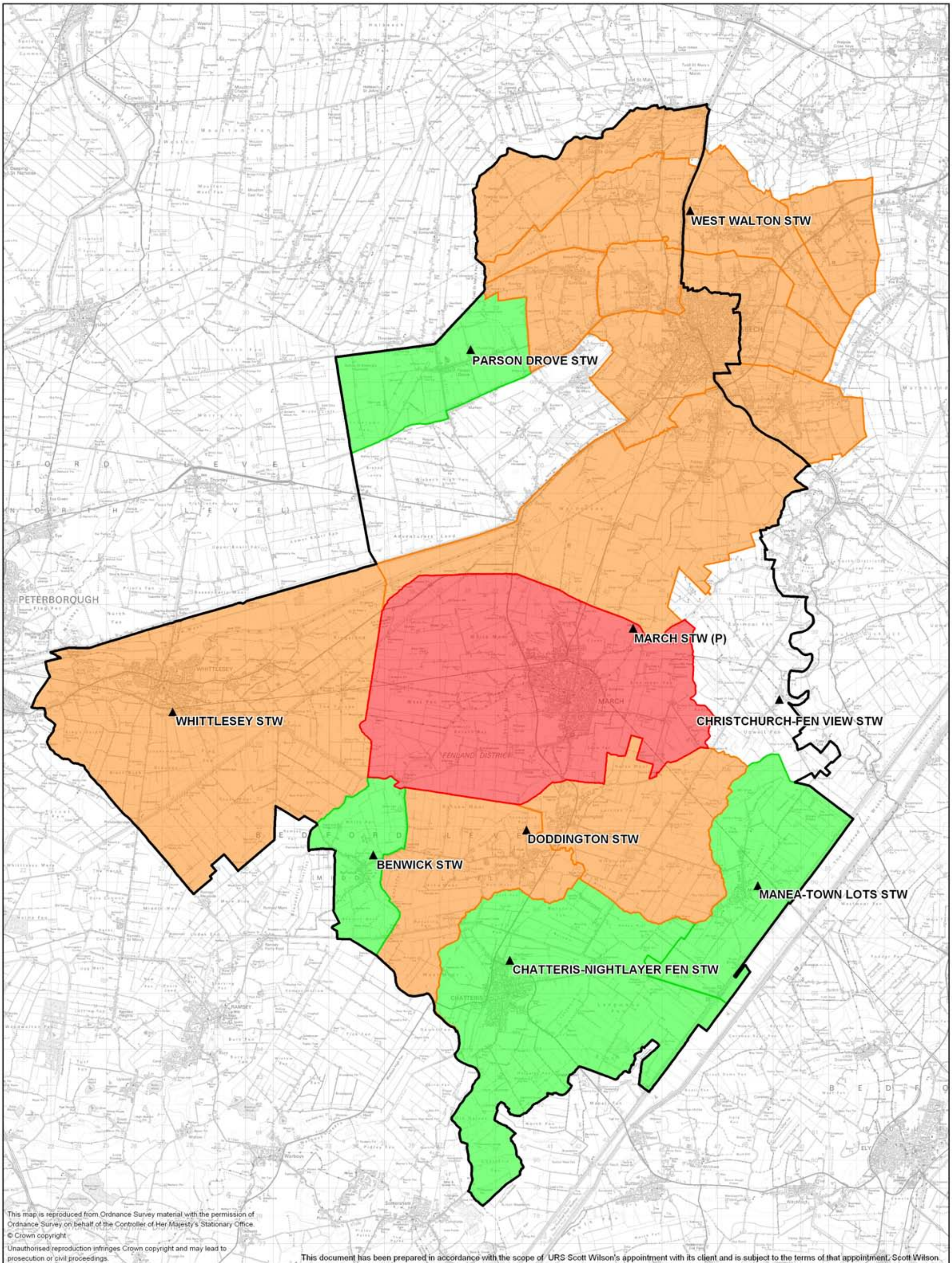
WwTW	Potential consent required to meet future good status			Is Good status achievable?
	BOD	NH4	P	
Whittlesey	N/A – watercourse already at High status	**3**	**0.29** (with growth) **0.33** (without growth)	**No** (with & without growth) Therefore, failure to attain future good status is not as a result of growth.
March	**> current consent**	N/A – watercourse already at Good status	**Not achievable** (as determined through no deterioration assessment	**No**
Doddington	N/A – not possible to assess with available data[20]			

[20] Assessment of future good status requires the use of RQP which requires input flow data for the receiving watercourse upstream. This was not available for all WwTWs.

West Walton	N/A – not possible to assess with available data[21]

The methodology is designed to look at the impact of proposed growth alone, and whether the achievement of Good Status will be compromised. It is important that AWS have an understanding of what consents may be necessary in the future. The RBMP and Periodic Review planning processes will deal with all other issues of disproportionate costs.

[21] Assessment of future good status requires the use of RQP which requires input flow data for the receiving watercourse upstream. This was not available for all WwTWs.



Job Title

FENLAND STAGE 2a WCS

Drawing Title

WwTW Capacity Assessment - No Deterioration (Scenario 3)

Modelled scenarios from RQP outputs

- Increase in flow consent required, quality conditions not achievanle LCT
- Increase in flow consent required, quality conditions achievanle LCT
- Volumetric capacity at WwTW (no need for change in consent)
- Not assessed

Figure 3.1

Scale: 1: 120,000		
Drw AR	App CP	Rev HJ
Chk CP	Date 24/05/2011	Date 01/07/2011

URS
Scott Wilson
www.scottwilson.com

3.2.2 Results Discussion

This previous section has identified constraints from modelling as follows:

- Whittlesey, West Walton and Doddington WwTW will exceed their flow consent; however, water quality modelling has shown that a solution is possible within the limits of conventional treatment. Implementation of the solution may require new treatment processes and may have an impact on phasing of development;
- March WwTW will exceed its flow consent and water quality modelling has shown that to prevent a deterioration in downstream water quality, a solution beyond the limits of conventional treatment would be required.

This section discusses solutions at the Whittlesey, West Walton, March and Doddington WwTWs. All other WwTW in the study area will not exceed their flow consent and do not need a solution before growth can proceed and hence are not discussed further in this WCS report.

Process Upgrade Requirements

For Whittlesey, Doddington and West Walton WwTWs, where a solution is available within limits of conventional treatment, an assessment of the likely process capacity at each of the two WwTWs was undertaken by URS Scott Wilson to determine impact of timing of upgrades on early phasing of development in Fenland. The assessment process included:

- a qualitative assessment of process capacity by consideration of whether the change in consent condition for either BOD, ammoniacal-N or phosphorus was significant in relation to the existing consent condition, and if the change was small, whether the change was likely to be achievable with current treatment processes; and,
- using satellite imagery, whether there is potential for suitable additional land available at the WwTW site to expand for the inclusion of new treatment process streams.

The results are summarised in Table 3-5 for Scenario 3 (worst case assumption).

Table 3-5: Results Summary of Treatment Process Capacity at WwTW Requiring an Increase in Flow Consent as a Result of Growth in Scenario 3

WwTW	Consent parameter	Current consent standards	Consent limits required[22]	Upgrade required	Is there space to expand WwTW
Whittlesey	BOD	15A	5	Yes	Yes, within existing site boundary
	NH4	8	5	Yes	
	P	223	1	It is likely that the change to the consent could be accommodated within the existing process capacity of the WwTW	

[22] As a worst case assessment, consent limits required are for the highest growth scenario (3)
[23] This WwTW has a PE greater than 10,000 and discharge to 'Sensitive Areas (Eutrophic)' as designated under the UWWTD, it is therefore required that either: a) the effluent achieves 2 mg/l of P as an annual average; or b) 80% of influent P is removed by the treatment process. Although the WwTW do not have a formal P consent value, it has been assumed for calculation purposes that a 2mg/l consent standard applies.

WwTW	Consent parameter	Current consent standards	Consent limits required[22]	Upgrade required	Is there space to expand WwTW
West Walton	BOD	40	37	It is likely that the change to the consent could be accommodated within the existing process capacity of the WwTW	Yes, if adjacent land is available
	NH4	20	18		
	P	N/A	N/A	N/A	
Doddington	BOD	20	17	It is likely that the change to the consent could be accommodated within the existing process capacity of the WwTW	Yes, if adjacent land is available
	NH4	N/A	N/A	N/A	
	P	N/A	N/A	N/A	

West Walton WwTW (Wisbech)

It is considered that the consent changes required at West Walton WwTW for BOD and Ammoniacal-N are relatively small and hence are likely to be achievable without the need to add new process streams to the WwTW. While consent limits are not likely to be a constraint on growth there are known limits within the network catchment that would need to be considered and addressed as appropriate before development proceeds (this is detailed in the Wisbech specific assessment – section 6). As the WwTW discharges to the tidal river Nene there is no requirement for a Phosphate consent, as P is not a limiting nutrient is tidal waters. This assessment includes for 1,134 new homes currently planned in West Norfolk which will also drain to Wisbech WwTW.

Doddington WwTW

The consent changes for BOD are considered relatively small and hence may be achievable without the need to add new process streams. There are no current permit limits for Ammonia or Phosphate so any changes/improvements needed to meet the WFD requirements would be pursued through the formal AMP planning process.

Whittlesey WwTW

Process upgrades required at Whittlesey (for BOD Ammonia), are significant, and hence would require new process streams to be added in order to meet the tighter quality conditions on the new discharge consent;. It is considered that upgrades required to deliver these improvements as part of the new application for a discharge consent would not be delivered in full until AMP6 (2015 onwards). Because the WwTW is considered to be at its volumetric discharge consent limit before a new consent would be needed, it is important to consider the hydraulic limitations on further discharge to the Middle Level system as discussed below.

Whittlesey WwTW – Hydraulic issues

A number of new houses are proposed in the town of Whittlesey and surrounds, ranging from 1,230 in Option 1 to 2,430 in Option 3. This would result in an additional wastewater flow of between $484m^3/d$ and $957m^3/d$.

The Stage 1 Outline WCS findings on current capacity at Whittlesey WwTW were based on a conservative approach that a new consent was being applied for as a result of recent flow audits and hence there was limited capacity to accept wastewater flows from growth. An increase in consented discharge volumes would therefore be required to facilitate any growth.

Subsequent discussions with AWS and MLC have confirmed that there are already hydraulic capacity concerns in the Whittlesey Dyke (receiving drain) and onwards to the Old River Nene with the volumes now consented for discharge. As a result, MLC have confirmed that they would be unlikely to consent further increases in discharge quantity from Whittlesey WwTW in order to prevent an increase in downstream flood risk. Several options therefore need to be considered in a separate study as part of the Stage 2b Detailed WCS:

- modelling of the Whittlesey Dyke and Old River Nene using the MLC ISIS hydraulic model of the system to determine whether there is any additional capacity for further discharge to be accepted at Whittlesey WwTW[24];
- consider whether water demand measures could free up capacity in the WwTW to accept additional flow within the existing consent;

Options for onsite treatment (i.e. not utilising the Whittlesey WwTW for treatment of wastewater from growth) are not considered to be feasible owing to:

- the geology and soils are not suitable for treatment and discharge to ground, owing to the low infiltration capacity; and
- it being contrary to EA guidance and FDC's Building Control section, which request that new development only connect to WwTWs operated and controlled by the water company.

It is considered that any growth connecting to the existing WwTW is not possible owing to an absolute constraint on hydraulic capacity in the Middle Level system, and that no growth can be accepted until further work is undertaken to determine a solution for the additional discharge. These constraints represent the combined view of the service providers and should be considered very carefully when planning for growth in Fenland. There would be significant challenges to delivering growth in areas that are highlighted in this WCS as having no hydraulic capacity.

New Solution Requirements – No Deterioration

The modelling results show that there is one wastewater catchment where deterioration from the current WFD waterbody status would result from the proposed growth and hence would require a new solution:

- March (for phosphate).

March WwTW

The modelling for March WwTW has demonstrated that there is no requirement to tighten the consent for BOD or Ammonia to maintain downstream WFD status; but that a consent for P will be required which is considered beyond that achievable within the limits of available technology (i.e. less than 1 mg/l). Although the WwTW discharges to The Twenty Foot River, the nearest

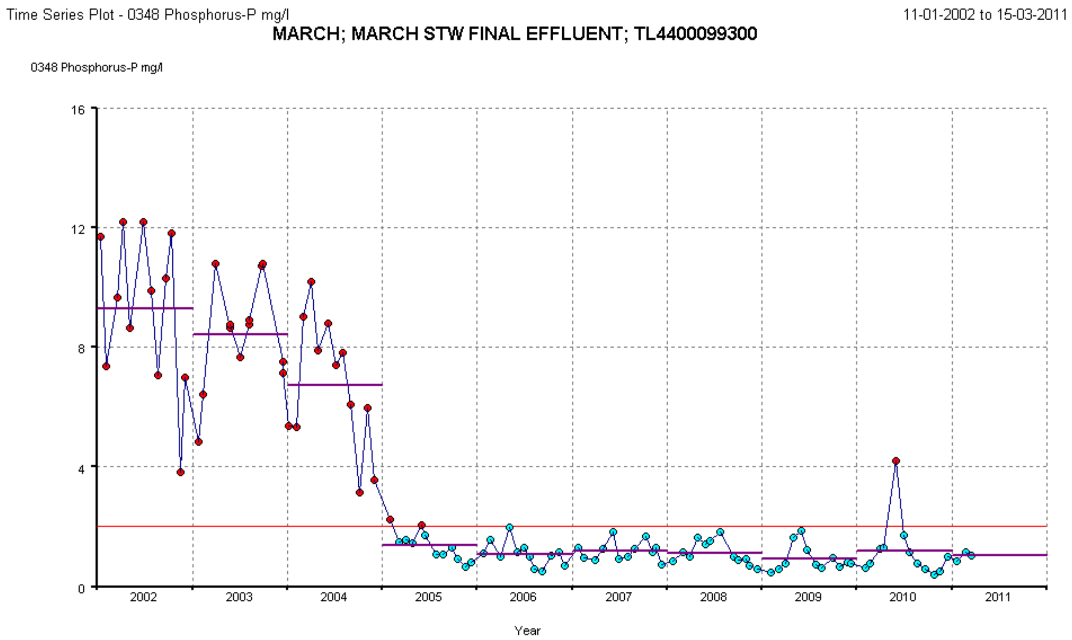
[24] Any increased discharge into the MLC' system would be subject to the MLC's usual requirements

downstream assessment point is on the Old River Nene (downstream of the confluence with the Twenty Foot River). At this location, the Old River Nene is currently achieving 'Good Potential' downstream of the WwTW, owing in part to the P-stripping currently in place at the WwTW as a result of the requirements under the Urban Wastewater Treatment Directive (UWWTD)[23]. The nearest upstream sampling point is also meeting 'Good Potential' requirements.

Further RQP modelling was undertaken into the sensitivity of the effect of increased wastewater flows into the Old River Nene on attainment of downstream Good Potential. Modelling showed that at a mean P consent of 2mg/l (as set under the UWWTD), achievement of downstream Good status was not theoretically possible and that if the WwTW operated at the upper limit required of 2mg/l, the downstream point on the Old River Nene would only achieve Moderate Potential.

Monitoring data supplied by the EA (see Figure 3-2) demonstrates that the reason Good status is achievable downstream is because March WwTW consistently out-performs its requirements under the UWWTD since P stripping was installed in 2004, achieving a mean annual average quality of discharge of 1.13 mg/lP.

Figure 3-2: Monitoring data for March WwTW



<u>Yearly statistics</u>

Yearly Summary - 0348 Phosphorus-P mg/l — 11-01-2002 to 15-03-2011

MARCH; MARCH STW FINAL EFFLUENT; TL4400099300

Year	Start Date	End Date	N	Mean	Std Dev	Min	Max
2002	03-01-2002	12-12-2002	12	9.30	2.610	3.810	12.200
2003	17-01-2003	17-12-2003	12	8.41	1.832	4.850	10.800
2004	06-01-2004	21-12-2004	12	6.71	2.175	3.140	10.200
2005	07-01-2005	13-12-2005	12	1.36	0.486	0.677	2.260
2006	06-01-2006	13-12-2006	12	1.09	0.407	0.511	1.980
2007	05-01-2007	17-12-2007	12	1.20	0.318	0.754	1.830
2008	09-01-2008	12-12-2008	12	1.13	0.393	0.586	1.840
2009	01-01-2009	10-12-2009	12	0.93	0.434	0.475	1.870
2010	01-01-2010	17-12-2010	12	1.19	1.028	0.416	4.220
2011	17-01-2011	01-04-2011	3	1.03	0.152	0.869	1.170

RQP modelling shows that in order to maintain the downstream status once growth is included, the mean consent requirements would need to be tightened to between 0.44 mg/l (growth Scenario 3) and 0.52 mg/l (growth scenario 1) depending on which growth scenario is considered. A new solution is therefore required to ensure that there is no downstream deterioration in WFD status.

March WwTW – Phasing

Although the analysis undertaken for this Stage 2a Detailed WCS shows that when all growth is considered, March WwTW will exceed its flow consent, information provided by AWS suggests that there is currently some headroom in the flow consent before it is exceeded. AWS have advised that the headroom is sufficient for approximately 1,500 of the new dwelling target to be served within the existing consent. This level of development would not require any changes in the existing consent and hence could be accommodated without affecting WFD status in the Old River Nene downstream. While consent limits are not likely to be a constraint on growth there are known limits within the network catchment that would need to be considered and addressed as appropriate before development proceeds.

As discussed in Section 2.1, Fenland DC have yet to determine preferred allocations and likely trajectories. Therefore, in order to determine at which point in the plan period the available headroom at March WwTW will be used, an assumption has been applied that the housing total for each of the growth scenarios will be split evenly each year between 2011 and 2031 to give a per annum completion for March and surrounds.

Table 3-6: Estimation of Headroom utilisation at March WwTW for the three growth scenarios

Growth Scenario	Scenario Housing total	Per annum completion estimate[25]	Estimated Year headroom capacity is reached
Scenario 1	3,395	170	2019
Scenario 2	5,445	272	2016
Scenario 3	6,345	317	2015

March WwTW – Potential Solutions

The following solutions should be considered either as a separate study to inform the LDF or as part of the Stage 2b Detailed WCS to determine a potential solution for growth targets in March in the medium to long term.

a) development in March in excess of 1,500 homes to be considered elsewhere in the district;

b) an agreement to be reached between the Environment Agency and AWS as to how much additional growth would be feasible at the WwTW before it would be considered that the growth would be having additional detrimental impact to that currently caused by existing flows and flow consents;

c) consider potential alternative engineering solutions via the transfer of wastewater flow generated by new development to alternative WwTWs although the sustainability of these options would need to be considered given the potentially large distances involved and the requirement to pump the wastewater; or

[25] Assumes housing total will be split evenly over the plan period to 2031

d) consideration could be given to installing tertiary treatment technology beyond that conventionally applied specifically at March to treat phosphorous to a higher level. The technology would need to ensure a mean discharge limit of between 0.44 mg/l P and 0.52 mg/l P. Such technology would require an increase in energy use at the WwTW and a significant financial investment beyond that normally approved and funded by OFWAT. This option would need to be discussed between EA, AWS and OFWAT as part of the next Asset Management Planning round (AMP6 – 2015 to 2020).

In addition to treatment constraints, there are known limits within the network catchment that would need to be considered and addressed as appropriate before development proceeds (this is detailed in the March specific assessment – section 6).

3.3 Ecological appraisal

Manea Town Lots WwTW was identified in the outline WCS as potentially having a pathway linking it to the Ouse Washes SAC/SPA/Ramsar site/SSSI. However, this WwTW is not identified in the detailed WCS for expansion or consent alteration and therefore does not need to be considered further.

There is one statutory designated site which was identified in the outline WCS as being connected to WwTW discharges in Fenland – Nene Washes SAC/SPA/Ramsar site/SSSI. Of the eight non-statutory County Wildlife Sites in Fenland which are fluvial systems and therefore potentially vulnerable to water quality changes due to treated effluent discharged upstream, only one is now being linked to wastewater treatment works:

- Forty Foot Drain (East) – this feature is linked to Nightlayer Fen and may therefore be influenced by discharges from Chatteris - Nightlayer Fen WwTW

These designated sites are therefore the focus of this water quality appraisal. The ecological background to the statutory designated sites included the details of the interest features and relevant condition assessments are provided in Appendix 3.

3.3.1 Forty Foot Drain (East) County Wildlife Site

Chatteris – Nightlayer Fen which is pumped into the MLC's Forty Foot River which, in turn, is pumped into the Great Ouse to the south of Kings Lynn. It has been identified that the new development in Chatteris can be accommodated within the remaining headroom of the existing consent. Impacts will therefore have been assessed when the initial consent was granted and do not need to be considered further as part of the detailed WCS.

3.3.2 Nene Washes SAC/SPA/SSSI and River Nene CWS

The interest features of the Nene Washes include a spined loach population, uncommon invertebrates in the internal ditch system, swamp vegetation communities (as well as a range of other communities) and a population of both wintering and breeding lowland wetland birds, all of which are susceptible to deteriorating water quality. Further information on the ecological interest of the Nene Washes is included in Appendix 3.

At times of potential flooding along the Nene Valley water is channelled from the River Nene into Morton's Leam and onto the washes. Water is released from The Washes via a sluice gate Link near Guyhirn and back into the River Nene at low tide when the threat of flooding the surrounding fenland has subsided. Flow from Morton's Leam is returned to the lower tidal Nene at Rings End Sluice, and subsequently discharges into The Wash. During winter the entire washes and Morton's Leam may take floodwater from the River Nene.

Water quality is of concern in the Nene Washes/River Nene. During the summer, flows in the Nene are occasionally maintained only through treated sewage effluent, with raised levels of phosphate in particular. Morton's Leam is also included within the SAC notification for its population of spined loach *Cobitis taenia*, which occurs at the highest density in the UK.

There is a general assumption (used for example in the Environment Agency Review of Consents) that pollution and/or excessive nutrients, particularly phosphorus, may cause damage or undesirable change to the other features. Therefore, phosphorus is the main focus for the assessment of water quality discharges. The target of 0.1mg/litre Soluble Reactive Phosphorus (annual average) is used as a provisional "threshold value" for river water in and adjacent to the site as per the EA RoC and JNCC Common Standards Monitoring guidance.

Stage 4 of the RoC concluded that inputs from WwTW's upstream on the River Nene do contribute 'in combination' to water quality impacts on the SAC/SPA but also concluded that there contribution to P loading was sufficiently low that '*although P stripping could be put in on smaller STWs* [such as Whittlsey]*, the effect* [that would be achieved] *on SRP levels at the Nene Washes is considered negligible. It is unlikely a measurable effect could be detected at the Nene Washes from such a programme'*, implying that the WwTWs concerned do not make a significant contribution to loadings at the Washes or in Morton's Leam; WwTW discharges are only responsible for approximately 8% of all phosphorus reaching the Washes, with approximately 90% deriving from agriculture or other diffuse sources. The RoC report adds that '*the site is ecologically buffered to a certain extent from the adverse effects of excess P'* and concludes that '*Populations of spined loach appear to be healthy, despite nutrient exceedence'* and that *'… the Nene Washes can probably withstand a higher input of phosphorus before any radical changes occur'*. The RoC report clearly concludes that while inputs from WwTWs cannot be dismissed, the principal water quality risk to the SAC/SPA/Ramsar site relates to unconsented (diffuse) sources of phosphorus and this is where efforts to reduce P inputs should be targeted.

At the time of the Outline WCS and previous drafts of this Stage 2a WCS it was considered that there was a hydraulic link enabling WwTW discharges into the Whittlesey Dyke to reach Morton's Leam such that Whittlesey WwTW would be hydrologically linked to the Nene Washes SAC/SPA and options to increase the consented discharge volumes from the WwTW could therefore result in impacts on the SAC/SPA through changes in water quality and risk of increased flooding. **However**, correspondence with the Middle Level Commissioners[26] has now confirmed that effluent discharged to the Whittlesey Dyke <u>does not</u> reach Morton's Leam. Whittlesey Dyke is in fact part of the Mid-Level Commissioners pumped drainage system and despite the proximity of its western end to Morton's Leam is pumped north-east (away from the SAC/SPA/Ramsar site/SSSI) into the Middle Level Main Drain, which is in turn pumped into the Great Ouse at Wiggenhall St Germans, 12km downstream of the Ouse Washes and just south of King's Lynn.

Based on this new information, it can be concluded that there is unlikely to be a significant effect on the interest features of the Nene Washes SAC/SPA/Ramsar site/SSSI due to discharges from Whittlesey WwTW.

3.3.3 Ecology outside designated sites

In addition to impacts on designated sites, a range of other UK or Cambridgeshire BAP species or otherwise protected/notable species that are found in Cambridgeshire can be affected by wastewater discharge. These include:

[26] Correspondence between the Mid-Level Commissioners and Paul Mumford at Cambridgeshire Horizons, dated 19/07/11

- Water vole (protected through Wildlife & Countryside Act 1981 and a UK BAP species)
- Grass snake (partially protected through Wildlife & Countryside Act 1981)
- Common toad (UK BAP species)
- Great crested newt (legally protected through Conservation of Habitats & Species Regulations 2010, Wildlife & Countryside Act 1981 and a UK BAP species)
- Birds such as kingfisher (protected through Wildlife & Countryside Act 1981 and a UK BAP species), reed bunting, sedge warbler and reed warbler
- Invertebrates such as the hairy dragonfly *Brachytron pratense*, the aquatic beetle *Donacia dentata*, the weevil *Bagous subcarinatus* and the diving beetle *Agabus undulatus*
- Rare plant species including grass-wrack pondweed *Potamogeton compressus*, fringed water-lily *Nymphoides peltata* and greater water-parsnip *Sium latifolium*.
- European eel (protected under the Eels (England & Wales) Regulations 2009); and
- Otter (legally protected through Conservation of Habitats & Species Regulations 2010, Wildlife & Countryside Act 1981 and a UK BAP species)

Similarly important habitats (all listed in the Middle Level BAP) include:

- Drainage ditches;
- Rivers;
- Reedbeds;
- Fens;
- Grazing marsh;
- Open water.

Cambridgeshire BAP habitats present (or possibly present) in Fenland are Drainage Ditches, Fens, Rivers & Streams, Floodplain Grazing Marsh and Reed beds, as well as the following BAP species: bittern (particularly Wicken Fen and Woodwalton Fen), white-clawed crayfish, Desmoulin's whorl snail (at Wicken Fen), otter (particularly in the Cam catchment) and water vole.

It is understood that Fenland's Public Water Supply demands can be met within the limits of Anglian Water's Water Resource Management Plan. It therefore requires no further consideration.

It is not possible within the scope of this commission to undertake a detailed investigation and evaluation of the impacts of the changes in water quality/flow and infrastructure to be delivered under the water cycle study on wildlife generally, since it would be necessary to undertake detailed species surveys of each watercourse and utilise detailed flow and quality data/modelling which has not been available for this commission for most watercourses. However, a broad analysis is possible.

Four WwTWs in Fenland will require a change to their consents in order to comply with the Water Framework Directive requirements for no deterioration downstream:

- Whittlesey
- March

- Doddington; and
- West Walton

For Whittlesey, Doddington and West Walton 'no deterioration' is achievable within the limits of Best Available Technology. With such consent tightening in place there should be no deterioration in downstream water quality and therefore there will be no adverse effects on wildlife in the receiving watercourses (Whittlesey Dyke, the Old River Nene and tidal River Nene respectively).

March will however require novel treatment solutions to enable 'no deterioration' to be achieved that have not yet been identified. March discharges to the Twenty Foot River

Twenty Foot River and Old River Nene both have populations of otter and probably also of water vole and contain populations of chub, perch, pike, roach and tench. The solutions selected for March WwTW will need to take into account ecological impacts on these species and others using the receiving watercourses as part of any planning application associated with expansion proposals.

A population of grass wrack pondweed *Potamogeton compressus* has also been identified at the outfall of March WwTW in Twenty Foot River. It is considered that this population should not act as an inherent constraint to future operation of this WwTW although their presence will of course need to be taken into account into any proposals for changes to the outfall or increased discharges.

3.3.4 Flood risk

Flood risk calculations are only available for one WwTW covered by the detailed WCS – Whittlesey - due to an absence of flow and/or cross-sectional data for other receiving watercourses. For this WwTW, it is shown that on average discharge volumes will increase by between 484m^3/d and 957m^3/d. Discussions with AWS and the local drainage board have confirmed that there are already hydraulic capacity concerns in the Whittlesey Dyke (receiving drain) and in downstream watercourses with the volumes now consented for discharge.

The Nene Washes SAC is vulnerable to (and already suffering from) excessive flooding. However, it has now been established that Whittlsey WwTW is not hydrologically connected to Morton's Leam and a conceptual plan to potentially discharge effluent from the WwTW directly into Morton's Leam is not to be taken forward. As such, there is no mechanism for discharges from Whittlesey WwTW to exacerbate flooding in the Nene Washes.

3.4 Climate Change Analysis

Though not directly influencing water quality and water environments, climate change has the potential to impact and alter the water environment through increasing river temperatures, reducing flows and increasing diffuse run-off from heavier rainfall and storm events, all of which can alter the quality of the receiving water bodies.

The Environment Agency's 'Potential Impacts of Climate Change on River Water Quality' study[27] reported that relatively little research has been undertaken in assessing the impacts of climate change on water quality. However, the following high-level findings were reported from the literature review undertaken as part of the Environment Agency study:

- Water quality will be affected by changes in flow regime;

[27] Potential Impacts of Climate Change on River Water Quality. Science Report SC070043/SR1, Environment Agency 2008

- Lower minimum flows imply less volume for dilution and hence higher concentrations downstream of point discharges;
- Enhanced growth of algal blooms in rivers and reservoirs could affect levels of dissolved oxygen and the costs of treating water for potable supply;
- Increased storm events, especially in summer, could cause more frequent incidence of combined sewer overflows, discharging highly polluted waters into receiving water bodies. The potential impacts on urban water quality will be largely driven by these changes in short duration rainfall intensity overwhelming drainage systems, as well as rising sea levels affecting combined sewerage outfalls;
- The most immediate reaction to climate change is expected to be an increase in river and lake water temperatures with subsequent effects on Dissolved Oxygen levels;
- More intense rainfall and flooding could result in increased suspended solids, sediment yields and associated contaminant metal fluxes;
- Nutrient loads are expected to increase;
- In shallow lakes, oxygen levels may decline and cyanobacteria blooms may become more extensive; and,
- In the UK, there has been relatively little research on toxins in streams, lakes and sediments, as the problems are thought to be limited. However, climate change may alter this perception.

In addition to the above, it should be noted that most watercourses in the study area do not flow in very low flow summers and is reliant on the operation of pumps which may not operate for weeks at a time. Low dissolved oxygen and algal blooms are therefore current problems which will be exacerbated by climate change effects (less water entering the Middle Level and North Level system and warmer temperatures),

Climate change studies, especially in relation to water quality and ecology, are at fairly early stages and the outcomes are subject to considerable uncertainty. However, understanding the processes and mechanisms controlling water quality and ecology, and how these combine and interact, is essential for sustaining potable water supplies and conserving river systems.[28] As such, the findings of the Environment Agency study and planned adaptation and mitigation options should be updated when further research and guidance becomes available.

One of the key climate change adaptation challenges will be managing increased wastewater flows (from new developments) while protecting the water environment in the area, particularly where the impacts of climate change on the water environment are still uncertain. This Stage 2a Detailed WCS has undertaken a sensitivity analysis on the vulnerability of water quality to climate change impacts through assessing the impact of reduced summer flows on dilution of wastewater discharges. A broad brush sensitivity test was undertaken using RQP whereby the Q95 of the receiving watercourse has been reduced by 20% to model a reduction in summer flows. The consent requirements for the WwTW were then determined assuming the WFD objective of 'no deterioration' under these conditions compared to those under the existing climate. These results are summarised in Table 3-7. It should be noted that only WwTW that have data for river flows in the receiving watercourses have been assessed as the RQP analysis cannot be undertaken without estimates of river flow statistics.

[28] Potential Impacts of Climate Change on River Water Quality. Science Report SC070043/SR1, Environment Agency 2008

The assessment shows that under potential future climates, WwTW consents are likely to need to be tighter than existing consents, but in the majority of cases these are small changes and discharge consents are still within the LCT.

Climate Change, Water Quality and Adaptation

Table 3-8 provides a summary of the potential climate change adaptation and mitigation measures that could be considered in the Fenland District with regards to water quality and wastewater services infrastructure. The organisations likely to be responsible for leading these measures have been identified alongside the suggested timescale for these actions to start being taken forward (Immediate (within 1 year), Medium (1 - 10 years) and Long (10+ years)).

Table 3-7: Potential Impact of Climate Change (Reduced Summer Flows) on WwTW Consent Requirements to Meet WFD Objectives

WwTW	Determinand / Scenario[29]	WwTW Consent Requirements to Meet No Deterioration WFD Objective (BOD/NH4 = 95%, P= mean)		% Change	Comment
		Current Climate	Future Potential Climate Change (20% reduction in Q95 river flow)		
March	P (Scenario 3)	0.44	0.37	18.9%	Approx 20% impact on P consent but as below LCT unlikely to have significant impacts above that of current climate requirements
Whittlesey	BOD (Scenario 3)	5.49	5.20	5.6%	Small impact on consents. P consent will be pushed below LCT level, but very close to LCT, so likely to be achievable
	NH4 (Scenario 3)	5.74	5.14	11.7%	
	P (Scenario 3)	1.07	0.97	10.3%	

[29] Only those determinands that have been identified as requiring consent tightening under the current climate have been included.

Table 3-8: Water Quality and Wastewater Potential Climate Change Adaptation and Mitigation Measures[30]

Potential Climate Change	Potential Impact	Adaptation and Mitigation Measures	Lead Organisation (s)				Timescale for Action
			FDC	EA	AWS	NE	
Temperature rise	• Decrease in Dissolved Oxygen in rivers – impact on river ecology and wildlife • Faster wastewater asset deterioration • Changes in wastewater process efficiency	• Ensure climate change mitigation strategies are in place for species and habitats at risk, e.g. Biodiversity Action plans		✓		✓	Medium
		• Monitor long-term Dissolved Oxygen levels in rivers and impacts		✓			Medium
		• Improve resilience of wastewater assets to temperature rise, where new assets are required or upgraded			✓		Medium
Winter rainfall increase	• Increased diffuse pollution • Insufficient infrastructure capacity – storm tanks, CSOs etc. • Increased risk to rivers from combined sewer outflows	• Where possible, control diffuse pollution runoff through SuDS	✓	✓	✓	✓	Immediate
		• Promoting the creation and preservation of space (e.g. verges, agricultural land, and green urban areas, including roofs) in support of water quality, biodiversity and flood risk goals	✓	✓		✓	Immediate
		• Long-term monitoring of CSO spill volume and frequency. Ensure Urban Pollution Management (UPM) study is undertaken for major development upstream of CSOs	✓	✓	✓		Medium
Summer rainfall decrease	• Degraded wetlands • More frequent low river flows • Less dilution in rivers for wastewater discharge • Reduced risk to rivers from combined sewer outflows • Tightening of discharge consent • Reduced flexibility – effluent required to maintain river flows	• Ensure climate change mitigation strategies are in place for species and habitats at risk, e.g. Biodiversity Action plans		✓		✓	Medium
		• Consideration of future climate change impacts on wastewater discharges when renewing consents		✓	✓		Medium
Sea level rise	• Saline Intrusion • Asset loss	• Monitor water quality for potential impacts from saline intrusion		✓			Medium
		• Ensure that key assets are located inland and are not susceptible to being lost through sea level rise		✓	✓		Long
Increase in weather extremes (heatwaves, intense rainfall, storms)	• Increased flooding and risk of service loss • Increased clean-up costs • Inability of infrastructure to cope • Increased subsidence – pipe failure	• Promoting the creation and preservation of space (e.g. verges, agricultural land, and green urban areas, including roofs) in support of water quality, biodiversity and flood risk goals	✓	✓		✓	Immediate
		• Improve resilience of key wastewater assets such as CSOs, WwTW and outfalls, including new industry design standards for wastewater assets			✓		Medium

30 Some inputs edited from AWS Strategic Direction Statement 2010 – 2035 http://www.anglianwater.co.uk/about-us/statutory-reports/strategic-direction/

4 Water Supply Strategy

4.1 Introduction

The Stage 1 Outline WCS concluded that through a series of demand management measures and improvement of existing resources, AWS are predicting a supply surplus of available water in 2035 within the water resources zones located within Fenland[31] which would provide sufficient water supply to cater for the levels of growth within Fenland throughout the plan period.

4.2 The Vision

Despite the availability of raw resources within the plan period, there are several key drivers for ensuring that water use in the development plan period is minimised as far as possible. In keeping with the overall vision of the Fenland WCS, there is drive to ensure new development meets the sustainable development aspirations within Cambridgeshire and hence sustainable water delivery is a key part of achieving this vision. As is the case for all sustainable use of resources, the three 'R's of reduce, reuse and recycle are key to maximising the sustainability and reduce is the first and arguably most important element of sustainable water use to consider.

The key vision of the WCS to aspire to water neutrality also makes it key for water use to be minimised as far as practical.

4.2.1 Drivers and Justification for Water Efficiency

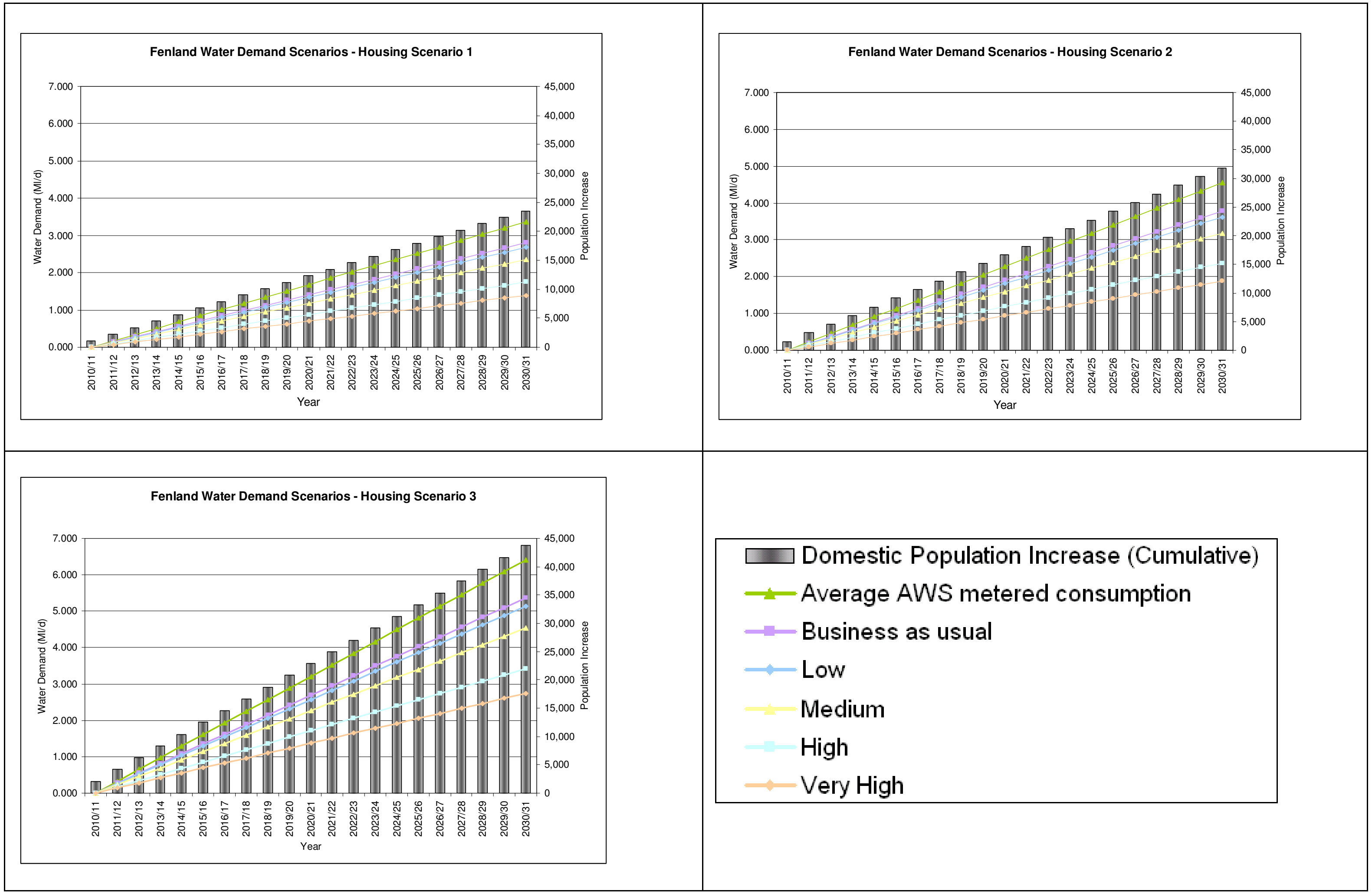
As well as the key study visions, there are also several other drivers and justification for considering more water efficient and more sustainable development.

The study area, and East Anglia generally, is an area of serious water stress[32] and is the driest part of the UK. In addition, the key sources of raw water (rivers and aquifers) supplying Fenland, which are outside the Study Area, are considered to be at their limit of water they can continue to yield for abstraction before ecosystems reliant on these sources, and other users of these sources, would be adversely affected. Further abstraction, other than that currently licensed for abstraction and planned by AWS to 2035 is not likely to be possible, and strategic transfers of water into the area would be required. Based on the 'business as usual scenario' of 150l/h/d of water use, demand for water in Fenland could increase through the plan period across a range of between 3.39 Ml/d and 6.51Ml/d depending on which growth scenario materialises (see Figure 4-1).

It is predicted that climate change will further reduce the available water resources in Fenland as rainfall patterns change to less frequent, but more extreme, rainfall events. Climate change is thought to be the biggest single risk to water supplies post 2020 in the WRZs within Fenland. This could lead to sustainability reductions of abstraction licences. In order to manage the effects of climate change effectively, the single most cost effective step in water resources climate change resilience is to manage demand downwards.

[31] Fenland WRZ supplying Wisbech and surrounds, Ruthamford WRZ supplying March, Doddington & Chatteris ,and Peterborough WRZ supplying Whittlesey and surrounds
[32] As classified by the Environment Agency

Figure 4-1: Range of water demands across the plan period on Fenland (three potential housing scenarios)



This Stage 2a Detailed WCS has assessed a higher growth target that was previously considered in the Stage 1 Outline WCS. Whilst this target is aspirational and has been assessed to consider an upper limit to growth, it represents (approximately) an additional 5,000 homes which will not have been considered in AWS' WRMP. Hence, if this level of development were to transpire and existing levels of demand continued, new resources or further demand measures would be required before the end of plan period

Policy and Legislative Drivers

Future Water, the Government's water strategy for England[33] was published in February 2008 and lays out the Government's policies for the future management of water in England. Part of its vision is for water efficiency to play a prominent role in achieving a sustainable supply and demand balance.

For relevance to the aspiration of water neutrality, Future Water specifically aims to reduce water consumption in existing homes to 130 or 120 l/h/d by 2030. This will require the retrofitting of water efficient measures in existing homes and business and behavioural change in the use of water and understanding of where it comes from.

The Building a Greener Future Policy Statement[34] published by Communities and Local Government in 2007 gives the target of zero carbon by 2016 (CSH Level 6) for all new homes. This will be achieved by a progressive tightening of the Building Regulations.

Climate Change and Availability of Water

It is predicted that climate change will further reduce the available water resources in Fenland as rainfall patterns change to less frequent, but more extreme, rainfall events. Climate change is thought to be the biggest single risk to water supplies in the longer term in the WRZs within Fenland.

Managing Climate Change

In their Strategic Direction Statement, AWS state that climate change is the biggest single risk facing their business over the next 25 years. Similarly, in their 2010-2035 WRMP, AWS highlight that over the planning period one of the key water resources challenges they face are from the impacts of climate change. Customers expect AWS to provide a continuous supply of water, but the resilience of the supply systems have the potential to be affected by the impact of climate change with severe weather-related events, such as flooding or an 'outage' incident at a source works supplying one of the major centres of population in the region. In their businnes plan submission for the current asset planning round (2010 to 2015), AWS addressed the impacts of climate change through the need for investment in both mitigation and adaptation, with changes both to long-term averages and short-period acute events.

In planning for future water resources availability, AWS has accounted for the impacts of climate change within their calculations of available raw water for use and forecast demand. AWS has used assumptions on climate change impacts based on the UKCIP02 scenarios, the information on sustainability changes provided at the time by the Environment Agency and the Environment Agency' Water Resources Plan guideline. AWS will be reviewing the more recent UKCP09 climate change projections and the outcome of the Habitat's Directive review of consents on their abstraction licences and these will be incorporated into future reviews and

[33] Future Water, the Government's water strategy for England, DEFRA, 2008
[34] Building a Greener Future: policy statement, CLG, 2007, http://www.communities.gov.uk/publications/planningandbuilding/building-a-greener

planning, including the annual review of the WRMP and the next business planning round (2015 t o2020)..

AWS have reported in their WRMP that the changes that are most significant for managing water resources are:

- the increase in rainfall in the winter;
- reduction in the summer rainfall; and,
- an increase in summer temperatures that will reduce the length of the winter recharge season and potentially increase the demand for water.

At a strategic level, AWS have highlighted that it will be important to store more run-off from winter rainfall and to enhance the natural groundwater recharge.

AWS have assessed the impacts of climate change on both supply and demand. The main findings from these, as included in their WRMP, are summarised below.

Impact on Supplies

AWS have undertaken analysis of the impacts of climate change on the future availability of their water resources on both their groundwater and surface water sources, and incorporated these results into their assessment of deployable output. The analysis involved processing median, best and worst case scenarios through a number of recognised climate change models, for 25 groundwater and 10 surface water sources considered vulnerable to the potential impacts of climate change on source yield. The results identified a more significant impact on surface water source yield than for groundwater. The modelling results also indicated that in some cases potential groundwater yield could increase, as the climate change scenarios not only predict higher temperatures but increased periods of prolonged and heavy rainfall. The overall impact of climate change on water resources over the plan period is estimated as around 30 Ml/d, indicating that small reductions in deployable output at source works level may affect local areas of the supply network.

Impact on Demand

The main impact of climate change on demand is related to periods of extremely hot and dry weather that will increase the peak demand for water. AWS have accounted for the impact on the peak demand and the longer duration effect of a dry year through applying factors to the household and non-household water consumption rate in their supply-demand modelling. The effect of peak demand varies between Water Resource Zones due to factors such as the location of holiday resorts and heavy industry and socio-economic factors reflected in the type and age of housing stock and customers' behaviour.

Although AWS have planned for the anticipated impacts of climate change, the view of AWS and other water companies is that, in order to manage the effects of climate change effectively, the single most cost effective step in water resources climate change resilience is to manage demand downwards.

4.3 Ecological Appraisal

AWS are predicting a supply surplus of available water in 2035 within the water resources zones located within Fenland which would provide sufficient water supply to supply the levels of growth within Fenland through the plan period. Therefore, there will be no impact that hasn't already been covered in the WRMP approval process. There is thus no need to consider water supply issues further in this detailed WCS.

4.4 Water Neutrality Pathway

4.4.1 What is Water Neutrality?

Water neutrality is a concept whereby the total demand for water within a planning area after development has taken place is the same (or less) than it was before development took place[35]. If this can be achieved, the overall balance for water demand is 'neutral', and there is considered to be no net increase in demand as a result of development. In order to achieve this, new development needs to be subject to planning policy which aims to ensure that where possible, houses and businesses are built to high standards of water efficiency through the use of water efficient fixtures and fittings, and in some cases rainwater harvesting and greywater recycling.

It is theoretically possible that neutrality can be achieved within a new development area, through the complete management of the water cycle within that development area. In addition to water demand being limited to a minimum, it requires:

- all wastewater to be treated and re-used for potable consumption rather than discharged to the environment;
- maximisation of rainwater harvesting (in some cases complete capture of rainfall falling within the development) for use in the home; and,
- abstraction of local groundwater or river flow storage for treatment and potable supply.

Achieving 'total' water neutrality within a development remains an aspirational concept and is usually only considered for an eco-town or eco-village type development, due to the requirement for specific catchment conditions to supply raw water for treatment and significant capital expenditure. It also requires specialist operational input to maintain the systems such as wastewater re-use on a community scale. Total neutrality for a single development site is yet to be achieved in the UK, although there are examplar ecotowns and eco-settlements such as Rackheath in Norfolk where it is an aspiration that is being worked towards.

For the majority of new development, in order for the water neutrality concept to work, the additional demand created by new development needs to be offset by reducing the demand from existing population and employment. Therefore, a 'planning area' needs to be considered where measures are taken to reduce existing or current water demand from the current housing and employment stock. The planning area in this case is considered to be the Fenland District as a whole.

The Twin-track Approach

Attainment of water neutrality requires a 'twin track' approach whereby water demand in new development is minimised as far as possible, whilst at the same time taking measures, such as retrofitting of water efficient devices on existing homes and business to reduce water use in existing development.

In order to reduce water consumption and manage demand for the limited water resources within the study area, a number of measures and devices are available[36], including:

- cistern displacement devices;
- flow regulation;

[35] Water Neutrality is defined more fully in the Environment Agency report 'Towards water neutrality in the Thames Gateway' (2007)
[36] Source: Water Efficiency in the South East of England, Environment Agency, April 2007.

- greywater recycling;
- low or variable flush replacement toilets;
- low flow showers;
- metering;
- point of use water heaters;
- pressure control;
- rainwater harvesting;
- variable tariffs;
- low flows taps;
- water audits;
- water butts;
- water efficient garden irrigation; and,
- water efficiency promotion and education.

The varying costs and space and design constraints of the above mean that they can be divided into two categories, measures that should be installed for new developments and those which can be retrofitted into existing properties. For example, due to economies of scale, to install a rainwater harvesting system is more cost effective when carried out on a large scale and it is therefore often incorporated into new build schools, hotels or other similar buildings. Rainwater harvesting is less well advanced as part of domestic new builds, as the payback periods are longer for smaller systems and there are maintenance issues. To retrofit a rainwater harvesting system can have very high installation costs, which reduces the feasibility of it.

However, there are a number of the measures listed above that can be easily and cheaply installed into existing properties, particularly if part of a large campaign targeted at a number of properties. Examples of these include the fitting of dual-flush toilets and low flow shower heads to social housing stock, as was successfully carried out in Preston by Reigate and Banstead Council in conjunction with Sutton and East Surrey Water and Waterwise[37].

Achieving Total Neutrality – Is It Feasible?

Even when considering neutrality within an existing planning area, it is recognised by the Environment Agency (2009)[38] that achievement of total water neutrality (100 per cent) for new development is often not possible, as the levels of water savings required in existing stock may not be possible for the level of growth proposed. A lower percentage of neutrality may therefore be a realistic target, for example 50 per cent neutrality.

This Stage 2a Detailed WCS therefore considers four water neutrality targets and sets out a 'pathway' for how the most likely target (or level of neutrality) can be achieved

[37] Preston Water Efficiency Report, Waterwise, March 2009, www.waterwise.org.uk
[38] Environment Agency (2009) *Water Neutrality, an improved and expanded water management definition*

4.4.2 The Pathway Concept

The term 'pathway' is referred to here as it is acknowledged that, to achieve any level of neutrality, a series of steps are required in order to go beyond the minimum starting point for water efficiency. This is currently mandatory for new development under current and planned national planning policy and legislation.

Whilst it is compulsory that all new homes are given a rating under the Government's Code for Sustainable Homes (CSH), only affordable housing has a minimum rating that must be achieved (Code Level 3); there is no statutory requirement under the Code for all other new housing to have a low water use specification as previous government proposals to make different levels compulsory have been postponed pending government review. For non-domestic development, there is no statutory requirement to have a sustainability rating with the Building Research Establishment Environmental Assessment Method (BREEAM) only being mandatory where specified by a public body in England such as:

- Local Authorities incorporating environmental standards as part of supplementary planning guidance
- NHS buildings for new buildings and refurbishments
- Department for Children, Schools and Families for all projects valued at over £500K (primary schools) and £2million (secondary schools);
- English Partnerships (now incorporated into the Homes and Communities Agency) for all new developments involving their land; and
- Office of Government Commerce for all new buildings;

At the time of completing this WCS, regional planning policies on water efficiency are also set to be withdrawn as part of the proposed revocation of the East of England plan through the proposed Localism Bill.

Therefore, other than potential local policies delivered through the LDF process, the only water efficiency requirements for new development are through the Building Regulations[39] where new homes must be built to specification to restrict water use to 125l/h/d. However, the key aim of the Localism Bill is to decentralise power away from central government towards local authorities and the communities they serve. It therefore creates a stronger driver for local authorities such as Fenland to propose local policy to address specific local concerns. New local level policy is therefore key to delivering aspirations such as water neutrality and the proposed Localism Bill will assist in providing the legislative mechanism to achieve this in Fenland.

In addition to the steps required in new local policy, the use of a pathway to describe the process of achieving water neutrality is also relevant to the other elements required to deliver it, as it describes the additional steps required beyond 'business as usual' that both developers and stakeholders with a role (or interest) in delivering water neutrality would need to take e.g.

- the steps required to deliver higher water efficiency levels on the ground (for the developers themselves); and,
- the partnership initiative that would be required beyond that normally undertaken by local authorities and water companies in order to minimise existing water use from the current housing and business stock.

[39] Part G of the Building Regulations

Therefore, the pathway to neutrality described in this section of the WCS requires a series of steps which are likely to include the following:

- technological inputs in terms of physically delivering water efficiency measures on the ground;
- local planning policies which go beyond national guidance; and,
- partnership initiatives and partnership working.

The following sections outline the types of water efficiency measures which have been considered in developing the technological pathway for the water neutrality target scenarios.

4.4.3 Improving Efficiency in Existing Development

Metering

The installation of water meters in existing housing stock has the potential to generate significant water use reductions because it gives customers a financial incentive to reduce their water consumption. Being on a meter also encourages the installation and use of other water saving products, by introducing a financial incentive and introducing a price signal against which the payback time of new water efficiency measures can be assessed. Metering typically results in a 5-10 per cent reduction from unmetered supply, which equates to a water saving of approximately 14.56 l/h/d or 33.5 l per household, assuming occupancy rate of 2.3[40] for existing properties.

In 2009, DEFRA instructed Anna Walker (the Chair of the Office of Rail Regulation) to carry out an independent review of charging for household water and sewerage services (the Walker Review)[41]. The typical savings in water bills of metered and unmetered households were compared by the Walker review, which gives an indication of the levels of water saving that can be expected (see Table 4-1).

Table 4-1: Change in Typical Metered and Unmetered Household Bills

2009-10 Metered	2009-10 Unmetered	2014-15 Metered	2014-15 Unmetered	% change Metered	% change Unmetered
348	470	336	533	-3	13

Low or Variable Flush Toilets

Toilets use about 30 per cent of the total water used in a household[42]. An old style single flush toilet can use up to 13 litres of water in one flush. New, more water-efficient dual-flush toilets can use as little as 2.6 litres[43] per flush. A study carried out in 2000 by Southern Water and the Environment Agency[44] on 33 domestic properties in Sussex showed that the average dual flush saving observed during the trial was 27 per cent, equivalent to a volumetric saving of around 2.6 litres per flush. The study suggested that replacing existing toilets with low or variable flush

[40] 2.3 is used for existing properties as opposed to 2.1 for new properties – the latter reflects changes in population over time. This figure was discussed and agreed with AWS prior to the assessment.
[41] Independent Walker Review of Charging and Metering for Water and Sewerage services, DEFRA, 2009, http://www.defra.gov.uk/environment/quality/water/industry/walkerreview/
[42] http://www.waterwise.org.uk/reducing_water_wastage_in_the_uk/house_and_garden/toilet_flushing.html
[43] http://www.lecico.co.uk/
[44] The Water Efficiency of Retrofit Dual Flush Toilets, Southern Water/Environment Agency, December 2000

alternatives could reduce the volume of water used for toilet flushing by approximately 27 per cent on average.

Cistern Displacement Devices

These are simple devices which are placed in the toilet cistern by the user, which displace water and therefore reduce the volume that is used with each flush. This can be easily installed by the householder and are very cheap to produce and supply. Water companies and environmental organisations often provide these for free.

Depending on the type of devices used (these can vary from a custom made device, such as a bag filled with material that expands on contact with water, to a household brick) the water savings can be up to 3 litres per flush.

Low Flow Taps and Showers

Flow reducing aerating taps and shower heads restrict the flow of water without reducing water pressure. Thames Water estimates that an aerating shower head can cut water use by 60 per cent with no loss of performance[45].

Pressure Control

Reducing pressure within the water supply network can be an effective method of reducing the volume of water supplied to customers. However, many modern appliances, such as Combi boilers, point of use water heaters and electric showers require a minimum water pressure to function. Careful monitoring of pressure is therefore required to ensure that a minimum water pressure is maintained. For areas which already experience low pressure (such as those areas with properties that are included on a water company's DG2 Register) this is not suitable. Limited data is available on the water savings that can be achieved from this method.

As concluded in the Stage 1 Outline WCS, AWS are already proposing pressure control measures in WRZs within Fenland as part of their WRMP to increase available supply to 2035. Further reductions are not considered possible without affecting the DG2 register.

Variable Tariffs

Variable tariffs can provide different incentives to customers and distribute a water company's costs across customers in different ways.

The Walker Review assessed variable tariffs for water, including:

- rising block tariff;
- a declining block tariff;
- a seasonal tariff; and,
- time of day tariff.

A rising block tariff increases charges for each subsequent block of water used. This can raise the price of water to very high levels for customers whose water consumption is high, which gives a financial incentive not to consume additional water (for discretionary use, for example) while still giving people access to low price water for essential use.

[45] http://www.thameswater.co.uk/cps/rde/xchg/corp/hs.xsl/9047.htm

A declining block tariff decreases charges for each subsequent block of water used. This reflects the fact that the initial costs of supply are high, while additional supply has a marginal additional cost. This is designed to reduce bills for very high users and although it weakens incentives for them to reduce discretionary water use, in commercial tariffs it can reflect the economies of scale from bulk supplies.

A seasonal tariff reflects the additional costs of summer water supply and the fact that fixed costs are driven largely by the peak demand placed on the system, which is likely to be in the summer.

Time-of-day tariffs have a variable cost per unit supply according to the time of the day when the water is used; this requires smart meters. This type of charging reflects the cost of water supply and may reduce an individual household's bill, it may not reduce overall water use for a customer.

AWS's WRMP[46] reviewed variable tariffs and concluded:

'Tariff proposals will only work if customer behaviour and demand is elastic. We carried out research as part of the last Periodic Review to draw together evidence of price elasticity from around the world. The results gave us some clear messages. First, demand tends to be elastic for large industrial customers, but much less elastic for small household customers. Second, demand tends to be elastic in countries such as Australia, where the discretionary use of water is high, but is low in the UK where discretionary use is a relatively small proportion of total water use. This leads us to conclude that increasing the marginal price of water and wastewater services would have some impact on our largest customers, but would tend to have a limited effect on household water consumption either by affecting total demand or by influencing peak profiles. We consider that customer behaviour can be influenced more effectively by promoting 'Waterwise' behaviour rather than by changing the way customer charges are applied.'

Water Efficient Appliances

Washing machines and dishwashers have become much more water efficient over the past twenty years; whereas an old washing machine may use up to 150 litres per cycle, modern efficient machines may use as little as 35 litres per cycle. An old dishwasher could use up to 50 litres per cycle, whereas modern models can use as little as 10 litres. However, this is partially offset by the increased frequency with which these are now used. It has been estimated[47] that dishwashers, together with the kitchen tap, account for about 8-14 per cent of water used in the home.

The Water Efficient Product Labelling Scheme provides information on the water efficiency of a product (such as washing machines) and allows the consumer to compare products and select the efficient product. The water savings from installation of water efficient appliances therefore vary, depending on the type of machine used.

Non-domestic Properties

There is also the potential for considerable water savings in non-domestic properties; depending on the nature of the business water consumption may be high e.g. food processing businesses. Even in businesses where water use is not high, such as B1 Business or B8

[46] Anglian Water Services, Water Resource Management Plan, 2010, http://www.anglianwater.co.uk/environment/water-resources/resource-management/
[47] Water Efficiency Retrofitting: A Best Practice Guide, Waterwise, 2009, www.waterwise.org.uk

Storage and Distribution, there is still the potential for water savings using the retrofitting measures listed above Water audits are useful methods of identifying potential savings and implementation of measures and installation of water saving devices could be funded by the asset owner; this could be justified by significant financial savings which can be achieved through implementation of water efficient measures. Non-domestic buildings such as warehouses and large scale commercial (e.g. supermarkets) property have sinifican scope for rainwater harvesting on large roof areas.

There is significant potential for water efficiency in the agricultural sector from rainwater harvesting. The Environment Agency guide for farmers[48] illustrates the potential benefits to both the environment and the farmer from the installation of a RWH system. For example, a farm growing soft fruit in polytunnels could harvest 5,852 m^3 of water per year from 120 hectares of tunnels, which could give the following benefits:

- better soil drainage between the tunnels,
- improved humidity levels inside them; and,
- an improvement in plant health through the use of harvested water.

4.4.4 Water Efficiency in New Development

The use of efficient fixtures and fittings as described in Section 4.4.3 above also apply to the specification of water use in the building of new homes. The simplest way of demonstrating the reductions that use of efficient fixtures and fitting has in new builds is to consider what is required in terms of installation of the fixtures and fittings at different ranges of specification to ensure attainment of code levels under the CSH water use requirements. The Cambridge WCS[49] gave a summary of water use savings that can be achieved by the use of efficient fixtures and fittings, as shown below in Table 4-2.

Table 4-2: Summary of Water Savings Borne by Water Efficiency Fixtures and Fittings

Component	150 l/h/d Standard Home	130 l/h/d	120 l/h/d CSH1/2	115 l/h/d	105 l/h/d CSH Level 3/4	80 l/h/d CSH Level 5/6
Toilet flushing	28.8	19.2[b]	19.2[b]	16.8[d]	16.8[d]	8.4 + 8.4[f]
Taps[a]	42.3	42.3	31.8	31.8	24.9	18
Shower	30	24	24	22	18	18
Bath	28.8	25.6[c]	25.6[c]	25.6[c]	25.6[c]	22.4[e]
Washing machine	16.7	15.3	15.3	15.3	15.3	7.65 + 7.65[f]
Dishwasher	3.9	3.6	3.6	3.6	3.6	3.6
Recycled water						-16.1
Total per head	**150.5**	**130**	**119.5**	**115.1**	**104.2**	**78**
Outdoor[g]	11.5	11.5	11.5	11.5	11.5	11.5
Total per household	**366.68**	**319.3**	**293.52**	**284.14**	**257.41**	**195.58**

a Combines kitchen sink and wash hand basin

[48] Rainwater Harvesting: an on-farm guide, Environment Agency, 2009
[49] Cambridge (and surrounding major growth areas) WCS Phase 2, Halcrow, 2010

b 6/3 litre dual-flush toilet (f) recycled water
c 160 litre bath filled to 40% capacity, frequency of use 0.4/day
d 4.5/3 litre dual flush toilet
e 120 litre bath
f rainwater/greywater harvesting
g Assumed garden use

Table 4-2 highlights that in order for Code levels 5/6 to be achieved for water use under the CSH (80 l/h/d); water re-use technology (rainwater harvesting and/or greywater recycling) needs to be incorporated into the development. In using the BRE Water Demand Calculator[50], the experience of URS/Scott Wilson BREEAM/CHS assessors is that it is theoretically possible to get close to 80l/h/d through the use of fixture and fittings, but that this requires extremely high specification efficiency devices which are unlikely to be acceptable to the user and either affect the saleability of new homes or result in the immediate replacement of the fixtures and fittings upon habitation. This includes baths at capacity below 120 litres, and shower heads with aeration which reduces the pressure sensation of the user. For this reason, it is not considered practical to suggest that code levels 5 and 6 can be reached without some form of water recycling.

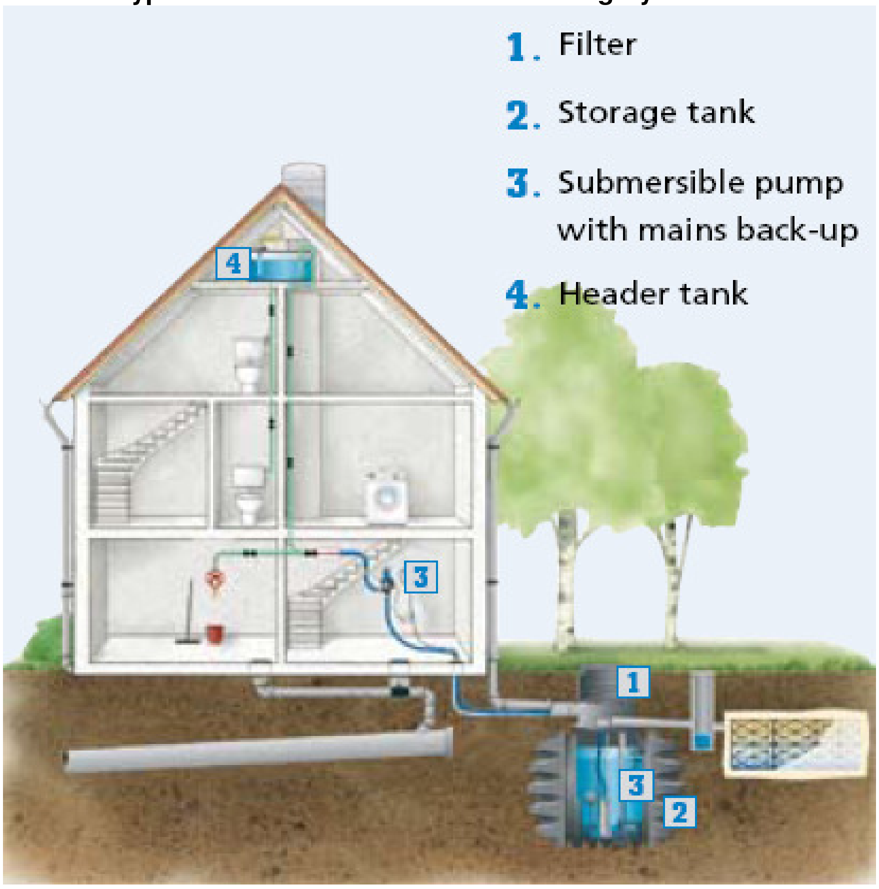
Rainwater Harvesting

Rainwater harvesting (RWH) is the capture and storage of rain water that lands on the roof of a property. This can have the dual advantage of both reducing the volume of water leaving a site, thereby reducing surface water management requirements and potential flooding issues, and be a direct source of water, thereby reducing the amount of water that needs to be supplied to a property from the mains water system.

RWH systems typically consist of a collection area (usually a rooftop), a method of conveying the water to the storage tank (gutters, down spouts and pipes), a filtration and treatment system, a storage tank and a method of conveying the water from the storage container to the taps (pipes with pumped or gravity flow). A treatment system may be included, depending on the rainwater quality desired and the source. Figure 2-1 below gives a diagrammatic representation of a typical domestic system[51].

[50] http://www.thewatercalculator.org.uk/faq.asp
[51] Source: Aquality Intelligent Water management, www.aqua-lity.co.uk

Figure 4-2: A Typical Domestic Rainwater Harvesting System[51]



The level to which the rainwater is treated depends on the source of the rainwater and the purpose for which it has been collected. Rainwater is usually first filtered, to remove larger debris such as leaves and grit. A second stage may also be incorporated into the holding tank; some systems contain biological treatment within the holding tank, or flow calming devices on the inlet and outlets will allow heavier particles to sink to the bottom, with lighter debris and oils floating to the surface of the water. A floating extraction system can then allow the clean rainwater to be extracted from between these two layers[52].

A recent sustainable water management strategy carried out for a proposed EcoTown development at Northstowe[53], approximately 10 km to the north west of Cambridge, calculated the size of rainwater storage that may be required for different occupant numbers, as shown below in Table 4-3.

Table 4-3: RWH Systems Sizing (taken from Northstowe SWMS[53])

Number of occupants	Total water consumption	Roof area (m^2)	Required storage tank (m^3)	Potable water saving per head (l/d)	Water consumption with RWH (l/h/d)
1	110	13	0.44	15.4	94.6
1	110	10	0.44	12.1	97.9
1	110	25	0.88	30.8	79.2
1	110	50	1.32	57.2	52.8
2	220	25	0.88	15.4	94.6
2	220	50	1.76	30.8	79.2
3	330	25	1.32	9.9	100.1
3	330	50	1.32	19.8	90.2
4	440	25	1.76	7.7	102.3
4	440	50	1.76	15.4	94.6

A family of four, with an assumed roof area of 50 m^3, could therefore expect to save 61.6 litres per day[54] if a RWH system were installed.

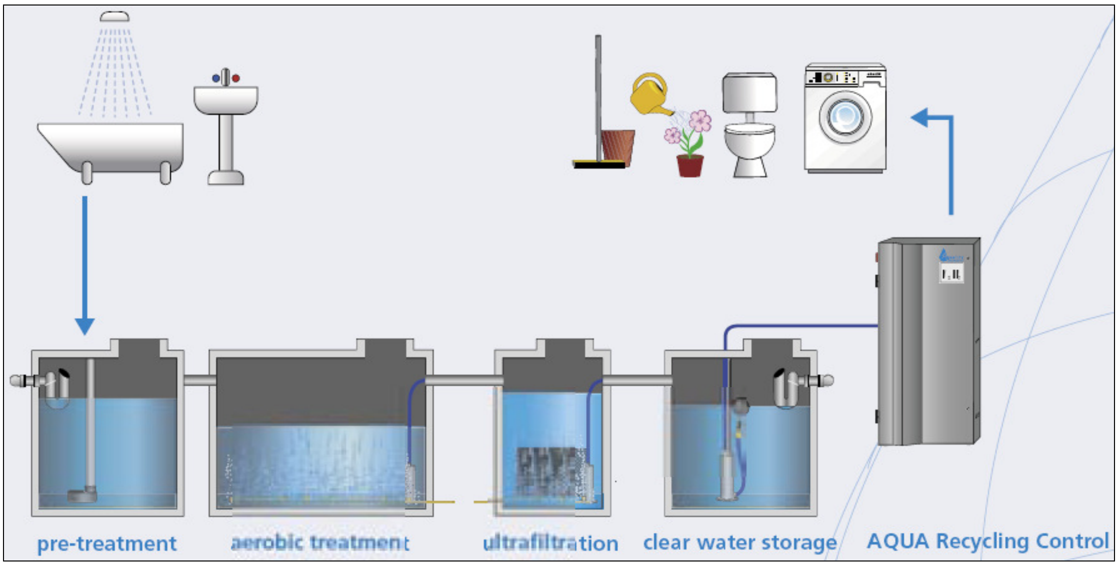
Greywater Recycling

Greywater recycling (GWR) is the treatment and re-use of wastewater from showers, baths and sinks for use again within a property where potable quality water is not essential e.g. toilet flushing. Recycled greywater is not suitable for human consumption or for irrigating plants or crops that are intended for human consumption. The source of greywater should be selected by available volumes and pollution levels, which often rules out the use of kitchen and clothes washing waste water as these tend to be most highly polluted. However, in GWR systems on large properties virtually all non-toilet sources can be used, subject to appropriate treatment.

[52] Aquality Rainwater Harvesting brochure, 2008
[53] Sustainable water management strategy for Northstowe, WSP, December 2007
[54] 4 occupants at 15.4 l/h/d each = 61.6 litres saved per day

The storage volumes required for GWR are usually smaller than those required for rainwater harvesting as the supply of greywater is more reliable than rainfall. In domestic situations, greywater production often exceeds demand and a correctly designed system can therefore cope with high demand application and irregular use, such as garden irrigation. Figure 4-3 below gives a diagrammatic representation of a typical domestic system[55].

Figure 4-3: A Typical Domestic Greywater Recycling System[51])



Combined rainwater harvesting and greywater recycling systems can be particularly effective, with the use of rainwater supplementing greywater flows at peak demand times (e.g. morning and evenings).

The Northstowe Sustainable Water Management Strategy calculated the volumes of water that could be made available from the use of GWR. These were assessed against water demand calculated using the BRE Water Demand Calculator[56].

Table 4-4: Potential Water Savings from GWR (taken from Northstowe SWMS[53])

Appliance	Demand with Efficiencies (l/h/day)	Potential Source	Greywater Required (l/h/day)	Out As	Greywater available (80% efficiency) (l/h/day)	Consumptions with GWR (l/h/day)
Toilet	15	Grey	15	Sewage	0	0
Wash hand basin	9	Potable	0	Grey	7	9
Shower	23	Potable	0	Grey	18	23
Bath	15	Potable	0	Grey	12	15
Kitchen Sink	21	Potable	0	Sewage	0	21
Washing Machine	17	Grey	17	Sewage	0	0
Dishwasher	4	Potable	0	Sewage	0	4
Total	**103**		**31**		**37**	**72**

[55] Source: Aquality Intelligent Water management, www.aqua-lity.co.uk
[56] http://www.thewatercalculator.org.uk/faq.asp

The above demonstrates the water savings that can be achieved by GWR. If the toilet and washing machine are connected to the GWR system a saving of 32 litres per person per day can be achieved.

The treatment requirements of the GWR system will vary as water which is to be used for flushing the toilet does not need to be treated to the same standard as that which is to be used for the washing machine. The source of the greywater also greatly affects the type of treatment required. Greywater from a washing machine may contain suspended solids, organic matter, oils and grease, detergents (including nitrates and phosphates) and bleach. Greywater from a dishwasher could have a similar composition, although the proportion of fats, oils and grease is likely to be higher; similarly for wastewater from a kitchen sink. Wastewater from a bath or shower will contain suspended solids, organic matter (hair and skin), soap and detergents. All wastewater will contain bacteria, although the risk of infection from this is considered to be low[57].

Treatment systems for GWR are usually of the following four types:

- basic (e.g. coarse filtration and disinfection);
- chemical (e.g. flocculation);
- physical (e.g. sand filters or membrane filtration and reverse osmosis); and,
- biological (e.g. aerated filters or membrane bioreactors).

4.4.5 Water Neutrality Scenarios

Water neutrality scenarios have been developed based on the following generic assumptions. For clarity, the Fenland district as a whole has been considered when assessing the scenarios:

Very High Scenario

The key assumptions for this scenario are:

- it assumes water neutrality is achieved, however it is considered as aspirational only as it is unlikely to be feasible based on:
    - existing research into financial viability of such high levels of water efficiency measures in new homes; and,
    - Uptake of retrofitting water efficiency measures considered to be at the maximum achievable (35%) in the county58.
- It would require:
    - a significant funding pool and a specific joint partnership ‘delivery plan’ to deliver the extremely high percentage of retrofitting measures required;
    - strong local policy within the LDF on restriction of water use in new homes on a district scale which is currently unprecedented in the UK; and,
    - all new development to include water recycling facilities across the district which is currently limited to small scale development in the UK.

The scenario has been developed as a context to demonstrate what is required to achieve the full aspiration of water neutrality.

[57] Centre for the Built Environment, www.cbe.org.uk
[58] Cambridge (and surrounding major growth areas) WCS Phase 2, Halcrow, 2011

High Scenario

The key assumptions for this scenario are:

- A high water neutrality percentage[59] is achieved but requires significant funding and partnership working, and adoption of new local policy which is currently unprecedented in the UK.
- It would require:
  - Uptake of retrofitting water efficiency measures to be very high (25%) in relation to studies undertaken across the UK;
  - a significant funding pool and a specific joint partnership 'delivery plan' to deliver the high percentage of retrofitting measures required; and,
  - strong local policy within the LDF on restriction of water use in new homes on a district scale which is currently unprecedented in the UK.

It is considered that, despite being at the upper scale of percentage uptake of retrofitting measures, it is technically and politically feasible to obtain this level of neutrality if a fully funded joint partnership approach could be developed.

Medium Scenario

The key assumptions for this scenario are:

- The water neutrality percentage[60] achieved is approximately 50% of the total neutrality target and would require funding and partnership working, and adoption of new local policy which has only been adopted in a minimal number of LDFs in the UK.
- It would require:
  - Uptake of retrofitting water efficiency measures to be reasonably high (20%) in the county[61]
  - a significant funding pool and a specific joint partnership 'delivery plan' to deliver the high percentage of retrofitting measures required; and,
  - Local policy within the LDF on restriction of water use in new homes on a district scale which goes beyond that seen generally in the UK.

It is considered that, it is technically and politically feasible to obtain this level with a relatively modest funded joint partnership approach and with new developers contributing relatively standard, but high spec water efficient homes

Low Scenario

The key assumptions for this scenario are:

- The water neutrality percentage[62] achieved is low but would require small scale level of funding and partnership working, and adoption of new local policy which is likely to be easily justified and straightforward for developers to implement.

[59] WN percentage refers to the percentage of water use savings made by various measures against the total new demand if the business as usual demand were to continue
[60] WN percentage refers to the percentage of water use savings made by various measures against the total new demand if the business as usual demand were to continue
[61] Cambridge (and surrounding major growth areas) WCS Phase 2, Halcrow, 2011
[62] WN percentage refers to the percentage of water use savings made by various measures against the total new demand if the business as usual demand were to continue

- It would require:
  - Uptake of retrofitting water efficiency measures to be fairly low (10%);
  - a relatively small funding pool and a partnership working not moving too far beyond business as usual for stakeholders; and,
  - Local policy within the LDF on restriction of water use would be easy to justify and implement.

It is considered that it is technically and politically straightforward to obtain this level with a small funded joint partnership approach and with new developers contributing standard, but water efficient, homes with a relatively low capital expenditure.

As described, four water neutrality targets have been proposed and assessed as part of this Stage 2a Detailed WCS. Each target moves beyond the business as usual scenario which is considered to be:

- 105l/h/d for new affordable homes[63] and 125 l/h/d for all other new homes[64];
- no mandatory efficiency target for non-domestic property; and,
- continued meter installation in existing homes as planned in AWS's WRMP up to 2035.

At 65 per cent, the existing level of metering within the AWS region is already twice the national average[65]. AWS's future target for meter penetration[66] is 90 per cent penetration on domestic water meters by 2035. During AMP4 (from 2005-06 to 2009-10) over 100,000 customers opted to use a water meter, which when combined approximately 20,000 new metered connections each year, resulted in the growth in metered households by 2 per cent per year. The WRMP assumes this rate will continue to the target of 90% of customers metered by 2035.

Therefore, the Water Neutrality scenarios can only assume a further 10% meter penetration within the existing housing stock by the end of the plan period in line with AWS' WRMP.

Neutrality Scenario Assessment Results

For each neutrality scenario, an outline of the required water efficiency specification was developed for new houses, combined with an estimate of the savings that could be achieved through metering and further savings that could be achieved via retrofitting of water efficient fixtures and fittings in existing property. This has been undertaken utilising research undertaken by groups and organisations such as Waterwise East, UKWIR[67], the Environment Agency and Ofwat to determine realistic and feasible efficiency savings as part of developer design of properties, and standards for non-residential properties.

It is important to note that, although three housing scenarios have been assessed in this WCS for Fenland, only the medium growth scenario (scenario 2) has been assessed for water neutrality.

To achieve total neutrality, the demand post growth must be the same as, or less than existing demand. Based on estimates of population size, existing demand in Fenland was calculated to be 14.42 Ml/d.

[63] Levels 3&4 - CSH
[64] Building regulations Part G requirement
[65] Anglian Water Services- Water Resources Management Plan, Main Report (2010)
[66] that is the proportion of properties within the AWS supply area which have a water meter installed
[67] UKWIR – The United Kingdom Water Industry Research group, attended and part funded by all major UK water companies

- Stage 1 – total demand post growth without any assumed water efficiency retrofitting for the differing levels of water efficiency in new homes;
- Stage 2 – total demand post growth with effect of metering applied for the differing levels of water efficiency in new homes; and,
- Stage 3 – total demand post growth with metering and water efficient retrofitting applied to existing homes for the differing levels of water efficiency in new homes.

The results are shown in Table 4-5. If neutrality is achieved, the result is displayed as green. If it is not, but within 20%, it is displayed as amber, and red if not achieved. The percentage of total neutrality achieved per scenario is also provided.

Table 4-5: Results of the Neutrality Scenario Assessments

New homes & employment demand Projections	Demand (Ml/d)	Total demand post growth (Ml/d)	Total demand after metering effect (Ml/d)	Total demand after metering & WE F&F (Ml/d)	% neutrality achieved
Existing Demand	14.421	14.421			
Average AWS metered consumption	4.55	18.97	18.54	18.54	-8.68%
Business as usual	3.79	18.21	17.64	17.64	15.01%
Low	3.62	18.05	17.48	17.38	21.84%
Medium	3.18	17.61	17.04	16.47	45.92%
High	2.37	16.79	16.22	15.06	83.23%
Very High	1.88	16.30	15.73	14.10	108.35%

* prior to demand management for existing stock

Neutrality is achieved only by applying the very high scenario, whilst the high neutrality scenario gives close to 83% neutral water use.

4.4.6 Delivery Requirements - Technological

The details of what is required technologically from each scenario in terms of new build are included in Table 4-6.

Table 4-6: Details of New Build Specification to Meet Each Water Use Target

Component	150 l/h/d Standard Home	Business as usual	Low (120 l/h/d target CSH 1/2)	Medium (105 l/h/d CSH Level 3/4)	High (80 l/h/d target CfSH Level 5/6)	very High
Toilet flushing	28.8	19.2	19.2	16.8	16.8	16.8
Taps	42.3	31.8	31.8	24.9	18	18
Shower	30	30	24	18	18	18
Bath	28.8	25.6	25.6	25.6	22.4	22.4
Washing machine	16.7	15.3	15.3	15.3	15.3	15.3
Dishwasher	3.9	3.9	3.6	3.6	3.6	3.6
Recycled water					-16.1	-32.2
Total per head	150.5	125.8	119.5	104.2	78	61.9
Total per household	316.05	264.18	250.95	218.82	163.8	129.99

COLOUR KEY
Combines kitchen sink and wash hand basin
6/3 litre dual-flush toilet (f) recycled water
160 litre bath filled to 40% capacity, frequency of use 0.4/day
4.5/3 litre dual flush toilet
120 litre bath
Rainwater harvesting
rainwater harvesting & greywater for toilet flushing and washing machine

Table 4-7 below gives further detail on the measures required in new builds and from retrofitting, including assumptions on the predicted uptake of retrofitting from the existing housing and commercial building use.

Table 4-7: Water Neutrality Scenarios – Specific Requirements for Each Scenario

WN Scenario	New development requirement				Retrofitting existing development	
	New development Water use target (l/h/d)	Relevant CSH target	Water Efficient Fixtures and Fittings[b]	Water Recycling technology	Metering Penetration assumption[a]	Water Efficient Fixtures and Fittings
Business as usual	125	Building Regs only	- 3-6 litre dual flush toilet; - Low aeration taps; - 160 litre capacity bath; - High efficiency washing machine	None	90%	None
Low	120	Level 1/2	- 3-6 litre dual flush toilet; - Low spec aeration taps; - 160 litre capacity bath; - low spec low flow shower head - High efficiency dishwasher - High efficiency washing machine	None	100%	- 3-6 litre dual flush toilet or cistern device fitted; - 10% take up across district
Medium	105	Level 3/4	- 3-4.5 litre dual flush toilet; - Medium spec aeration taps; - high spec low flow shower head; - 160 litre capacity bath; - high spec flow shower head - High efficiency dishwasher - High efficiency washing machine	None	100%	- 3-4.5 litre dual flush toilet or cistern device fitted; - medium spec aerated taps fitted - 20% take up across district
High	78	Level 5/6	- 3-4.5litre dual flush toilet; - High spec aeration taps; - high spec low flow shower head; - 120 litre capacity bath; - high spec low flow shower head - High efficiency dishwasher - High efficiency washing machine	Rainwater harvesting	100%	- 3-4.5 litre dual flush toilet or cistern device fitted; - high spec aerated taps fitted - high spec low flow shower head fitted - 25% take up across district

WN Scenario	New development requirement				Retrofitting existing development	
	New development Water use target (l/h/d)	Relevant CSH target	Water Efficient Fixtures and Fittings[b]	Water Recycling technology	Metering Penetration assumption[a]	Water Efficient Fixtures and Fittings
Very High	62	Level 5/6	- 3-4.5litre dual flush toilet; - High spec aeration taps; - high spec low flow shower head; - 120 litre capacity bath; - high spec low flow shower head - High efficiency dishwasher - High efficiency washing machine	Rainwater harvesting and Greywater recycling	100%	- 3-4.5 litre dual flush toilet or cistern device fitted; - high spec aerated taps fitted - high spec low flow shower head fitted - 35% take up across district

a: only the additional metering beyond business as usual has been accounted for (i.e. 10%)

b: refers to fittings above that included in a standard home using approximately 150l/h/d

Financial Cost Considerations

The financial cost of delivering the technological requirements of each neutrality scenario have been calculated from available research and published documents.

New Build Costs

Costs for water efficiency in new property have been provided based on homes achieving different code levels under the CSH based on the cost analysis undertaken by CLG[68] and as set out in Table 4-8.

Table 4-8: CSH Specifications and Costs

Code Level	Estimated water consumption (l/h/d)	Specification	Cost	
			Additional Cost (£)	Cumulative Cost (£)
1 and 2	120	2 x 6/4 litre flush toilets 4 x taps with flow regulators (2.5 l/m) 1 x shower 6 litres/min 1 x standard bath (90 litres per use) 1 x standard washing machine* 1 x standard dishwasher*	£0	£0
3 and 4	105	As Level 1 and 2, except: 2x4/2.5 litre flush toilets 1x smaller shaped bath	£125	£125
5 and 6	80	Houses As Level 3 and 4, except: Rainwater harvesting 2 x 6/4 litre flush toilets	£2,520	£2,645
		Apartments As Level 3 and 4, except: Rainwater harvesting 2 x 6/4 litre flush toilets	£680	£805

Notes: *Additional cost of washing machine and dishwasher is assumed to be zero as these fittings are 'standard' industry performance. Therefore, if they are typically installed by house builder there would be no additional cost over their current specifications.

An additional cost was required for the 'very high' neutrality scenario that included for greywater recycling as well as rainwater harvesting and this is detailed in the following section.

[68] CLG (2008) cost analysis of he Code for Sustainable Homes

Water Recycling

Research into the financial costs of installing and operating GWR systems gives a range of values, as follows:

Table 4-9: Costs of GWR Systems

Cost	Cost	Comments
Installation cost	£1,750 £2,000 £800 £2,650	Cost of reaching Code Level 5/6 for water consumption in a 2-bed flat[69] For a single dwelling[70] Cost per house for a communal system[71] Cost of reaching Code Level 3/4 for water consumption in a 3-bed semi-detached house[72]
Operation of GWR	£30 per annum[73]	
Replacement costs	£3,000 to replace[23]	It is assumed a replacement system will be required every 25 years

There is less research and evidence relating to the cost of community scale systems compared to individual household systems, but it is thought that economies of scale will mean that larger scale systems will be cheaper to install than those for individual properties. As shown above, the Cost review of the Code for Sustainable Homes indicated that the cost of installing a GWR system in flats is less than the cost for a semi-detached house. Similarly, the Water Efficient Buildings website estimates the cost of installing a GWR system to be £2,000 for a single dwelling and £800 per property for a share of a communal system.

As it is not possible to determine how many of the outstanding housing developments in Fenland will be of a size large enough to consider communal recycling facilities, an approximation has been made of an average per house cost (£1,400) using the cost of a single dwelling (at £2,000) and cost for communal (at £800). This has been used for the assessment of cost for a greywater system in a new property required for the 'very high' neutrality scenario.

Installing a Meter

The cost of installing a water meter has been assumed to be £500 per property[74]. It is assumed that the replacement costs will be the same as the installation costs (£500), and that meters would need to be replaced every 15 years[75].

Retrofitting of Water Efficient Devices

Using the costs presented in the Environment Agency report Water Efficiency in the South East of England[76], costs have been given as a guide for installation of retrofitting of water efficient fixtures and fittings and are presented in Table 4-10 below.

[69] Code for Sustainable Homes: A Cost Review, Communities and Local Government, 2008
[70] http://www.water-efficient-buildings.org.uk/?page_id=1056
[71] http://www.water-efficient-buildings.org.uk/?page_id=1056
[72] Code for Sustainable Homes: A Cost Review, Communities and Local Government, 2008
[73] Environment Agency Publication - Science Report – SC070010, Greenhouse Gas Emissions of Water Supply and Demand Management Options, 2008
[74] Cambridge (and surrounding major growth areas) WCS Phase 2, Halcrow, 2010
[75] Environment Agency Publication - Science Report – SC070010: Greenhouse Gas Emissions of Water Supply and Demand Management Options, 2008
[76] Ref – Water Efficiency in the South East of England

Table 4-10: Water Saving Methods

Water Saving Method	Approximate Cost per House (£)	Comments/uncertainty
Variable flush retrofit toilets	£50 - £140	Low cost for 3-6 litre system and high cost for 3-4.5 litre system. Needs incentive to replace old toilets with low flush toilets.
Low flow shower head scheme	£15 - £50	Low cost for low spec shower head; high costs for high spec. Cannot be used with electric, power or low pressure gravity fed systems.
Aerating taps	£10 - £20	Low cost is med spec, high cost is high spec.

Toilet cistern displacement devices are often supplied free of charge by water companies and this is therefore also not considered to be an additional cost.

Neutrality Scenario Costs

Using the above information, the financial cost per scenario has been calculated and are included in Table 4-11.

Table 4-11: Estimated Cost of Neutrality Scenarios

Neutrality Scenaro	CSH - Code Level	Outstanding housing		Existing properties					Costs Summary		
		Numbers	CSH cost	No. to be metered (10% of existing)	Metering cost	Retrofit %	Nos to retrofit	Retrofit cost	Developer	Non developer	Total
Low	1 or 2	15,165	£ -	4,180	£ 2,090,000	10.00%	4180	£ 209,000	£ -	£ 2,299,000	£ 2,299,000
Medium	3 or 4	15,165	£ 1,895,625	4,180	£ 2,090,000	20.00%	8360	£ 1,379,400	£ 1,895,625	£ 3,469,400	£ 5,365,025
High	5 or 6 (RWH)	15,165	£ 40,111,425	4,180	£ 2,090,000	25.00%	10450	£ 2,299,000	£ 40,111,425	£ 4,389,000	£ 44,500,425
Very High	5 or 6 (RWH & GWR)	15,165	£ 60,735,825	4,180	£ 2,090,000	35.00%	14630	£ 3,218,600	£ 60,735,825	£ 5,308,600	£ 66,044,425

Carbon Cost Considerations

As described in this section, there are sustainability issues to consider when deciding on a policy for promotion of water neutrality. Reaching the very highest levels of efficiency requires the use of recycling technology (either through rainwater harvesting and treatment or greywater recycling), which requires additional energy both embedded in the physical structures required and also in the treatment process required to make the water usable.

Whilst being water efficient is a key consideration of this study, due to the wider vision for sustainable growth, reaching neutrality should not be at the expense of increasing energy use and potential increasing the carbon footprint of development

It is also important to consider that through using less water, more water efficient homes require less energy to heat water hence there are energy savings.

In order to give an overview of the likely sustainability of each of the WN scenarios, a 'carbon cost' has been applied to each of the scenarios based on the water efficiency measures proposed for new homes, and the retrofitting of existing.

Methodology

A joint study by the Environment Agency and the Energy Saving Trust[77] assessed the energy and carbon implications of the installation of water saving devices. The report initially calculated a baseline water consumption figure for existing housing stock, using the following assumptions:

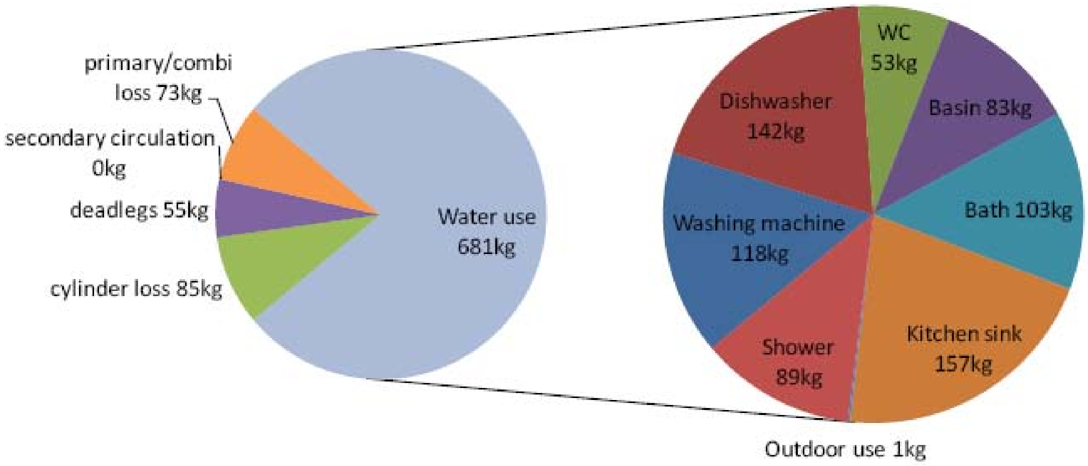
Table 4-12: Baseline Energy Consumption Assumptions

Device	Volume of water per use (litres)	Frequency of use (per person per day)
Toilet	9.4	4.66
Kitchen Taps	59	Taps taken as volume/day, 40% cold
Basin taps hot	42	Taps taken as volume/day, 30% cold
Bath	70	0.21
Washing machine	50	0.34
Shower	25.7	0.59
Dishwasher	21.3	0.29

The study then modelled the CO_2 emissions from this 'standard' existing dwelling, as shown below in Figure 4-4. Appliances requiring hot water using appliances dominate, but water use for toilet flushing produces 53kg of CO_2 emissions per year (approximately 50 per cent from water company emissions and 50 per cent due to heat loss as cold mains water in the toilet cistern heats to room temperature).

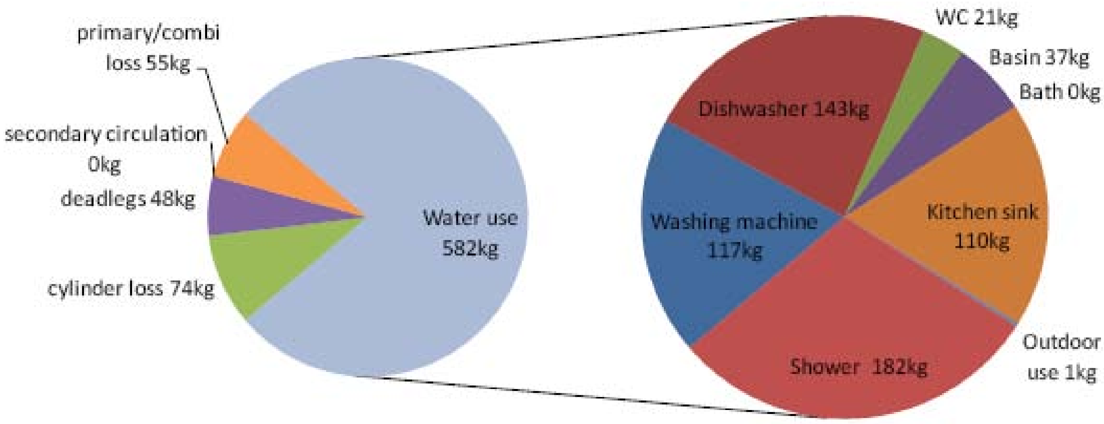
[77] Quantifying the energy and carbon effects of water saving, Full technical report, Environment Agency and the Energy Saving Trust, 2009

Figure 4-4: CO_2 Emissions from a 'Standard' Existing Dwelling[77]



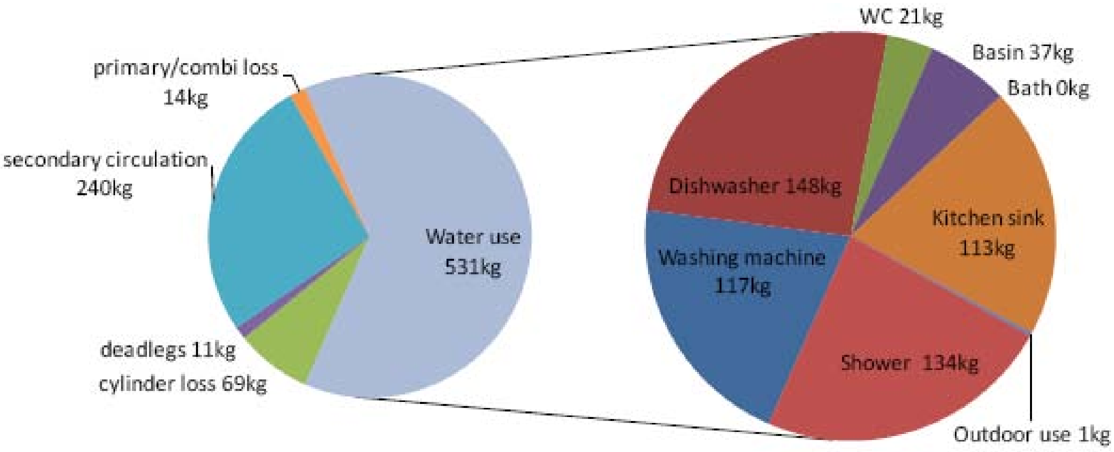
The study then assessed the impacts on this baseline figure of 681 kg CO_2 for water use from a home which has water use compliant with CfSH level 3/4.

Figure 4-5: CO2 Emissions from a CfSH Level 3/4 Dwelling[77]



The study then assessed the impacts of a home which has water use compliant with CfSH level 5/6.

Figure 4-6: CO_2 Emissions from a CfSH Level 5/6 Dwelling[7977]



It can therefore be seen that the carbon cost of achieving Levels 3/4 and 5/6 compares favourably to the baseline scenario of current average water use of 681kg/CO_2. CfSH level 3/4 represents a carbon saving of 99 kg/CO_2 and CfSH Level 5/6 represents a carbon saving of 150 kg/CO_2.

The energy savings from water efficiency measures within the home would be offset to a certain degree by increased energy demands of RWH or GWR systems, which have been shown to be required to meet CfSH Level 5/6. Energy savings for AWS from not treating additional water to potable standard, as with the conventional mains water supply, can be thought of to be simply a transfer of energy consumption away from the AWS to the individual householders. While AWS will benefit from this reduction in energy demand, which will assist with meeting its Carbon Reduction Commitment (CRC) (as laid down in 2007's Energy Reduction White Paper[78]), the expense will be passed to householders.

For households with the GWR/RWH required for CfSH Levels 5/6, any financial benefits to householders experienced through a reduction in water bills (for metered properties) will be offset by the increased expense of energy bills for pumping and treating water in GWR and RWH systems.

The WRMP Direction 2007[79] and WRP Guideline[80] require details of the greenhouse gas emissions that are likely to arise through the delivery of a water company's proposed WRMP. AWS estimated these from calculation of greenhouse gases as tonnes of carbon dioxide equivalent (tCO2e) for the base year 2007-08 of 143,889 tCO2e for drinking water treatment and distribution. For subsequent years the value of 0.34 tCO2e/Ml has been used with the forecast demand to give the mass of CO2e likely to be emitted on the basis of current technologies. In order to calculate the carbon costs of achieving water efficiency for the proposed growth in Fenland, the value of 0.34 tCO2e/Ml has been used.

[78] Meeting the Energy Challenge - A White Paper on Energy, May 2007, Department of Trade and Industry
[79] WRMP Regulations Statutory Instrument 2007 No. 727, WRMP Direction 2007, WRMP (No.2) Direction 2007, WRMP (No.2) (Amendment) Direction 2007, WRMP Direction 2008
[80] Water resources planning guideline, Environment Agency, November 2008, http://www.environment-agency.gov.uk/business/sectors/39687.aspx

Results

The information was used along with estimates of energy used in recycling technology[81] to provide a carbon cost for each of the WN scenarios for Fenland. The results are presented in Table 4-13.

The following assumptions have been applied:

- under the 'High' and 'Very high' scenarios, consideration must be taken of carbon use in rainwater harvesting as well as water use;
- a basic assumption that each new home is a $90m^2$ 2-storey house with a small biological system; and,
- insufficient information was available to differentiate between energy used in a building regulations standard home at 125l/h/d and a code level 1 or 2 home on the CSH. Therefore, energy used per home is the same for 'business as usual (i.e. building regulations) and the low WN scenario.

[81] Environment Agency (2010) Energy and carbon implications of rainwater harvesting and greywater recycling

Table 4-13: Carbon Costs of WN Scenarios

WN Scenario	Relevant CSH target	Water use reduction from retrofit per WN scenario	Carbon reduction per WN scenario	Carbon use per new home (kg/y)	carbon use per new home (kg/d)	Total carbon use for new homes in Fenland (tCO2e/d)	Total tCO2e/d
Business as usual	Building Regs only	0	0	681	1.865753425	20.92442466	20.92442
Low	Level 1/2	0.09	-0.031380096	681	1.865753425	20.92442466	20.89304
Medium	Level 3/4	0.57	-0.192203088	582	1.594520548	17.88254795	17.69034
High	Level 5/6	1.16	-0.39470277	578	1.583561644	17.75964384	17.36494
Very High	Level 5/6	1.63	-0.552583878	614.9	1.684657534	18.89343425	18.34085

The results show that there a significant CO_2 savings to be made by homes being built to a higher water efficiency level and from the effect of existing homes using less energy to heat water through retrofitting of water efficient devices.

The additional energy used per house for RWH in the High scenario is offset by the savings made in using less water in line with code levels 5/6 on the CSH; however the additional energy required for greywater recycling in the very high scenario makes this scenario higher in CO_2 emissions than both the medium and high WN scenarios. This suggests that in order to meet total neutrality there will be an increase in CO_2 emissions over less intensive WN scenarios and hence there are concerns over the long term sustainability of pursuing such a strategy,

4.4.7 Preferred Strategy – Delivery Pathway

The stakeholder group has agreed that in order to start on the pathway to neutrality that measures are taken to deliver the first step of the 'low' WN scenario. This would allow a WN target of 25% to be reached and is generally considered to require a small scale level of funding and partnership working, and adoption of new local policy which is likely to be easily justified and straightforward for developers to implement.

It is considered that it is technically and politically straightforward to obtain this level with a small funded joint partnership approach and with new developers contributing standard, but water efficient, homes with a relative low capital expenditure

Depending on the success of the first step to neutrality, higher WN scenarios could be aspired to by further developing policies and partnership working to deliver greater efficiencies,

In order to meet the low WN scenario, the following measures are suggested to support its delivery.

Delivery Requirements – Policy

In order to meet the water neutrality target scenario given above (ie. the low WM Scenario), the following planning policy is recommended:

POLICY RECOMMENDATION 1:

Ensure all housing and non-domestic property is water efficient, new housing development must go beyond Building Regulations and as a minimum reach Code for Sustainable Homes Level 1/2.

Developers should prove that code levels 1 or 2 for water have been met. When considering planning applications for new development (regardless of size), the planning authority and all consultees should consider whether the proposed design of the development has incorporated water efficiency measures, including (but not necessarily limited to) garden water butts, low flush toilets, low volume baths, aerated spray taps, and water efficient appliances sufficient to meet 105l/h/d.

In addition, it is recommended that the following policies be introduced, to assist with the implementation of the above planning policy:

POLICY RECOMMENDATION 2:

Carry out a programme of retrofitting and water audits of existing dwellings and non domestic buildings. Aim to move towards delivery of 10% of the existing housing stock with easy fit water savings devices

This recommendation must work in parallel with the promotion and education programme outlined by Policy Recommendation 3. Further recommendations on how to achieve it are included below, including recommended funding mechanisms.

POLICY RECOMMENDATION 3:

Establish a programme of water efficiency promotion and consumer education, with the aim of behavioural change with regards to water use.

4.4.8 Delivery Requirements – Partnership Approaches

To Support Policy Recommendation 2

Local authority owned building or those the council are responsible for, should be targeted for a programme of retrofitting water efficient devices, to showcase the policy and promote the benefits. This should be a collaborative scheme between the Council, AWS and Waterwise. In addition, RWH/GWR schemes could be implemented into buildings such as schools or community centres. RWH could be introduced to public toilets, as has been carried out in Cambridge.

The retrofitting scheme should then be extended to privately owned properties, via the promotion and education programme outlined by Policy Recommendation 3.

A programme of water audits should be carried out in existing domestic and non-domestic buildings, again showcased by Council owned properties, to establish water usage and to make recommendations for improving water efficiency measures. The water audits should be followed up by retrofitting water efficient measures in these buildings, as discussed above. In private non-domestic buildings water audits and retrofitting should be funded by the asset owner, the cost of this could be offset by the financial savings resulting from the implementation of water efficient measures. Funding options for domestic properties are discussed above.

AWS should consider a policy of moving towards 100% meter installation in the WRZs within the next update to the WRMP (2015).

To Support Policy Recommendation 3

In order to ensure the uptake of retrofitting water efficient devices for private properties, the Council should implement an awareness and education campaign, which could include the following:

- working with AWS to help with its water efficiency initiative, which has seen over 20,000 leaflets distributed directly to customers and at events across the region each year[82];
- a media campaign, with adverts/articles in local papers and features on a local news programme;
- a media campaign could be supplemented by promotional material, ranging from those that directly affect water use e.g. free cistern displacement devices, to products which will raise awareness e.g. fridge magnets with a water saving message;
- encouraging developers to provide new residents with ‘welcome packs’, explaining the importance of water efficiency and the steps that they can take to reduce water use;
- working with retailers to promote water efficient products, possibly with financial incentives as were undertaken as part of the Preston Water Initiative[83];

[82] Anglian Water Services, Water Resource Management Plan, 2010, http://www.anglianwater.co.uk/environment/water-resources/resource-management/

- carrying out educational visits to schools and colleges, to raise awareness of water efficiency amongst children and young adults;
- working with neighbourhood trusts, community groups and local interest groups to raise awareness of water efficiency; and,
- carrying out home visits to householders to explain the benefits of saving water, this may not be possible for the general population of Fenland District, but rather should be used to support a targeted scheme aimed at a specific residential group, as was carried out for the Preston Water Initiative[84].

Responsibility

The three policy recommendations above are targeted at the Council and AWS, as these are the major stakeholders, although the Environment Agency and other statutory consultees can also influence future development to ensure the water neutrality target of 24 percent is achieved.

It is therefore suggested that responsibility for implementing water efficiency policies be shared as follows:

- Responsibility for ensuring planning applications are compliant with the recommended policies lies with the Council and Environment Agency (and other statutory consultees as appropriate);
- Responsibility for fitting water efficient devices in accordance with the policy lies with the developer, but this should be guided and if necessary enforced by the Council through the planning application process (as above);
- Responsibility to ensure continuing increases in the level of water meter penetration lies with AWS;
- Responsibility for retrofitting devices lies solely with the Council for Council owned housing stock and with the Council and developers (via Section 106 agreements and CIL) for privately owned housing stock;
- Responsibility for promoting water audits lies with the Council. It is suggested that the Council sets targets for the numbers of businesses that have water audits carried out and that a specific individual or team within the Council is responsible for promoting and water audits and ensuring the targets are met. The same team or individual could also act as a community liaison for households (council and privately owned) and businesses where water efficient devices are to be retrofitted, to ensure the occupants of the affected properties understand the need and mechanisms for water efficiency; and,
- Responsibility for education and awareness of water efficiency should be shared between the Council, AWS and energy companies, as a partnership managed by the Council.

However it should be noted that a major aim of the education and awareness programme, as outlined by Policy Recommendation 3, is to change peoples' attitude to water use and water saving and to make the general population understand that it is everybody's responsibility to reduce water use. Studies have shown that the water efficiencies in existing housing stock achieved by behavioural changes, such as turning off the tap while brushing teeth or reducing shower time, can be as important as the installation of water efficient devices.

[83] Preston Water Efficiency Report, Waterwise, March 2009, www.waterwise.org.uk
[84] Preston Water Efficiency Report, Waterwise, March 2009, www.waterwise.org.uk

Retrofitting Funding Options

In addition to possible resistance from existing householders, the biggest obstacle to retrofitting is the funding mechanism.

Water companies are embarking on retrofit as part of their response to meeting Ofwat's mandatory water efficiency targets. These programmes are funded out of operational expenditure. If a company has, or is forecasting a supply-demand deficit over the planning period, water efficiency programmes can form part of a preferred option(s) set to overcome the deficit. However, these option are identified as part of the companies water resource management plans and will have to undergo a cost-benefit analysis.

The Council could consider developer contributions to the Community Infrastructure Levy (CIL) or through S106 agreements.

Part 11 of the Planning Act 2008[85] (c. 29) ("the Act") provides for the imposition of a charge to be known as Community Infrastructure Levy (CIL). This is a new local levy that authorities can choose to introduce to help fund infrastructure in their area. CIL will help pay for the infrastructure required to serve new development, and although CIL should not be used to remedy pre-existing deficiencies, if the new development makes the deficiency more severe (as is the case with water resources in the Fenland area) then the use of CIL is appropriate.

Section 106 (S106) of the Town and Country Planning Act 1990[86] allows a local planning authority (LPA) to enter into a legally-binding agreement or planning obligation with a landowner in association with the granting of planning permission, known as a Section 106 Agreement. These agreements are a way of delivering or addressing matters that are necessary to make a development acceptable in planning terms. They are increasingly used to support the provision of services and infrastructure, such as highways, recreational facilities, education, health and affordable housing.

However, there are considerable existing demands on developer contributions and it is unlikely that all of the retrofitting required in Fenland could be funded through these mechanisms; the Council therefore needs to look beyond developer contributions, possibly to the water companies, for further funding sources. Some councils offer council tax rebates to residents who install energy efficient measures (rebates jointly funded by council and Energy Company)[87]. Fenland Council should consider a similar scheme, although this would require the agreement of AWS.

There are two possible European funding mechanisms available for the promotion of water efficiencies:

- European Investment Bank (EIB); and,
- European Regional Development Funds.

The EIB's lending policy[88] sets out how the EIB will support water efficiency measures by water service providers and grant loans to promote water efficiency in buildings. This could be a possible funding route for a widespread retrofitting programme.

European Regional Development Funds are more limited, as funds are often preferentially directed towards energy efficiency projects, with the aim of reducing carbon emissions to achieve European targets. Allocated funding for the current programming period (2007 to 2013

85 http://www.legislation.gov.uk/ukpga/2008/29/contents
86 http://www.legislation.gov.uk/ukpga/1990/8/contents
87 Cambridge (and surrounding major growth areas) WCS Phase 2, Halcrow, 2010
88 http://www.eib.org/attachments/strategies/water_sector_lending_policy_2008_en.pdf

are mainly allocated to such projects[89] although the possibility of funding for water efficiency project post-2013 should be investigated.

Retrofitting Monitoring

During delivery stage, it will be important to ensure sufficient monitoring is in place to track the effects of retrofitting on reducing demand form existing housing stock. The latest research shows that retrofitting can have a significant beneficial effect and can be a cost effective way of managing the water supply-demand balance[90]. However, it is acknowledged that savings from retrofitting measures do diminish with time. This means that a long-term communication strategy is also needed to accompany any retrofit programme taken forward and this needs to be supported by monitoring so that messages can be targeted and water savings maintained in the longer-term. The communication and monitoring message also applies to new builds to maintain continued use of water efficient fixtures and fittings.

4.5 Water Supply and Climate Change Adaptation

Table 4-14 provides a summary of the potential climate change adaptation and mitigation measures that could be considered in the Fenland District with regards to water resources and water supply infrastructure. The organisations likely to be responsible for leading these measures have been identified alongside the suggested timescale for these actions to start being taken forward (Immediate (within 1 year), Medium (1 - 10 years) and Long (10+ years)).

[89] Ensuring Water for All, Scoping Study Final Report, Environment Agency, 2010

[90] Waterwise (2011: Evidence base for large-scale water efficiency, Phase II Final report

Table 4-14: Water Resources Potential Climate Change Adaptation and Mitigation Measures[91]

Potential Climate Change	Potential Impact	Adaptation and Mitigation Measures	Lead Organisation(s)				Timescale for Action
			FDC	EA	AWS	NE	
Temperature rise	• Increase in demand for water in summer • Increased evapotranspiration • Increased peak demand • Faster water supply asset deterioration • Changes in process efficiency	• Ensure regional drought plans take into account the impacts of climate change		✓	✓		Medium
		• Manage seasonal changes in climate by reducing summer peaks in demand for water	✓		✓		Medium
		• Contribute to managing water demand through increased water efficiency in homes, businesses, industry and agriculture and promotion of water efficiency measures	✓	✓	✓		Immediate
Winter rainfall increase	• Opportunity for more water storage • Inadequate pump capacity for raw water • Increased diffuse pollution	• Manage seasonal changes in climate by increasing winter storage			✓		Medium
		• Endure adequate pump capacity for increased winter storage requirements			✓		Medium
		• Where possible, control diffuse pollution runoff through SuDS, particularly for new / redevelopment close to river and water bodies	✓	✓	✓	✓	Immediate
Summer rainfall decrease	• More frequent low river flows • Increased competition for water • Increased peak demand • Changing customer expectations	• Manage seasonal changes in climate by reducing summer peaks in demand for water	✓		✓		Medium
		• Contribute to managing water demand through increased water efficiency in homes, businesses, industry and agriculture and promotion of water efficiency measures	✓	✓	✓		Immediate
		• Ensure that water abstraction is sustainable through monitoring		✓	✓		Medium
Sea level rise	• Saline intrusion • Asset loss	• Ensure that water quality is suitable for abstraction through monitoring		✓	✓		Medium
		• Ensure that key assets are located inland and are not susceptible to being lost through sea level rise		✓	✓		Long
Increase in weather extremes (heatwaves, intense rainfall, storms)	• Increased run-off reduces recharge of aquifers • Decrease in raw water quality – increased treatment cost • Increased flooding and risk of service loss • Increased flooding and risk of service loss • Increased subsidence – pipe failure • Increased contamination • Peak demand delivery during heat waves	• Improve resilience of key water supply assets such as pumps, including new industry design standards for water assets			✓		Medium
		• Where possible, control diffuse pollution runoff through SuDS, particularly for new / redevelopment close to river and water bodies	✓	✓	✓	✓	Immediate
		• Improve RBMP Programme of Measures to ensure WFD objectives are met and include climate change allowance		✓			Medium

[91] Some inputs edited from AWS Strategic Direction Statement 2010 – 2035 http://www.anglianwater.co.uk/about-us/statutory-reports/strategic-direction/

4.6 Agricultural and Recreational Water Demand

The initial joint scoping WCS for East Cambridgeshire and Fenland WCS stated that:

"Agriculture in the study area has a high demand for irrigation water and it is important that public water supply is balanced against the requirements for agriculture; for example the supply of water from the River Nene to the Middle Levels."

and recommended that:

There is a high demand for water to meet the statutory requirement to maintain navigation levels within the IDB systems and it is important that public water supply is balanced against these requirements; for example the supply of water from the River Nene to the Middle Levels. These issues need to be taken into account including changes in upstream demand for water beyond the study area."

It is considered that agriculture and navigation are not likely to significantly impact on the larger "growth" issues; however, the study area is likely to remain agriculturally based for the foreseeable future, as it creates employment and contributes to the economy. Similarly, navigation does the same but on a much smaller scale and has sustainability and biodiversity benefits. Through the ongoing Core Strategy development for Fenland the Environment Agency and FDC are encouraging tourism in the area and the MLC consider that there is significant tourism created by navigators in Ely.

Agriculture in the study area has a high demand for irrigation water and within the Middle Level area, also to maintain navigation levels during the summer months. Water demand management includes:

- abstracting water from the Environment Agency's' River Nene - this can be up to 130,000 tonnes/day for several weeks.
- requiring irrigation at night, when it is cooler,
- restricting and baning abstraction, which has an adverse affect on the crops and hence the local economy, in an effort to maintain flows for abstraction within the internal system. The Middle Level Commissioners have to balance these against the need to retain both flows and a navigation level.

It has been suggested that storage of winter flows could be a potential solution to provide water for irrigation and navigation in the summer months when water entering the Middle Level system is low and the Middle Level Commissioners have a long term plan to locate a suitable void which could be used to store excess winter water for use during the summer. The MLC also consider that storage of runoff from urban areas could be used and consider that all sites at March, Wisbech and Chatteris together with Z2 and Z3 at Whittlesey could be suitable sites.

5 Surface Water Drainage Management

5.1 The Vision

Surface water drainage methods that take account of run-off rates, water quality, pollution control, biodiversity and amenity issues are collectively referred to as Sustainable Drainage Systems (SuDS). Sustainable surface water management takes account of long term environmental and social factors in designing a surface water drainage system that avoids the problems of flooding, pollution or damage to the environment that may occur with conventional surface water management systems.

The vision for sustainable surface water management in the proposed new growth in Fenland is based on the following key aims:

- 100% separation of surface and foul water drainage;
- linkage to green infrastructure giving multiple benefits to users and ecology;
- linkage to water efficiency measures, including rainwater harvesting; and,
- linkage to the Cambridgeshire wide Surface Water Management Plan (SWMP).

As with the Cambridge WCS[92], the ultimate vision for the Fenland WCS is to achieve 100% above ground drainage for all future developments, where feasible. In addition, above ground drainage should include environmental enhancement and should provide amenity, social and recreational value.

In order to achieve this vision, it is the intention for all new development that there be 100% separation of foul and surface water drainage. While it is recognised that this may not be possible for all new development, depending on individual site constraints, the aspiration is to achieve either 100% separation, or as close to 100% as possible. All foul sewage will drain to a WwTW..

5.1.1 Surface Water Drainage in Fenland

This section outlines what is required from Sustainable Drainage systems in order to meet the aspiration for controlling surface water runoff to the existing runoff rates in accordance with PPS25. However, it is important to note that at a site specific level, the requirements of any discharge of surface water from a site are dictated by the specifics of the water level management system operated by the IDB receiving that discharge.

Both developers and development control officers need to consider the specific nature of the surface water management system in Fenland on a site by site basis and consider that individual IDBs may have a preference for surface water to be discharged from a site more quickly, rather than holding it back. This requirement could arise to allow water to be pumped from managed systems prior to peak flood flows arriving in the Middle Level and North Level systems from the fluvial watercourses or from high tidal levels.

Therefore, as a first step developers should consider including SuDS to mimic the rate and volume of runoff that would occur from the site prior to development taking place and advice on how to do this is provided in this section of the WCS; however a second step should occur whereby developers or development control officers seek the advice of the relevant IDB to determine whether retention of surface water is preferable to a faster (but controlled) rate of

[92] Cambridge (and surrounding major growth areas) WCS Phase 2, Halcrow, 2010

runoff. The MLC and associated boards promote pre-application discussion as also detailed in the Level 1 District Wide SFRA.

5.2 Justification

Conventional surface water drainage systems were designed to convey rainwater and surface water run-off away as quickly as possible. This helps to prevent flooding of the drained area, but may cause flooding of downstream areas as the run-off patterns become 'flashier', with high peak flows caused by increasing areas of impermeable surfacing connected to the surface water drainage system. SuDS seek to mimic natural drainage patterns; by holding surface water run-off close to its source, run-off can be controlled and peak flows reduced.

In addition to the increased flood risk, conventional drainage systems can cause pollution of the receiving watercourses as impermeable surfaces accumulate pollutants such as hydrocarbons, tyre fragments and debris, detergents and grit and particulates. SuDS systems can be used to treat surface water run-off as they trap debris and allow for the natural degradation of pollutants.

The main legislative driver for the use of SuDS is the Flood and Water Management Act, which implements Sir Michael Pitt's recommendations[93] requiring urgent legislation, following his review of the 2007 floods. The Act gives new responsibility to Cambridgeshire County Council as a Lead Local Flood Authority (LLFA), which gives the County Council powers to:

- issue Local Flood Risk Management Strategies for surface water run-off, groundwater and non-main rivers; and
- carry out works for the management of surface water run-off and groundwater

In implementing an above-ground sustainable surface water management system, developers would achieve the following benefits compared to conventional surface water drainage systems:

- reduced capital and operational costs (less 'hard' engineering and pumping required);
- reduced carbon emissions (less 'hard' engineering and pumping required);
- enhanced water quality and a reduction in polluted run-off;
- opportunities to integrate surface water management into amenity areas and enhance biodiversity through development;
- contribute to a 'network of protected sites, nature reserves, greenspaces and greenways' (as defined in Cambridgeshire Horizons Green Infrastructure Review Strategy), and;
- they are considered 'best practice' as advocated by the CIRIA SuDS Manual.

In order to quantify the above benefits, a comparison will be made of the SuDS vision with the 'business as usual' strategy. The 'business as usual' strategy can be considered to be where all sites are drained by a piped underground network that leads to a surface watercourse.

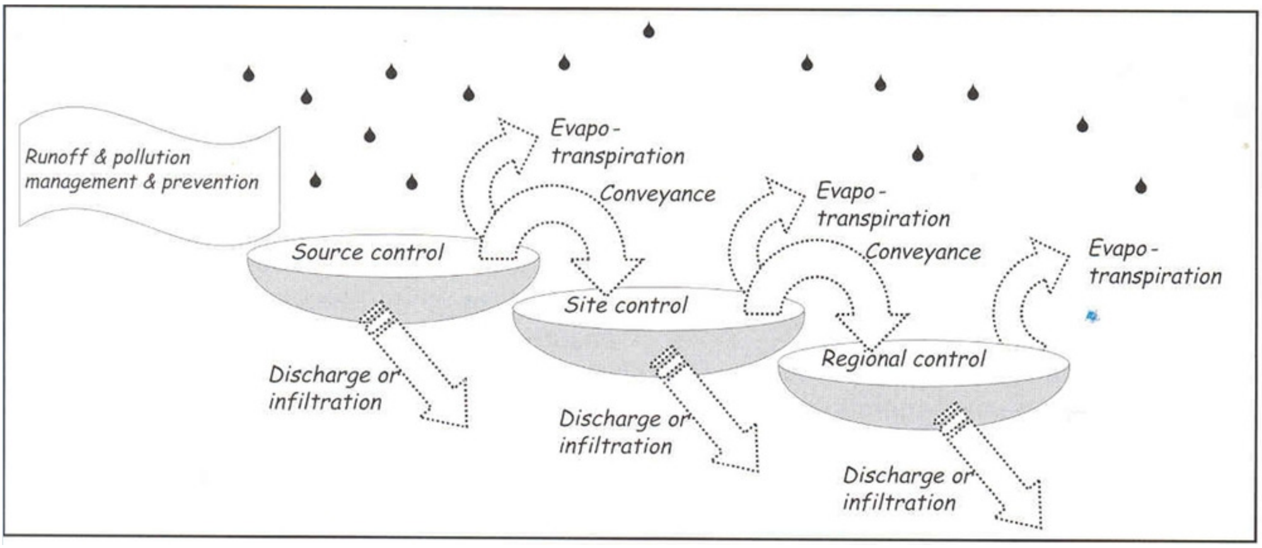
[93] http://webarchive.nationalarchives.gov.uk/20100807034701/http:/archive.cabinetoffice.gov.uk/pittreview/thepittreview.html

5.3 Options for Surface Water Management

5.3.1 SuDS Hierarchy

SuDS systems should be designed in accordance with the SuDS hierarchy, also known as the SuDS management train. This hierarchy gives the preference for SuDS systems that should be introduced and can be used in series to change and manage the flow characteristics of surface water catchments, similar to a natural catchment.

Figure 5-1: The SuDS Management Train[94]



Where underlying soils and geology will allow, infiltration SuDS systems can be used, such as permeable paving, soakaways, etc. Where infiltration is not possible, for example due to impermeable soils or a high water table, attenuation SuDS such as constructed wetlands, balancing ponds or detention ponds can be used. Use of such attenuation SuDS can allow for a linkage of SuDS with green and blue infrastructure, for example parks and amenity spaces and the water features within them.

Section 4 of this report discussed water saving and efficiency measures that could be included within new developments to reduce the water demand and ease the pressure on the already stretched water resources in Fenland. Integrated of SuDS and water efficiency measures will ensure that the collection of rainwater allows for its sustainable re-use.

A Cambridgeshire-wide SWMP was commissioned by Cambridge City and Cambridge County Council and is currently underway by Edenvale Young and Hyder Consulting. The strategic phase SWMP has modelled surface water flows and flooding throughout Cambridgeshire and identified flooding 'wet spots' in the County which are to be considered in more detail (see Section 5.4 below). The findings of the SWMP should be taken into consideration when designing SuDS for individual developments, to ensure there is a strategy developed to manage surface water flows coming onto the site from surrounding land. The SuDS design for individual sites will manage surface water run-off within the development sites and from the development site to other areas.

[94] Source: SuDS management train – CIRIA -http://www.ciria.org.uk/suds/suds_management_train.htm, accessed July 2011

5.3.2 SuDS options

Prevention

Through good site design, the volume of runoff produced from a site can be minimised. Using permeable rather than impermeable surfacing e.g. gravel or brick rather than concrete driveways, will allow rainwater to infiltrate into the ground. Roofs and other impermeable areas can be drained to adjacent lawns or landscaped areas.

Filter strips and swales

Filter strips and swales are vegetated surface features that drain water evenly off impermeable areas. Swales are long shallow channels whilst filter strips are gently sloping areas of ground. Both these types of devices slow and filter the flow to mimic natural drainage patterns. Plant growth in the swale/filter strip traps organic and mineral particles that are then incorporated into the soil, while the vegetation takes up any nutrients, thereby effectively removing pollution. Swales and filter strips are often integrated into the surrounding land use, for example public open space or road verges.

Permeable surfaces and filter drains

Filter drains and permeable surfaces store surface water below the permeable surface, for example:

- grass or reinforced grass if the area will be trafficked;
- gravelled areas;
- solid paving blocks with large vertical holes filled with soil or gravel;
- solid paving blocks with gaps between the individual units;
- porous paving blocks with a system of voids within the unit; and
- continuous surfaces with an inherent system of voids.

The volume of storage depends on the voids ratio of the permeable fill or sub-base, the plan area and depth. Water can drain from the devices by infiltration, an underdrain, or be pumped out to a watercourse. In some situations the water should not be stored for extended periods as it can affect the strength of the surrounding soil.

Sediment is trapped by the permeable fill, which filters runoff and removes pollutants. Some treatment and degradation is also provided of other pollutants, such as oil.

The design and appearance of the surfaces can be chosen to compliment the design of the proposed development and by their nature, filter drains and permeable surfaces ensure an efficient use of space.

Infiltration devices

Infiltration devices drain water directly into the ground, which mimics and enhances the natural drainage patterns of undeveloped land, by increasing enhancing the natural capacity of the ground to store and drain water. Examples include soakaways, infiltration trenches and infiltration basins as well as swales, filter drains and ponds. Infiltration devices may be used at source or the runoff can be conveyed in a pipe or swale to the infiltration area.

The amount of water that can be disposed of by an infiltration device within a specified time depends mainly on the infiltration potential of the surrounding soil. Limitations occur where the soil is not very permeable, the water table is shallow or the groundwater under the site may be put at risk.

Infiltration techniques also provide storage for runoff. In the case of soakaways and infiltration trenches, this storage is provided in an underground chamber, lined with a porous membrane and filled with coarse crushed rock. Infiltration basins store runoff by temporary and shallow ponding on the surface.

Treatment is provided for runoff, depending on the size of the rock material used and the length of the flow path through the system, which controls the time taken for the runoff to pass into the surrounding soil. Pre-treatment may be required before polluted runoff is allowed into an infiltration device.

Infiltration systems are easy to integrate into a site. They are ideal for use as playing fields, recreational areas or public open space. Infiltration basins can be planted with trees, shrubs and other plants, improving their visual appearance and providing habitats for wildlife. They increase soil moisture content and help to recharge groundwater, thereby mitigating problems of low river flows.

Fenland District Council's Building Control section require that soakaways and all infiltration devices should:

- be designed to cope with excess water and not cause a problem to foundations iof any adjacent building (existing or proposed);
- be designed in accordance with BS EN 752 or BRE digest 365; and
- be positioned in accordance with the document Local Authority Building Control – Technical Information Note 5: Guide to Non-Mains Foul and Surface Water Drainage.

Basins and ponds

Basins are areas for storage of surface runoff that are free from water under dry weather flow conditions, for example detention basins, lagoons, wetlands or attenuation ponds which contain water in dry weather but have additional spare capacity for more when it rains.

The structures can be used in combination, including both a permanently wet area for wildlife or treatment of the runoff and an area that is usually dry to cater for flood attenuation. Basins and ponds tend to be found towards the end of the surface water management train, so are used if source control cannot be fully implemented, if soils types do not allow for infiltration, if extended treatment of the runoff is required or if they are required for wildlife or landscape reasons.

Basins and ponds treat runoff and reduce pollution by:

- settlement of solids in still water - having plants in the water enhances calm conditions and promotes settlement;
- absorption by aquatic vegetation or the soil; and
- biological activity.

Basins and wetlands offer many opportunities for the landscape designer. Basins should not be built on, but can be used for sports and recreation. Permanently wet ponds can be used to store water for reuse, and offer excellent opportunities for the provision of wildlife habitats. Both basins and ponds can be part of public open space.

5.4 Development Site Requirements

As discussed in previous sections, until potential site options are developed, it is not possible to undertake detailed assessment of the types of SuDS and amount of attenuation storage that would be required for each site. Such assessment requires detailed information on site size, site use, and local topography. This assessment soulc be completed as part of the Stage Detailed WCS if this is undertaken.

Best practice examples and ownership advice are also provided in the proceeding sections whilst an assessment of infiltration suitability and potential surface water connection points for each main growth town has been included in the growth area assessments in Section 6.

A Cambridgeshire-wide SWMP was commissioned by Cambridge City and Cambridge County Council has been prepared by Edenvale Young and Hyder Consulting[95]. The SWMP has modelled surface water flows and flooding throughout Cambridgeshire. The findings of the SWMP should be taken into consideration when designing SuDS for individual developments, to ensure there is a strategy developed to manage surface water flows coming onto the site from surrounding land. The SuDS design for individual sites will manage surface water run-off within the development sites and from the development site to other areas.

In particular, the SWMP identified 'wetspots' within the County through a review of the historical flooding database, the Environment Agency's National Receptor Database (NRD) and the Flood Maps for Surface Water (FMfSW). A total of 273 wetspots were identified which were then given a Multi-Criteria Analysis (MCA) score based on their potential flood risk and the likely damages to people, properties, infrastructure and the environment as a result of surface water flooding. The top ten wetspots (those with the highest MCA score) were identified for a more detailed assessment and optioneering. Within the Fenland District, March and Wisbech were chosen as they were assessed to have a MCA score of 2796.3 and 2547, respectively. Following further consideration March has been selected for a more detailed study and it is intended a flood alleviation or mitigation strategy will be proposed. The MLC have also advised that other towns within the Council's area will be studied in the next few years.

5.4.1 Wisbech Level 2 SFRA

A Level 2 SFRA is being produced for Wisbech where an assessment of SuDS suitability has been undertaken. Reference should be made to this document when considering specific SuDS for preferred sites as they come forward.

5.4.2 SuDS and Groundwater Protection

When considering infiltration SuDS, developers should consider the following with respect to protection of water quality in aquifers in the study area:

- the water environment is potentially vulnerable (for several of the growth area zones) and there is an increased potential for pollution from inappropriately located and/or designed infiltration SuDS;
- soakaways and other infiltration SuDS must not be constructed in contaminated ground. The use of infiltration drainage would only be acceptable if a phased site investigation (in line with CLR11, 'Model Procedures for the Management of Land Contaminatio') showed the presence of no significant contamination. The use of non infiltration SUDS may be acceptable subject to agreement with the Environment Agency;

[95] Edenvale Young and Hyder Consulting (2011) Cambridgeshire Surface Water Management Plan

- the maximum acceptable depth for infiltration SUDS is 2m below ground level, with a minimum of 1.23m clearance between the base of the infiltration SUDS and peak seasonal groundwater levels; this is particularly important in the the study area with the large number of field drains suggesting shallow groundwater. The Environment Agency considers that deep bore and other deep soakaways systems are not appropriate in areas where groundwater constitutes a significant resource. Deep soakways increase the risk of groundwater pollution; and,
- the use of infiltration drainage methods will depend on local groundwater level and the predominant geology.

5.5 Best Practice Examples

5.5.1 Lamb Drove

Lamb Drove[96] is a residential development to the west of Cambridge, in the town of Cambourne. It is a one hectare site of 35 affordable homes built by Cambridge Housing Society in 2004-2006. The site was chosen to show case innovative SuDS Sustainable Water Management Techniques. The project was commended in the 2006 RTPI National Planning Awards, and subsequent Monitoring Project (2008 – 2010).

A range of SuDS measures were used in the Lamb Drove development, including

- water butts are provided for houses to collect roof water;
- permeable paving - the paving within the adoptable roads and in some of the car parking areas is of permeable construction;
- a green roof - a small demonstration green sedum roof was included to reduce and treat runoff;
- swales - excess water from the site is fed into a series of shallow open channels, further slowing the flow of water and continuing the water treatment process;
- detention and wetland basins - sculpted depressions in open spaces help to slow down the runoff rate and store water on a temporary short-term basis during extreme events; and
- a retention pond – attenuates surface water runoff from the development.

The Lamb Drove development uses the principles of the SuDS management train, as discussed above in Section 5.3.1, to control the runoff starting as close as possible to its source. The use of source control features (water butts, permeable paving etc) within the housing development areas manages most pollution and deals with the day-to-day runoff storage requirements.

When the capacity of source control measures are exceeded the excess water is safely stored and treated in larger SuDS features integrated within public open space until the flood threat has passed. Such measures also contribute to the provision of green space, visual amenity and promoting wildlife.

5.5.2 Dunfermline Eastern Expansion

The Dunfermline Eastern Expansion[97] (DEX) is a 550ha site to the east of Dunfermline in Scotland. The site, which was predominantly green field, will be developed over the next 20

[96] http://www.ciria.org.uk/suds/cs_lamb_drove.htm
[97] http://www.ciria.org.uk/suds/cs_dunfermline_eastern_expansion.htm

years as a mixture of industrial, commercial, residential and recreational areas. The site lies over largely impermeable geology and infiltration SuDS and the downstream catchment is known to suffer from existing flooding issues. An overall site-wide SuDS design was therefore essential.

The watersheds were divided into a number of sub-catchments connecting into a spinal SuDS network of retention basins, swales, regional extended detention ponds and wetlands. Much of the spine road system is drained using offlet kerbs; filter drains and swales, which discharge into extended detention basins and wetlands which also serve adjoining housing areas. Treatment of surface water run-off from the development and roads is achieved through a system of regional ponds and wetlands prior to discharge to the watercourses. Ponds and basins are widely used to achieve maximum attenuation of storm flows.

5.5.3 Cambourne Pool and Redruth Redevelopment

As part of the urban regeneration of Cambourne, Pool and Redruth in Cornwall[98], a SuDS network has been incorporated as a blue corridor with paths for cyclists and pedestrians adjacent to the SuDS features. The design allows low flows to be accommodated within the SuDS channel, with an overflow for higher flows that exceed the channel capacity to spill over onto the cycle and footpaths.

5.6 Adoption and Maintenance of SuDS

Under the Flood and Water Management Act, responsibility for the adoption and maintenance of SuDS systems has been clarified. Before the implementation of the Act, maintenance and responsibility for SuDS systems in developments was inconsistent with some SuDS systems becoming ineffective some time before their design life was exceeded due to inadequate maintenance.

The Act will confirm the exact arrangement for adoption and maintenance of SuDS systems during 2012, but for the purposes of this Level 2 WCS it should be assumed that:

- Cambridgeshire County Council will become responsible for the adoption and maintenance of new build SuDS;
- Cambridgeshire County Council will become the SuDS Approving Body (SAB) for all new build SuDS;
- the requirements for approving new build SuDS will be outlined in forthcoming national standards on the construction and operation of surface water drainage; and
- the current right to connect new developments to the existing public surface water sewerage network will be revoked and new surface water drainage systems will need to be approved in line with forthcoming National Standards (to be published in 201299) before any connection to the public sewerage network is allowed.

At the point in time when Cambridgeshire County Council formally take over the role of SAB they will issue guidelines on the requirements of SuDS system which developers will need to follow in order for SuDS systems to meet their approval Until this time, it is recommended that that SuDS should be designed in accordance with the National SuD Working Group Code of Practice.

98 http://www.cprregeneration.co.uk
99 http://ww2.defra.gov.uk/news/2010/07/29/benyon-flood-speech/

5.7 Climate Change and SuDS

It is predicted that the effects of climate change will cause the weather in the UK to continue to get warmer. It is expected that summers will continue to get hotter and drier while winters will continue to get milder and wetter and sea levels will rise along much of the coastline

As well as changes in average climate, there will be changes in climatic extremes. Some weather extremes (such as very hot days and intense downpours of rain) will become more common whereas others, such as snowfall, will become less common. UKCP09[100] has predicted a series of Green House Gas (GHG) emissions scenarios (low, medium and high) are run through global climate models to give changes in a number of climatic variables including rainfall, wind patterns, temperature and sea level rise.

With regards to surface water management and SuDS, climate change could lead to the following effects:

- increasing the build up of contaminants between rainfall, leading to more polluted runoff when rainfall does occur; and,
- increasing peak surface water flows, which could require SuDS sizes to be increased.

When potential development site information is available, estimated indicative SuDS sizings should be calculated using the 1-in-100 year rainfall event, plus an increase to allow for the effects of climate change. According to the requirements of PPS25 and its Practice Guide, residential development has an assumed design life of 100 years and non-residential development has an assumed design life of 60 years. Therefore, in order to account for climate change for the residential development, a 30% allowance should be made, in accordance with table B.2 of PPS25.

Mitigation and Adaptation Measures for New Development

In order to assess the measures that need to be taken for an individual development to adapt to climate change, the UKCP09 Adaptation Wizard[101] provides guidance on the factors that should be taken into consideration. The tool will help a developer assess vulnerability to current climate and future climate change, identify options to address key climate risks, and help to implement a climate change adaptation strategy.

The first stage of this is to assess vulnerability, by identifying:

- exposure to climate hazards;
- sensitivity to climatic variability; and,
- capacity to adapt.

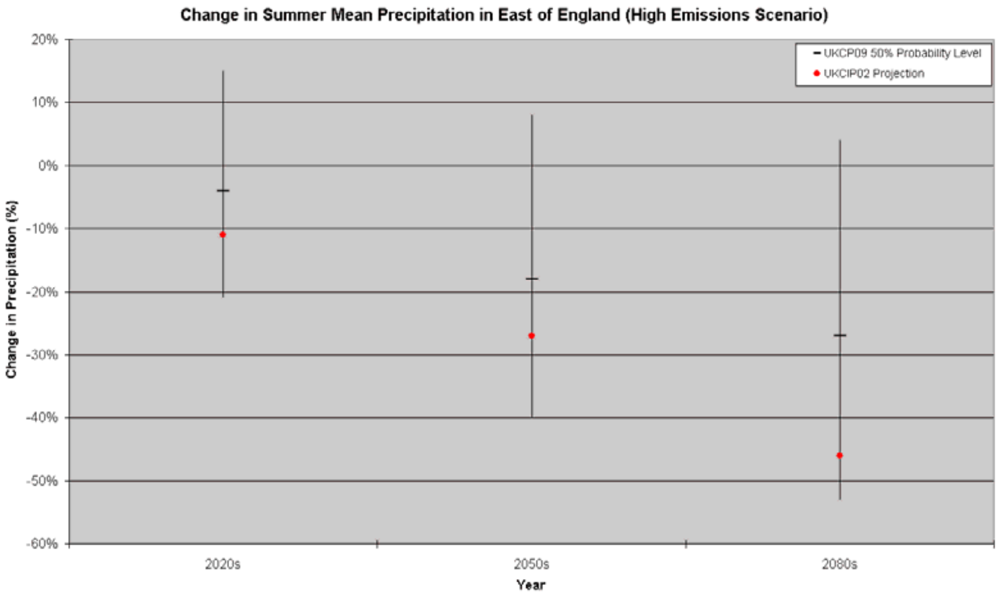
The developer should then conduct a qualitative risk assessment to identify high level climate risks, and compare the relative importance of these climate risks with other non-climate related risks. This will then identify the priority climate risks that require an adaptation response. Adaptation options can then be identified, along with a programme for action to implement the chosen adaptations.

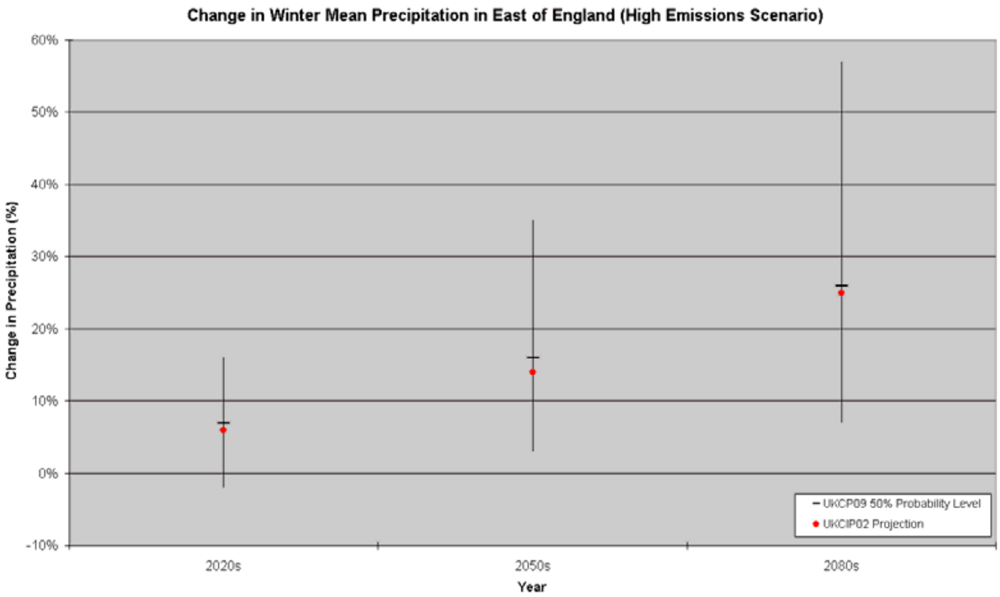
The timeline for climate change effects is difficult to predict although the UKCP09 predictions have produced estimated timelines for the changes in precipitation for the 2020s, 2050s and

[100] http://www.ukcip.org.uk
[101] http://www.ukcip.org.uk/wizard/

2080s. Figure 5-2 below shows the change in summer and winter mean precipitation in the 2080s under a High Emissions scenario (i.e. worst case scenario) for the Fenland Study Area.

Figure 5-2: Change in Summer and Winter Mean Precipitation for 2020s, 2050s and 2080s (High Emissions Scenario) – UKCIP02 and UKCP09 projections. Black vertical lines represent 'Very likely' (10% to 90% probability) range for UKCP09 projections





For new development it is most likely that the requirements of PPS25 will ensure that climate change adaptation is taken into account when designing the surface water management system for the proposed development. All drainage design for new developments should include an allowance for climate change, in accordance with the requirements of PPS25 and any subsequent National Policy Statements.

5.8 Ecological opportunities

This section is intended to describe ecological enhancement opportunities to which the initiatives developed within the WCS could contribute.

5.8.1 Wastewater Treatment Works

There are theoretically considerable opportunities available to enhance the biodiversity of Fenland through initiatives associated with the WCS. As a first step towards identifying these opportunities the Cambridgeshire Green Infrastructure (GI) Strategy was reviewed for the Outline WCS in order to determine which, if any, WwTWs are physically close to any of the green corridors initiatives identified on Drawing 050406/31 of the Strategy. However, no WwTWs in Fenland were identified as being located within or immediately adjacent to GI initiatives.

There may be opportunities for treated effluent to be used at a greater distance to supplement wetland habitat creation initiatives such as the Great Fen Project, although this would be subject to confirmation of acceptable water quality standards and non-prohibitive costs of infrastructure delivery. Caution must be applied in the consideration of enhancement opportunities, such as using treated effluent to feed into the Great Fen Project / Wicken Vision and an alternative Ouse Washes habitat creation project. This must be investigated at another level since it would constitute a viability study in itself.

For all WwTW where the current downstream quality of the receiving watercourse is less than good, a calculation was undertaken to determine if the receiving watercourse could achieve future Good status with the proposed growth within limits of conventional treatment technology and what consent limits would be required to achieve this. Achievement of Good ecological status if achievable would also have significant ecological enhancement benefits; 'Good' ecological status means that human activities have had only slight impacts on the ecological characteristics of aquatic plants and animal communities. A change to 'Good' status can therefore be expected to involve an increase in the diversity (both in terms of number and pollution sensitivity of species) for invertebrates, fish, macrophytes and conventional vegetation which will in turn have positive impacts on associated amphibian and bird populations.

It has not been possible to evaluate as part of this detailed WCS whether some of the relevant WwTWs can contribute to achievement of 'Good' ecological status. For the two that could be modelled (Whittlesey and March) it has been determined that it would be not possible for the receiving watercourses to achieve Good ecological status even in the absence of the associated increase in discharge volumes due to other factors not associated with the WwTW.

5.8.2 March, Wisbech and Whittlesey

None of these settlements are identified as being near any corridors or strategic greenspace identified within the Cambridgeshire Green Infrastructure Strategy, but the development areas around these settlements all have potential for the enhancement of ecological value through new SuDS opportunities linked to the new development which could provide habitat for Cambridgeshire BAP species and habitats such as grazing marsh, great crested newt or water vole.

5.8.3 Chatteris

Unlike March, Wisbech and Whittlesey, Chatteris is linked to several green corridors identified within the Cambridgeshire Green Infrastructure Strategy. There is a new green corridor (the Chatteris to Ely Green Corridor) proposed to the south east of Chatteris which could potentially tie in to all three possible development areas in this part of the town. The proposed Chatteris to Somersham Biodiversity and Access Corridors lie to the west of Chatteris and there is also the proposed South Chatteris Country Park initiative but none of these appear to connect with any of the key identified potential development areas.

There are also wider opportunities for developments to assist with the delivery of WFD objectives that will improve the ecological status of rivers such as the installation of fish passages, improvement of floodplain connectivity, in-channel enhancements such as the creation of backwaters and berms and the installation of deflectors. These enhancements would also help to delivery the objectives of previously mentioned strategies, such as the Great Ouse Wetland Vision and the 50 Year Wetland Vision, in addition to the WFD.

Opportunities also exist of course for non-aquatic ecological enhancements to be achieved (for example through their inclusion in new WwTW infrastructure) but the opportunities are to great and varied to be covered in this report.

5.9 Recommendations

POLICY RECOMMENDATION 1:

In accordance with the Building Regulations, developers should ensure foul and surface water from new development and redevelopment are kept separate where possible.

POLICY RECOMMENDATION 2:

Developers should aspire to achieve 100% above ground drainage for all future developments, where feasible. Where this is not feasible due to for example housing densities, land take, ground conditions, topography, or other circumstances such as IDB specific requirements, the development proposals should maximise opportunities to use SuDS measures which require no additional land take, i.e. green roofs, permeable surfaces and water butts.

POLICY RECOMMENDATION 4:

Developers should ensure linkage of SuDS to water efficiency measures, including rainwater harvesting.

POLICY RECOMMENDATION 5:

Developers should ensure SuDS design supports the findings and recommendations of the Cambridgeshire wide Surface Water Management Plan (SWMP), the Wisbech Level 2 SFRA and Fenland Level 1 SFRA.

POLICY RECOMMENDATION 6:

Developers should ensure, where possible that SuDS are designed to deliver water quality improvements in the receiving watercourse or aquifer.

6 Potential Growth Area Infrastructure Requirements

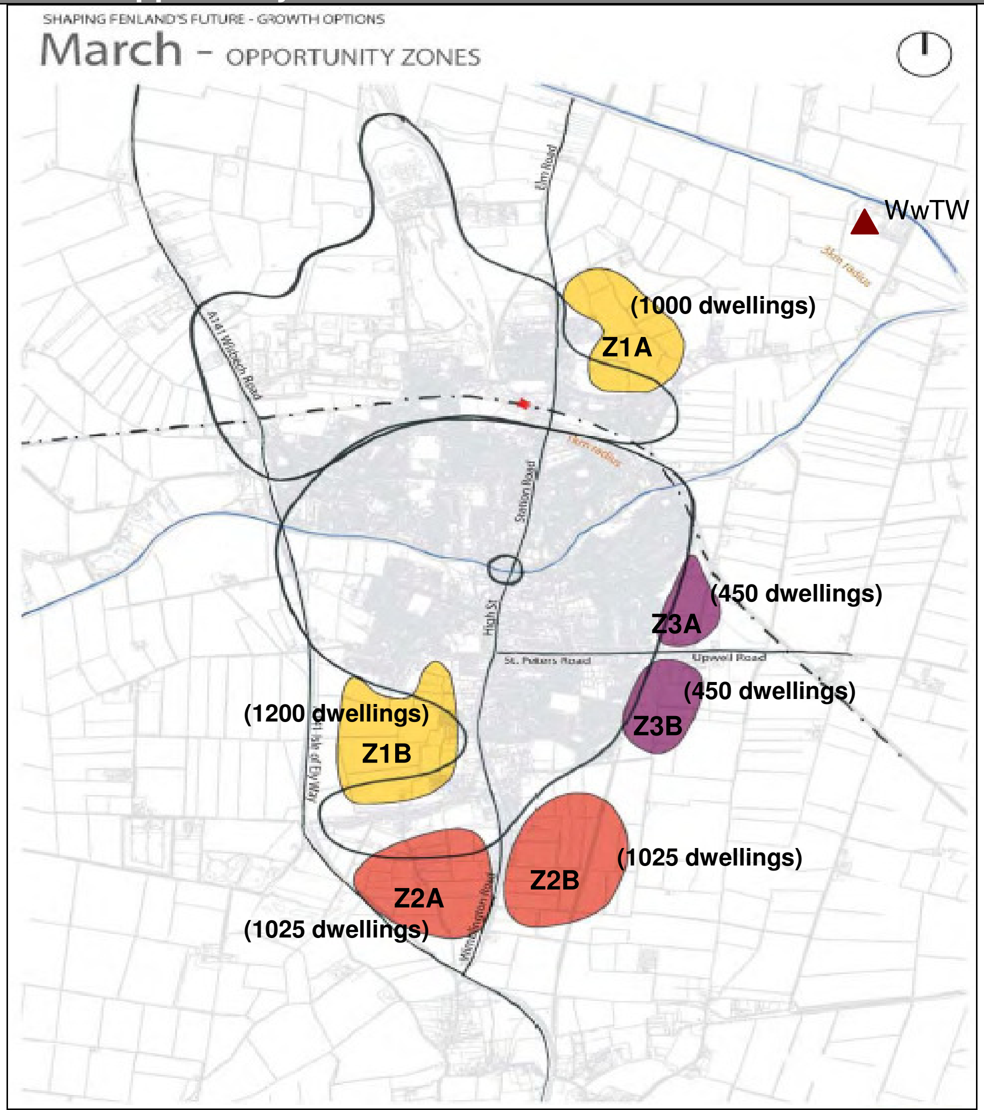
In order to support the further development of the Fenland Neighbourhood Planning Vision Study with respect to water services infrastructure and the water environment, this section reports a high level assessment of the potential constraints on each of the growth areas (or towns) where the majority of development within Fenland is likely to take place.

The draft opportunity zones that have been identified within the initial Fenland Neighbourhood Planning Vision Study have been detailed and a high level assessment of constraints undertaken for each growth area. The Red-Amber-Green (RAG) methodology has been used to give a visual representation of constraints and text has been provided to detail the RAG conclusion for each water cycle topic.

With respect to Flood Risk, this assessment has been based on fluvial and tidal flood zones as an initial screening in relation to PPS25 and the Sequential Test. This assessment does not remove the need for site specific FRAs and drainage plans to be prepared early in the consideration of new development sites where the Level 1 SFRA indicates that an FRA may be required due to other sources of flooding or to meet the requirements of IDBS under the Land Drainage Act and Flood and Water Management Act.

6.1 March Cluster

March Opportunity Zones



Total housing to be assessed for March Cluster is 5150.

Assessment Details

- The WwTW is located to the north east of March; as a result, Zone 1A, and to a lesser extent Zones 3 A&B would theoretically be able to connect to the WwTW with small upgrades in the wastewater network in order to transmit flows to the WwTW (RAG assessment amber);
- Growth in Zones 1B, 2A and 2B would be unlikely to be able to connect via the existing system which would need to drain through the constrained existing system and through central March and hence would required extensive new mains, the cost of which would be borne by the developer which could affect financial viability. (RAG assessment red). Once individual preferred sites are known, sewer network modelling could be undertaken in the Stage 2b Detailed WCS (or as a separate assessment by AWS to feed into the Fenland LDF) to determine where and when new wastewater services infrastructure would be required; this may include funding towards separation of surface water (e.g. from highways drainage) and foul sewers;
- Infiltration is unlikely to be suitable in hence will require surface storage (amber);
- Sufficient Water Resources are available for all growth in the water resource zone;
- Upgrades are required at March WwTW, so all sites will be constrained initially until a solution is implemented;
- The North East of Z1A and Z3A and East of Z2B and Z3B fall into Flood Zones 2 and 3 where any highly vulnerable development should be avoided;
- Z2A appears to be almost entirely within Flood Zone 1 so theoretically (according to PPS25) any development type could be considered,; However, some of the zones are in IDB attenuated areas and hence require consideration of surface water management - an FRA together with a drainage strategy should be submitted in the early assessment of growth areas (amber sites). Zone 1B has also experience historical flooding from St Thomas Cut (therefore Amber); and,

Following attenuation to Greenfield runoff rates all of the identified development zones have a number of field drains within them to which surface water could be discharged to; following approval from either the March 3rd, 5th or East DDC.

RAG Assessment

Opportunity Zone	Wastewater treatment	Wastewater network	Water Resources	SuDS (infiltration)	Flood Risk
Z1A	Red (amber for initial phasing)	Amber	Green	Amber	Green
Z1B	Red (amber for initial phasing)	Red	Green	Amber	Amber
Z2A	Red (amber for initial phasing)	Red	Green	Amber	Amber
Z2B	Red (amber for initial phasing)	Red	Green	Amber	Amber
Z3A	Red (amber for initial phasing)	Amber	Green	Amber	Amber
Z3B	Red (amber for initial phasing)	Amber	Green	Amber	Green

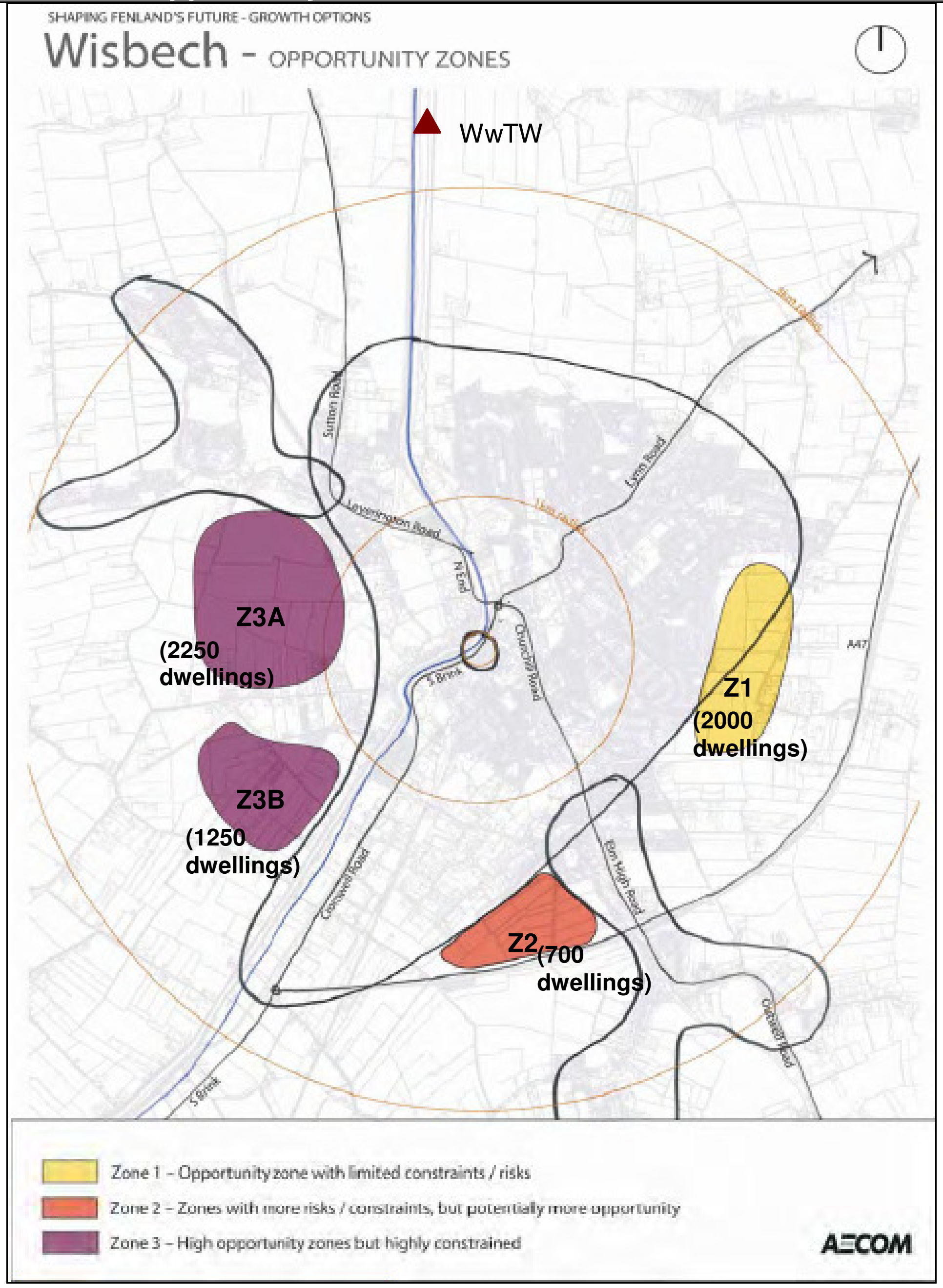
Lower Housing Targets

- Further revisions of the Fenland Neighbourhood Planning Vision Study suggest that the housing targets assessed in this Stage 2a Detailed WCS may be revised downwards. For the key constraints of wastewater treatment and wastewater network, this is not considered to materially alter the conclusions. The network constraint is linked to location (irrespective of numbers) and the inability of the WwTW to meet the required P standards within conventional treatment is still the case even when very low development figures were modelled.

•

6.2 Wisbech Cluster

Wisbech Opportunity Zones



Total housing to be assessed for Wisbech Cluster is 6200.

Assessment Details

- West Walton WwTW is located North of Wisbech. Proposed development zones are mainly south of the town so would be unlikely to be able to connect via the existing system which would need to drain through the constrained central system where sewer flooding is an existing problem. In addition, Zones 3A and 3B would drain to Harecroft Road TPS which would most likely need uprating to take the extra flow. These sites would require extensive new mains, the cost of which would be borne by the developer which could affect financial viability. (RAG assessment red). Once individual preferred sites are known, sewer network modelling could be undertaken in the Stage 2b Detailed WCS to determine where and when new wastewater services infrastructure would be required. Infiltration is unlikely to be suitable in any zone and hence will require surface storage (amber);
- Development should be prioritised in Z1 and Z2 as these areas fall entirely within Flood Zone 1. This assessment should be checked against the Wisbech Level 2 SFRA when complete; and,
- Z3A and Z3B both fall entirely within Flood Zone 3 where the majority of development should be avoided without significant flood remediation measures; Zone Z2 is in an IDB attenuated area and hence requires consideration of surface water management - an FRA together with a drainage strategy should be submitted in the early assessment of this growth area.
- Sufficient Water Resources are available for all growth in the water resource zone;
- It is unlikely that any significant upgrades are required at West Walton WwTW, so there are no wastewater treatment constraints to any zones;
- Z2 is within the catchment area of the Hundred of Wisbech IDB which discharges by gravity into the adjacent pumped South Brink catchment maintained by Waldersey IDB. There are many Boards' Drains and open watercourses which serve this area. The IDBs are currently undertaking a channel improvement scheme to facilitate further development in his area.
- Depending on the permeability of the soils and geology in this zone a discharge of surface water maybe required. The Hundred of Wisbech IDB promote the rapid movement of excess water away from the urban area in Wisbech.

RAG Assessment

Opportunity Zone	Wastewater treatment	Wastewater network	Water Resources	SuDS (infiltration)	Flood Risk
Z1*	Green	Red	Green	Amber	Green
Z2	Green	Red	Green	Amber	Amber
Z3A	Green	Red	Green	Amber	Red
Z3B	Green	Red	Green	Amber	Red

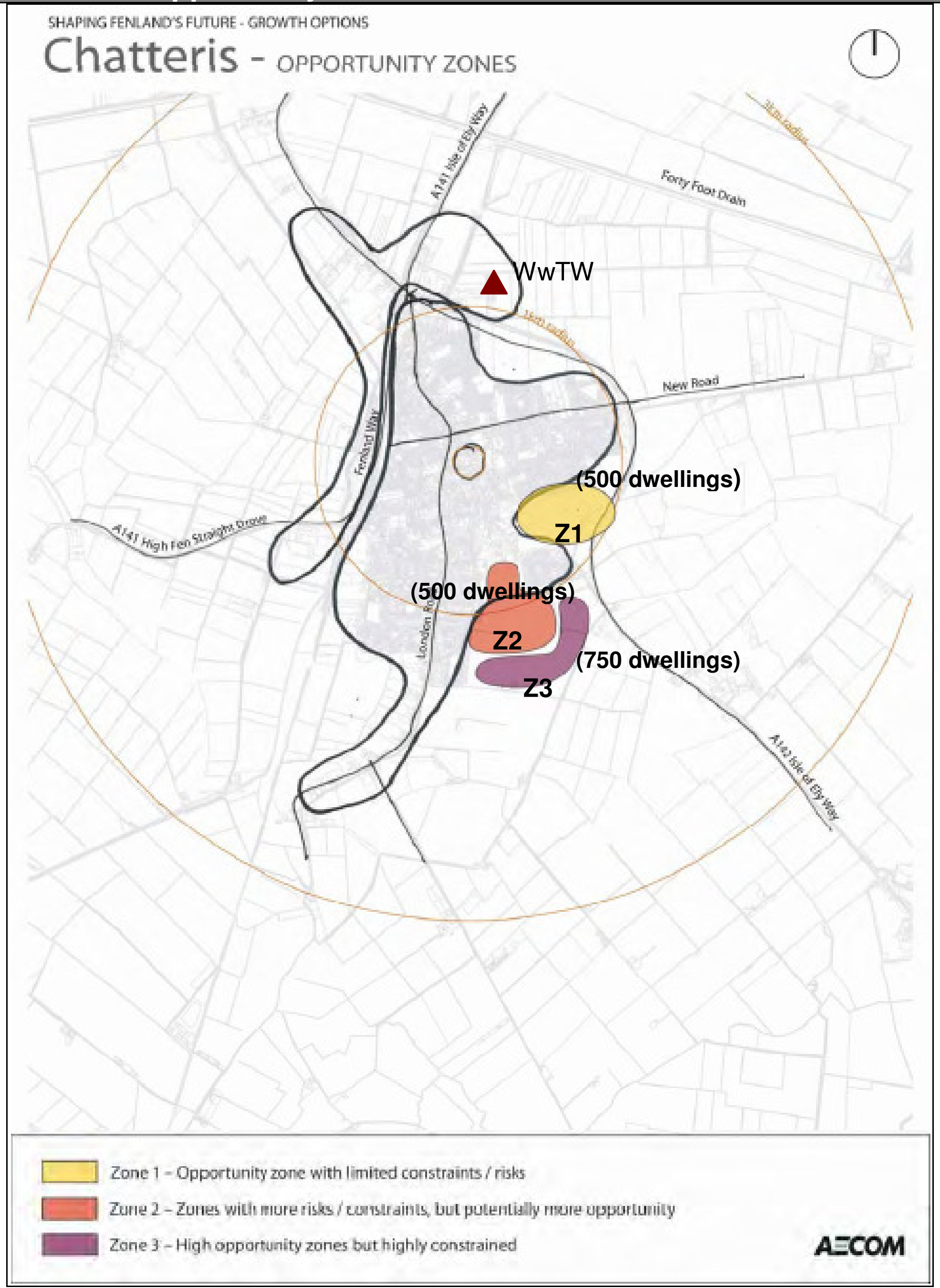
Lower Housing Targets

- Further revisions of the Fenland Neighbourhood Planning Vision Study suggest that the housing targets assessed in this Stage 2a Detailed WCS may be revised downwards. For the key constraints of wastewater network and flood risk, this is not considered to materially alter the conclusions. The network constraint and flood risk constraint is linked to location (irrespective of numbers)

* Z1 assessment also applies to the proposed development of 1,134 homes in West Norfolk.

6.3 Chatteris Cluster

Chatteris Opportunity Zones from



Total housing to be assessed for Chatteris Cluster is 1750.

Assessment Details

- The WwTW is located to the north of Chatteris. Proposed development zones 2 and 3 are mainly located some distance so would be unlikely to be able to connect via the existing system which would need to drain through the constrained system where sewer flooding is an existing problem. These sites would require extensive new mains, the cost of which would be borne by the developer which could affect financial viability. (RAG assessment red). Once individual preferred sites are known, sewer network modelling could be undertaken in a Stage 2b Detailed WCS to determine where and when new wastewater services infrastructure would be required;
- Zone 1 would likely require new infrastructure but over a lesser distance and hence has been coded amber;
- All proposed zones fall within Flood Zone 1 suggesting all types of development would be feasible here. However as Chatteris is surrounded by floodplain consideration is needed for refuge and emergency measures in the event of a flood as it may be cut off from other larger areas with respect to emergency services – historically, surface water flooding has been an issue (combination of drainage capacity, poor soil conditions for infiltration) an amber coding has therefore been given for flood risk which should be investigated at a site specific FRA level.;
- Sufficient Water Resources are available for all growth in the water resource zone; a private water company – Pretoria Water – operate in this area.
- No upgrades are required at Chatteris WwTW, so there are no wastewater treatment constraints to any zones;
- The Chatteris area has mixed geology. Most of zones 2 and 3 fall in areas of high or medium infiltration potential however depth is shallow to clay below and infiltration capacity is likely to be lmited. The majority of zone 1 falls in an area of low infiltration potential (confirmed by MLC). Zone Z1 is in an IDB attenuated area and hence requires consideration of surface water management - an FRA together with a drainage strategy should be submitted in the early assessment of this growth area
- Depending on the permeability of the soils and geology in this zone a discharge of surface water maybe required. Following attenuation to Greenfield runoff rates all of the identified development zones have a number of field drains within them to which surface water could be discharged to Birch Fen Drain; however, the MLC have advised that significant investment in this watercourse would be requires to support development

RAG Assessment

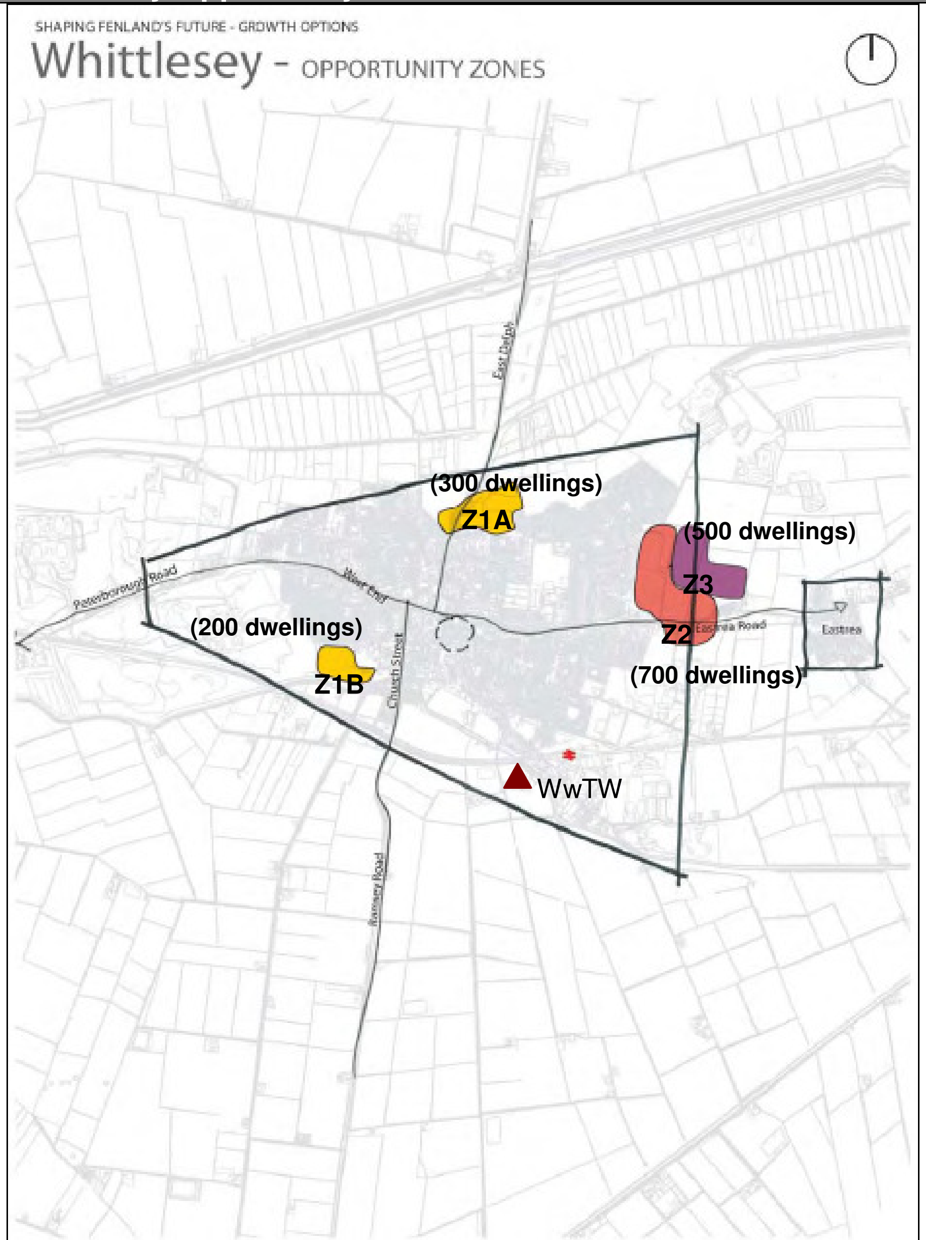
Opportunity Zone	Wastewater treatment	Wastewater network	Water Resources	SuDS (infiltration)	Flood Risk
Z1	Green	Amber	Green	Red	Amber
Z2	Green	Red	Green	Amber	Amber
Z3	Green	Red	Green	Amber	Amber

Lower Housing Targets

- Further revisions of the Fenland Neighbourhood Planning Vision Study suggest that the housing targets assessed in this Stage 2a Detailed WCS may be revised downwards. For the key constraint of wastewater network, this is not considered to materially alter the conclusions. The network constraint is linked to location (irrespective of numbers).

6.4 Whittlesey Cluster

Whittlesey Opportunity Zones from



Total housing to be assessed for Whittlesey Cluster is 1700.

Assessment Details

- The WwTW is just south of Whittlesey, as a result, Zone 1B to the south west will likely be the most straightforward to connect to the wastewater network and can likely make use of existing network capacity (green);
- Z2 and Z3 are mainly located some distance so would be unlikely to be able to connect via the existing system which would need to drain through the constrained system where sewer flooding is an existing problem. These sites would require extensive new mains, the cost of which would be borne by the developer which could affect financial viability. (RAG assessment red). ;
- Growth in Zone 1A to the north is unlikely to be able to connect via the existing system. This zone would required extensive new mains, the cost of which would be borne by the developer which could affect financial viability (RAG assessment red). It may be possible for growth in zones 2 and 3 to connect to existing wastewater network with smaller upgrades – amber;
- Zones 1A, 2 and 3 fall largely within areas of predicted high infiltration (sands and gravel). However, MLC advise that the depth of permeable geology is shallow before impermeable clay is reached – water tables are high and perched and hence infiltration SuDS will vary in success – a precautionary assessment has been applied for all zones (amber);
- There are sufficient water resources within this zone;
- Wastewater treatment is constrained for further development due to hydraulic capacity in the watercourse until a solution is put in place, potentially not until 2020 at the earliest;
- Z1B, Z2 and Z3 fall entirely within zone 1 so theoretically (according to PPS25) any type of development would be suitable in these areas. Most of Z1A is also in Flood Zone 1 but a small section in the north of the area falls into Flood Zone 2 so any highly vulnerable development should be directed away from there – MLC advised however that historical flooding is a concern in the settlement due to poor infiltration, lack of surface water sewers and use of combined sewers for surface water disposal – potential limitation of surface water diposal from Z1 during flooding in the Nene washes is also a concern. As a result an FRA together with a drainage strategy should be submitted in the early assessment of these growth areas;
- Whittlesey forms an island surrounded by floodplain so consideration is needed for refuge and emergency measures in the event of a flood as it may be cut off from other larger areas with respect to emergency services and services; and,
- Depending on the permeability of the soils and geology in this zone a discharge of surface water maybe required. Following attenuation to Greenfield runoff rates all of the identified development zones have at least one field drain within them to which surface water could be discharged to; following approval from the either the Feldale or Whittlesey IDB.

RAG Assessment

Opportunity Zone	Wastewater treatment	Wastewater network	Water Resources	SuDS (infiltration)	Flood Risk
Z1A	Red	Red	Green	Amber	Amber
Z1B	Red	Red	Green	Amber	Amber
Z2	Red	Amber	Green	Amber	Amber
Z3	Red	Amber	Green	Amber	Amber

Lower Housing Targets

- Further revisions of the Fenland Neighbourhood Planning Vision Study suggest that the housing targets assessed in this Stage 2a Detailed WCS may be revised downwards. For the key constraints of wastewater treatment and wastewater network, this is not considered to materially alter the conclusions. The network constraint is linked to location (irrespective of numbers) and the hydraulic constraint on discharge from the WwTW would occur unless growth was substantially reduced.

7 Water Cycle Strategy Recommendations and Policy

7.1 Policy Recommendations Overview

This Stage 2a Detailed WCS has set out a series of policy recommendations which are summarised for each topic in this section. It is recommended that these policies are considered for inclusion in the LDF:

7.1.1 Wastewater

WW1: Development Phasing in March:

Development in March will need to be restricted to a minimal annual completion rate to be agreed with AWS and EA until a new solution for the WwTW (water quality) is in place, likely to be post 2015.

WW2: Development Phasing in Whittlesey:

Development in Whittlesey will need to be restricted to a minimal annual completion rate to be agreed with AWS and EA until a new solution for the WwTW (physical constraints in the Middle Level) is in place, likely to be post 2015.

WW3: Wastewater Discharge Permission:

Middle Level Commissioner's consent should be sought for any discharges resulting in an increase in rate or volume to the Middle Level drainage system

7.1.2 Water Supply

WS1: Water Efficiency on New Homes:

Ensure all housing and non domestic property is water efficient, new housing development must go beyond Building Regulations and as a minimum reach Code for Sustainable Homes Level 1 or 2

WS2: Water Efficiency Retrofitting:

Carry out a programme of retrofitting and water audits of existing dwellings and non-domestic buildings. Aim to move towards delivery of 10% of the existing housing stock with easy fit water savings devices

WS3: Water Efficiency Promotion:

Establish a programme of water efficiency promotion and consumer education, with the aim of behavioural change with regards to water use

7.1.3 Surface Water Management and Flood Risk

SWM1: Sewer Separation:

Developers should ensure foul and surface water from new development and redevelopment are kept separate where possible. Where sites which are currently connected to combined sewers are redeveloped, the opportunity to disconnect surface water and highway drainage from combined sewers must be taken.

SWM2: Above Ground Drainage:

Developers should aspire to achieve 100% above ground drainage for all future developments, where feasible. Where this is not feasible due to for example housing densities, land take, ground conditions, topography, or other circumstances such as IDB specific requirements, the development proposals should maximise opportunities to use SuDS measures which require no additional land take, i.e. green roofs, permeable surfaces and water butts.

SWM3: SuDS and Green Infrastructure:

Where SuDS are considered appropriate by the appropriate IDB, developers should ensure linkage of SuDS to green infrastructure to provide environmental enhancement and amenity, social and recreational value. SuDS design should maximise opportunities to create amenity, enhance biodiversity, and contribute to a network of green (and blue) open space.

SWM4: SuDS and Water Efficiency:

Where SuDS are considered appropriate by the appropriate IDB, developers should ensure linkage of SuDS to green infrastructure to provide environmental enhancement and amenity, social and recreational value. SuDS design should maximise opportunities to create amenity, enhance biodiversity, and contribute to a network of green (and blue) open space.

SWM5: Linkages to SWMP and SFRA:

Where SuDS are considered appropriate by the appropriate IDB, developers should ensure SuDS design supports the findings and recommendations of the Cambridgeshire wide Surface Water Management Plan (SWMP) and the Fenland District Wide Level 1 SFRA and Wisbech Level 2 SFRA).

SWM6: Water Quality Improvements

Developers should ensure, where possible that discharges of surface water are designed to deliver water quality improvements in the receiving watercourse or aquifer where possible to help meet the objectives of the Water Framework Directive.

7.1.4 Ecology

ECO1: Water Quality Improvements

It is recommended that the Council include a policy in its Core Strategy which commits to seeking and securing (through planning permissions etc) enhancements to aquatic biodiversity in Fenland through the use of SuDS and other means as outlined in this WCS (subject to appropriate project-level studies to confirm feasibility including environmental risk and discussion with relevant authorities) in keeping with the Cambridgeshire Green Infrastructure Strategy.

7.2 Climate Change and the Water Cycle – Adaptation

7.2.1 Planning and Climate Change

The Planning and Climate Change supplement to Planning Policy Statement 1 (PPS1) sets out how planning, in providing for the new homes, jobs and infrastructure needed by communities, should help shape places with lower carbon emissions and resilience to climate change. This should take into account: the contribution to be made from existing and new opportunities for open space and Green Infrastructure to urban cooling, SuDS, conserving and enhancing biodiversity; known physical and environmental constraints on the development of land such as sea level rises, flood risk and stability, and take a precautionary approach to increases in risk that could arise as a result of likely changes to the climate. The PPS1 supplement allows local planning authorities to implement higher sustainability standards than required in the Building Regulations, provided that:

- there is a robust evidence base through WCS, CAMS, water stress classification, environmental assessment, or the Habitats Directive and Appropriate Assessment;
- the standards used are nationally recognised, including Code for Sustainable Homes and BREEAM;
- the standards can be viably achieved, and;
- the policies are appropriately focussed and embedded within the Core Strategy and Development Plan Documents (DPDs)[102]

In line with the PPS1 supplement on climate change the requirement to meet CSH 5/6 in domestic dwellings and high levels of water efficiency in non-domestic buildings should be established in Development Plan Documents (DPDs). Additionally, the findings of the WCS, and evidence relating to climate change impacts within the Fenland District, should be incorporated into any future Climate Change Strategy developed for the District.

[102] edited from the Water Efficient Building website, more information is available at http://www.water-efficient-buildings.org.uk/?page_id=191

The Stage 1 Outline WCS identified that most of the water-cycle related evidence and future management plans currently in use are based on UKCIP02 predictions. A comparison between the UKCIP02 and UKCP09 projections indicated that the projections were broadly similar, and in most cases the UKCP09 projections present less extreme predictions for temperature, precipitation and sea level rise. As such, policy, planning and guidance documents produced using the UKCIP02 projections are based on projections that appear to be providing a worse case scenario. However, moving forward, it will be important to ensure that when available, new evidence / guidance / management plans are considered in all planning activities. Table 7-1 provides a summary of the key documents important to a WCS.

Table 7-1: Water Related Planning Documents and climate change

Document	Produced By	Date for Review
AWS Water Resource Management Plan	AWS	2015 (though plan is reviewed annually)
Anglian River Basin District River Basin Management Plan	Environment Agency	December 2015
AWS Strategic Direction Statement	AWS	2015 (for period 2015 – 2040)
PPS25	Department for Communities and Local Government	Unknown – likely to be dependent on future Government stance regarding top-down policy
Nene and Great Ouse Catchment Abstraction Management Strategies	Environment Agency	Yearly updates provided. Date of next full review unknown.
UKCP09 Projections and Impacts	UKCIP	On-going – check website for further research and case studies for mitigation / adaptation (http://www.ukcip.org.uk/)

7.3 Further Recommendations

7.3.1 Stakeholder Liaison

It is recommended that key partners in the WCS maintain regular consultation with each other as development proposals progress. AWS and the MLC have engaged in a regular rolling consultation forum to discuss current and emerging issues, and it is recommended that FDC, Cambridgeshire County Council and the EA consider a similar approach. MLC also attend a weekly ‘surgery’ at FDC to discuss current issues and are a member of the Fenland Development Forum.

7.3.2 WCS Periodic Review

The WCS should remain a living document, and be reviewed on an annual basis as development progresses and changes are made to the various studies and plans that support it; these include:

- five yearly reviews of AWS’ WRMP (next full review in 2015, although interim reviews are undertaken annually);
- second round of RBMP updates;
- price review 14 (AWS’ business plan for AMP6 – 2015 to 2019);

- climate change impact assessment milestones (see Table 7-1);
- it is also important to consider the change to Planning Policy Statements that will occur as a result of consolidation of national planning policy into a single National Planning Policy Framework and how this may affect the overall water cycle strategy; or
- any other documents which update or superseded these.

7.4 Stage 2b – Full Detailed Strategy Scope

Once preferred potential allocation sites are determined following the development of the Core Strategy, the Stage 2b Detailed WCS could be commenced. If the decision is taken to take forward the Stage 2b study, the following task elements would be recommended:

Wastewater Strategy

- Where the proposed development figures are significantly different to those assessed in this Stage 2a Detailed WCS, the water quality modelling to determine consent standards should be repeated with new housing figures;
- A new solution for the WwTW Whittlesey (flow) and March (quality) should be identified and worked up. This will require hydraulic modelling of the Middle Level system for Whittlesey WwTW;
- Impact of phasing of sites on any ongoing WwTW restrictions will need to be assessed;
- Connections to the sewer system should be assessed for development sites, either through AWS modelling of the sites, or where models do not exist or are unreliable, through assessment of impact on CSOs, sewer flooding an assessment of pipe sizes relative to the development site proposals; and
- Where new solutions are required for sewer network, these will need to be identified and costed.

Surface Water Management

- Calculation of SuDS types and sizes will need to be undertaken for each site with costings provided where the operating authority deems SuDS are the most appropriate solution; and
- Determine implications of detailed surface water management plan solutions in wetspots (as defined by the SWMP) in the study area such as March.

Water Supply

- Where the proposed development figures are significantly different to those assessed in this Stage 2a Detailed WCS, the water demand and neutrality calculations and assessment will need to be repeated.

Ecology

- Natural England have requested that detailed studies to evaluate the impacts of increased discharges on wider biodiversity;
- The conclusions of the ecological assessments contained within this Stage 2a will need to be re-examined in more detail to confirm their validity;

- Where the proposed development figures are significantly different to those assessed in this Stage 2a Detailed WCS, review the findings of the Stage 2a Detailed WCS assessment to see if further screening of sites is required or conclusions need to be altered; and
- Consider opportunities for sites to link with Green Infrastructure.

Settlement Assessment

- Undertake a settlement wide assessment of development sites and present in the final report; and
- Complete a Developer Checklist once Strategy is complete.

Appendices

Appendix 1: Legislative Drivers shaping the Stage 2a Detailed WCS

Directive/Legislation/Guidance	Description
Birds Directive 2009/147/EC	Provides for the designation of Special Protection Areas.
Code for Sustainable Homes	The Code for Sustainable Homes has been introduced to drive a step-change in sustainable home building practice, providing a standard for key elements of design and construction which affect the sustainability of a new home. It will become the single national standard for sustainable homes, used by home designers and builders as a guide to development and by home-buyers to assist their choice of home. It will form the basis for future developments of the Building Regulations in relation to carbon emissions from, and energy use in homes, therefore offering greater regulatory certainty to developers. The Code sets out a minimum water demand per person as a requirement for different code levels. CLG is currently in consultation on proposals to make certain code levels mandatory for all new homes. At present, only affordable homes must reach a certain code.
Eel Regulations 2009	Provides protection to the European eel during certain periods to prevent fishing and other detrimental impacts.
Environment Act 1995	Sets out the role and responsibility of the Environment Agency.
Environmental Protection Act 1990	Integrated Pollution Control (IPC) system for emissions to air, land and water.
Flood & Water Management Act 2010	The Flood and Water Management Act 2010 is the outcome of a thorough review of the responsibilities of regulators, local authorities, water companies and other stakeholders in the management of flood risk and the water industry in the UK. The Pitt Review of the 2007 flood was a major driver in the forming of the legislation. Its key features relevant to this WCS are: • To give the Environment Agency an overview of all flood and coastal erosion risk management and unitary and county councils the lead in managing the risk of all local floods. • To encourage the uptake of sustainable drainage systems by removing the automatic right to connect to sewers and providing for unitary and county councils to adopt SuDS for new developments and redevelopments. • To widen the list of uses of water that water companies can control during periods of water shortage, and enable Government to add to and remove uses from the list. • To enable water and sewerage companies to operate concessionary schemes for community groups on surface water drainage charges. • To make it easier for water and sewerage companies to develop and implement social tariffs where companies consider there is a good cause to do so, and in light of guidance that will be issued by the SoS following a full public consultation.
Future Water, February 2008	Sets the Government's vision for water in England to 2030. The strategy sets out an integrated approach to the sustainable management of all aspects of the water cycle, from rainfall and drainage, through to treatment and discharge, focusing on practical ways to achieve the vision to ensure sustainable use of water. The aim is to ensure sustainable delivery of water supplies, and help improve the water environment for future generations.

Directive/Legislation/Guidance	Description
Groundwater Directive 80/68/EEC	To protect groundwater against pollution by 'List 1 and 2' Dangerous Substances.
Habitats Directive 92/44/EEC and Conservation of Habitats & Species Regulations 2010	To conserve the natural habitats and to conserve wild fauna and flora with the main aim to promote the maintenance of biodiversity taking account of social, economic, cultural and regional requirements. In relation to abstractions and discharges, can require changes to these through the Review of Consents (RoC) process if they are impacting on designated European Sites. Also the legislation that provides for the designation of Special Areas of Conservation, provides special protection to certain non-avian species and sets out the requirement for Appropriate Assessment of projects and plans likely to have a significant effect on an internationally designated wildlife site.
Land Drainage Act 1991	Sets out the statutory roles and responsibilities of key organisations such as Internal Drainage Boards, local authorities, the Environment Agency and Riparian owners with jurisdiction over watercourses and land drainage infrastructure.
Making Space for Water, 2004	Outlines the Government's strategy for the next 20 years to implement a more holistic approach to managing flood and coastal erosion risks in England. The policy aims to reduce the threat of flooding to people and property, and to deliver the greatest environmental, social and economic benefit.
Natural Environment & Rural Communities Act 2006	Covering Duties of public bodies – recognises that biodiversity is core to sustainable communities and that Public bodies have a statutory duty that states that "every public authority must, in exercising its functions, have regard, so far as is consistent with the proper exercise of those functions, to the purpose of conserving biodiversity
Planning Policy Statements	Planning policy in the UK is set by Planning Policy Statements (PPSs). These explain statutory guidelines and advise local authorities and others on planning policy and operation of the planning system. PPSs also explain the relationship between planning policies and other policies which have an important bearing on issues of development and land use. These must be taken into account in preparing development plans. A WCS helps to balance the requirements of various planning policy documents, and ensure that land-use planning and water cycle infrastructure provision is sustainable. The most relevant PPSs to WCS are: PPS1 – Delivering Sustainable Development; PPS3 – Housing; PPS4 – Planning for Sustainable Economic Growth PPS9 – Biodiversity and Geological Conservation PPS12 – Local Development Frameworks; PPS23 – Planning and Pollution control; and PPS25 – Development and Flood Risk
Pollution Prevention and Control Act (PPCA) 1999	Implements the IPPC Directive. Replaces IPC with a Pollution Prevention and Control (PPC) system, which is similar but applies to a wider range of installations.
Ramsar Convention	Provides for the designation of wetlands of international importance
Urban Waste Water Treatment Directive (UWWTD) 91/271/EEC	This Directive concerns the collection, treatment and discharge of urban waste water and the treatment and discharge of waste water from certain industrial sectors. Its aim is to protect the environment from any adverse effects caused by the discharge of such waters.

Directive/Legislation/Guidance	Description
Water Industry Act 1991	Sets of the duties and powers of Water and Sewerage Companies
Water Act 2003	Implements changes to the water abstraction management system and to regulatory arrangements to make water use more sustainable.
Water Framework Directive (WFD) 2000/60/EC	The WFD was passed into UK law in 2003. The overall requirement of the directive is that all river basins must achieve 'good ecological status' by 2015, or by 2027 if there are grounds for derogation. The WFD, for the first time, combines water quantity and water quality issues together. An integrated approach to the management of all freshwater bodies, groundwaters, estuaries and coastal waters at the river basin level has been adopted. It effectively supersedes all water related legislation which drives the existing licensing and consenting framework in the UK. The Environment Agency is the body responsible for the implementation of the WFD in the UK. The Environment Agency have been supported by UKTAG[103], an advisory body which has proposed water quality, ecology, water abstraction and river flow standards to be adopted in order to ensure that water bodies in the UK (including groundwater) meet the required status[104]. These have recently been finalised and issued within the River Basin Management Plans (RBMP).
Water Resources Act 1991	Protection of the quantity and quality of water resources and aquatic habitats. Parts have been amended by the Water Act 2003.
Wildlife & Countryside Act 1981 (as amended)	Legislation that provides for the protection and designation of SSSIs and specific protection for certain species of animal and plant among other provisions.

[103] The UKTAG (UK Technical Advisory Group) is a working group of experts drawn from environment and conservation agencies. It was formed to provide technical advice to the UK's government administrations and its own member agencies. The UKTAG also includes representatives from the Republic of Ireland.
[104] UK Environmental Standards and Conditions (Phase I) Final Report, April 2008, UK Technical Advisory Group on the Water Framework Directive.

Appendix 2: Detailed WwTW Capacity Assessment Results

Volumetric Capacity Assessment Results

Table A2-1 shows the results of volumetric capacity assessment for each WwTW in the study area. WwTW assessed as Amber in the RAG assessment have been taken forward for consent modelling.

Table A2-1 Initial Assessment of Developments up to 2031

Relevant WwTW	Current BOD 95%ile consent (mg/l)	Current Ammonia 95%ile consent (mg/l)	Current P consent mean (mg/l)	Current Consented DWF (m^3)	Current actual DWF (m^3)	Origin of actual DWF	Growth Scenario 1 - 2031 DWF (m^3)	RAG status	Growth Scenario 2- 2031 DWF (m^3)	RAG status	Growth Scenario 3 - 2031 DWF (m^3)	RAG status
Manea Town Lots	15A	5	2.5[105]	320	233	measured	297		297		297	
Chatteris	15A	6	2[106]	3,800	2,242	measured	2683		2880		3696	
Whittlesey	15A	8	2[106]	3,487	3,487	As consented[107]	3966	2011	4249	2011	4450	2011
March	10A	3	2[106]	4,358	3,885	advised by AWS[108]	5238	2019	6077	2016	6445	2015
Parsons Drove	15A	10	-	100	41	measured	41		41		41	
Benwick	15A	17	-	180	146	calculated[109]	146		146		146	
Doddington	20A	-	-	640	490	As consented[107]	707	2011	707	2011	707	2011

[105] A consent limit was applied following the review of consents to protect the Ouse Washes
[106] These WwTWs have a PE greater than 10,000 and discharge to 'Sensitive Areas (Eutrophic)' as designated under the UWWTD, it is therefore required that either: a) the effluent achieves 2 mg/l of P as an annual average; or b) 80% of influent P is removed by the treatment process. Although the WwTWs do not have a formal P consent value, it has been assumed for calculation purposes that a 2mg/l consent standard applies.
[107] AWS requested that all WwTW that have had a new recent consent volume applied, should be treated as having no capacity.
[108] AWS advised that new MCERTs data at March suggested headroom for approximately 1,500 properties
[109] Calculated has been used where measured flow wasn't available or measured flow was different to calculated by greater than 100% - this is to reflect that some measured flow provided by AWS was considered by AWS to be unreliable until a longer record of flow data is available.

Relevant WwTW	Current BOD 95%ile consent (mg/l)	Current Ammonia 95%ile consent (mg/l)	Current P consent mean (mg/l)	Current Consented DWF (m^3)	Current actual DWF (m^3)	Origin of actual DWF	Growth Scenario 1 - 2031 DWF (m^3)	RAG status	Growth Scenario 2- 2031 DWF (m^3)	RAG status	Growth Scenario 3 - 2031 DWF (m^3)	RAG status
West Walton	40	20	-	14,421	11,700	measured	13,972		14,248		15,626	Depends on phasing (likely 2020 onwards

Key

Additional development can be accommodated within existing consent	Note that process improvements may be required at these "green" sites.
Flow consent will be breached new consent standards will be required	Date indicates when the flow consent is likely to be breached[110]

The assessment for West Walton WwTW allows for the proposed growth which will drain to the WwTW from West Norfolk District Council (1,134 new dwellings).

Consents to Meet No Deterioration

No deterioration analysis has been carried out to provide an estimate of the quality consent required to prevent a deterioration of the WwTW discharge; the results are provided in table A2-2 below. Where no upstream flow/quality data or downstream targets have been provided, Load Standstill Calculations have been used as a guide for the consents required up to 2031.

Table A2-2 No deterioration assessment

WwTW	Downstream target			Scenario 1 2031 - consents required			Scenario 2 2031 - consents required			Scenario 3 1 2031 - consents required			Comments
	BOD	Amm	P	BOD 95%ile (mg/l)	Amm 95%ile (mg/l)	P mean (mg/l)	BOD 95%ile (mg/l)	Amm 95%ile (mg/l)	P mean (mg/l)	BOD 95%ile (mg/l)	Amm 95%ile (mg/l)	P mean (mg/l)	
Whittlesey	High Target: 4 mg/l	Moderate Target: 1.1 mg/l	Moderate Target: 0.25 mg/l	5	6	1	5	6	1	5	5	1	Targets provided by the Environment Agency
March	Moderate Target:	Good Target:	Good target:	>current consent	>current consent	0.52	>curre nt	>current consent	0.46	>current consent	>current consent	0.44	Targets provided by the Environment

[110] This is based on the number of housing for that scenario divided by the 20 year timeframe to 2031 to give an annual completion rate per year assuming an even distribution of delivery over the plan preiod

	6.5 mg/l	0.6 mg/l	0.12 mg/l				consen t						Agency
Doddington	N/A – Load Standstill used			17	N/A – No existing consent	N/A – No existing consent	17	N/A – No existing consent	N/A – No existing consent	17	N/A – No existing consent	N/A – No existing consent	Load Standstill Calculations used
West Walton	N/A – Load Standstill used			N/A - Flow Consent not exceeded for these scenarios						37	18	N/A – tidal watercourse	Load Standstill Calculations used

Key

Green Value – no change to current consent required	Amber Value – consent tightening required, but within limits of conventionally applied treatment processes	Red Value – not achievable within limits of conventionally applied treatment processes

Consents to Achieve 'Good Status'

Further analysis has been undertaken to establish likely consents required to meet WFD Good Status and this is reported in Table A2-3. These calculations are based on the assumption that the river upstream of the works is currently meeting WFD Good Status and has therefore only been carried out for works and consent parameters where the current downstream water quality is currently at less than good status[111].

Table A2-3 WFD Good Ecological Status Analysis

WwTW	Downstream target			Current consents required (without growth)			Scenario 1 2031 - consents required			Scenario 2 2031 - consents required			Scenario 3 1 2031 - consents required		
	BOD	Amm	P	BOD 95%ile (mg/l)	Amm 95%ile (mg/l)	P mean (mg/l)	BOD 95%ile (mg/l)	Amm 95%ile (mg/l)	P mean (mg/l)	BOD 95%ile (mg/l)	Amm 95%ile (mg/l)	P mean (mg/l)	BOD 95%ile (mg/l)	Amm 95%ile (mg/l)	P mean (mg/l)
Whittlesey	N/A**	Good Target: 0.6 mg/l	Good Target: 0.12 mg/l		3	0.33		2	0.31		1	0.3		1	0.29
March	Good Target:	N/A *	N/A *	>current consent			>curre nt			>current consent			>current consent		

[111] This analysis is only possible where flow data has been provided for the RQP (monte-carlo model) and therefore has not been undertaken for the WwTW where only load calculations were undertaken.

Doddington	5 mg/l Good Target: 5 mg/l	N/A *	N/A *	7	N/A *	N/A *	consent 7	N/A *	N/A *	7	N/A *	N/A *	7	N/A *	N/A *

* The water course in question is already at Good status.
** The watercourse in question is already at High status

RQP outputs to support consent calculations

MASS BALANCE CALCULATION: MONTE CARLO METHOD

Version 2.5

Calculations done on 22/06/2011 at 13.50

ENVIRONMENT AGENCY

Name of discharge	Whittlesey No deterioration scenario 3
Name of river	Whittlesey dyke
Name of determinand	Ammonia

INPUT DATA

UPSTREAM RIVER DATA

Mean flow	39484.0
95% exceedence flow	9590.0
Mean quality	0.00
Standard deviation of quality	0.00
90-percentile	0.00

DISCHARGE DATA

Mean flow	5562.0
Standard deviation of flow	1390.0
Mean quality	0.90
Standard deviation of quality	0.30
... or 95-percentile	1.46

DOWNSTREAM RIVER QUALITY TARGET

Quality target	1.10
Percentile	90.00

RESULTS

RIVER DOWNSTREAM OF DISCHARGE

Mean quality	0.59
Standard deviation of quality	0.36
90-percentile quality	1.10
95-percentile quality	1.32
99-percentile quality	1.73
Quality target (90-percentile)	1.10

DISCHARGE QUALITY NEEDED

Mean quality	3.57
Standard deviation of quality	1.17
95-percentile quality	5.74
99-percentile quality	7.04
99.5-percentile quality	7.44

MASS BALANCE CALCULATION: MONTE CARLO METHOD

Version 2.5

Calculations done on 22/06/2011 at 13.51

Name of discharge	Whittlesey No deterioration scenario 3
Name of river	Whittlesey dyke
Name of determinand	BOD

INPUT DATA

UPSTREAM RIVER DATA

Mean flow	39484.0
95% exceedence flow	9590.0
Mean quality	2.02
Standard deviation of quality	2.02
90-percentile	4.15

DISCHARGE DATA

Mean flow	5562.0
Standard deviation of flow	1390.0
Mean quality	9.00
Standard deviation of quality	3.00
... or 95-percentile	14.56

DOWNSTREAM RIVER QUALITY TARGET

Quality target	4.00
Percentile	90.00

RESULTS

RIVER DOWNSTREAM OF DISCHARGE

Mean quality	2.27
Standard deviation of quality	1.73
90-percentile quality	4.00
95-percentile quality	5.27
99-percentile quality	8.20
Quality target (90-percentile)	4.00

DISCHARGE QUALITY NEEDED

Mean quality	3.42
Standard deviation of quality	1.12
95-percentile quality	5.49
99-percentile quality	6.72
99.5-percentile quality	7.10

MASS BALANCE CALCULATION: MONTE CARLO METHOD

Version 2.5

Calculations done on 22/06/2011 at 13.44

ENVIRONMENT AGENCY

Name of discharge	Whittlesey No deterioration scenario 2
Name of river	Whittlesey dyke
Name of determinand	P

INPUT DATA

UPSTREAM RIVER DATA

Mean flow	39484.0
95% exceedence flow	9590.0
Mean quality	0.09
Standard deviation of quality	0.09
90-percentile	0.17

DISCHARGE DATA

Mean flow	5311.0
Standard deviation of flow	1328.0
Mean quality	0.36
Standard deviation of quality	0.36
... or 95-percentile	1.00

DOWNSTREAM RIVER QUALITY TARGET

Quality target (Mean standard)	0.25

RESULTS

RIVER DOWNSTREAM OF DISCHARGE

Mean quality	0.25
Standard deviation of quality	0.21
90-percentile quality	0.48
95-percentile quality	0.64
99-percentile quality	1.07
Quality target (Mean)	0.25

DISCHARGE QUALITY NEEDED

Mean quality	1.10
Standard deviation of quality	1.01
95-percentile quality	3.03
99-percentile quality	5.10
99.5-percentile quality	5.87

MASS BALANCE CALCULATION: MONTE CARLO METHOD

Version 2.5

Calculations done on 22/06/2011 at 13.41

ENVIRONMENT AGENCY

Name of discharge	Whittlesey No deterioration scenario 2
Name of river	Whittlesey dyke
Name of determinand	Ammonia

INPUT DATA

UPSTREAM RIVER DATA

Mean flow	39484.0
95% exceedence flow	9590.0
Mean quality	0.00
Standard deviation of quality	0.00
90-percentile	0.00

DISCHARGE DATA

Mean flow	5311.0
Standard deviation of flow	1328.0
Mean quality	0.90
Standard deviation of quality	0.30
... or 95-percentile	1.46

DOWNSTREAM RIVER QUALITY TARGET

Quality target	1.10
Percentile	90.00

RESULTS

RIVER DOWNSTREAM OF DISCHARGE

Mean quality	0.59
Standard deviation of quality	0.36
90-percentile quality	1.10
95-percentile quality	1.32
99-percentile quality	1.74
Quality target (90-percentile)	1.10

DISCHARGE QUALITY NEEDED

Mean quality	3.68
Standard deviation of quality	1.21
95-percentile quality	5.93
99-percentile quality	7.27
99.5-percentile quality	7.68

MASS BALANCE CALCULATION: MONTE CARLO METHOD

Version 2.5

Calculations done on 22/06/2011 at 13.43

ENVIRONMENT AGENCY

Name of discharge	Whittlesey No deterioration scenario 2
Name of river	Whittlesey dyke
Name of determinand	BOD

INPUT DATA

UPSTREAM RIVER DATA

Mean flow	39484.0
95% exceedence flow	9590.0
Mean quality	2.02
Standard deviation of quality	2.02
90-percentile	4.15

DISCHARGE DATA

Mean flow	5311.0
Standard deviation of flow	1328.0
Mean quality	9.00
Standard deviation of quality	3.00
... or 95-percentile	14.56

DOWNSTREAM RIVER QUALITY TARGET

Quality target	4.00
Percentile	90.00

RESULTS

RIVER DOWNSTREAM OF DISCHARGE

Mean quality	2.27
Standard deviation of quality	1.74
90-percentile quality	4.00
95-percentile quality	5.29
99-percentile quality	8.22
Quality target (90-percentile)	4.00

DISCHARGE QUALITY NEEDED

Mean quality	3.49
Standard deviation of quality	1.14
95-percentile quality	5.60
99-percentile quality	6.86
99.5-percentile quality	7.24

MASS BALANCE CALCULATION: MONTE CARLO METHOD

Version 2.5

Calculations done on 22/06/2011 at 13.46

Name of discharge	Whittlesey No deterioration scenario 1
Name of river	Whittlesey dyke
Name of determinand	P

INPUT DATA

UPSTREAM RIVER DATA

Mean flow	39484.0
95% exceedence flow	9590.0
Mean quality	0.09
Standard deviation of quality	0.09
90-percentile	0.17

DISCHARGE DATA

Mean flow	4957.0
Standard deviation of flow	1339.0
Mean quality	0.36
Standard deviation of quality	0.36
... or 95-percentile	1.00

DOWNSTREAM RIVER QUALITY TARGET

Quality target (Mean standard)	0.25

RESULTS

RIVER DOWNSTREAM OF DISCHARGE

Mean quality	0.25
Standard deviation of quality	0.21
90-percentile quality	0.48
95-percentile quality	0.63
99-percentile quality	1.05
Quality target (Mean)	0.25

DISCHARGE QUALITY NEEDED

Mean quality	1.17
Standard deviation of quality	1.07
95-percentile quality	3.21
99-percentile quality	5.40
99.5-percentile quality	6.21

MASS BALANCE CALCULATION: MONTE CARLO METHOD
Version 2.5
Calculations done on 22/06/2011 at 13.36

Name of discharge	Whittlesey No deterioration scenario 1
Name of river	Whittlesey dyke
Name of determinand	Ammonia

INPUT DATA

UPSTREAM RIVER DATA

Mean flow	39484.0
95% exceedence flow	9590.0
Mean quality	0.00
Standard deviation of quality	0.00
90-percentile	0.00

DISCHARGE DATA

Mean flow	4957.0
Standard deviation of flow	1239.0
Mean quality	0.90
Standard deviation of quality	0.30
... or 95-percentile	1.46

DOWNSTREAM RIVER QUALITY TARGET

Quality target	1.10
Percentile	90.00

RESULTS

RIVER DOWNSTREAM OF DISCHARGE

Mean quality	0.59
Standard deviation of quality	0.36
90-percentile quality	1.10
95-percentile quality	1.32
99-percentile quality	1.76
Quality target (90-percentile)	1.10

DISCHARGE QUALITY NEEDED

Mean quality	3.89
Standard deviation of quality	1.28
95-percentile quality	6.26
99-percentile quality	7.68
99.5-percentile quality	8.11

MASS BALANCE CALCULATION: MONTE CARLO METHOD

Version 2.5

Calculations done on 22/06/2011 at 13.34

Name of discharge	Whittlesey No deterioration scenario 1
Name of river	Whittlesey dyke
Name of determinand	BOD

INPUT DATA

UPSTREAM RIVER DATA

Mean flow	39484.0
95% exceedence flow	9590.0
Mean quality	2.02
Standard deviation of quality	2.00
90-percentile	4.14

DISCHARGE DATA

Mean flow	4957.0
Standard deviation of flow	1239.0
Mean quality	9.00
Standard deviation of quality	3.00
... or 95-percentile	14.56

DOWNSTREAM RIVER QUALITY TARGET

Quality target	4.00
Percentile	90.00

RESULTS

RIVER DOWNSTREAM OF DISCHARGE

Mean quality	2.27
Standard deviation of quality	1.75
90-percentile quality	4.00
95-percentile quality	5.29
99-percentile quality	8.20
Quality target (90-percentile)	4.00

DISCHARGE QUALITY NEEDED

Mean quality	3.56
Standard deviation of quality	1.16
95-percentile quality	5.71
99-percentile quality	6.99
99.5-percentile quality	7.38

MASS BALANCE CALCULATION: MONTE CARLO METHOD

Version 2.5

Calculations done on 22/06/2011 at 14.37

Environment Agency

Name of discharge	Whittlesey scenario 2 to achieve good
Name of river	Whittlesey Dyke
Name of determinand	Phosphate

INPUT DATA

UPSTREAM RIVER DATA

Mean flow	39484.0
95% exceedence flow	9590.0
Mean quality	0.09
Standard deviation of quality	0.09
90-percentile	0.17

DISCHARGE DATA

Mean flow	5562.0
Standard deviation of flow	1390.0
Mean quality	0.36
Standard deviation of quality	0.36
... or 95-percentile	1.00

DOWNSTREAM RIVER QUALITY TARGET

Quality target (Mean standard)	0.12

RESULTS

RIVER DOWNSTREAM OF DISCHARGE

Mean quality	0.12
Standard deviation of quality	0.09
90-percentile quality	0.22
95-percentile quality	0.28
99-percentile quality	0.49
Quality target (Mean)	0.12

DISCHARGE QUALITY NEEDED

Mean quality	0.29
Standard deviation of quality	0.27
95-percentile quality	0.80
99-percentile quality	1.34
99.5-percentile quality	1.54

MASS BALANCE CALCULATION: MONTE CARLO METHOD

Version 2.5

Calculations done on 22/06/2011 at 14.36

ENVIRONMENT AGENCY

Name of discharge	Whittlesey scenario 2 to achieve good
Name of river	Whittlesey Dyke
Name of determinand	Phosphate

INPUT DATA

UPSTREAM RIVER DATA

Mean flow	39484.0
95% exceedence flow	9590.0
Mean quality	0.09
Standard deviation of quality	0.09
90-percentile	0.17

DISCHARGE DATA

Mean flow	5311.0
Standard deviation of flow	1328.0
Mean quality	0.36
Standard deviation of quality	0.36
... or 95-percentile	1.00

DOWNSTREAM RIVER QUALITY TARGET

Quality target (Mean standard)	0.12

RESULTS

RIVER DOWNSTREAM OF DISCHARGE

Mean quality	0.12
Standard deviation of quality	0.09
90-percentile quality	0.22
95-percentile quality	0.29
99-percentile quality	0.49
Quality target (Mean)	0.12

DISCHARGE QUALITY NEEDED

Mean quality	0.30
Standard deviation of quality	0.27
95-percentile quality	0.82
99-percentile quality	1.37
99.5-percentile quality	1.58

MASS BALANCE CALCULATION: MONTE CARLO METHOD

Version 2.5

Calculations done on 22/06/2011 at 14.31

Name of discharge	Whittlesey scenario 1 to achieve good
Name of river	Whittlesey Dyke
Name of determinand	Phosphate

INPUT DATA

UPSTREAM RIVER DATA

Mean flow	39484.0
95% exceedence flow	9590.0
Mean quality	0.09
Standard deviation of quality	0.09
90-percentile	0.17

DISCHARGE DATA

Mean flow	4957.0
Standard deviation of flow	1239.0
Mean quality	0.36
Standard deviation of quality	0.36
... or 95-percentile	1.00

DOWNSTREAM RIVER QUALITY TARGET

Quality target (Mean standard)	0.12

RESULTS

RIVER DOWNSTREAM OF DISCHARGE

Mean quality	0.12
Standard deviation of quality	0.09
90-percentile quality	0.22
95-percentile quality	0.29
99-percentile quality	0.49
Quality target (Mean)	0.12

DISCHARGE QUALITY NEEDED

Mean quality	0.31
Standard deviation of quality	0.28
95-percentile quality	0.85
99-percentile quality	1.43
99.5-percentile quality	1.65

MASS BALANCE CALCULATION: MONTE CARLO METHOD

Version 2.5

Calculations done on 23/06/2011 at 10.30

ENVIRONMENT AGENCY

Name of discharge	Whittlesey WwTW - current flows at LCT
Name of river	Whittlesey Dyke
Name of determinand	Phosphate

INPUT DATA

UPSTREAM RIVER DATA

Mean flow	39484.0
95% exceedence flow	9590.0
Mean quality	0.09
Standard deviation of quality	0.09
90-percentile	0.17

DISCHARGE DATA

Mean flow	4359.0
Standard deviation of flow	1089.0
Mean quality	0.36
Standard deviation of quality	0.36
... or 95-percentile	1.00

RESULTS

RIVER DOWNSTREAM OF DISCHARGE

Mean quality	0.12
Standard deviation of quality	0.09
90-percentile quality	0.24
95-percentile quality	0.30
99-percentile quality	0.50

DISCHARGE QUALITY

Mean quality	0.37
Standard deviation of quality	0.34
95-percentile quality	1.02
99-percentile quality	1.71
99.5-percentile quality	1.97

MASS BALANCE CALCULATION: MONTE CARLO METHOD

Version 2.5

Calculations done on 22/06/2011 at 14.35

Name of discharge	Whittlesey current consent to achieve good
Name of river	Whittlesey Dyke
Name of determinand	Phosphate

INPUT DATA

UPSTREAM RIVER DATA

Mean flow	39484.0
95% exceedence flow	9590.0
Mean quality	0.09
Standard deviation of quality	0.09
90-percentile	0.17

DISCHARGE DATA

Mean flow	4359.0
Standard deviation of flow	1089.0
Mean quality	0.36
Standard deviation of quality	0.36
... or 95-percentile	1.00

DOWNSTREAM RIVER QUALITY TARGET

Quality target (Mean standard)	0.12

RESULTS

RIVER DOWNSTREAM OF DISCHARGE

Mean quality	0.12
Standard deviation of quality	0.09
90-percentile quality	0.22
95-percentile quality	0.29
99-percentile quality	0.49
Quality target (Mean)	0.12

DISCHARGE QUALITY NEEDED

Mean quality	0.33
Standard deviation of quality	0.31
95-percentile quality	0.92
99-percentile quality	1.54
99.5-percentile quality	1.78

MASS BALANCE CALCULATION: MONTE CARLO METHOD

Version 2.5

Calculations done on 22/06/2011 at 15.05

ENVIRONMENT AGENCY

Name of discharge	Whittlesey scenario 3 to achieve good
Name of river	Whittlesey Dyke
Name of determinand	Ammonia

INPUT DATA

UPSTREAM RIVER DATA

Mean flow	39484.0
95% exceedence flow	9590.0
Mean quality	0.25
Standard deviation of quality	0.15
90-percentile	0.44

DISCHARGE DATA

Mean flow	5562.0
Standard deviation of flow	1390.0
Mean quality	0.90
Standard deviation of quality	0.30
... or 95-percentile	1.46

DOWNSTREAM RIVER QUALITY TARGET

Quality target	0.60
Percentile	90.00

RESULTS

RIVER DOWNSTREAM OF DISCHARGE

Mean quality	0.39
Standard deviation of quality	0.16
90-percentile quality	0.60
95-percentile quality	0.69
99-percentile quality	0.87
Quality target (90-percentile)	0.60

DISCHARGE QUALITY NEEDED

Mean quality	1.09
Standard deviation of quality	0.36
95-percentile quality	1.75
99-percentile quality	2.15
99.5-percentile quality	2.27

MASS BALANCE CALCULATION: MONTE CARLO METHOD

Version 2.5

Calculations done on 22/06/2011 at 15.04

ENVIRONMENT AGENCY

Name of discharge	Whittlesey scenario 2 to achieve good
Name of river	Whittlesey Dyke
Name of determinand	Ammonia

INPUT DATA

UPSTREAM RIVER DATA

Mean flow	39484.0
95% exceedence flow	9590.0
Mean quality	0.25
Standard deviation of quality	0.15
90-percentile	0.44

DISCHARGE DATA

Mean flow	5311.0
Standard deviation of flow	1328.0
Mean quality	0.90
Standard deviation of quality	0.30
... or 95-percentile	1.46

DOWNSTREAM RIVER QUALITY TARGET

Quality target	0.60
Percentile	90.00

RESULTS

RIVER DOWNSTREAM OF DISCHARGE

Mean quality	0.39
Standard deviation of quality	0.16
90-percentile quality	0.60
95-percentile quality	0.69
99-percentile quality	0.87
Quality target (90-percentile)	0.60

DISCHARGE QUALITY NEEDED

Mean quality	1.11
Standard deviation of quality	0.37
95-percentile quality	1.79
99-percentile quality	2.20
99.5-percentile quality	2.32

MASS BALANCE CALCULATION: MONTE CARLO METHOD

Version 2.5

Calculations done on 22/06/2011 at 15.01

Name of discharge	Whittlesey scenario 1 to achieve good
Name of river	Whittlesey Dyke
Name of determinand	Ammonia

INPUT DATA

UPSTREAM RIVER DATA

Mean flow	39484.0
95% exceedence flow	9590.0
Mean quality	0.25
Standard deviation of quality	0.15
90-percentile	0.44

DISCHARGE DATA

Mean flow	4957.0
Standard deviation of flow	1239.0
Mean quality	0.90
Standard deviation of quality	0.30
... or 95-percentile	1.46

DOWNSTREAM RIVER QUALITY TARGET

Quality target	0.60
Percentile	90.00

RESULTS

RIVER DOWNSTREAM OF DISCHARGE

Mean quality	0.39
Standard deviation of quality	0.16
90-percentile quality	0.60
95-percentile quality	0.69
99-percentile quality	0.86
Quality target (90-percentile)	0.60

DISCHARGE QUALITY NEEDED

Mean quality	1.16
Standard deviation of quality	0.38
95-percentile quality	1.87
99-percentile quality	2.29
99.5-percentile quality	2.42

MASS BALANCE CALCULATION: MONTE CARLO METHOD

Version 2.5

Calculations done on 22/06/2011 at 15.02

ENVIRONMENT AGENCY

Name of discharge	Whittlesey current consent to achieve good
Name of river	Whittlesey Dyke
Name of determinand	Ammonia

INPUT DATA

UPSTREAM RIVER DATA

Mean flow	39484.0
95% exceedence flow	9590.0
Mean quality	0.25
Standard deviation of quality	0.15
90-percentile	0.44

DISCHARGE DATA

Mean flow	4359.0
Standard deviation of flow	1089.0
Mean quality	0.90
Standard deviation of quality	0.30
... or 95-percentile	1.46

DOWNSTREAM RIVER QUALITY TARGET

Quality target	0.60
Percentile	90.00

RESULTS

RIVER DOWNSTREAM OF DISCHARGE

Mean quality	0.39
Standard deviation of quality	0.16
90-percentile quality	0.60
95-percentile quality	0.69
99-percentile quality	0.87
Quality target (90-percentile)	0.60

DISCHARGE QUALITY NEEDED

Mean quality	1.25
Standard deviation of quality	0.41
95-percentile quality	2.01
99-percentile quality	2.46
99.5-percentile quality	2.60

MASS BALANCE CALCULATION: MONTE CARLO METHOD

Version 2.5

Calculations done on 22/06/2011 at 13.19

Environment Agency

Name of discharge	March No deterioration scenario 3
Name of river	Twenty Foot River
Name of determinand	Phosphate

INPUT DATA

UPSTREAM RIVER DATA

Mean flow	132000.0
95% exceedence flow	23400.0
Mean quality	0.09
Standard deviation of quality	0.09
90-percentile	0.17

DISCHARGE DATA

Mean flow	8056.0
Standard deviation of flow	2014.0
Mean quality	0.36
Standard deviation of quality	0.36
... or 95-percentile	1.00

DOWNSTREAM RIVER QUALITY TARGET

Quality target (Mean standard)	0.12

RESULTS

RIVER DOWNSTREAM OF DISCHARGE

Mean quality	0.12
Standard deviation of quality	0.09
90-percentile quality	0.22
95-percentile quality	0.30
99-percentile quality	0.50
Quality target (Mean)	0.12

DISCHARGE QUALITY NEEDED

Mean quality	0.44
Standard deviation of quality	0.41
95-percentile quality	1.22
99-percentile quality	2.05
99.5-percentile quality	2.36

MASS BALANCE CALCULATION: MONTE CARLO METHOD

Version 2.5

Calculations done on 22/06/2011 at 13.20

Environment Agency

Name of discharge	March No deterioration scenario 2
Name of river	Twenty Foot River
Name of determinand	Phosphate

INPUT DATA

UPSTREAM RIVER DATA

Mean flow	132000.0
95% exceedence flow	23400.0
Mean quality	0.09
Standard deviation of quality	0.09
90-percentile	0.17

DISCHARGE DATA

Mean flow	7596.0
Standard deviation of flow	1899.0
Mean quality	0.36
Standard deviation of quality	0.36
... or 95-percentile	1.00

DOWNSTREAM RIVER QUALITY TARGET

Quality target (Mean standard)	0.12

RESULTS

RIVER DOWNSTREAM OF DISCHARGE

Mean quality	0.12
Standard deviation of quality	0.09
90-percentile quality	0.22
95-percentile quality	0.30
99-percentile quality	0.50
Quality target (Mean)	0.12

DISCHARGE QUALITY NEEDED

Mean quality	0.46
Standard deviation of quality	0.43
95-percentile quality	1.27
99-percentile quality	2.14
99.5-percentile quality	2.46

MASS BALANCE CALCULATION: MONTE CARLO METHOD

Version 2.5

Calculations done on 22/06/2011 at 13.21

Name of discharge	March No deterioration scenario 1
Name of river	Twenty Foot River
Name of determinand	Phosphate

INPUT DATA

UPSTREAM RIVER DATA

Mean flow	132000.0
95% exceedence flow	23400.0
Mean quality	0.09
Standard deviation of quality	0.09
90-percentile	0.17

DISCHARGE DATA

Mean flow	6547.0
Standard deviation of flow	1637.0
Mean quality	0.36
Standard deviation of quality	0.36
... or 95-percentile	1.00

DOWNSTREAM RIVER QUALITY TARGET

Quality target (Mean standard)	0.12

RESULTS

RIVER DOWNSTREAM OF DISCHARGE

Mean quality	0.12
Standard deviation of quality	0.09
90-percentile quality	0.22
95-percentile quality	0.30
99-percentile quality	0.50
Quality target (Mean)	0.12

DISCHARGE QUALITY NEEDED

Mean quality	0.52
Standard deviation of quality	0.47
95-percentile quality	1.42
99-percentile quality	2.38
99.5-percentile quality	2.74

MASS BALANCE CALCULATION: MONTE CARLO METHOD

Version 2.5

Calculations done on 22/06/2011 at 15.13

Environment Agency

Name of discharge	March WwTW scenario 1 to meet good
Name of river	Twenty Foot River
Name of determinand	BOD

INPUT DATA

UPSTREAM RIVER DATA

Mean flow	132000.0
95% exceedence flow	23400.0
Mean quality	2.36
Standard deviation of quality	1.42
90-percentile	4.12

DISCHARGE DATA

Mean flow	6547.0
Standard deviation of flow	1637.0
Mean quality	6.00
Standard deviation of quality	2.14
... or 95-percentile	9.99

DOWNSTREAM RIVER QUALITY TARGET

Quality target	5.00
Percentile	90.00

RESULTS

RIVER DOWNSTREAM OF DISCHARGE

Mean quality	3.13
Standard deviation of quality	1.46
90-percentile quality	5.00
95-percentile quality	5.86
99-percentile quality	7.62
Quality target (90-percentile)	5.00

DISCHARGE QUALITY NEEDED

Mean quality	11.93
Standard deviation of quality	4.17
95-percentile quality	19.70
99-percentile quality	24.46
99.5-percentile quality	25.93

MASS BALANCE CALCULATION: MONTE CARLO METHOD

Version 2.5

Calculations done on 22/06/2011 at 15.11

Environment Agency

Name of discharge	March WwTW current consent to meet good
Name of river	Twenty Foot River
Name of determinand	BOD

INPUT DATA

UPSTREAM RIVER DATA

Mean flow	132000.0
95% exceedence flow	23400.0
Mean quality	2.36
Standard deviation of quality	1.42
90-percentile	4.12

DISCHARGE DATA

Mean flow	5447.0
Standard deviation of flow	1362.0
Mean quality	6.00
Standard deviation of quality	2.14
... or 95-percentile	9.99

DOWNSTREAM RIVER QUALITY TARGET

Quality target	5.00
Percentile	90.00

RESULTS

RIVER DOWNSTREAM OF DISCHARGE

Mean quality	3.12
Standard deviation of quality	1.47
90-percentile quality	5.00
95-percentile quality	5.87
99-percentile quality	7.63
Quality target (90-percentile)	5.00

DISCHARGE QUALITY NEEDED

Mean quality	13.47
Standard deviation of quality	4.71
95-percentile quality	22.24
99-percentile quality	27.61
99.5-percentile quality	29.28

MASS BALANCE CALCULATION: MONTE CARLO METHOD
Version 2.5
Calculations done on 22/06/2011 at 13.48

ENVIRONMENT AGENCY

Name of discharge	Whittlesey No deterioration scenario 3
Name of river	Whittlesey dyke
Name of determinand	P

INPUT DATA

UPSTREAM RIVER DATA

Mean flow	39484.0
95% exceedence flow	9590.0
Mean quality	0.09
Standard deviation of quality	0.09
90-percentile	0.17

DISCHARGE DATA

Mean flow	5562.0
Standard deviation of flow	1390.0
Mean quality	0.36
Standard deviation of quality	0.36
... or 95-percentile	1.00

DOWNSTREAM RIVER QUALITY TARGET

Quality target (Mean standard)	0.25

RESULTS

RIVER DOWNSTREAM OF DISCHARGE

Mean quality	0.25
Standard deviation of quality	0.21
90-percentile quality	0.49
95-percentile quality	0.64
99-percentile quality	1.07
Quality target (Mean)	0.25

DISCHARGE QUALITY NEEDED

Mean quality	1.07
Standard deviation of quality	0.98
95-percentile quality	2.93
99-percentile quality	4.93
99.5-percentile quality	5.67

DODDINGTON STW

Year	Flow (m3/d)	Flow (Ml/d)	Current Quality Consents			Current Load (kg/d)			Increase in Load (kg/d)		
			BOD	Amm	P	BOD	Amm	P	BOD	Amm	P
Current (2010)	616	0.770	20	5	2	15.4	3.9	1.5	0.0	0.0	0.0
Future (2026)	707	0.884	20	5	2	17.7	4.4	1.8	2.3	0.6	0.2

Year	Flow (m3/d)	Flow (Ml/d)	Future Quality Consents			Future Load (kg/d)		
			BOD	Amm	P	BOD	Amm	P
Future (2026)	707	0.884	17.4	4.4	1.7	15.4	3.9	1.5

WEST WALTON STW

Scenario 3

Year	Flow (m3/d)	Flow (Ml/d)	Current Quality Consents BOD	Amm	P	Current Load (kg/d) BOD	Amm	P	Increase in Load (kg/d) BOD	Amm	P
Current (2010)	14,421	18.026	60	20	2	1081.6	360.5	36.1	0.0	0.0	0.0
Future (2026)	15,376	19.220	60	20	2	1153.2	384.4	38.4	71.6	23.9	2.4

Year	Flow (m3/d)	Flow (Ml/d)	Future Quality Consents BOD	Amm	P	Future Load (kg/d) BOD	Amm	P
Future (2026)	15,376	19.220	56.3	18.8	1.9	1081.6	360.5	36.1

Flow Capacity	955
Dwelling Capacity	3638.095238

Appendix 3 Ecological Background for Statutory Designated Sites

Nene Washes SAC

Nene Washes is designated as an SAC for its population of spined loach centred on Morton's Leam, a large drainage channel running along the eastern flank of the Washes, contains the highest recorded density of spined loach *Cobitis taenia* in the UK.

The Conservation Objective for the spined loach population of the site is to maintain the population at Favourable Condition. Specifically, there should be no reduction in densities from existing levels (and in any case no less than 0.1 m^{-2}), no change in extent of Spined Loach habitat (Morton's Leam). Targets for defining favourable conservation status include:

- At least three year-classes should be present at significant densities. At least 50% of the population should consist of 0+ fish
- Maintain the characteristic physical form of the river channel
- Maintain natural substrate character.
- Maintain vegetation management to no more than 50% of the channel width (for submerged plants) and 50% of the bank length (for marginal fringing plants)
- No artificial barriers significantly impairing essential fish movement
- No stocking/transfers of fish species at excessively high densities
- Biological water quality equivalent to Class 'b' in the Biological module of the General Quality Assessment scheme
- Dissolved oxygen/ammonia/BOD equivalent quality to Chemical GQA Class 'C'
- Soluble reactive phosphorus of 0.1 mg L-1 annual mean
- Flow regime should be characteristic of the river. As a guideline, at least 90% of the naturalised daily mean flow should remain in the river throughout the year.

Nene Washes SPA

The Nene Washes are located in eastern England on one of the major tributary rivers of The Wash. It is an extensive area of seasonally flooding wet grassland ('washland') lying along the River Nene. The cycle of winter storage of floodwaters from the river and traditional summer grazing by cattle have given rise to a mosaic of rough grassland and wet pasture, with a diverse ditch flora. Areas of arable cropping provide some winter feeding areas for wildfowl. In summer, it is of importance for breeding waders, as well as Spotted Crake *Porzana porzana*, whilst in winter the site holds large numbers of waders and wildfowl. During severe winter weather elsewhere the site can attract waterbirds from other areas due to its relatively mild climate (compared with continental Europe) and abundant food resources. Likewise, the site can act as a refuge for wildfowl displaced by deep flooding of the nearby Ouse Washes SPA. In winter, some wildfowl, especially Bewick's Swan *Cygnus columbianus bewickii*, feed in surrounding areas of agricultural land outside the SPA.

The continued international importance of this site is dependant on the maintenance of a winter flooding regime and a high but controlled summer water table. The establishment of a water level management regime is being addressed through the Nene Washes Management Strategy Group. A Management Plan was agreed in 1992 and a Water Level Management Plan is currently being drafted. English Nature also has management agreements with a number of landowners. Wildfowling occurs on all sections of the Washes but is not considered to cause significant disturbance at current levels. Any proposals for increased wildfowling will be regulated through the Habitat Regulations.

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

During the breeding season;

- Ruff *Philomachus pugnax*, 1 individuals representing at least 9.1% of the breeding population in Great Britain (Count as at 1993)
- Spotted Crake *Porzana porzana*, 5 individuals representing at least 10.0% of the breeding population in Great Britain (5-11 males = minimum)

Over winter;

- Bewick's Swan *Cygnus columbianus bewickii*, 1,718 individuals representing at least 24.5% of the wintering population in Great Britain (5 year peak mean 1991/2 - 1995/6)
- Ruff *Philomachus pugnax*, 91 individuals representing at least 13.0% of the wintering population in Great Britain (5 year peak mean 1991/2 - 1995/6)

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

During the breeding season;

- Black-tailed Godwit *Limosa limosa limosa*, 16 pairs representing <0.1% of the breeding Western Europe/W Africa population (Count, as at 1992)

Over winter;

- Pintail *Anas acuta*, 1,435 individuals representing at least 2.4% of the wintering Northwestern Europe population (5 year peak mean 1991/2 - 1995/6)
- Shoveler *Anas clypeata*, 413 individuals representing at least 1.0% of the wintering Northwestern/Central Europe population

The area qualifies under Article 4.2 of the Directive (79/409/EEC) by regularly supporting at least 20,000 waterfowl. Over winter, the area regularly supports 25,437 individual waterfowl (5 year peak mean 1991/2 - 1995/6) including: Black-tailed Godwit *Limosa limosa islandica*, Lapwing *Vanellus vanellus*, Pochard *Aythya ferina*, Teal *Anas crecca*, Gadwall *Anas strepera*, Wigeon *Anas penelope*, Shoveler *Anas clypeata*, Pintail *Anas acuta,* Ruff *Philomachus pugnax*, Bewick's Swan *Cygnus columbianus bewickii*.

The detailed targets for determining favourable condition are too extensive to be reproduced here but the overall conservation objective for the SPA bird populations is to maintain the designated species in favourable condition, which is defined in part in relation to their population attributes and in part to habitat attributes (such as maintaining the extent and structure of the lowland neutral grassland habitat on site). On this site favourable condition requires the maintenance of the population of each designated species or assemblage.

Nene Washes Ramsar site

This site is an extensive area of seasonally-flooding wet grassland (washland) of importance for national and international populations of breeding and wintering waders and wildfowl. During severe winter weather elsewhere, the site can attract waterfowl from other areas due to its relatively mild climate (compared with continental Europe) and abundant food resources available. The site is also notable for the diversity of plant and associated animal life within its network of dykes.

The Nene Washes are designated as a Ramsar site for meeting criteria 2 and 6:

- Ramsar criterion 2 - The site supports an important assemblage of nationally rare breeding birds. In addition, a wide range of raptors occur through the year. The site also supports several nationally scarce plants, and two vulnerable and two rare British Red Data Book invertebrate species have been recorded.
- Ramsar criterion 6 – The site supports species/populations occurring at levels of international importance, namely Bewick's swan *Cygnus columbianus bewickii* and pintail *Anas acuta* in winter and black-tailed godwit *Limosa limosa islandica* in autumn.

The detailed targets for determining favourable condition are too extensive to be reproduced here but the overall conservation objectives for the Ramsar site are to maintain the designated habitats and species in favourable condition, which is defined in part in relation to their population attributes and in part to habitat attributes (such as maintaining the extent and structure of the lowland neutral grassland and open water habitat on site). On this site favourable condition requires the maintenance of the population of each designated species or assemblage.

Nene Washes SSSI

This site represents one of the country's few remaining areas of washland habitat which is essential to the survival nationally and internationally of populations of wildfowl and waders. The site is additionally notable for the diversity of plant and associated animal life within its network of dykes.

The washlands are used for the seasonal uptake of floodwaters and, traditionally, for cattle grazing in the summer months. The mosaic of rough grassland and wet pasture provide a variety of sward structure and herbs of importance respectively for bird nesting habitat and feeding. Additional winter feeding is provided by remains of arable cropping on small areas. These washlands play an additional role in relation to the nearby Ouse Washes in that they accommodate wildfowl populations displaced from the Ouse Washes when deep floodwaters prevent their feeding.

The site is favoured by large numbers of wintering wildfowl and particularly the dabbling ducks wigeon *Anas penelope*, teal *Anas crecca*, pintail *A. acuta* and Bewick's swan *Cygnus bewickii*. Wetland birds such as snipe *Gallinago gallinago* and redshank *Tringa totanus* regularly breed and during passage periods there is often a large movement of waders and raptors through the area. Many of the ditches hold a rich flora which includes such uncommon species as frogbit *Hydrocharis morsus-ranae*, water violet *Hottonia palustris* and flowering rush *Butomus umbellatus*.

In the most recent condition assessment the SSSI was judged to be 80.05% unfavourable recovering and 19.95% favourable condition.

The detailed targets for determining favourable condition are too extensive to be reproduced here but the overall conservation objectives for the Ramsar site are to maintain the designated habitats and species in favourable condition, which is defined in part in relation to their population attributes and in part to habitat attributes (such as maintaining the extent and structure of the lowland neutral grassland and open water habitat on site). On this site favourable condition requires the maintenance of the population of each designated species or assemblage.