Halcrow Group Limited

Water Cycle Strategy

Major Growth Areas in and around Cambridge

Phase 1 - Outline Strategy

October 2008

Environment Agency

Cambridgeshire Horizons

driving forward sustainable communities

Halcrow

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Contents Amendment Record

This report has been issued and amended as follows:

Issue	Revision	Description	Date	Approved by
1	0	First draft for stakeholder comment	14/03/08	EJG
1	1	Final draft	30/05/08	EJG
2	0	Final	8/06/08	EJG
2	1	Final including stakeholder sign off comments	05/08/08	EJG
2	2	Appendix A, Section 2.3 replaced with Client text.	09/09/08	EJG
2	3	Section 7.5.1 and 7.2.6 amended based on EA comments.	24/10/08	EJG

Glossary of Terms

AAP	Area Action Plan
AMP	Asset Management Plan
AWS	Anglian Water Services
BAP	Biological Action Plan
CAMS	Catchment Abstraction Management Strategy
CBC	Cambridge Biomedical Campus
CSH	Code for Sustainable Homes
CSO	Combined Sewer Overflow
CWC	Cambridge Water Company
DCLG	Department for Communties and Local Governments
DMRB	Design Manual for Roads and Bridges
DPD	Development Plan Document
DWF	Dry Weather Flow – the minimum or baseflow in a sewer network in dry weather conditions
EO	Emergency Overflow
FEH	Flood Estimation Handbook
Flood Risk	The percentage probability of a flood occuring which causes significant damage or disruption within a given year
Flood zones	Zone 2 has a flood risk probability of between 1 in 100 and 1in 1,000 (1% - 0.1%). Zone 3 has a probability of greater than 1 in 100 (1%)
FRA	Flood Risk Assessment
IDB	Internal Drainage Board
IUD	Integrated Urban Drainage
LDF	Local Development Framework
LNR	Local Nature Reserve
LPA	Local Planning Authority
MUSCO	Multi Utility Services Company
pcc	Per Capita Consumption (litres per head per day)
PPS25	Planning Policy Statement 25: development and flood risk
PR09	Periodic Review 2009 (Water company infrastructure planning)
RE1	River Ecosystem 1
RQO	River Quality Objectives
THE EAST OF ENGLAND PLAN	Regional Spatial Strategy for the East of England
SAC	Special Area of Conservation
SFRA	Strategic Flood Risk Assessment
SPA	Special Protection Areas
SPD	Strategic Planning Document
SSSI	Site of Special Scientific Interest
Standard of protection	The probability of a flood occurring which causes the existing flood defences to be overtopped or fail
SUDS	Sustainable Urban Drainage Systems
TPS	Terminal Pumping Station
WAT1 / WAT2 etc.	East of England Plan Water Policies
WCS	Water Cycle Strategy
WFD	Water Framework Directive
WRMP	Water Resource Management Plan

WSI	Water Services Infrastructure
WwTW	Wastewater Treatment Works

Executive Summary

Overview

1.1.1 The draft East of England Plan has set a target of approximately 42,500 new dwellings and associated employment to be provided across Cambridge City and South Cambridgeshire by 2021. A number of strategic development areas around the existing Cambridge urban area have been identified which, along with the satellite developments of Northstowe and Cambourne, are expected to provide the majority of this growth. Delivering the right infrastructure is critical to sustainable and economic development, in particular housing. This includes the "hidden infrastructure" associated with the urban water cycle; a fact which has been brought into the spotlight recently through events such as the droughts of 2006 and the extreme flooding events of 2007. This Phase 1 Water Cycle Strategy (WCS) for major growth in and around Cambridge looks at the challenges of accommodating large scale housing and economic development in an area of contradictions: the typically low-lying, flat topography poses significant surface water management and foul drainage challenges; whilst Cambridge's location in the driest area of England (identified by the Environment Agency as an area of serious water stress) poses entirely different challenges relating to availability of water.

1.1.2 This WCS has been developed under the direction of a stakeholder steering group including Cambridgeshire County Council, Cambridge City Council, South Cambridgeshire District Council, the Environment Agency, Anglian Water Services, Cambridge Water Company, the relevant Internal Drainage Boards, and Cambridgeshire Horizons (who commissioned the work). It has assessed the potential impacts and constraints associated with the proposed major development areas with regard to the key topics of: flood risk; water resources and supply; foul sewerage; wastewater treatment; water quality; and water-related ecology. Urban infill development has been accounted for within baseline calculations as appropriate. In accordance with the strong sustainability stance adopted by Cambridgeshire Horizons and relevant Local Authorities, this WCS provides guidance on the role of water cycle infrastructure in achieving sustainable development. It identifies actions and responsibilities to help move toward a more sustainable future, and addresses potential barriers to achieving this vision.

1.1.3 This Phase 1 WCS identified no insurmountable technical constraints to the proposed level of growth for the study area. It identified a number of important issues which need to be addressed in detail within Phase 2 to ensure that the development is sustainable from a water cycle perspective. These include:

- Develop an integrated drainage strategy/Surface Water Management Plan.
- Detailed analysis of flow regime to develop detailed technical solution and costing to mitigate increased flood risk in Swavesey Drain.
- Investigate viability of achieving water neutrality, via detailed cost benefit analysis to determine practical achievability of the aspirational targets suggested.

1.1.4 The study recommends that Phase 2 should investigate the common needs of developers and planning authorities.

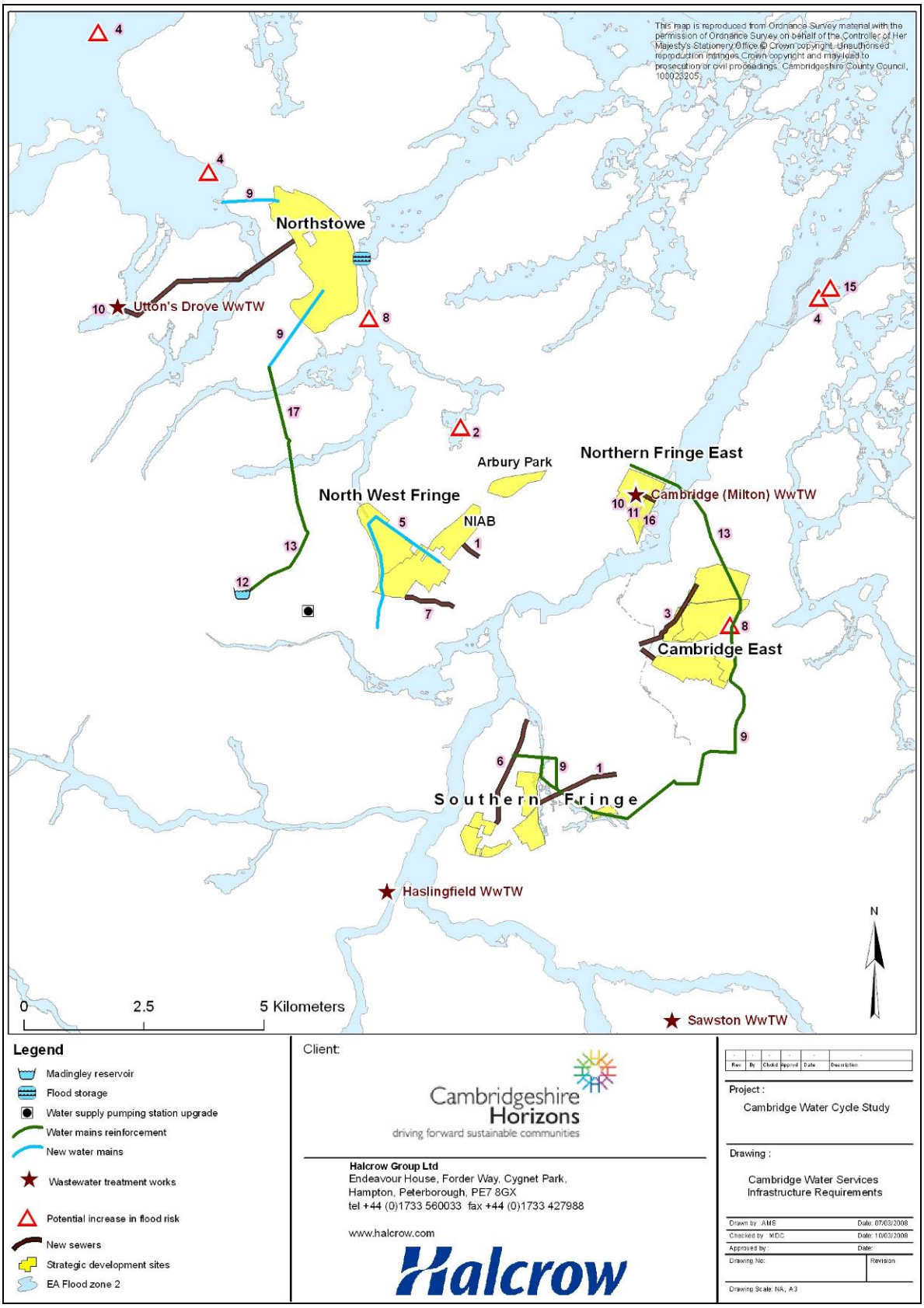

Figure A1: Proposed infrastructure requirements to support LDF growth

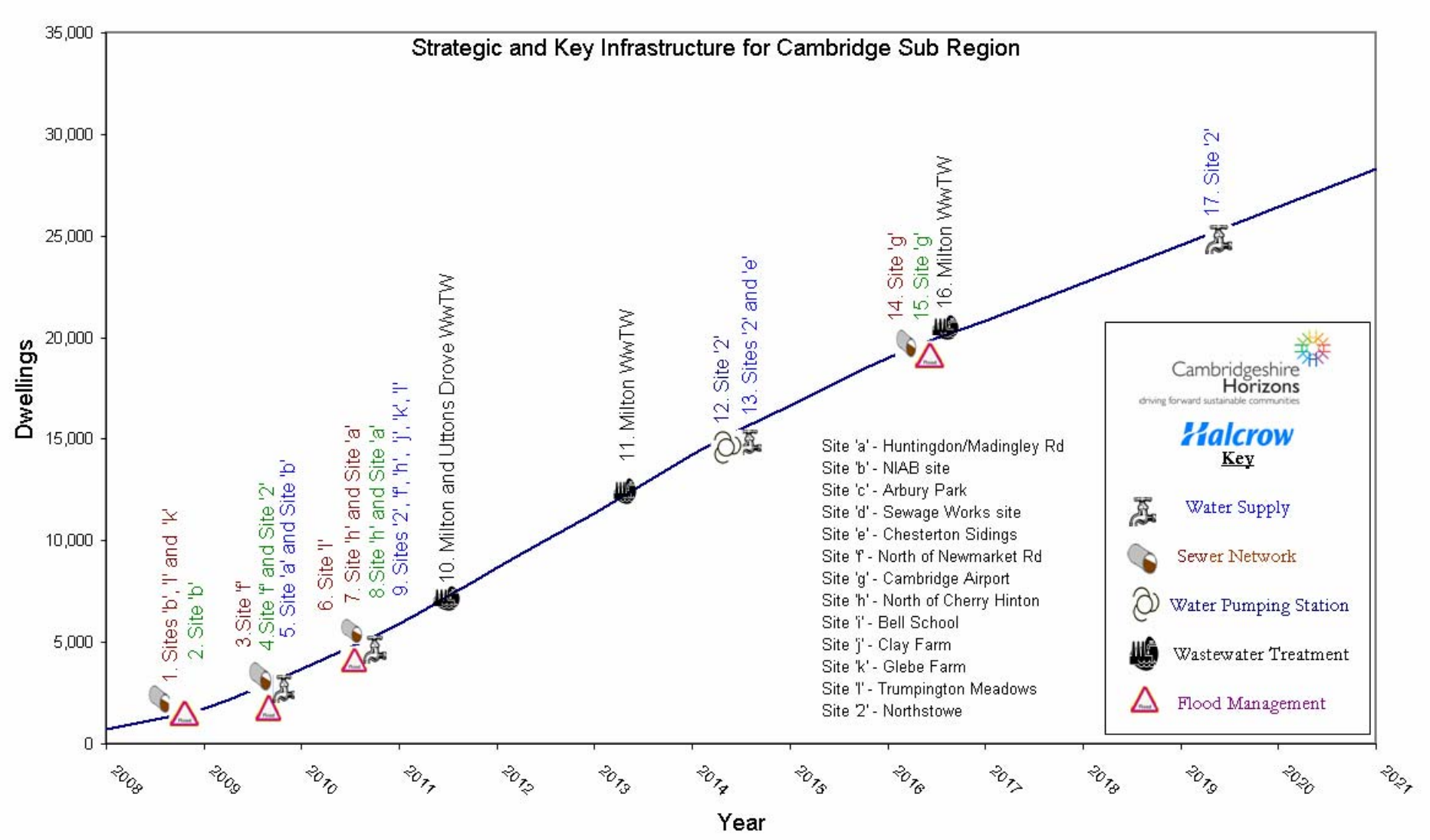

Figure A2: Timeline of Cambridge area infrastructure requirements to support LDF growth

I.D.	Year	Site	Aspect	Description of Infrastructure	Report Reference
1	2008/09	NIAB site Southern Fringe sites	Sewerage	Increased sewer capacity	Section 7.3
2	2008/09	NIAB site	Flood Risk	Flood risk mitigation measures	Section 5.6
3	2009/10	North of Newmarket Rd	Sewerage	Connection of site into existing system	Section 7.3
4	2009/10	Northstowe North of Newmarket Rd	Flood Risk	Flood risk mitigation measures	Section 5.6
5	2009/10	NIAB site Huntingdon/Madingley Rd	Water	New water transfer infrastructure	Section 8.8
6	2010/11	Trumpington Meadows	Sewerage	Increased sewer capacity and storage	Section 7.3
7	2010/11	North of Cherry Hinton Huntingdon/Madingley Rd	Sewerage	Increased sewer capacity required	Section 7.3
8	2010/11	North of Cherry Hinton Huntingdon/Madingley Rd	Flood Risk	Flood risk mitigation measures	Section 5.7 Section 5.6
9	2010/11	Southern Fringe sites North of Cherry Hinton/Newmarket Rd Northstowe	Water	Reinforcement of southern ring main Reinforcement of eastern ring main Connecting mains into Northstowe	Section 8.8
10	2011/12	Milton WwTW Uttons Drove WwTW	Wastewater Treatment Works	Capacity upgrades	Section 7.2
11	2013/14	Milton WwTW	Wastewater Treatment Works	Capacity upgrades	Section 7.2
12	2014/15	Northstowe	Water Pumping	Upgrading Coton Pump station	Section 8.8
13	2014/15	Northstowe Chesterton Sidings	Water	Reinforcement of transfer mains	Section 8.8
14	2016/17	Cambridge Airport	Sewerage	Increased sewer capacity	Section 7.3
15	2016/17	Cambridge Airport	Flood Risk	Flood risk mitigation measures	Section 5.7
16	2016/17	Milton WwTW	Wastewater Treatment Works	Capacity upgrades	Section 7.2
17	2019/20	Northstowe	Water	Reinforcement of transfer mains	Section 8.8

Table A1: Water Services Infrastructure for Major Growth Areas in and around Cambridge

Contents

1 Achieving Sustainability

In response to the Government's recent policy review surrounding sustainable growth, Cambridgeshire Horizons and its local planning authority partners have been proactive in setting out ambitious sustainability goals and seeking out ways to achieve these through planning policy. Strategic planning of Water Services Infrastructure (WSI) plays a crucial role in working toward sustainability goals such as water neutrality, integrated surface water management, and a water aware society.

Cambridge is situated in an area of *Serious Water Stress* as classified by the EA. If we continue to rely solely upon traditional infrastructure approaches, new development will inevitably result in increased demand for water. Achieving high standards of water efficiency in new homes under the Code for Sustainable Homes; through measures such as increased metering, water efficient appliances and other forms of demand management; can help to reduce consumption. In order to make significant progress toward the sustainability ideal of water neutral development; however, a behavioural step change is required in the way we think of, use, and dispose of water. Without application of new technologies and more sustainable behaviours, the demand for water is likely to increase in the existing customer base as well as due to new development. This is not sustainable in the long run, and particularly in water stressed areas it is critical that planning authorities encourage and incentivise the uptake of water efficiency measures and water re-use systems through planning policy and conditions. Australia is ahead of the UK on this issue, being a much more water-aware society by necessity, and there is much we can learn from that country's experience.

Box: Future Water House

New housing will need to be more efficient in the way water is used. A house with the following fittings shows how level 5 of the Code for Sustainable Homes could be achieved. The water use in this house is around 80 litres per person per day (l/p/d), compared to around 150 l/p/d in a standard new house built today.

	Standard new built house (150 l/p/d)		House meeting Code for Sustainable Homes level 5 (80 l/p/d)		
Appliance/fitting	Specification	Contribution to daily use	Specification	Water reuse	Contribution to daily use
WC	6 litre single flush	28.8	4/2.6 litre dual flush (6.33+ 8.36)	14.69	14.69
Washbasin taps	4 l/min	14.11	6 l/min		15.87
Shower	10 l/min	30	7.75 l/min		23.25
Bath	180 litre	28.8	120 litre		19.2
Sink taps	8 l/min	28.22	7 l/min		18.52
Washing machine	49 litre	16.66	40 litre	13.6	13.6
Dishwasher	13 litre	3.9	10 litre		3
Water re-use system	–	0	-100m² roof, 0.6m annual rainfall, 0.6 efficient, 3 persons. Water butts could also meet a significant proportion of garden watering demand	collected = 32.88 WC+washing machine use =28.29 Max benefit = 28.29	–28.29
TOTAL		150.49			79.84
	Source: BRE		Source: Code for Sustainable Homes		

Figures 1.4: Consumption figures for Future Water House - Future Water (Defra)

Box: Vision for 2030

Consumers using water wisely, appreciating its value and the consequences of wasting it

A sustainable supply-demand balance across England, with no seriously water stressed areas

Reduced per capita consumption of water through cost effective measures, to an average of 130 litres per person per day by 2030, or possibly even 120 litres per person per day depending on new technological developments and innovation

Water companies actively encouraging demand management to protect customer and environmental needs

Low levels of leakage, with targets set and met at the optimum balance of economic, environmental and other costs

Water efficiency playing a prominent role in achieving a sustainable supply demand balance, with high standards of water efficiency in new homes, and water-efficient products and technologies in existing buildings

Pro-active industrial and commercial sectors leading by example, through initiatives such as voluntary agreements

Figure 1.3: Vision for the future, from Future Water (Defra)

Image courtesy of B&Q and Waterwise.

Figures 1.5: Schematic of future water house - Future Water (Defra)

In order to achieve genuine sustainability in our approach to water, we need to re-define traditional approaches to WSI to reflect the environmental pressures the world is facing, which are only likely to increase with time. The following tables aim to provide a 'roadmap' to help stakeholders in the growth agenda in and around Cambridge to move forward from the present day scenario; operating with conventional and dated approaches to WSI; into a sustainable vision of the future when the lessons we have learned are incorporated through innovative and effective new methods. The urban water cycle in this instance has been broken down into two fundamental aspects – 'Water Provision and Management', and 'Flood Risk and Surface Water Management'. This aims to reflect a fundamental paradigm shift in the way society needs to view water resource, removing the concept of 'wastewater' from our minds and our behaviour. Water consumed through one process, may be reused through another. The following tables provide an overview of:

- the conventional approach currently taken with respect to WSI and its planning, design, and maintenance;
- the drivers that have brought about the need for the significant and far reaching changes that are currently emerging in the new approach to sustainable development;
- the barriers that planners, developers, water companies and other stakeholders are faced with when implementing changes to the status quo scenario;
- general methods, solutions and responses that may be implemented along the path to sustainability, that can overcome the identified barriers, and achieve the long and short term goals of sustainability; and
- the roles and responsibilities of stakeholders in implementing the changes and measures identified. This has been provided in both a general context, and a specific context for Cambridgeshire Horizons, the Steering Group and relevant stakeholders.

"We are literally flushing our drinking water down the toilet!" – www.yourhome.gov.au

1.1 Water Provision and Management

Sustainable future vision →

Current Approach	Drivers for Change	Barriers to Change	Response	Role of Stakeholders	Actions and Timing
Water is abstracted from limited groundwater and surface water resources, Water is pumped over long distances. Highest demand typically occurs during periods of hot, dry weather when low flows are most likely.	Increasing water scarcity associated with unrestrained consumption and climate change. Increasing population and housing growth. Cumulative impacts of increasing abstraction on the natural environment and ecology. Conventional system is expensive and inefficient, requiring increasing operational expenditure due to rising energy costs. Increasing pressure on water companies to reduce carbon footprint. More extreme weather patterns, including drier, hotter summers and lower average rainfalls associated with climate change.	Lack of evidence to demonstrate environmental and economic benefits of water efficiency measures. Aging water / wastewater infrastructure leading to high leakage. Lack of incentive for developers and water companies to break the mould of conventional approach and implement more innovative solutions. Water companies are required to design for worse case scenarios. Public expectation of unlimited potable water on demand.	Water companies to take account of sustainability reductions and climate change through agreement of Water Resource Management Plans with the EA. Pilot studies to investigate long term sustainability and cost benefit of consumption reduction methods such as rainwater harvesting, grey water recycling, communal third pipe systems, urine separating toilets, community stormwater tanks for non-potable supply. Implementation of greywater re-use systems, rainwater harvesting, and stormwater collection tanks for non-potable supply (to achieve CSH 6). Reduce leakage to inspire customer confidence and lead by example. Implementation of water efficient appliances. Water companies may become a statutory consultee for large scale development applications.	Increased regulatory pressure to reduce leakage (OFWAT), and limiting abstractions (EA). Ensure new development and associated infrastructure is designed in a sustainable fashion. Achieve water consumption reduction in existing housing stock to work toward ideal vision of water neutrality. Water utilities to aim for 20% renewable energy use by 2020.[1]	**Long term** – Ofwat implement measures to CWC to reduce leakage. **Short term** – assess developer applications using proposed application process ensuring sustainable development. **Short term** – consider incentives for affecting existing housing stock consumption. **Short term** – LPAs to process developer applications ensure water minimisation and reuse schemes to minimise loads for system pumping.
Traditional policy and planning has not empowered planning authorities or water companies to take action to reduce consumption.	Current water usage and consumption targets are not possible under traditional policies and without a review of the planning application processes. There is little control on development in relation to sustainability based on traditional policy.	Vision is currently unenforceable (policy, guidance, application process). Difficulty within the existing water company planning system to integrate longer term innovation and sustainability strategies.	Tightening of regulation and policy to drive sustainability and aim for water neutrality in all new homes. Revise the conventional policy, and the development application process.	The LPAs should implement, with the aid of the Halcrow developer checklist, an Appendix to the 1APP Developer Application form covering sustainability objectives and ensuring policy and targets are met. Tightening of regulation and policy to drive sustainability and aim for water neutrality in all new homes. CLG and Defra to amend the Building Regulations to increase minimum requirements for water efficiency in new homes.[1] Water company to become a statutory consultee for large scale development applications.	**Short term** - Cambridgeshire Horizons facilitate uptake of the new 1APP forms and append an additional list of requirements based upon sustainability targets and the Halcrow Developer Checklist. **Short term** - LPAs to implement emerging sustainability policy and through strict developer submission requirements. **Medium term** – Cambridgeshire Horizons to lobby government to expedite changes to the Building Regulations. **Short term** – Cambridgeshire Horizons to facilitate a continuing relationship between CWC and LPAs following on from the WCS.

Sustainable future vision

Current Approach	Drivers for Change	Barriers to Change	Response	Role of Stakeholders	Actions and Timing
Charging for water is not representative of its value, provided at very low cost. Water has traditionally not been a respected resource. There are no incentives to reducing consumption reflected in charging.	No value of water is being conveyed to the consumers. Existing pricing mechanisms are unfair. Economically and environmentally inefficient. New policy demands reassessment of this approach.	There may exist some public opposition to change. 40% of dwellings in Cambridge are currently unmetered.	Universal metering using advanced technology that quantifies water use activities. Informative billing showing a customer's current and historical consumption patterns. Revision of the charging system to ensure fairer tariffs, and revised water costs. More consideration into customers struggling to pay bills such as tax and benefits systems, and tariff revision. Financial incentives for implementing water efficiency measures or purchasing water efficient products. Adaptation of energy efficiency incentives such as the Energy Efficiency Commitment and the new Carbon Emission Reductions Targets, into the water industry. Implementing incentives such as reclassification of large scale water efficiency projects to CAPEX rather than OPEX.	More advanced, standardised and universal metering should be planned and implemented by water companies and the Government. [2] The water company, with government support and OFWAT engagement should refine the billing system to provide standardised customer consumption information. [1] Ofwat to be more robust in exercising its sustainability duty and provide greater incentives.[2] Implementation of a fairer tariff and charging system.	**Medium to long term** – CWC to identify effective metering and achieve universal application through Cambridge. **Medium term** – CWC to identify what is being done nationally in regards to improving the functionality and attributes of standard billing, and make moves to implement. **Medium term** – Cambridgeshire Horizons lobby Ofwat to develop realistic incentives. **Medium to long term** - CWC to tap into work undertaken within the water industry (and Water UK, Ofwat, the Government and Defra) trialling new and fairer tariff systems, such as rising block tariffs.
The consumer has little relationship or knowledge on water conservation and high consumption practices are rife.	Water consumption starts with the consumer and it will require a water aware society to achieve water efficiency targets.	Lack of awareness of water conservation issues within the community. The existing housing stock must have water efficiency measures applied retrospectively. Changing lifestyles that consume more water, and the existence of water inefficient products.	Education of public, LPAs and developers, school education, advertising campaigns, stakeholder knowledge sharing. Provision of information packs in new homes explaining sustainable features, their roles and maintenance. Phasing out of certain water inefficient products, and water efficient labelling on appliances to inform consumers.	Government should review how it creates awareness of water issues with its consumers[2] Market based and European Commission based initiative to provide water efficient labelling on products.[1] Government to take a lead in phasing out water inefficient products such as single flush toilets.[2] All stakeholders to promote water conservation and customer awareness.	**Short to medium term** – Cambridge Horizons to lobby government for increased social education on sustainability. **Medium to long term** – Cambridgeshire Horizons lobby Government to encourage water labelling and phase out water inefficient products. **Short term** – ongoing commitment from all stakeholders to communicate and disseminate the ideals of sustainable water usage.

1 Future Water: The Government's Strategy for England – Defra (2008)
2 The Future of the UK Water Sector – All Parliamentary Water Group (2008)
3 The Pitt Report – Sir Michael Pitt (2007)
4 Funding and charging Arrangements for Sustainable Urban Drainage – Defra (2007)

1.2 Flood Risk and Surface Water Management

Sustainable future vision →

Current Approach	Drivers for Change	Barriers to Change	Response	Role of Stakeholders	Actions and Timing
Management of surface water drainage issues typically piecemeal and uncoordinated, with poorly defined roles and a lack of communication between stakeholders.	Flooding events and costs expected to continue to increase with climate change and increased urbanisation. Climate change leading to increased quantities of surface water, and higher intensity and frequency of flood events. Cost of damage from June/July 2007 flooding estimated at £3bn. Annual cost of surface water flooding estimated at £270m and rising.	A conventional system that includes a lack of integrated planning in relation to different developments and different stakeholders, and no overarching responsibility for action.. Lack of clarity on roles and responsibilities. Lack of clarity on funding mechanisms. Conventional planning has not incorporated impacts of climate change. Land use planning has not historically included flood risk consideration. Perceived cost of strategic measures.	Consistent and holistic management of urban flood risk, with strategic planning, partnerships of responsible bodies, and clear understanding of responsibilities.[1] A coordinated and integrated approach by stakeholders, to prepare Surface Water Management Plan (SWMP) for study area to clarify issues and define responsibilities. Preparation of suitable flood risk plans for all Cambridge catchments identifying high flood risk areas, outlining proposals to manage risks and specifying priorities for action. No planning applications to be approved without Flood Risk Assessment and satisfactory Drainage Strategy (may be addressed by developers contributing to joint SWMP). EA, sewerage undertakers and IDBs to be consulted and listened to, from earliest stage of planning.	"Local authorities should lead on the management of surface water flooding and drainage at the local level with the support of all responsible organisations." This includes the preparation of a SWMP identifying tasks, roles and responsibilities of stakeholder.[3] LPAs to oversee formation of a coordinating group to develop and manage flood risk plans for the area.[2] Under guidance of the EA, LPAs are best placed to manage specific local issues concerning clearing of drains, protection of critical local infrastructure, damage assessment, and advice on flood risk mitigation.[2] All key stakeholders, including sewerage undertakers, IDBs and EA, to fully engage with the WCS and SWMP processes.	**Short term** – Cambridgeshire Horizons to coordinate production of joint Surface Water Management Plan with LPAs and developers. **Short term** – All stakeholders to be prepared to accept appropriate levels of responsibility as identified by SWMP. **Medium term** – EA to provide general guidance and support to LPAs regarding flood defence, surface water drainage and preparation of SWMP. **Ongoing** – LPAs to ensure developers undertake Flood Risk Assessments and provide satisfactory drainage strategies (with advice from EA and water companies as appropriate) for all proposed sites prior to agreement of planning permission. **Ongoing** – Anglian Water to continue their full engagement with the LDF planning process and WCS.
Surface water flows are channelled overland or by underground sewerage networks (combined or stormwater) to be discharged into nearby water courses, or flood storage areas. Surface water is drained into underground piped systems along with foul sewerage.	Large areas of surface runoff will cause water quality issues as by transporting pollutants into waterways. Underground systems have limited capacity and cannot practicably be designed to accommodate large storm peaks. Piped systems will therefore always, eventually, be beaten and when this happens foul sewerage is discharged as well as surface water. Combined sewer overflows are required because of storm peaks, and these discharge untreated sewerage into watercourses when they spill. Surface water entering combined systems demands significantly increased pumping at treatment works.	The existence of extensive conventional systems that require altering in an 'unconventional' way. Perceived expense of new technologies. The "automatic right to connect" (see below) – this acts as a dis-incentive for developers to take a different approach. Water companies traditionally unwilling to take responsibility for non-piped drainage systems.	Separate surface water from foul sewerage for all new developments. Investigate feasibility and cost benefit of separating surface water from foul sewerage in existing combined systems with high incidence of sewer flooding. More adaptable drainage systems delivering reduced flood risk, improved water quality, and decreasing burdens on the sewer system.[1] Implementation of a locally adapted appendix for the standard 1APP application form, incorporating planning requirements as outlined within the Halcrow Developer Checklist and the Guidance for Flood Risk. E.g. FRAs and SUDS strategies should be submitted with the planning applications. Employing the Planning Performance Agreement process developed by ATLAS to aid the planning application process. Run pilot studies trialling new technologies such as SUDS innovations – e.g. underground stormwater tanks for non-potable re-use, porous pavements, grass swales etc.	"….a local register of all the main flood risk management and drainage assets (overland and underground) should be compiled by the relevant local authority…." [3] LPAs should implement the emerging standardised application processes (1APP), with an appendix based on the Halcrow Developer Checklist, and ensure surface drainage objectives are incorporated into all new development. AWS (and other water companies) should investigate potential for adopting non-piped drainage systems (AWS SUDS statement recently produced to this effect).	**Short term** – Cambridgeshire Horizons coordinate a more rigorous and thorough development application process by the LPAs, integrating measures and standards outline in the Phase 1 WCS. **Short term** – LPAs append specific developer requirements to the 1APP application forms, to ensure sustainability goals. **Medium term** – LPAs start collating an information database on flood risk and drainage assets.

Sustainable future vision

Current Approach	Drivers for Change	Barriers to Change	Response	Role of Stakeholders	Actions and Timing
Significant loads added by new development act to directly increase flood risk	Flood risk is steadily increasing (>50% of June 2007 flooding attributed to sewer flooding). Cost of flooding estimated at £270M/yr in UK. Incremental flow increase (creep) is leading to the reduction of pervious surfaces as urban areas take over greenfield areas. Where separate stormwater and foul water systems exist, cross connection can lead to pollution risk if foul water enters the storm water, or flood risk if storm water enters the foul water network.	No organisation with overarching responsibility for Sustainable Drainage Systems (SUDS). Lack of clarity regarding responsibility for surface water drainage infrastructure (e.g. SUDS). A current lack of understanding of LPAs regarding suitable design standards for SUDS. Water companies traditionally unwilling to take responsibility for non-piped drainage systems. Lack of coordinated response by developers.	Community resilience to flooding from improved development planning, emergency and response, and resilience of homes, buildings, services and utilities.[1] Link green infrastructure with SUDS and ecology requirements during the planning process. Utilise SUDS wherever possible and integrate space for water in outline planning stages, with a goal to increase natural groundwater recharge (hence buffering climate change) Clarify responsibilities and ownership associated with SUDS (current guidance suggests LPAs take a leading role). Ensure the provision of Flood Risk Management documents with significant development applications as per the PPS25.	"…..the Government, as part of its Water Strategy, should resolve the issue of which organisations should be responsible for the ownership and maintenance of sustainable drainage systems."[3] Usual for a developer to design the SUDS strategy, and have it reviewed by the LPA or sewerage undertaker. The adopting party will maintain, and will negotiate commuted sums from the developer.[4] AWS (and other water companies) should investigate potential for adopting non-piped drainage systems (AWS SUDS statement recently produced to this effect). Developers of sites with potential for cumulative flood risk impact should work together to develop joint Drainage Strategies.	**Short term –** LPAs ensure that developer applications include SUDS strategies and FRAs in accordance with PPS25, and their individual planning goals. Strategies should be properly assessed. **Short term** – Cambridgeshire Horizons to coordinate production of joint Surface Water Management Plan with LPAs and developers. **Medium term** – Cambridgeshire Horizons to lobby the government to revise ownership and maintenance of SUDS.
Developers / customers can connect directly into the surface and foul water networks. The water and wastewater service providers maintaining the network have no control over the material or volumes entering the foul water network.	Increase in risk of flooding due to extra loads into sewerage system. Rising energy costs and increasing emphasis on sustainability making treating and pumping of additional loads from runoff untenable. Water companies coming under pressure to reduce carbon footprint.	The automatic right for developers to connect to sewers leads to a loss of control over the system. Lack of consistent approach from one area to another. Restriction of the customer freedom associated with discharging to sewer could result in negative publicity.	Withdraw the automatic right to connect surface water to the existing network.	Government to remove the right for uncontrolled and open connections to the sewerage system. Government to consult on the way forward, including the case for regulation in regards to discharging into sewers.[1]	**Ongoing** – Sewerage undertakers to lobby Ofwat to withdraw automatic right to connect.
A standard rate for surface water drainage is applied to customers.	Increased surface water into sewers leads to increased (and uncontrollable) flood risk. Rising energy costs and increasing emphasis on sustainability making treating and pumping of additional loads from runoff untenable.	No incentivisation for regulating surface runoff from sites.	Manage surface water locally and do not overload sewers. Implement the 'polluter pays' principle based on contributions of surface water to the system.	Water authorities to apply surface water drainage charges to customers which reflect their contribution to surface water, including Highway Authority.[1]	**Medium term** – AWS to seek revision of the surface water drainage charges in relation to developers and Highways Authority so a pro rata scale can be established.
Customers have little awareness of flooding and its causes.	Little social ownership or awareness of flooding issues is apparent.	Public opposition. Funding required to educate the public.	Better public appreciation of the causes and consequences of surface water run-off and the actions we can all take to minimise the risks[1]	Educating the public on the causes and mitigation options for surface water run-off.	**Medium to long term** – Anglian Water and LPAs to create awareness through education campaigns.

Current Approach	Drivers for Change	Barriers to Change	Response	Role of Stakeholders	Actions and Timing
Surface water drainage planning is based on flood risk alone.	Public requirement for attractive, multi-functional open spaces Sustainability Appraisal approach requires multi-functional open spaces, encouraging integration of green infrastructure with SUDS.	Lack of integration between various open space stakeholders. Historically, ecological and lifestyle green space aspects of growth have been considered separately.	Consider flood risk mitigation measures in context of requirements for ecological habitat, and general city aesthetics and open space requirements. Network of attractive, multi-functional open spaces that adds value to new development for all stakeholders.	LPAs to ensure consideration of Green Infrastructure, requirements of the Water Framework Directive, and other ecological frameworks within Surface Water Management Plans.	**Short to medium term** – Cambridgeshire Horizons facilitate establishment and effective operation of appropriate working groups to ensure ecological, aesthetic, flood risk and other open space aspects are aligned.

Sustainable future vision

1 Future Water: The Government's Strategy for England – Defra (2008)
2 The Future of the UK Water Sector – All Parliamentary Water Group (2008)
3 The Pitt Report – Sir Michael Pitt (2007)
4 Funding and charging Arrangements for Sustainable Urban Drainage – Defra (2007)

2 A Water Cycle Strategy for Cambridge

2.1 Introduction

2.1.1 Within the draft East of England Plan, the Cambridge Sub-region (CSR) provides a strategic approach to planning for Cambridge and its surrounding market towns. The East of England Plan has defined the need for 75,000 new houses by 2021. Approximately 42,500 dwellings are to be provided within Cambridge City and South Cambridgeshire. It is crucial that a holistic view is taken to the planning of all necessary infrastructure and services for these dwellings, and the Water Cycle Strategy for Cambridge forms a key part of the strategic planning process.

2.1.2 The major growth areas in and around Cambridge (see Figure 2-1) as defined for the purpose of this study include:

- The existing Cambridge urban area.
- Cambridge East – made up of 3 areas: Cambridge Airport; North of Newmarket Road & North of Cherry Hinton.
- The Cambridge Northern Fringe – Arbury Park.
- Northstowe - the former Oakington Airfield and adjacent land near Longstanton.
- The new settlement at Cambourne – This development is well established and has been included where relevant in the baseline analysis.
- Cambridge Southern Fringe - consists of main sites: to the east of Trumpington – Clay Farm and the showground site; to the south – Glebe Farm; to the south-west – the former Monsanto site; the expansion of Addenbrooke's and adjacent Bell School.
- North West Cambridge - two new residential areas are planned - Land between Madingley Road and Huntingdon Road; & Land between Huntingdon Road and Histon Road.

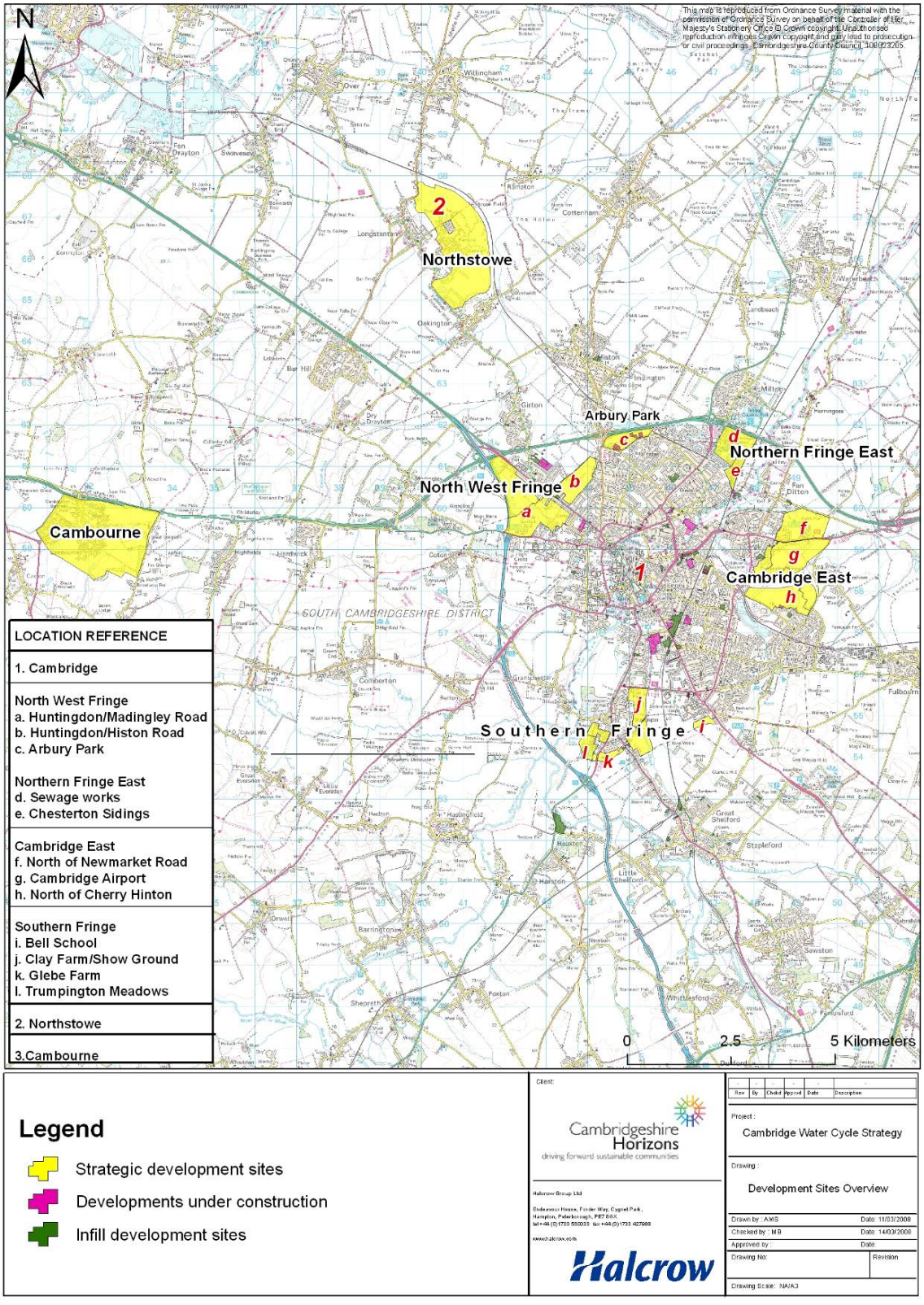

Figure 2-1: Major growth areas in and around Cambridge

Source: Vision for the Cambridge Sub-region – Cambridge and Peterborough Structure Plan (2003)

2.2 What is a Water Cycle Strategy (WCS)?

2.2.1 Figure 2-2 shows the elements that comprise the water cycle. Although the methods of dealing with them may change, the basic requirements never will. Rain will fall, clean water will be needed for life, and sewage treatment will be needed for public health. There is a significant amount of "hidden infrastructure" associated with the interaction between water and development. Houses, employment sites, hospitals and community centres all require (in varying degree) the provision of clean water, the removal of wastewater, and protection from flooding. In addition, the impact of new development on existing communities and the water cycle status quo must be assessed, minimised and mitigated.

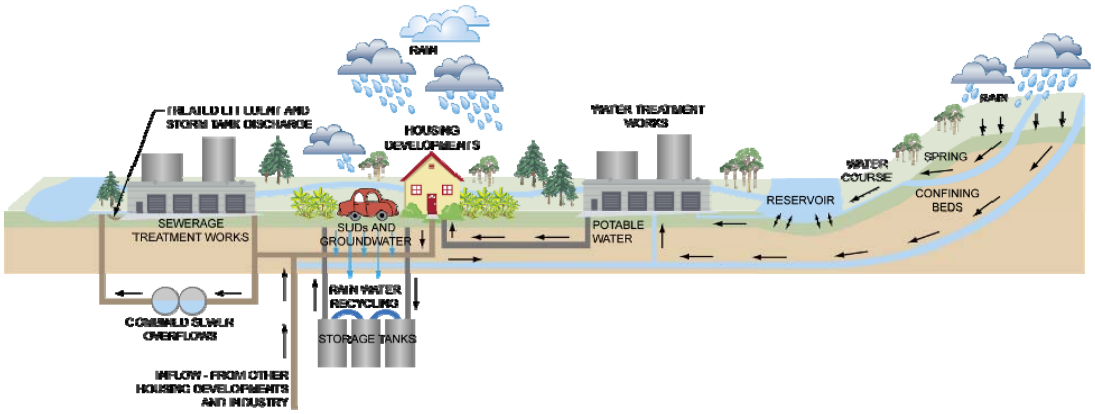

Figure 2-2: The Water Cycle

2.2.2 The infrastructure associated with the water cycle is referred to by the Environment Agency as Water Services Infrastructure (WSI) and is defined as:

- licensed water resource systems for abstraction from rivers, reservoirs and aquifers;
- raw water storage reservoirs and inter-basin transfer schemes;
- raw water abstraction and water treatment works;
- treated water reservoirs, transfer pipelines and pumping stations to local areas of demand;
- local water supply distribution pipelines;
- modified channels and structures to control surface water runoff in urban areas;
- rainwater collection systems and storm water storage tanks;
- wastewater collection networks and treatment works; and
- receiving watercourses.

2.2.3 In addition to this traditional WSI, the Water Cycle Strategy also incorporates other management aspects associated with the water cycle including:

- water efficiency and demand reduction;
- SUDS and Integrated Urban Drainage;
- carbon footprinting; and
- climate change.

2.2.4 This WSI is needed to support new development; however, in the past it has not generally been integrated into the planning process. Policy statements in regional planning documents; for example policies WAT1 and WAT2 within the East of England Plan, and those shown below from the Structure Plan; are ensuring that WSI is considered early in the planning process, as an integral part of the planning process for new development. Policies relevant to the water cycle and associated WSI within the Cambridge Sub-region are discussed in Section 3.

2.2.5 The requirement for a progressive and integrated approach to development and population growth is underpinned by an increasing awareness of the need for sustainable development. The interrelationship of development, amenity and community growth with all aspects of the water cycle is being increasingly realised and new policies reflect the need for an integrated and informed procedure to deliver large scale development in the most sustainable fashion.

2.2.6 LDF documents submitted to the Secretary of State without sufficient evidence of this strategic approach (to the provision of infrastructure) carry a risk of being judged unsound. New planning application processes (See Appendix I) are being developed to support a more efficient approach to major developments.

2.2.7 The Water Cycle Strategy process has been developed to provide a coordinated, holistic approach to the planning of WSI that will support and enable sustainable development in areas of significant growth. The Environment Agency is in the process of preparing WCS guidance for local authorities at the time of writing, and is promoting them as best practice supported by Defra, CLG, a number of major water companies and other stakeholders in the Government's Sustainable Communities growth agenda. See Section 2.7 for discussion of how a WCS fits within the planning process and relates to other LDF evidence.

2.3 Cambridge WCS – project history

2.3.1 In August, 2007 Halcrow Group Ltd completed the "Cambridge Water Cycle Strategy Scoping Study". This was commissioned by the Environment Agency and was essentially a desk study to assess the potential impacts on the water cycle and existing WSI of the proposed level of growth for the Cambridge urban area. The study provided an overview of the potential issues and highlighted potential causes of constraint for further investigation.

2.3.2 One of the key findings of the Scoping Study was a need for more integrated planning for flood risk and surface water management, with the impacts of surface water run-off from new developments being identified as requiring further analysis.

2.3.3 The Scoping Study also identified the need to develop a strategy for the provision of increased wastewater network and treatment capacity. The two wastewater treatment works (WwTW) investigated were Uttons Drove and Milton, which were the two sites identified as being relevant to the growth areas designated within the study area and were both identified by the East of England Capacity Study as potential constraints to growth.

2.3.4 Anglian Water Services subsequently commissioned Halcrow to undertake the Southern Fringe Wastewater Capacity Study (October 2007), which itself led to the commission of a wastewater strategy for the whole of Cambridge, completed in draft form in May 2008. The findings of these two reports will be incorporated in this Water Cycle Strategy. The development of a preferred option is still being developed

through discussions with AWS. These studies include detailed modelling of the existing network and aspects since the Scoping Strategy, and will be used to develop a detailed wastewater infrastructure strategy for the area.

2.3.5 The key recommendation of the Scoping Study for progression of the WCS was that a more detailed stage be undertaken for the Cambridge urban area and other urgent development areas as soon as possible, to identify the WSI required to facilitate the most imminent phase of the development trajectory. The market towns are being progressed on a different timeline and are not being considered within this study.

2.3.6 This Phase 1 Water Cycle Strategy (WCS) has been commissioned to provide a more detailed analysis of the potential constraints identified in the Scoping Study, and to develop potential mitigation options and infrastructure solutions to enable the developments identified in Figure 2-1 to proceed according to the planned trajectory.

2.4 Study Area

2.4.1 This Phase 1 WCS covers the same area as the scoping study, namely the strategic development areas shown in Figure 2-1, and main urban area of Cambridge City.

2.4.2 The physical study area for the water cycle and ecology aspects associated with the listed development has been defined by the various catchment boundaries that need to be considered. The catchments relating to different aspects of the study cover different areas. To help understand the strategic water service infrastructure needs of the development sites, cross-boundary consideration has therefore been given to a wider, secondary study area. This area is shown in Figure 2-3 below.

2.4.3 The surrounding market towns have not been investigated within this Phase 1 WCS; however, these will need to be considered in the future as the wider development proposals are progressed for the rest of the Sub-region.

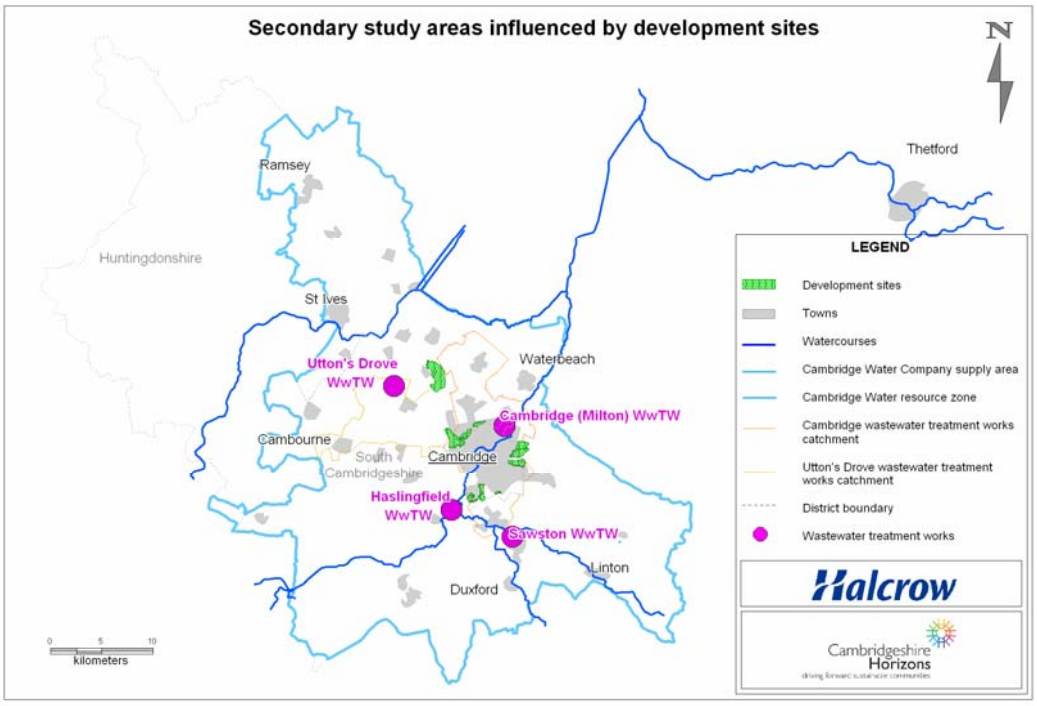

Figure 2-3: Study area for Phase 1 WCS

2.5 Who is Involved?

2.5.1 The growth identified for the Cambridge Sub-region involves six local authorities. These organisations are already working together to produce their Development Plan Documents (which form part of the Local Development Framework (LDF)). For example, Cambridge City Council and South Cambridgeshire District Council are jointly producing Area Action Plans (AAPs) for North West Cambridge and have completed one for Cambridge East. The study area and scope identified for this stage of the WCS necessitates the direct involvement of three of these authorities, namely: Cambridgeshire County Council, Cambridge City Council, and South Cambs District Council. The other local authorities should be kept informed as appropriate.

2.5.2 Cambridgeshire Horizons is the Local Delivery Vehicle for the Cambridge Sub-region. Its role is to facilitate new development and associated infrastructure in the Sub-Region in accordance with the approved Structure Plan and Local Development Framework.

2.5.3 The Phase 1 Water Cycle Strategy has been commissioned by Cambridgeshire Horizons, in partnership with the Environment Agency, Cambridgeshire County Council, Cambridge City Council, and the South Cambridgeshire District Council.

2.5.4 A Project Steering Group, led by Cambridgeshire Horizons, has been formed to contribute to and oversee the production of this Phase 1 WCS. This steering group comprises representatives from the following key stakeholder organisations:

- Environment Agency
- Cambridgeshire Horizons
- Cambridge City Council
- South Cambs District Council
- Cambridgeshire County Council
- Anglian Water Services Ltd.
- Cambridge Water Company
- The technical advisor to Swavesey Drain Internal Drainage Board (IDB), Old West IDB & Swaffham IDB
- Halcrow Group Ltd.

2.5.5 This approach of formulating a group of key stakeholders to develop project objectives and define the relevant parameters within which to develop the strategic direction for Cambridgeshire is in accordance with the Policy WAT2 below.

Policy WAT 2: Water Resource and Waste Water Infrastructure Development

The Environment Agency and water companies should work with….local authorities, delivery agencies and others to ensure timely provision of the appropriate additional infrastructure for both water supply and waste water treatment to cater for the levels of development provided through this plan, whilst meeting agreed surface and ground water standards.

A co-ordinated approach to plan making should be developed through a programme of water cycle studies to address water supply, water quality, wastewater treatment and flood risk issues in receiving water courses relating to development proposed in this RSS.

2.6 Objectives and Scope

2.6.1 The overall objective is to produce an integrated, sustainable approach to the provision of WSI for the Cambridge urban area and adjacent strategic development sites, including Northstowe. As planning applications have already been submitted for Northstowe and Southern Fringe sites, the WCS takes into account these submissions when assessing constraints and developing infrastructure solutions. A tailored approach to the WCS has been taken to suit the immediate and longer term planning requirements of the relevant local authorities. Strategic[1] WSI has been considered for the identified development areas and a more detailed analysis undertaken of key[2] infrastructure requirements for the most urgent developments at Northstowe (including reference to Cambourne as required) and Southern Fringe. A strong emphasis is placed on sustainable development, especially in alignment with the Code for Sustainable Homes.

2.6.2 The project scope has been defined as:

- Undertake a review of existing baseline evidence incorporating climate change, for water and wastewater infrastructure planning;
- Assess environmental capacity for growth with respect to water resources, receiving water courses and any remedial measures required to enable growth;
- Provide details of strategic water cycle based constraints and infrastructure proposals required to support growth;
- Provide a program for key (for Southern Fringe and Northstowe) and strategic (for all identified sites) water services infrastructure, incorporating environmental standards, and mitigation options;
- Provide guidance on water efficiency measures and their application;
- Develop guidance for setting up Integrated Urban Drainage Management for the growth area, including an approach for linking SUDS to green infrastructure;
- Estimate high level costs of strategic and key infrastructure and associated developer contributions;
- Consider the impacts and environmental constraints relating to an additional 20% growth in the study area over and above the proposed trajectory;
- Identify and scope any additional work required to progress the WCS for Cambridge.

2.6.3 The pressing time constraints relating to the Northstowe and Southern Fringe sites necessitate a more detailed investigation within the scope of this study. A technical liaison group has been established to take the lead agreeing technical solutions for Northstowe. Communication channels have also been established with the Environment Agency's Development Control team to allow issues arising in relation to these sites to be investigated quickly and effectively.

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[1] Serving a number of development areas or sites

[2] Serving a specific development area or site

2.7 Planning Context of the WCS

2.7.1 The status of the WCS in relation to the overarching planning process and other relevant documentation is not formally defined at this stage. The emerging national guidance (Environment Agency) suggests that the most appropriate approach is to treat the WCS as part of the technical evidence base for the LDF, meaning that formal public consultation is not required. Instead, the WCS should be referenced within the LDF documents and its key findings and recommendations drawn into the Core Strategy and other Local Development Documents.

2.7.2 As a key part of the supporting evidence for the LDF, on which future planning decisions and conditions will be based, it is important that those parties responsible for progressing development buy in to the principles of the WCS. A programme of stakeholder engagement is therefore recommended which will allow affected parties to have an input into the development of the WCS, so that those responsible for delivering the Strategy will be prepared to take ownership of the end product.

3 Relevant Policy and Guidance

3.1 Policy Overview

3.1.1 Reference has been made to relevant national, regional and local policy and guidance for the Cambridge City and South Cambridgeshire districts. Overarching government policy has introduced a strong sustainability aspect to the growth agenda and a number of key guidance and policy documents have been developed at various levels to support planning authorities in achieving this objective. An overview of these is provided below.

National

3.1.2 A number of national Planning Policy Statements have been produced by the Department for Communities and Local Government. Most relevant of these to this study are PPS1 concerning sustainable development, and PPS25 concerning development and flood risk.

3.1.3 The Defra document, Future Water, discusses many issues of direct relevance to this WCS, and provides much useful reference material.

3.1.4 The Pitt Review is an independent review commissioned by Ministers of the flooding emergency that took place in June and July 2007. The interim conclusions of this report were published in December 2007 and have been referred to during the development of this Phase 1 WCS.

Regional

3.1.5 The existing regional policy for Cambridgeshire is the Regional Spatial Strategy for the East of England (the East of England Plan) as outlined within the Sustainable Communities Plan. The Cambridgeshire and Peterborough Structure Plan (2003) defined the strategy for growth in Cambridgeshire prior to the production of the East of England Plan. The Government Office for the East of England (GO East) has ordered that the policies set out within the existing Structure Plan be retained.

Local

3.1.6 The Cambridge Local Plan (2006) and the South Cambridgeshire Local Plan (2004) have interpreted the objectives of the guiding policies set out by the Structure Plan and the East of England Plan at a local level to facilitate development. These Local Plans will ultimately be replaced by the Local Development Frameworks currently being prepared by the planning authorities.

3.1.7 Additionally, the South Cambridgeshire Core Strategy Development Plan Document (2007), and Development Control Policies Development Plan Document (2007) include policies set out by South Cambridgeshire District Council. Cambridge City Council has also defined local policy within its core strategy, the Cambridge Development Strategy.

3.1.8 Detailed site policy for the strategic development sites has been provided in the Cambridge Southern Fringe Action Area Plan DPD (AAP), the Cambridge East AAP, and the Northstowe AAP. The AAP for North West Cambridge is under development at the time of writing.

3.2 Sustainability Guidance

3.2.1 The draft East of England Plan identifies a target reduction of 25% per capita consumption for new housing (and 8% for existing housing) as a minimum to ease water stress in existing stressed areas throughout England, as identified by the Environment Agency. For new housing, the targets chosen by the WCS Steering Group are more efficient than these of the East of England Plan as they are aligned with the Code for Sustainable Homes. No consideration of achieving water efficiency in existing houses has been commissioned at this point.

3.2.2 The Sustainable Design and Construction SPD produced by Cambridge City Council offers qualitative and indicative guidance on sustainable development ideals. The Code for Sustainable Homes has been used as the basis of reference for sustainability assessment in this strategy. In relation to water cycle aspects, this document provides the most detailed and quantified guidance to assist developers and planning authorities in achieving sustainability targets.

3.2.3 The Cambridge Sustainable Design and Construction SPD is a useful document for introducing the intentions of the Cambridge sustainability agenda however as it was based on the Cambridge Local Plan (2006) which contained no explicit water saving policies, it is unable to provide strong directives or quantification of targets and guidance. For this reason, the document has not been referenced further in this strategy.

3.2.4 The following list, whilst not exhaustive, sets out the key local and national sustainable planning guidance referenced within this study:

- Sustainable Design and Construction SPD (June, 2007) – Cambridge City Council;
- Code for Sustainable Homes (December, 2006) – Department for Communities and Local Government;
- Cambridge Green Infrastructure Strategy – Cambridgeshire Horizons;
- Design Guide– South Cambridgeshire District Council;
- UK Climate Impact Programme;
- Sustainability Appraisal documents for Cambridge City Council and South Cambridgeshire District Council;
- Water Efficiency in New Buildings – DEFRA;
- Future Water – Defra;
- The Pitt Review (Interim Conclusions, Dec 2007);
- Strategic Flood Risk Assessments previously undertaken;
- The Stern Review.

4 Development and Planning

4.1 Introduction

4.1.1 The East of England Plan proposes that 73,300 homes are provided within Cambridgeshire between 2001 and 2021 of which 62,300 are within the Cambridge Sub-Region (which includes Cambridge City, South Cambridgeshire, Huntingdonshire and East Cambridgeshire). Based upon Policy H1 within the East of England Panel Report, the minimum development requirement for Cambridge City is 19,000 new dwellings, and 23,500 new dwellings in South Cambridgeshire. This report deals with the Cambridge area defined in Figure 4-1 below.

4.1.2 Of the combined 42,500 housing target for Cambridge City and South Cambridgeshire, 30,330 will be constructed at strategic development sites around Cambridge and at Northstowe. This water cycle strategy considers the strategic development sites only. Windfall, infill, and other allocations identified by the planning authorities (See Appendix B) are included within this study as a baseline scenario. In the event that more development is required beyond the LDF requirements, analysis of environmental and infrastructure capacity around the Cambridge urban area has been assessed.

4.2 Proposed Developments

4.2.1 Table 4.1 below shows a summary of the strategic sites included within this study. Ward dwelling forecasts and the latest available information from Cambridgeshire Horizons based upon developer information were reviewed. The higher figure in each case was used for this strategy and the final figures applied were confirmed with Cambridgeshire Horizons. Other growth (labelled 'Balance' in Table 4.1 below) was included within the strategy where relevant. These data sources are available in Appendix B.

	2001-2006	2006-2011	2011-2016	2016-2021	TOTAL
Arbury	-	900	-	-	**900**
Cambourne	1750	2,100	100	50	**4,000**
Northstowe	-	550	3,600	4,250	**8,400**
Northern Fringe	-	0	600	1,600	**2,200**
Southern Fringe	-	1,560	2,690	-	**4,250**
Cambridge East	-	400	2,950	3,200	**6,550**
Cambridge North West	-	850	2,980	200	**4,030**
Strategic Site Sub Total	**1,750**	**6,360**	**12,920**	**9,300**	**30,330**
Balance*					**12,170**
Total					**42,500**

*refers to all development not included in the LDF strategic sites. Information obtained from the latest LPA windfall figures, and LPA housing trajectories provided in Appendix B.

Table 4.1: Estimated growth trajectory for strategy sites (2001 – 2021)

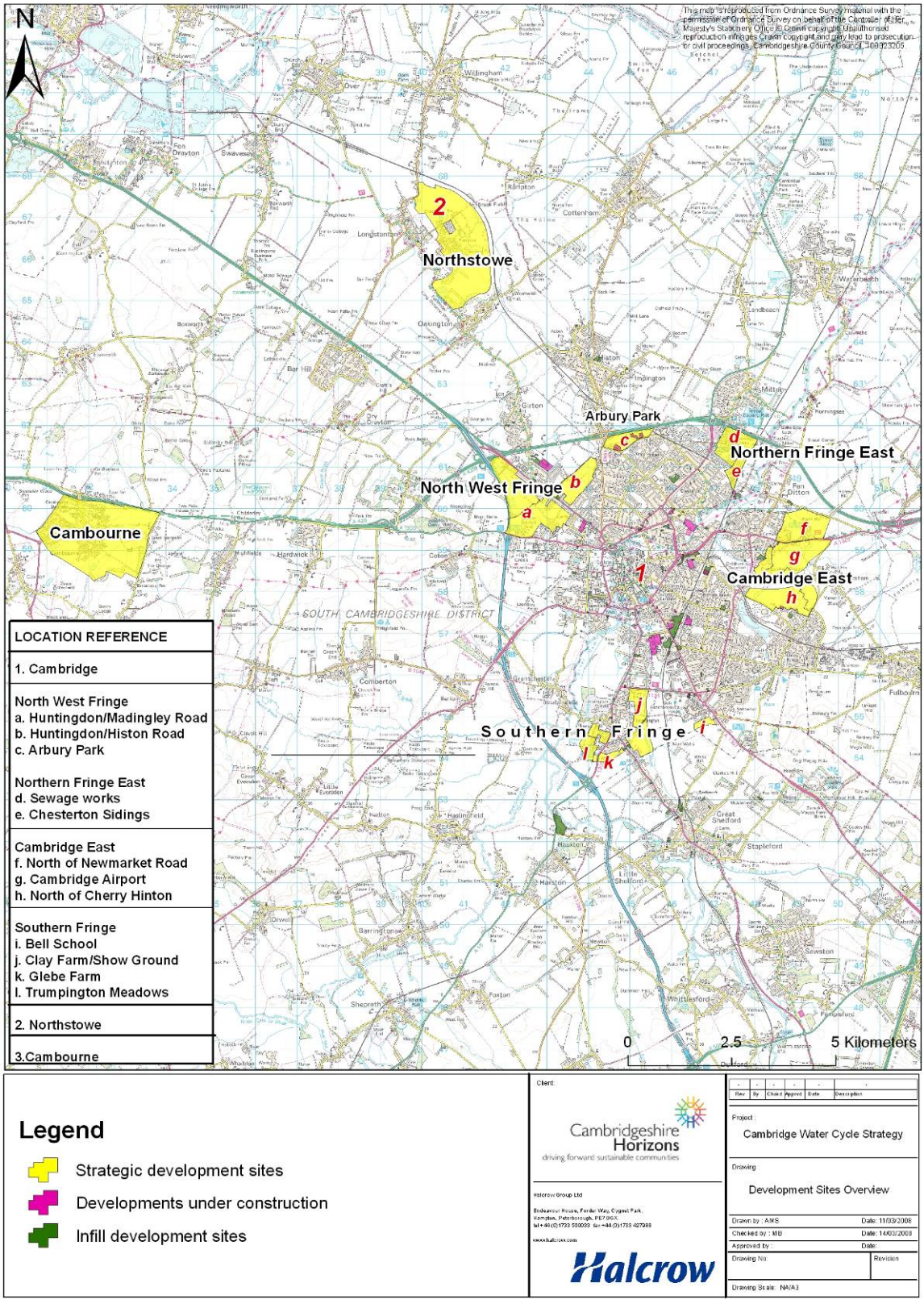


Figure 4-1: Overview of strategic sites

4.3 Overview of Developments

Cambourne

4.3.1 Cambourne (located approximately 14km west of Cambridge City) has been progressing for some time with planning approval being granted, and construction commenced by 1998. The planning permission is for up to 3,300 dwellings, of which 2,000 are already complete and occupied. Development is expected to be completed in 2012. An additional application has been submitted for a further 950 homes. This is yet to be granted planning permission. The original Cambourne site, as well as the proposed additional dwellings, has unresolved issues in relation to foul drainage and wastewater treatment, particularly concerning Uttons Drove Wastewater Treatment Works (WwTW). These issues are common to the Northstowe development, so the additional application has therefore been considered in conjunction with Northstowe for the purposes of assessing wastewater capacity and infrastructure requirements.

Northstowe

4.3.2 Northstowe is located approximately 10km northwest of Cambridge. The outline planning application has been submitted with a committee response intended toward the end of 2008. It is one integrated site with an ultimate capacity of 10,000 dwellings and satisfies the requirement within Policy P1/1 of the Cambridgeshire and Peterborough Structure Plan 2003, to provide a significant portion of the required growth within "a new small town at Longstanton / Oakington close to Cambridge". By 2021 it is estimated through latest planning figures that 8,400 dwellings will be constructed. The wastewater treatment strategy is still being investigated (see Section 7.2).

Southern Fringe

4.3.3 The Southern Fringe development lies on the south western extent of the Cambridge urban area. The majority of this development is contained within Cambridge City Council administrative boundary however a small segment of Trumpington Meadows lays in South Cambridgeshire. It is comprised of a number of different developments ranging from site capacities of 400 (maximum) at Glebe Farm up to 2,300 at Clay Farm. Four distinct developments have been identified including:

- Bell School site (outline planning application submitted – 347 dwellings and 100 student accommodation)
- Clay Farm/showground site (outline planning application submitted - 2,300 dwellings with accompanying services, shopping centres, and recreational facilities)
- Glebe Farm (application yet to be submitted)
- Trumpington Meadows (outline planning application approved Feb 2008 for 1,200 dwellings, primary school with plentiful community facilities, parks, pathways, etc)

4.3.4 The Addenbrooke's research and clinical site is also within the Southern Fringe strategic site and was approved in November, 2007. This has been included within the baseline for the WCS analysis.

North West Cambridge

4.3.5 The North West Cambridge site is divided into three major sites as indicated on Figure 4-1 above (and Table 4.2). The site between Histon Road and Huntingdon is commonly known as the NIAB site and was recently removed from the green belt under the Cambridge Local Plan. It is intended that 1,780 dwellings will be provided at the site which crosses the boundary of Cambridge City and South Cambridgeshire. An outline planning application has been submitted for a mixed use development and associated infrastructure to Cambridge City Council. Concurrent to this application, a detailed planning application has been submitted to South Cambridgeshire District Council for transport, drainage and landscaping infrastructure to support this urban extension.

4.3.6 The site between Huntingdon Road and Madingley Road will also be reclaimed from the green belt and is yet to have a planning application submitted. The area action plan defines the site as an extension area for the university with an estimated 2,250 dwellings to be provided.

4.3.7 Arbury Park has been approved and construction has commenced on a mixed use development including 900 homes. This is located within the South Cambridgeshire district.

Northern Fringe

4.3.8 It is proposed that the Northern Fringe will provide 2,200 dwellings, 1,600 of which are intended for the existing wastewater treatment works, subject to its potential relocation to Honey Hill (see Section 7.2.11).

Cambridge East

4.3.9 The Cambridge East development is formed by three separate development areas, North of Newmarket Road, Cambridge Airport and North of Cherry Hinton. The former area is planned to commence during 2009/10 and the latter in 2010/11. The commencement of the Cambridge Airport site is dependent upon the relocation of Marshalls. It is currently expected that the Airport site will commence in 2016/17. Based on forecasts obtained from local planning authorities for this strategy, the site capacity is forecast to be 6,600 dwellings by 2021 however the Cambridge Local Plan identifies it as having the potential capacity of between 10,000 – 12,000 dwellings. The Area Action Plan has recently been adopted in 2008 and no planning applications have been submitted as yet.

Development Status

4.3.10 The following table shows the planning application status of the proposed developments:

Site	Map Reference*	Planning Status
Southern Fringe		
- Trumpington Meadows	L	Outline approved
- Bell School	I	Outline submitted
- Clay Farm	J	Outline submitted
- Glebe Farm	K	Awaiting application
- Addenbrookes	I	Development Approved
Northstowe		Outline submitted
North West Fringe		
NIAB	B	Outline submitted
Huntingdon/Madingley	A	Awaiting application
Ardbury	C	Development approved
Cambridge East	F/G/H	Awaiting applications
Northern Fringe	D/E	Awaiting applications

* See Figure 4-1

Table 4.2: Strategic site planning application status

5 Flood Risk Management

5.1 Introduction

5.1.1 National planning policy regarding development and flood risk is set out in PPS25. This aims to ensure that flood risk, and the increase in flood risk due to climate change, is taken into account at all stages of the planning process. PPS25 requires local planning authorities to set out planning strategies that help to deliver sustainable development by appraising, managing and reducing the risk of flooding.

5.1.2 Mott MacDonald produced Strategic Flood Risk Assessments (SFRAs) for Cambridge City Council in February 2006, and for South Cambridgeshire District Council in 2005. These show the areas at risk of flooding and can be used for guiding development away from areas of flood risk. However, under PPS25 Local planning authorities are also required to:

- safeguard land from development that is required for current and future flood management e.g. conveyance and storage of flood water and flood defences;
- reduce flood risk to and from new development through location, layout and design, incorporating sustainable drainage systems (SUDS);
- use opportunities offered by new development to reduce the causes and impacts of flooding e.g. surface water management plans; making the most of the benefits of green infrastructure for flood storage, conveyance and SUDS; re-creating the functional floodplain; and set back defences.

5.1.3 This Water Cycle Strategy aims to help the local planning authority meet these aims by:

- Providing an indication of the amount of storage that will be required for new developments so that flood risk is not increased downstream.
- Providing an indication of the allowable run off from new development so that flood risk will not be increased downstream.
- Identifying areas where discharge from storage is likely to increase flood risk downstream and evaluating the cumulative effect of discharge from multiple development sites.
- Identifying opportunities for strategic flood risk mitigation that could reduce flood risk to existing development.
- Identifying areas where development is likely to restrict future options for reducing flood risk downstream.

5.1.4 When undertaking further analysis of the information and recommendations discussed here, close liaison with the Internal Drainage Boards' is recommended in the event of localised catchment specific issues.

5.2 Catchment Description

5.2.1 The largest water course in the study area is the river Cam which flows through Cambridge from the southwest to the northeast. The river Cam rises in Henham in South Cambridgeshire and flows north towards Cambridge. Upstream of Cambridge the Cam has four main river tributaries Wicken Water and the River Granta which joint the Cam at Newport and Great Chesterford respectively and the River Rhee and

Bourn Brook which join the Cam at Trumpington. See Figure 5-1 below for more information.

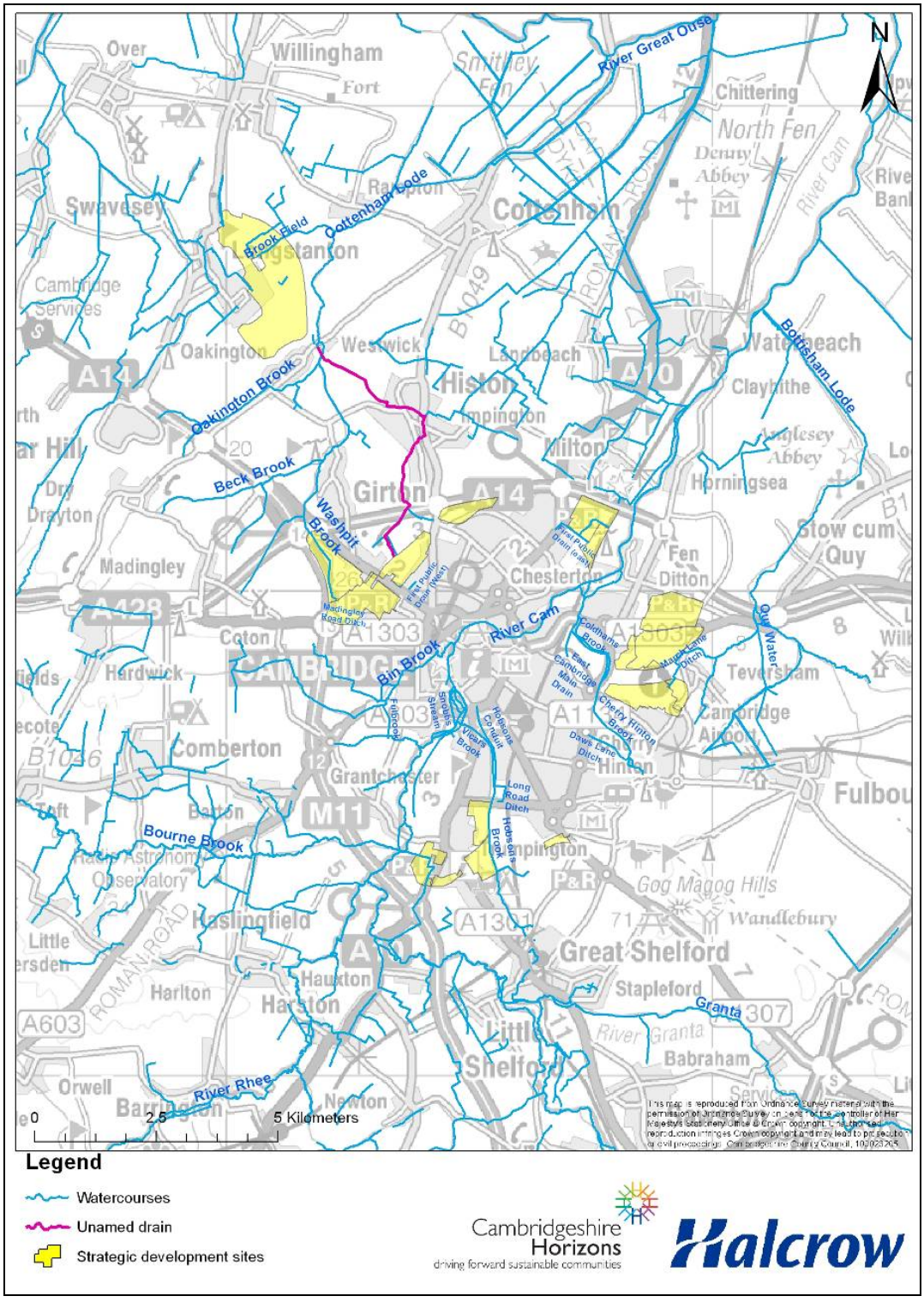


Figure 5-1: Cambridge flooding study area

5.2.2 The majority of the Cam catchment is rural, low-lying and flat Fenland and underlain by permeable geology. This means that the Cam responds very slowly to rainfall events as a relatively large proportion of rainfall is absorbed by the soil and there is a large amount of storage in the flood plain which increases the time taken for a flood to travel downstream. Development in this catchment therefore has the potential to

significantly alter the response to flood events unless mitigation is provided as it reduces infiltration of rainfall into the soil, and hence increases the volume and rate of runoff.

5.2.3 Bin Brook is the main river tributary of the Cam in the existing urban area of Cambridge. It flows east to join the Cam on the west of Cambridge. There are several smaller awarded water courses in the study area including:

- Hobson's Brook which flows north through the Southern Fringe development site and the south west of Cambridge to join the Cam at Newtown, and
- Cherry Hinton and Coldhams Brooks which flow north through the east of Cambridge to join the Cam at Ditton Meadows.

5.2.4 The majority of the existing urban area of Cambridge drains into the Cam.

5.2.5 North of Cambridge the villages of Girton and Oakington are in the Cottenham Lode catchment which flows into original course of the Great Ouse (also know as the Old West River), which joins the Cam at Stretham, 15km downstream of Cambridge. Downstream of Stretham the river changes its name to the Great Ouse. Pumped catchments governed by The Old West, Waterbeach Level and Swaffham Internal Drainage Boards cover much of the area to the north and east of Cambridge. These contain both low level ditches and high level water courses. The Old West Internal Drainage Board discharges into the Great Ouse upstream of Stretham, while the Waterbeach Level and Swaffham Internal Drainage Boards discharge into the Cam upstream of Stretham. Figure 5-2 depicts these boundary areas in relation to the development sites.

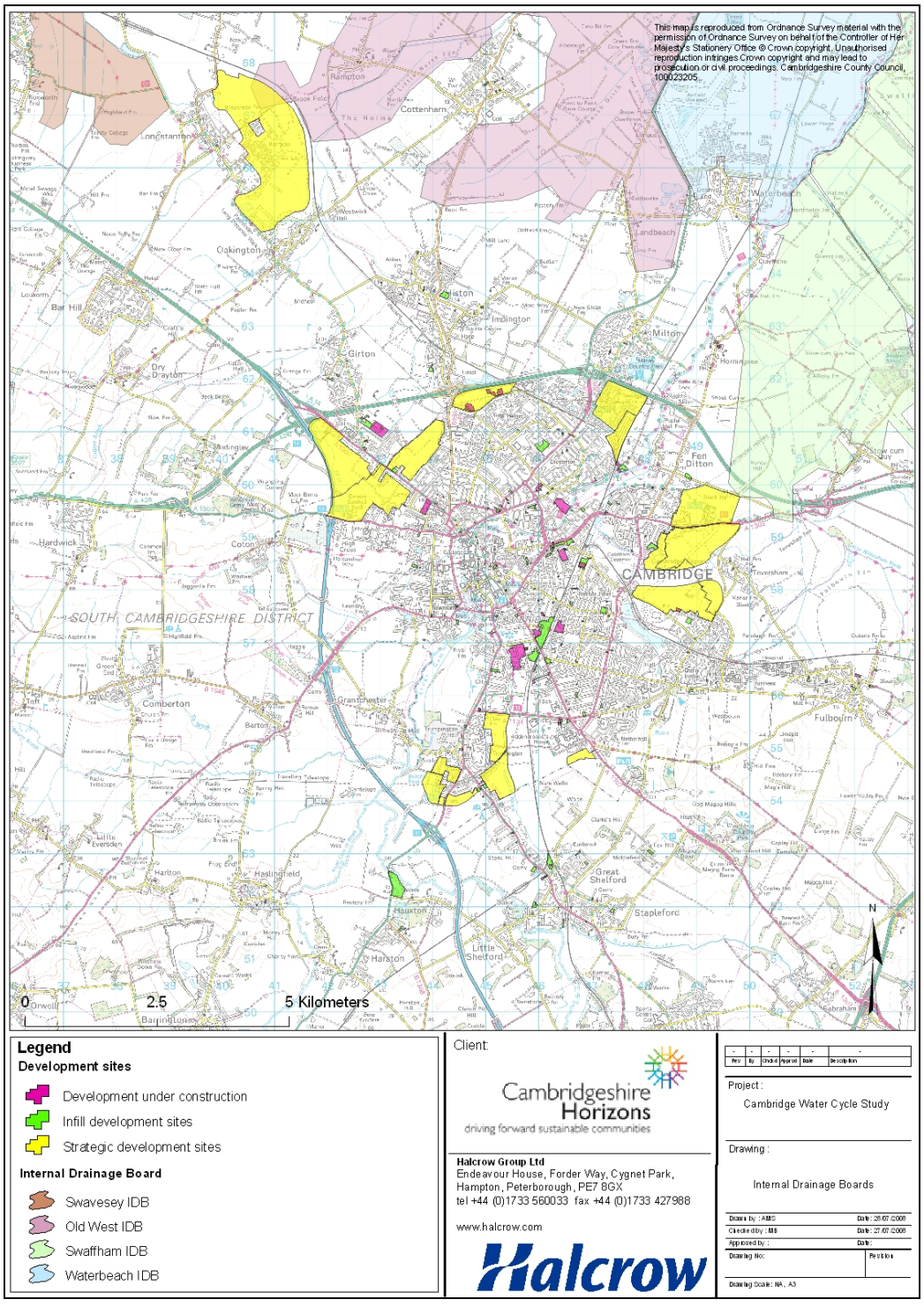


Figure 5-2: Internal Drainage Board Drainage Areas

Existing Studies

5.2.6 Several previous studies have looked at existing flood risk to the study area, and been used to inform this water cycle strategy. These studies include:

- The Cambridge SFRA (Mott MacDonald 2006), looked at flood risk from all sources to the whole study area. The South Cambridgeshire SFRA (Mott MacDonald 2005) focussed on major developments and larger villages only. These included new hydraulic modelling of the Cam, and a review of other flooding information.
- The Cottenham Lode Pre-feasibility study (Halcrow, 2003) modelled flood risk in the Beck Brook/Cottenham Lode catchment and looked at options for reducing flood risk to Oakington and Girton. There is ongoing modelling work on this catchment as part of the flood risk assessment for Northstowe development being undertaken by WSP Group.
- The Bin Brook Flood Alleviation Scheme Pre-feasibility study (Halcrow, 2002) looked at flood risk to the Gough Way estate in Cambridge.
- The Addenbrooke's Access Rd Flood Risk Assessment (Atkins, 2005) modelled Hobson's Brook upstream of Long Rd. Flood risk at the downstream end of Hobson's Brook/Vicar's Brook was considered in the Vicar's Brook Standards of Protection Report.
- The Cam and Granta Model Improvementss and SoP Assesment (Halcrow, 2004) looked at flood risk in the Cam and Granta immediately upstream of the study area.
- The Ely Ouse Lodes Standard of Protection Study (Halcrow, 2007) involved modelling of both the high level and low level system in the Swaffham Internal Drainage Board's Area, including Bottisham Lode.
- There is an ongoing modelling study looking at flood risk in Swavesey drain (WSP, 2008) which will potentially be affected by outfall from the sewage treatment works from the Northstowe development.
- A study to assess the impacts of discharging to Hobson's Brook has been agreed upon by Southern Fringe developers through planning conditions. This will follow on from Atkins work incorporating that section and continuing to the confluence with the River Cam.

5.2.7 The principal conclusions from these studies are discussed in the next sections.

5.3 Existing Flood Risk

5.3.1 Several parts of the study area are at risk of flooding. Development upstream of these areas has the potential to exacerbate the existing risk but there is also the opportunity to incorporate flood risk mitigation as part of the development proposals to reduce flood risk to existing properties. It is therefore important to understand where these areas of flood risk are in relation to the development sites. There are three principle sources of flood risk information for the study area, the Environment Agency Flood Zone Maps, SFRA Flood Risk Maps and liaison with local drainage authorities.

5.3.2 The Environment Agency divides land into four flood zones according to its probability of flooding from rivers or the sea, see Table 5.1. The flood zones produced for the SFRAs are significantly different to the Environment Agency flood zones. These differences are attributable to the following:

- The SFRA flood zones show flood risk with defences, the Environment Agency flood zones are without defences.
- The SFRAs were produced under superseded Planning Policy Guidance 25 (PPG25) when the functional flood plain (Zone 3b) was defined as land which would flood with an annual probability of 1 in 10 (10%) not 1 in 20 years (5%) as in the current guidance (PPS25). There is no Environment Agency Flood Zone 3b map for Cambridge.
- The SFRA flood zones include both flood zone 3a and the predicted increase in flood zone 3a due to climate change. The Environment Agency flood zones do not show climate change.
- Differences in the flood mapping method. Where hydraulic model results exist these have been used for both the Environment Agency Flood Zones and the SFRAs. Where there are no hydraulic models of the river system the Environment Agency use the results of the national JFLOW modelling exercise to define the flood zones, along with evidence from historic flood events where such records exist. JFLOW is a simple model, producing rapid results for large areas using relatively coarse topographic information derived from Synthetic Aperture Radar (SAR). In comparison the SFRAs use flood extents based on engineering judgement and site visits, and these are often significantly smaller than the JFLOW flood outlines.

Flood Zone	**Probability**
1 (Low Probability)	Less than a 1 in 1000 (<0.1%) annual probability of river or sea flooding in any year.
2 (Medium Probability)	Between 1 in 100 and 1 in 1000 annual probability of river flooding (1% – 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% – 0.1%) in any year.
3a (High Probability)	A greater than 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.
3b (Functional Floodplain)	Land which would flood with an annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in an extreme (0.1%) flood

Table 5.1: Flood zone definition

Existing flood risk for proposed development sites

5.3.3 The majority of the proposed development areas fall within Environment Agency's Flood Zone 1 and are therefore considered to be at low risk. The exception is the south west of the Northern Fringe East which is within the Environment Agency Flood Zone 3, generated from the river Cam. This area is not within the SFRA flood zone 3 as these are smaller due to the presence of defences. Please see Figure 5-3 below for flood zones within the study area.

5.3.4 Areas downstream of the development sites where there is known history of flooding, or which fall within the Environment Agency's Flood Zones 2 or 3, include:

- the Beck Brook/Cottenham Lode catchment where 46 houses in Oakington and 9 houses in Girton were flooded in October 2001.
- Approximately 50 properties within the SFRA flood zones on the left bank of the Cam on Elizabeth Way, Mariner's Way, Capstan Close, Acrefield Drive, Logan's Way, Lynefield Lane, Camside, and Water Street.

5.3.5 For an event with a 1 in 100 (1%) probability of being exceeded or occurring in a given year, 55 houses and 2 university halls of residence are also at risk of flooding from Bin Brook, which caused flooding to 38 properties in the vicinity of the Gough Way Estate, and Herschel Rd in October 2001. However none of the proposed development sites are within the Bin Brook catchment.

5.3.6 The SFRA flood zones and maps do not show flooding from sources other than rivers however the SFRA reports the following areas as having a history of flooding or have been identified as being at risk from flooding from surface water sewers. These are:

- Mill Rd which floods from surcharging of the East Cambridge Main Drain.
- Halifax Rd, Richmond Rd and Oxford Rd which flood from the First Public Main Drain.
- Castle Street, Hobson Street, Midsummer Common and Scotland Road.
- Coleridge Ward, which floods from Birdswood Rd ditch.

5.3.7 In addition the SFRA reports that there are problems with combined sewer flooding in the Coldhams Lane Catchment.

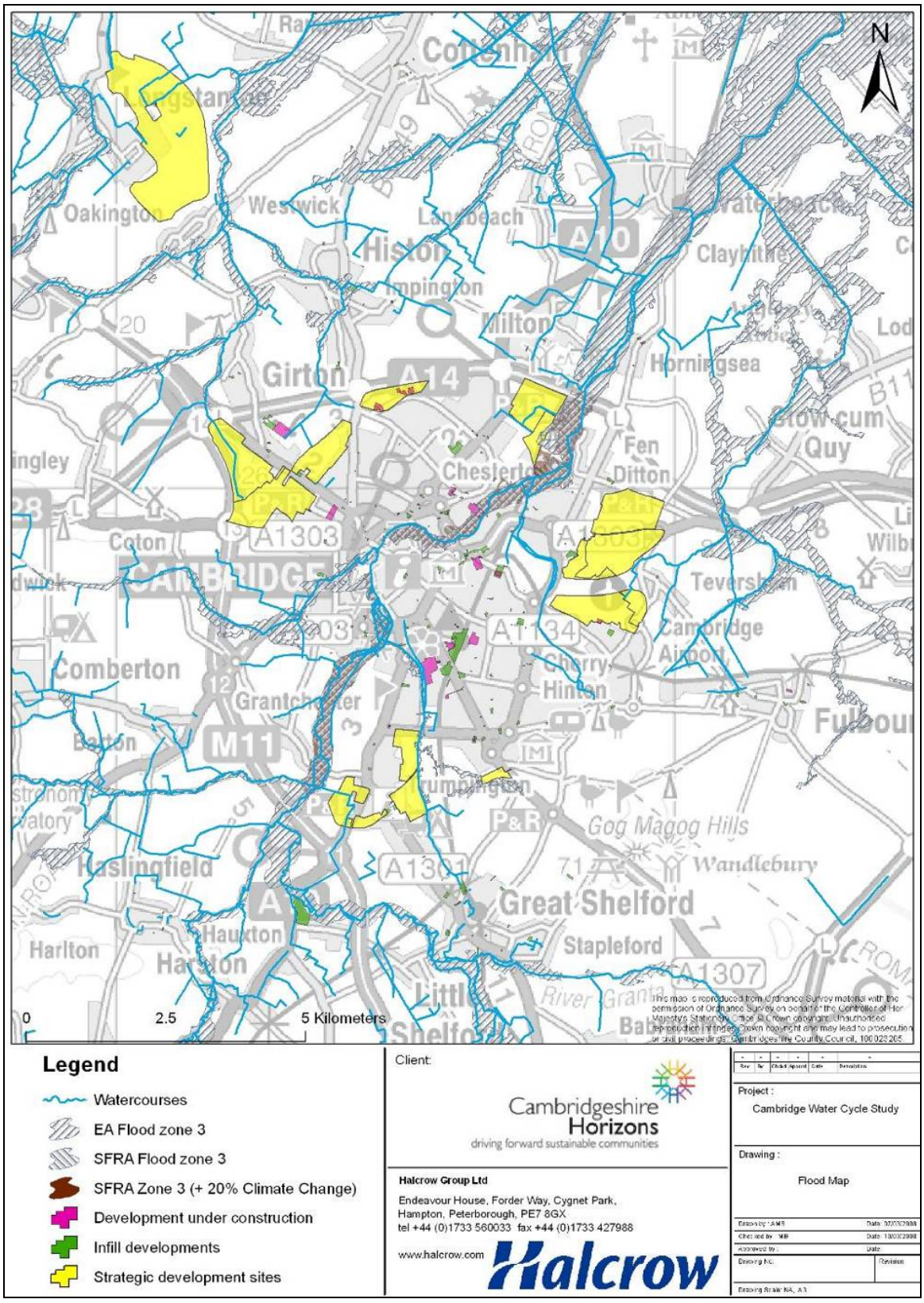


Figure 5-3: Cambridge flood zones

5.4 Evaluation of Development Proposals

5.4.1 The locations of the major development areas in relation to the water courses are shown in Figure 5-1. Please note that Cambourne has not been considered within this Water Cycle Strategy as it has already been planned and is under construction. It is included as baseline flow and is independent of this study in relation to flood risk. The developments can be divided into 4 groups according to the catchments into which they drain:

i. Northstowe and the North Western Fringe sites drain into the Beck Brook/Cottenham Lode catchment,

ii. the Northern Fringe and Arbury Park drain either directly into the Cam or through minor water courses to the Cam,

iii. Cambridge East drains west to the Cam through minor water courses or east into Bottisham Lode or partly draining into the Swaffham IDB low level catchment, and the

iv. Southern Fringe drains either directly into Cam or into Hobson's Brook a minor tributary of the Cam.

5.4.2 Development has the potential to increase flood risk downstream of all these areas as it increases the impermeable area and hence both the rate and volume of run off. There may also be an increase in the volume of water discharged from sewage treatment works. PPS25 requires that there is no increase in flood risk due to development, and development proposals must include measures to ensure that flood risk downstream is not increased. Typically planning requirements are that storage is provided so that the rate and volume of run off from development is equivalent to the greenfield rates. Local Internal Drainage Boards should be consulted in relation to specific drainage issues associated with development sites and their surrounds.

5.4.3 At the outline planning stage developers must ensure that their proposals include adequate space for flood risk management storage areas. More detailed plans will be required at later stages in the planning process to ensure that runoff is appropriately managed within the site to minimise flooding risk to new properties and to ensure safe routing of flood flows to the storage ponds and lakes. The Water Cycle Study considers the earlier phases of the development process and therefore investigates the high level opportunities and constraints posed by flood risk management.

5.4.4 The approximate storage volumes and allowable run off rates for the major development areas in Cambridge have been calculated using the method outlined in the Defra/Environment Agency Flood and Coastal Defence R&D Programme *Preliminary rainfall runoff management for developments R&D Technical Report.* This method shown in Table 5.2 provides initial estimates of the increase in peak flow and volume of runoff from developments less than 200 ha, and these figures have been used to provide a basis for evaluating the flood risk for each of the developments.

5.4.5 These calculations have assumed that 75% of the whole development site will be impermeable, compared to 0% prior to development. It is expected that the actual impermeable area will be lower so these represent conservative estimates of the storage area. In addition adoption of a sustainable drainage strategy can further reduce the impermeable areas for example through adoption of pervious paved areas.

5.4.6 A Flood Estimation Handbook (FEH) calculation was carried out for the Northstowe development which has an area of 314 ha and therefore exceeded the maximum area of 200ha considered using the Defra guide.

5.4.7 For each site the identified required storage volumes are broken down into: attenuation storage, which is provided to reduce the rate of run off to the equivalent predevelopment rate of run off; and long term storage, which is provided to reduce the volume of run off to the predevelopment runoff volume. Developers will be required to provide sufficient storage to meet the combined total on the long term and attenuation storage. Please refer to Figure 4-1 for site locations.

Site	Site Area (ha)	Long term storage (m^3)	Attenuation Storage (m^3)
1i,j,k	78	22000	36000
1l	32	2000	4000
1a	165	19000	56000
1b	53	9000	20000
1c	32	5000	12000
1d,e	73	10000	28000
1f	74	21000	34000
1g	100	28000	46000
1h	82	23000	38000
Northstowe (total)	314	37000	120000
Infill	94	20000	43000

Table 5.2: Approximate long term and attenuation storage volumes required for the major development sites in Cambridge, for a 100 year event with climate change.

5.4.8 Water from long term storage is either released by infiltration or at a low flow rate compared to the rates of flow in the receiving watercourse. Guidance is that the rate of discharge from long term storage is less than 2 l/s/ha. An exception to this is when discharge is into an IDB pump catchment, when discharge is required at less than 1.1 l/s/ha. An assessment has been made of where releasing water from long term storage is likely to have an adverse effect on flood risk in the receiving watercourse based on existing data and this is shown in Table 5.3. It has assumed that sites will drain into the same watercourses post development; the implications of this are discussed in the following sections on specific development sites. The extra flow is considered likely to be significant if it is comparable to an event which has a 1 in 2 (50%) probability of occurring or being exceeded in a year as past experience shows, that this is approximately bank full level for a natural channel.

5.4.9 Water is released from attenuation storage at greenfield equivalent rates. These have been calculated according to the Defra guidance, and are shown in Table 5.4. Where the development site is very permeable, as is the case for East Cambridge and the Southern Fringe, the Defra guidance comments that restrict development to greenfield runoff rates is likely to make development impracticable. Calculations of runoff are made based on Q_{bar}, which is the runoff that would occur in an event with a 1 in 2 (50%) probability of occurring or being exceeded within a given year. Defra guidance for permeable sites is that it should normally be sufficient to use a value of Q_{bar}, of 1 l/s/ha when calculating the permissible post development run off rates. The post development run off that would be allowed using a Q_{bar} of 1 l/s/ha for East Cambridge and the Southern Fringe is shown in Table 5.5, and the effects of allowing this level of run off are discussed in the sections on specific development sites. For a further site specific breakdown of information contained within the following tables, please refer to Appendix D.

Tributary	Contributing site area (ha)	Discharge at 2 l/s/ha from long term storage (m3/s)	Flow in 2 year event in receiving watercourse (m^3/s)
Total into Hobson's Brook	78.0	0.2	0.3
Total into Coldhams and East Cambridge Main Drain	69.5	0.1	0.58
Total into Bottisham Lode	110.0	0.2	0.08
Total into Swaffham IDB	47.8	0.1	2.5 m^3/s pumping station capacity at Upware
Total into Cam downstream of Bottisham Lode	518.8	1.0	18.6
Total for unnamed drain in Histon	53.0	0.1	1.2
Total for Washpit Brook	165.0	0.3	2.4
Total for Reynold's Ditch	109.5	0.2	0.3
Total into Beck Brook d/s Reynold Ditch Confluence	530.8	1.1	8.2

Table 5.3: Total discharge from long term storage into receiving watercourses compared with the flow in a 2 year event in the channel downstream of the development sites. A rate of discharge of 2 l/s/ha from long term storage has been assumed. Discharge from long term storage is assumed to be into the same water courses as predevelopment.

Tributary	Contributing site area (ha)	Greenfield rate 1 year (m^3s^{-1})	Greenfield rate 30 year (m^3s^{-1})	Greenfield rate 100 year (m^3s^{-1})	flow in channel 2 year (m^3s^{-1})	flow in channel 30 year (m^3s^{-1})	flow in channel 100 year (m^3s^{-1})	Return period at which flooding of existing property is expected.
Total into Hobson's Brook	78	0.02	0.05	0.08	0.3		1.0	> 100 years. Channel capacity $2m^3s^{-1}$ from Atkins' modelling.
Total into Coldhams and East Cambridge Main Drain	70	0.002	0.007	0.010	0.6	1.7	3.1	Assumed > 1000 years
Total into Bottisham Lode	110	0.004	0.010	0.015	0.1	3.6	6.5	10 – 25 years
Total into Swaffham IDB	48	0.001	0.002	0.002	2.5 m^3/s capacity of pumping station at Upware			10-25 years. Flooding occurs from overtopping of Bottisham Lode.
Total into Cam downstream Hobson's Brook Confluence	110	0.03	0.07	0.1				
Total into Cam downstream of Bottisham Lode	519	0.4	1.0	1.5	18.6	56.0	70.8	Unknown
Total for unnamed drain in Histon	53	0.1	0.3	0.4	1.2	2.8	4.2	Unknown
Total for Washpit Brook	165	0.6	1.7	2.5	2.4	4.8	7.0	1 in 10 years in parts of Girton
Total for Reynold's Ditch	110	0.4	1.0	1.5	0.3	0.8	1.2	Unknown
Total in Beck Brook d/s Reynold Ditch Confluence	531	1.7	4.8	7.2	8.2	13.8	16.2	Unknown

Table 5.4: Greenfield run of rates, and flows in the receiving water courses for the major development areas in Cambridge. All figures are indicative only.

Tributary	Runoff rate 1 year (m^3s^{-1})	Runoff rate 30 year (m^3s^{-1})	Runoff rate 100 year (m^3s^{-1})	Q_{bar} or Q_{med} (m^3s^{-1})
Total into Hobson's Brook	0.07	0.18	0.28	0.3
Total into Coldhams and East Cambridge Main Drain	0.06	0.16	0.25	0.58
Total into Bottisham Lode	0.09	0.26	0.39	0.084
Total into Swaffham IDB	0.01	0.02	0.04	2.5 m3/s capacity of pumpingstation at Upware

Table 5.5: Permissible runoff rates using a value of Q_{bar} of 1 l/s/ha as per the Defra guidance for permeable sites. All figures are indicative only.

5.5 North-West Cambridge and Northstowe

Drainage description

5.5.1 The North West Fringe and the south of Northstowe drain into the Cottenham Lode/Beck Brook catchment. Beck Brook flows north east through Girton before turning northwest and combining with Oakington Brook downstream of Oakington. The majority of the proposed site between Huntington Rd and Madingley Rd, drains into Washpit Brook, which has a confluence with Beck Brook immediately upstream of Girton. The majority of the site located between Huntington Rd and Histon Rd, drains north east through the land drainage system for the National Institute of Agricultural Botany. Analysis of OS maps shows that these drains connect with a Public Drain which flows north through Histon and Impington before connecting with Beck Brook downstream of Oakington. The Northstowe development site currently drains in 2 different directions. The south of the development drains eastwards into Beck Brook and Oakington Brook, while the north of the development site drains into Reynolds' Ditch which flows into Cottenham Lode under low flow conditions, and Burgess Drain when levels in Cottenham Lode prevent gravity discharge. These eventually discharge into the Great Ouse through Cottenham Lode, but under flood conditions discharges into the Old West Internal Drainage Board's Pumped Catchment.

5.5.2 Flood risk to Girton and Oakington was modelled as part of the Cottenham Lode Pre-Feasibility Study which estimated the standard of protection in parts of Oakington and Girton to be a low as 1 in 10 years, falling to 1 in 5 years with climate change. Flood peaks at the confluences of Beck Brook and Washpit Brook, and Beck Brook and Oakington Brook tend to coincide leading to an increase in flood risk at Girton and Oakington. Earlier Northstowe studies also looked at the potential of by-pass channels on both the Beck Brook and Longstanton Brook. These were never pursued as they were not deliverable by the developer, but could be implemented by the relevant drainage authority. Histon and Impington lie partially within the Environment Agency Flood Zone 3, but as there is no hydraulic model of the watercourse through Histon and Impington there is greater uncertainty in the accuracy of the Flood Zones extents. As part of the South Cambridgeshire Strategic Flood Risk Assessment Mott-MacDonald assessed the channel through Histon and used engineering judgment to determine the likely size of flood zones 2 and 3, concluding it is significantly smaller than the Environment Agency flood zones. This assessment was higher level for the purpose of land allocation. Site specific Flood Risk Assessments (FRAs) should be undertaken for each site to fully understand flooding issues.

Attenuation storage and opportunities for strategic flood risk mitigation

5.5.3 There is an existing flood risk in the Cottenham Lode catchment and other villages downstream. In order to prevent this flood risk increasing as a result of development it will be necessary to provide long term and attenuation storage for the development sites as per the approximate volumes given in Table 5.2. The Cottenham Lode Pre-Feasibility study found no economically viable flood risk mitigation option for the existing properties in the catchment. Current proposals for Northstowe include a flood risk mitigation area on Oakington Brook upstream of Oakington which would mitigate the extra run off from the Northstowe access road, and a planning condition has been imposed to oversize these ponds to reduce flood risk to Oakington. This is in line with Policy NS/21 of the Northstowe Area Action Plan regarding surface water drainage. The planning condition did not specify by how much flood risk should be reduced. A water park is also to be constructed to store additional runoff from the main Northstowe development, with discharges to Cottenham Lode only occurring when levels in the Lode are sufficiently low. Halcrow is currently

undertaking a hydraulic modelling study for the Environment Agency to assess the improved standard of protection that this would provide to Oakington. As Northstowe and the North West Fringe development sites are all located in the same catchment however, where there is an existing flood risk, there is a need to look at the cumulative effect of the individual developments. The development of Cambridge North West Fringe provides an additional opportunity to enhance levels of service in the Cottenham Lode catchment.

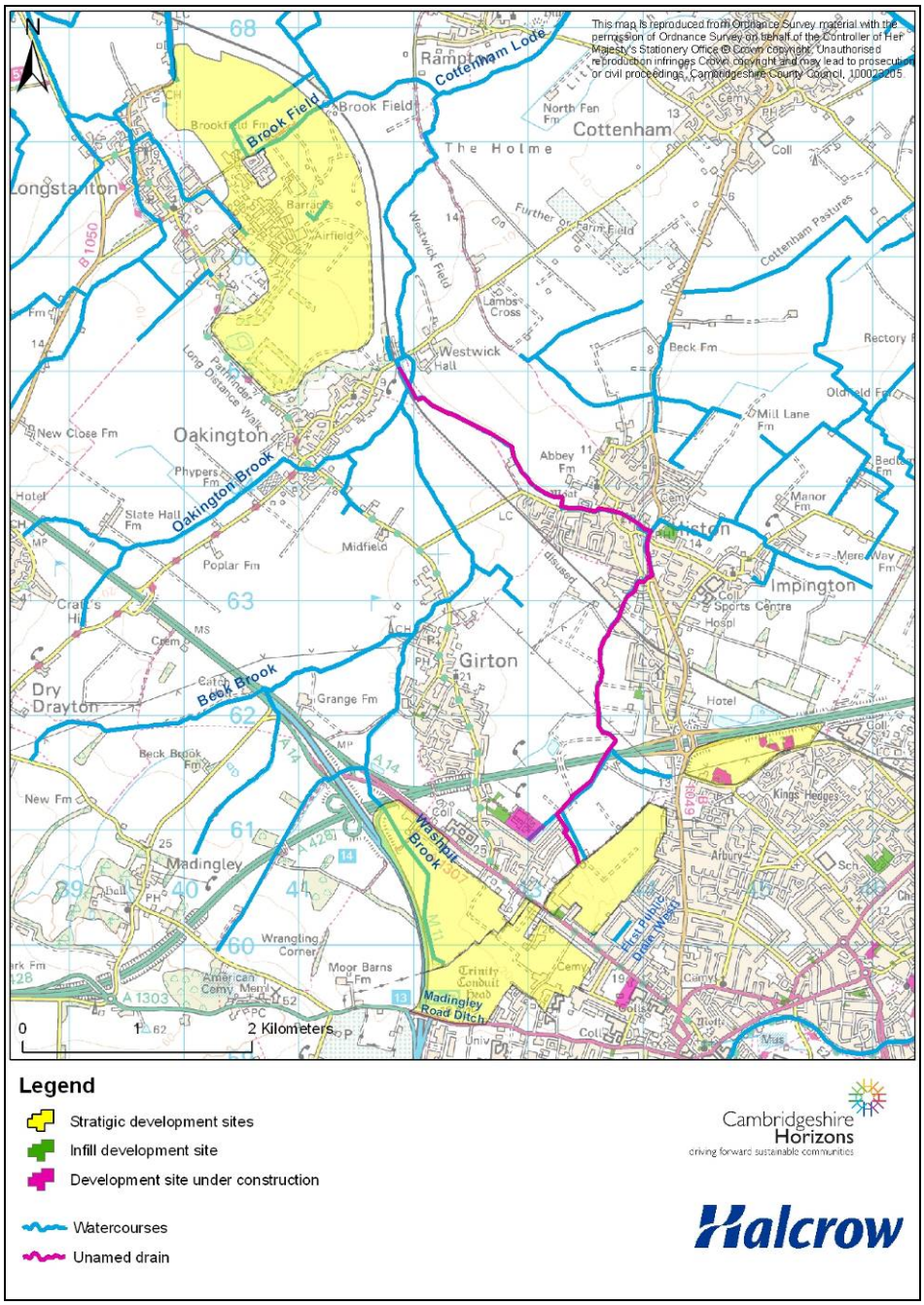


Figure 5-4: Northstowe and North West Fringe sites

Recommendations

5.5.4 The North West Fringe and Northstowe drain into the Cottenham lode catchment where there is a known flood risk to Oakington and Girton, and a potential flood risk to Histon and Impington. To ensure that flood risk in the Cottenham lode catchment

is not increased it is necessary for a single study to look at the combined effect of all developments in the Cottenham lode catchment. The development of Northstowe and the North West Fringe provides an opportunity for planning gain by enhancing the current standard of protection for areas where there is a known flood risk. It is therefore recommended that conditions are attached to the development of these sites such that the developers pay for an independent hydraulic modelling study to:

- Consider the cumulative impacts of their developments downstream.
- Assess the current standard of protection for Histon and Impington, by extending the hydraulic model to cover the tributary of Beck Brook through Histon and Impington. This would be the responsibility of Northern Fringe developers.
- Demonstrate that the flood risk in the Cottenham Lode catchment will not increase as a result of the combined cumulative effect of developments in the catchment, assuming climate change effects.
- Assess the opportunity for strategic flood risk mitigation options for the Cottenham Lode catchment.
- Assess the opportunity for enhancing the level of service to areas where there is a known flood risk.

5.5.5 The developers adopt the recommendations of the study including contributing towards any measures that may enhance the level of service to areas where there is a known flood risk.

5.6 Cambridge East

Drainage description

5.6.1 The three development sites in Cambridge East drain in four different directions. To the east of the park and ride site, the development site north of Newmarket Rd, and the eastern part of the Cambridge Airport site drains into the low level catchment of Swaffham IDB. This flow is ultimately pumped into the Cam at Upware. The eastern parts of sites 1g and 1h drain into Quy Water then Bottisham Lode, part of the high level carrier system across the Fenland. Bottisham Lode discharges into the Cam, either by pumping or by gravity depending on levels in the Cam. The western parts of the Cambridge Airport site and the site north of Cherry Hinton drain into Coldhams Brook and the East Cambridge Main Drain, which flow into the Cam.

5.6.2 South of the development area the SFRA reports that there are flooding problems from combined sewers in the Coldhams Lane catchment to the south of the East Cambridge development area. None of the development site is presumed to drain in this direction.

Attenuation storage and opportunities for strategic flood risk mitigation

5.6.3 The catchment descriptors contained on the FEH CD-ROM suggest that East Cambridge is highly permeable, with less than 5% surface run off, however some variability may exist with clay pockets evident in this area. In this situation the DEFRA guidance acknowledges that restricting post development runoff to greenfield rates would make development impractical due to the storage volumes required, and that it is generally sufficient to use a Q_{bar} of 1 l/s/ha for calculating the required attenuation storage, and allowable post development run off rates. Using these figures to calculate the allowed run off gives a run off from the site into Bottisham Lode comparable to the total flow in Bottisham Lode at Quy downstream of the development. This is likely to increase flood risk from Bottisham Lode and increase the pumping capacity needed at the outfall. Calculations of the permissible rate of runoff from East Cambridge cannot be made using a value of Q_{bar} of 1 l/s/ha as recommended in the Defra guidance, and further investigations will be needed to establish the permissible rate of run off from the development site.

5.6.4 There has been no modelling carried out of the Coldhams Brook and East Cambridge Main Drain Catchments, so there is limited information on which to base an assessment of the likely increase in flood risk due to development. The Environment Agency flood zones do not show any properties at risk in these catchments and the flooding from the East Cambridge Main drain reported in the SFRA is upstream of the development site.

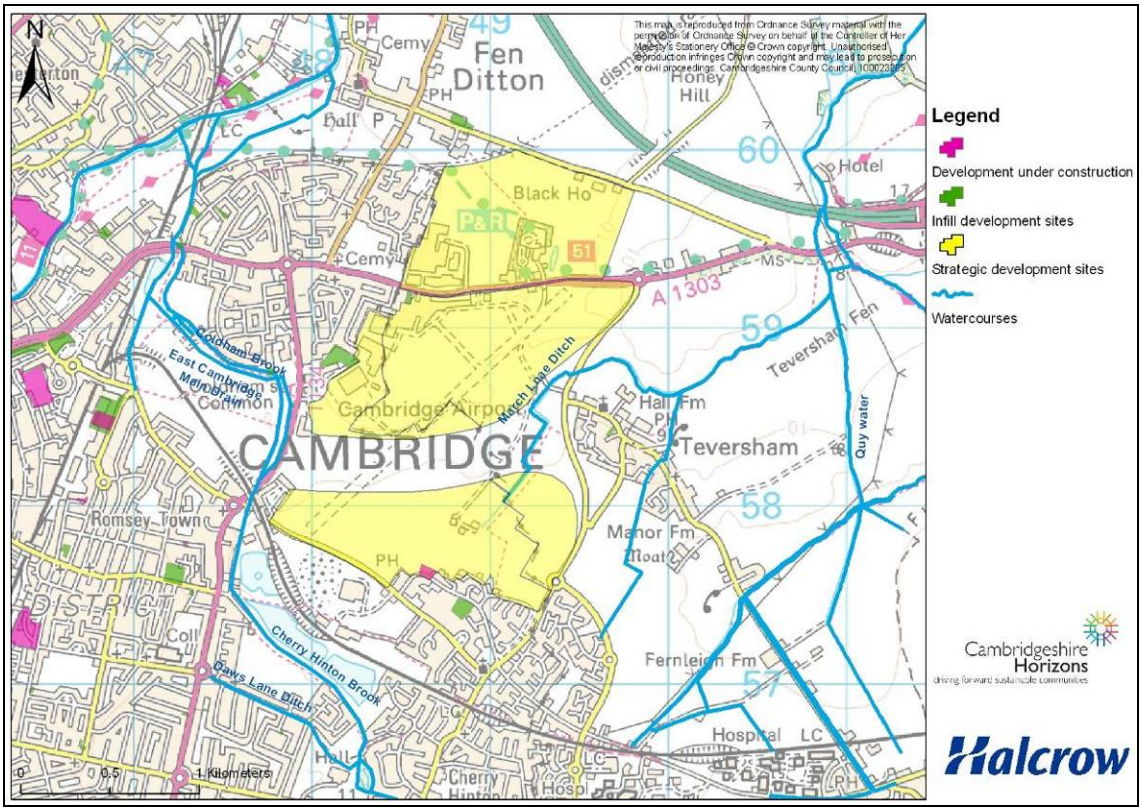


Figure 5-5: Cambridge East site

Release of water long term storage

5.6.5 Assuming that water is released from long term storage at 2 l/s/ha as per the Defra guidance the flow released into Bottisham Lode from long term storage would be equivalent to the total flow in Bottisham Lode in a 2 year event (See Table 5.3). Given that the standard of protection in Bottisham Lode is between 10 and 25 years discharging the long term storage from the development at this rate is unlikely to significantly increase flood risk from Bottisham Lode, but it would cause a significant change to the flow regime in Bottisham Lode and may increase the pumping duration at the outfall.

5.6.6 Coldhams Brook and the East Cambridge Main Drain are parallel channels across Colhdam's Common. The Cambridge SFRA reports that Coldhams Brook has erratic flow which leads to ecological problems in Coldhams Brook. No information on flows and levels for Coldhams Brook is available but releasing some of the water from long term storage into Coldhams Brook should be considered as part of the drainage strategy for East Cambridge.

5.6.7 Options for reducing flooding in the Coldhams Lane foul drainage catchment should be considered as part of the foul drainage proposals for East Cambridge.

Recommendations

5.6.8 Due to the highly permeable nature of the development area and the size of the downstream water courses the necessary storage areas for the East Cambridge sites are likely to be very large. Using the Defra guidance for permeable sites gives a permissible runoff from development which is very high compared to the total flow in Bottisham Lode, one of the downstream water courses. There have been no studies of the other downstream watercourses and it is therefore unclear what runoff would be permissible for these sites. The planning authority should make the following requirements for East Cambridge:

- The developers of the Cambridge East sites should conduct site investigations to determine the infiltration rate and greenfield runoff rates from these sites, and these rates should be agreed with the Environment Agency and the Swaffham IDB.
- The Environment Agency has recently completed the Lodes Study that outlines the future maintenance for the Lodes.
- The developers should produce site specific flood risk assessment to show there will be no increase in flood risk from development to Bottisham Lode, Coldhams Brook, the East Cambridge Main Drain, and the Swaffham Internal Drainage District.
- The developers of Cambridge East (Cambridge Airport and North of Cherry Hinton) should investigate the opportunity for ecological enhancement by increasing flows in Coldhams Brook using water released from storage.
- Swaffham IDB should be involved as a consultee in the planning process.
- The developers should fund the study to show that there will be no increase in flood risk from all development sites draining into the Cam catchment.

5.7 Northern Fringe East and Arbury Park

Drainage description

5.7.1 The Northern Fringe East drains into the First Public Main Drain and then into the Cam at Fen Road in Milton. Parts of the site are in the Environment Agency Flood Zones 2 and 3 and therefore would be unsuitable locations for SUDS (sustainable drainage systems).

5.7.2 There are no LiDAR[3] topographic data available for Arbury Park, but analysis of Ordnance Survey maps suggests that the site drains to the south east through the First Public Drain (East) into the Cam.

Attenuation storage and opportunities for strategic flood risk mitigation

5.7.3 These sites are both downstream of the areas of existing flood risk in the First Public Drain, and the Cam. There are no opportunities for strategic flood risk mitigation from these sites.

Release of Water from Long Term Storage

5.7.4 Releasing water from long term storage at a rate of 2 l/s/ha is unlikely to have any effect on flooding in the Cam. There is no information on the capacity or standard of protection of the East Cambridge Main Drain.

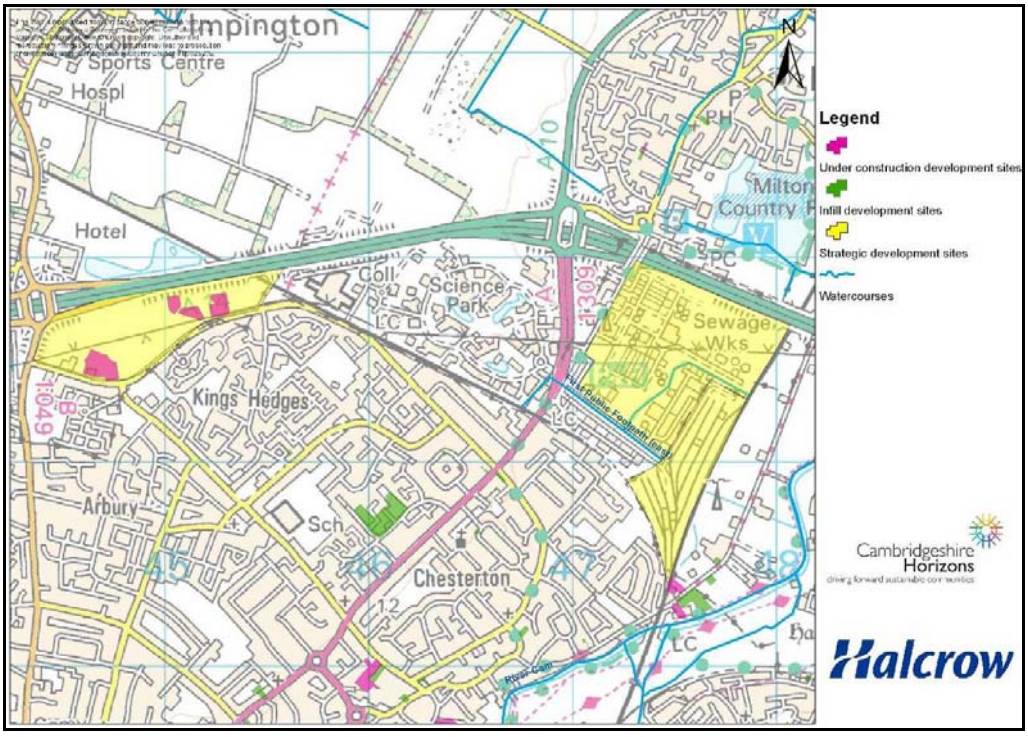


Figure 5-6: Arbury Park and Northern Fringe East

[3] Light Detection and Ranging – an airborne mapping technique which uses a laser to measure the distance between the aircraft and the ground.

Recommendations

5.7.5 The developers should contribute to a study to show that there will be no increase in flood risk from all development sites draining into the Cam catchment.

5.7.6 The developers of the Sewage Works sites should produce a site specific flood risk assessment to demonstrate that there will be no increase in flood risk to the East Cambridge Main drain as a result of their proposed development.

5.7.7 As part of the Northern Fringe East development sites are in flood zone 2 and 3 the developer of these sites should undertake a flood risk assessment to establish the extent of the flood zones 2, 3a and 3b for these sites, and the future extent of these flood zones including climate change. Land use within these sites should be allocated according to the appropriate uses for the flood zones according to in PPS25.

5.8 Southern Fringe

Drainage description

5.8.1 Trumpington Meadows drains westwards into the Cam. Clay Farm drains eastwards into Hobson's Brook, and Bell School drains westwards into Hobson's Brook. Glebe Farm is largely flat. The Clay Farm/Glebe Farm Surface Water Drainage Strategy for this site assumes that drainage from Glebe Farm is by infiltration only, with frequent water logging of the fields in winter. The latest proposals for Glebe Farm are for discharge to Hobson's Brook with additional attenuation provided. The additional, out of catchment, area will not be included in the calculation of allowable discharge, hence the run-off rate will be unaffected but there will be an increase in the volume of runoff. There is a small part of the development site in the Environment Agency flood zones upstream of Long Rd. Hobson's Brook was modelled by Atkins between Ninewells and Long Rd. The Atkins modelling estimated flows in Hobson's Brook of $1m^3/s$ at Long Rd Bridge for an event with a 1% annual exceedance probability, and found that for Hobson's Brook upstream of Long Rd that the channel capacity was around $2m^3/s$.

5.8.2 At Porson's Rd downstream of the development site Hobson's Brook bifurcates into Hobson's Conduit and Vicar's Brook. Areas in Trumpington Rd and Chaucer Rd are within the Environment Agency flood zones from Vicar's Brook, however this is attributable to water backing up from the Cam, not from Vicar's

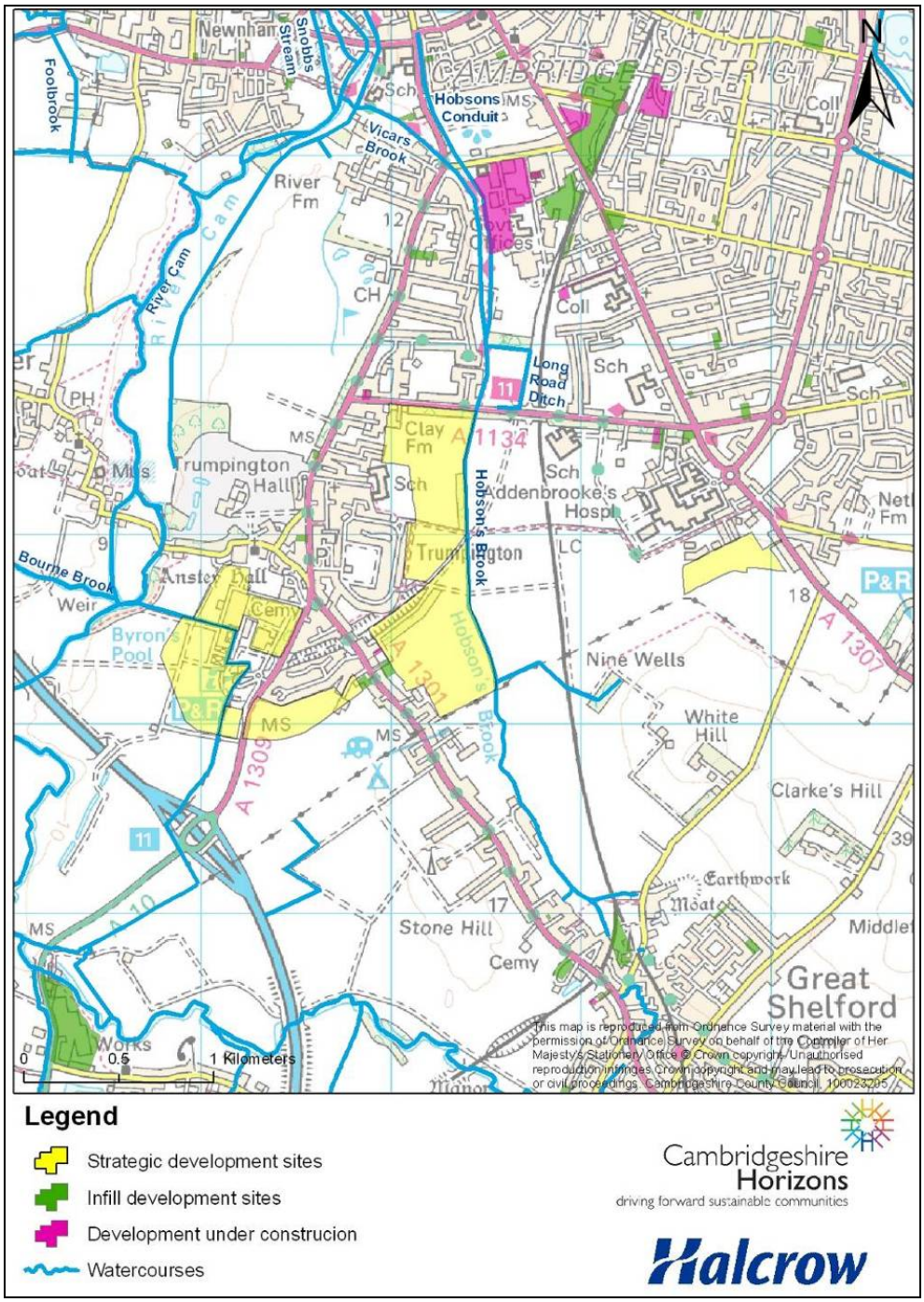


Figure 5-7: Southern Fringe sites

Attenuation storage and opportunities for strategic flood risk mitigation

5.8.3 Cambridge City Council has concerns regarding Hobson's/Vicar's Brook, in relation to its capacity and cumulative impacts of runoff peaks from the upper catchment. There are therefore no opportunities for strategic flood risk mitigation. Concerns over controlled discharge of flood storage volumes have instigated a combined developer modelling study of the watercourse.

Release of water from long term storage

5.8.4 The proposals for development sites Bell School, Clay Farm and Glebe Farm include strategic storage on Hobson's Brook. Hobson's Brook suffers from erratic and low flows, and it is possible that water released from long term storage could be used to enhance the flows in Hobson's Brook.

Recommendations

5.8.5 The results of the modelling work being undertaken on Hobson's Brook by developers should be considered and integrated into site planning.

5.8.6 The developers of Bell School, Clay Farm and Glebe Farm should produce a site specific flood risk assessment to show that there will be no increase in flood risk to Hobson's Brook.

5.9 All Sites Draining into the Cam

Drainage description

5.9.1 With the exception of the North West Fringe and Northstowe, all development sites eventually drain into the Cam, where there are around 50 properties at risk of flooding in both the SFRA and Environment Agency Flood Zones. In addition to the larger development sites there are 94 ha of infill development sites within the city existing urban area. The cumulative run off from these developments is likely to be of an equivalent magnitude to the run off from the Southern Fringe development sites. More detailed information is available in Appendix D.

Attenuation storage and opportunities for strategic flood risk mitigation

5.9.2 The total runoff from infill development sites is a small percentage of the flow in the Cam at the upstream boundary of the study area, and as the Cam responds very slowly to rainfall events runoff from the infill developments is likely to have passed down the river before the peak in flood flow from the Cam arrives. Runoff from infill development is therefore unlikely to increase flood risk from the Cam.

5.9.3 The total flow into the Cam from all development sites is still as small percentage of the total flow in the river. It is therefore not expected that flood risk on the Cam will increase if suitable attenuation storage is provided for these sites.

Release of water from long term storage

5.9.4 Table 5.3 shows that release of water from long term storage is unlikely to significantly increase flood risk from the Cam, as flows are low compared to Q_{bar} in the Cam. However, as the Cam responds slowly to rainfall events it is important that the water held in long term storage is not released into the Cam until after the peak flow on the Cam is passed. As part of the drainage strategy for the Southern Fringe sites Bell School, Clay Farm and Glebe Farm Mott MacDonald re-ran their Cam model with the additional inflow from these developments and found that there would be no increase in flood risk downstream. However, as there are several other development sites draining into the Cam this should be repeated for the cumulative impact of all development sites.

Recommendations

5.9.5 The developers of all sites draining into the Cam (smaller infill sites and all strategic sites except the North West Fringe and Northstowe) contribute to a modelling study to demonstrate that there will be no increase in flood risk from the Cam as a combined effect of the developments.

6 Groundwater, surface water management and Sustainable Drainage Systems

6.1 Use of SUDS

6.1.1 The application of suitable SUDS to minimise environmental impacts of development plays a significant role in sustainable development. The ideal SUDS option for a development site will vary in each situation, depending upon:

- The goals of the local planning authority and the developer
- The geological and topographical characteristics of the site
- The requirements of the Environment Agency

6.1.2 SUDS solutions may be selected and implemented to achieve many environmental objectives including:

- Pollution control arising from surface water runoff
- Reducing pollutant infiltration into groundwater
- Maintaining recharge to groundwater
- Reduce construction
- Providing natural amenity and green spaces within development
- Maintaining or restoring natural flow regimes of a receiving watercourse

Flood Risk Mitigation

6.1.3 One of the primary applications of SUDS with respect to PPS25 is mitigation against flood risk. This may be achieved through attenuation or filtration ponds, wetlands, or through a number of smaller scale infiltration and site specific SUDS such as porous pavements, green roofs, or rainwater harvesting.

6.1.4 The Code for Sustainable Homes requires that peak run-off rates and annual volumes of run-off are no greater than the previous conditions for the development site. As Cambridge's strategic growth sites are on previously undeveloped land, careful planning of flood risk mitigation will be required within the planning process.

6.1.5 It is the developer's responsibility to undertake the analysis required to provide the evidence base to prove that flood risk will not be exacerbated as a result of their development. This should be included within the planning application. Appendix E provides a process for an LPA to assess the requirements of a developer submission in relation to flood risk.

Groundwater Recharge

6.1.6 Where possible, minimising the impacts on natural environmental processes should be the objective of sustainable development. In the natural environment, rainfall will infiltrate the soil and recharge the underlying groundwater. This process should be imitated where practicable within development as required by within the Building Regulations, Part H.

6.1.7 There may be constraints to implementing infiltration SUDS such as limited soil permeability, or the situation of a development site within a protected groundwater zone (See Figure 6-1), however none of the Cambridge strategic development sites are located within a protected zone. Localised assessment surveys of each site are required to assess the suitability of infiltration SUDS. These surveys should be requested within the planning application submissions along with the SUDS strategy. Halcrow's 'Developer Checklist' in Appendix C provides an indication of what information should be requested.

Pollution Control

6.1.8 Use of SUDS for pollutant control is another possible application. None of the strategic development sites lie in a groundwater source protection zone as defined by the Environment Agency (EA). The EA will generally advise if pollution control SUDS is required for a development site. Table 6.1 adapted from (CIRIA, C697) provides an indication of the pollutant removal potential of various SUDS.

SUDS group	Technique	Water quality treatment potential					Hydraulic control			
		Total suspended solids removal	Heavy metals removal	Nutrient (phosphorous, nitrogen) removal	Bacteria removal (*)	Capacity to treat fine suspended sediments and dissolved pollutants	Runoff volume reduction	Suitability for flow rate control (probability)		
								0.5 (1/2 yr)	0.1 – 0.3 (10/30 yr)	0.01 (100 yr)
Retention	Retention pond	H	M	M	M	H	L	H	H	H
	Subsurface storage	L	L	L	L	L	L	H	H	H
Wetland	Shallow wetland	H	M	H	M	H	L	H	M	L
	Extended detention wetland	H	M	H	M	H	L	H	M	L
	Pond / wetland	H	M	H	M	H	L	H	M	L
	Pocket wetland	H	M	H	M	H	L	H	M	L
	Submerged gravel wetland	H	M	H	M	H	L	H	M	L
	Wetland channel	H	M	H	M	H	L	H	M	L
Infiltration	Infiltration trench	H	H	H	M	H	H	H	H	L
	Infiltration basin	H	H	H	M	H	H	H	H	H
	Soakaway	H	H	H	M	H	H	H	H	L
Filtration	Surface sand filter	H	H	H	M	H	L	H	M	L
	Sub-surface sand filter	H	H	H	M	H	L	H	M	L
	Perimeter sand filter	H	H	H	M	H	L	H	M	L
	Bioretention/filter strips	H	H	H	M	H	L	H	M	L
	Filter trench	H	H	H	M	H	L	H	H	L
Detention	Detention basin	M	M	L	L	L	L	H	H	H
Open channels	Conveyance swale	H	M	M	M	H	M	H	H	H
	Enhanced dry swale	H	H	H	M	H	M	H	H	H
	Enhanced wet swale	H	H	M	H	H	L	H	H	H
Source control	Green roof	n/a	n/a	n/a	n/a	H	H	H	H	L
	Rain water harvesting	M	L	L	L	n/a	M	M	H	L
	Permeable pavement	H	H	H	H	H	H	H	H	L

* limited data available

n/a: non applicable

H = high potential
M = medium potential
L = low potential

Table 6.1: Pollutant Removal Potential of SUDS

Amenity and Green Spaces

6.1.9 Local policies within the Cambridgeshire area create a strong emphasis on public amenity and maintaining green space in line with the Green Infrastructure Strategy. SUDS measures should be planned carefully at the master planning stage of development to achieve these goals.

6.1.10 SUDS measures provide an effective ecological opportunity to enhance existing habitats, or to compensate for encroachment on natural habitat elsewhere within the development site.

Policy 4/2: Protection of Open Space (Cambridge Local Plan, 2006)

Development will not be permitted which would be harmful to the character of, or lead to the loss of, open space of environmental and/or recreational importance unless the open space uses can be satisfactorily replaced elsewhere and the site is not important for environmental reasons.

Integrated urban drainage

6.1.11 SUDS should be considered in the wider context of effective surface water management delivered through integrated urban drainage management techniques. Components of the whole drainage system include roads, sewers, detention storage and SUDS together with water courses. Each element plays a role in conveying and managing surface water so that it limits flood risk locally and at downstream locations. The planning and management of this whole is system is integrated urban drainage management (IUDM), a concept currently being developed and defined through Defra's Integrated Urban Drainage Pilot studies. It's proposed that in areas of high need a surface water management plan (SWMP) is developed under the leadership of the local authority to ensure that the actions of all other stakeholders (developers, water companies and the Environment Agency) are aligned. One driver for SWMP is new development and therefore closely linked to surface water management aspects of water cycle studies.

6.1.12 The provision of a strategically planned and properly maintained series of SUDS is central to good IUDM. This report provides guidance on how this can be provided for new development in Cambridge. The report also discusses upgrades to exsiting pubic sewers that are being driven by growth but also current levels of service which are below agreed levels. Another aspect is the proper consideration of exceedance flows within developments which occur once the design capacity of normal sewers or drainage (1 in 30 year) is exceeded. For new development in and around Cambridge the developer should demonstrate that exceedance flow routes have been identified and integrated within their plans so that property is protected from surface water flooding for up to 100 year return period events. This often necessitates planning the provision of green space to store excess flows, the design of highways to retain flows and/or the raising of building thresholds to reduce flood consequences in flow pathways. Proprietary software tools now allow flood pathways to be identified with relative ease. Full technical guidance on how to manage exceedance flows is specified in CIRA Report C635 'Designing for exceedance in urban drainage – good practice'.

6.2 Geological Environment

Groundwater

6.2.1 The major development sites on the south and east of Cambridge are located above a major chalk aquifer. Development in this area may mean a loss of recharge area and volumes of water entering the aquifer. However in sites where sustainable drainage

with infiltration is utilised, which is the presumption of the Building Regulations Part H, the flows to ground will be comparable to the existing condition.

6.2.2 As shown in Figure 6-1, none of the proposed development sites are in groundwater source protection zones. Careful consideration of any proposed infiltration arrangements plus any upstream treatment does need to be made to ensure that the requirements of the Groundwater Regulations 1998 to protect groundwater from pollution are complied with. The groundwater table in Cambridge is relatively close to the surface.

Geology

6.2.3 The superficial geology of the Cambridge study area is variable with large sporadic deposits of riverine gravel and alluvium which has a high permeability. The underlying bedrock is also variable with clay, greensand, and chalk all being present. While chalk is permeable, clay and greensand have limited permeability. The strategic development sites are located on different combinations of superficial and underlying geology.

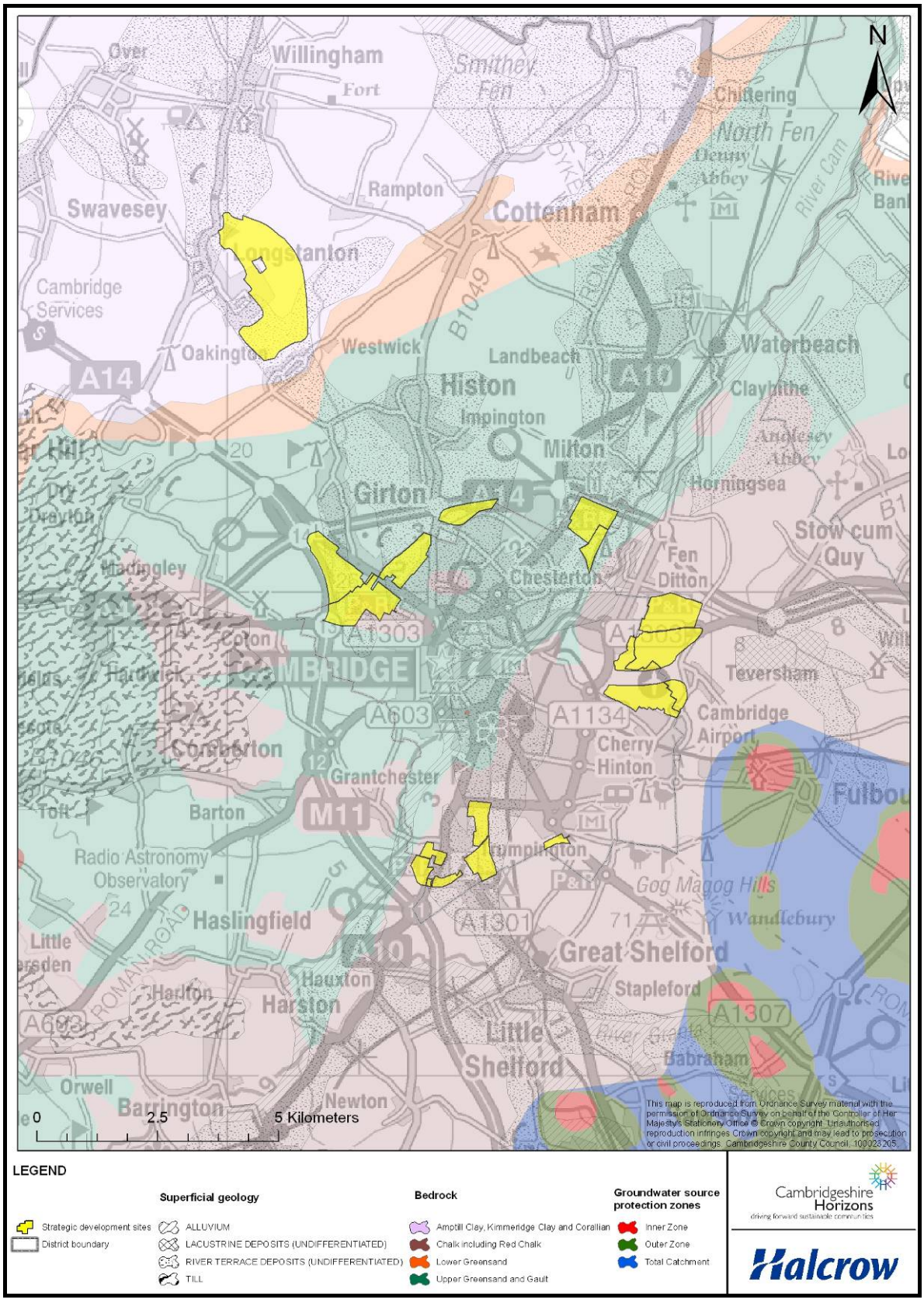


Figure 6-1: Cambridge Geological Environment

6.3 Development Site Geology and SUDS

6.3.1 This Water Cycle Strategy aims to provide a high level indication of what SUDS may be suitable for each site based upon underlying geology, source protection zones, and aquifer characteristics. Detailed site geological surveys should be undertaken by developers as required, as a part of planning application process to define the most suitable SUDS options. Requirements for developers are listed in Halcrow's Developer Checklist in Appendix C. Please note that Cambourne has not been included in this SUDS analysis as planning approval has already been granted.

6.3.2 The major development sites on the south and east of Cambridge are proposed above a major aquifer flowing through highly permeable chalk. Developments in this area may mean a loss of recharge area and volumes of water entering the aquifer. However in sites where sustainable drainage with infiltration is utilised, which is the presumption of the Building Regulations Part H, the flows to ground will be comparable to the existing condition. In some situations the flow to ground could be greater if the soil conditions permit.

6.3.3 The most important factor in determining if infiltration techniques are used is the depth to groundwater. Generally where the groundwater is less than 5m below the ground surface there is very limited potential for the pollutants to be dispersed, absorbed or otherwise neutralised before they enter the groundwater. Therefore the depth to groundwater and in particular the seasonal maximum must be known. From this information the degree of risk assessment can be determined. For shallow groundwater the risk assessment should be detailed.

6.3.4 Where the geology does not permit infiltration then the volume of detention storage required at a site will increase as no runoff can be lost to ground. This is also the case when numerous small scale source control elements are not used, e.g. permeable paved driveways/paths, as the major attenuation elements then need to store the full volume of runoff.

6.3.5 For sustainable drainage to be most effective a site specific tailored series of elements for the runoff to pass through should be implemented. This is known as the treatment or management train (see Figure 6-2). Therefore whilst it is often necessary to have ponds or wetlands to store large volumes of runoff SUDS elements should be introduced at house or street level to provide source control. The smaller scale elements are most typically a soakaway. However it should be noted that soakaways are only normally designed to attenuate runoff for up to 1 in 10 year events. Building Regulations require an assessment to be made to determine if soakaways can be utilised. An overall site strategy will be required and this may show them to be unnecessary.

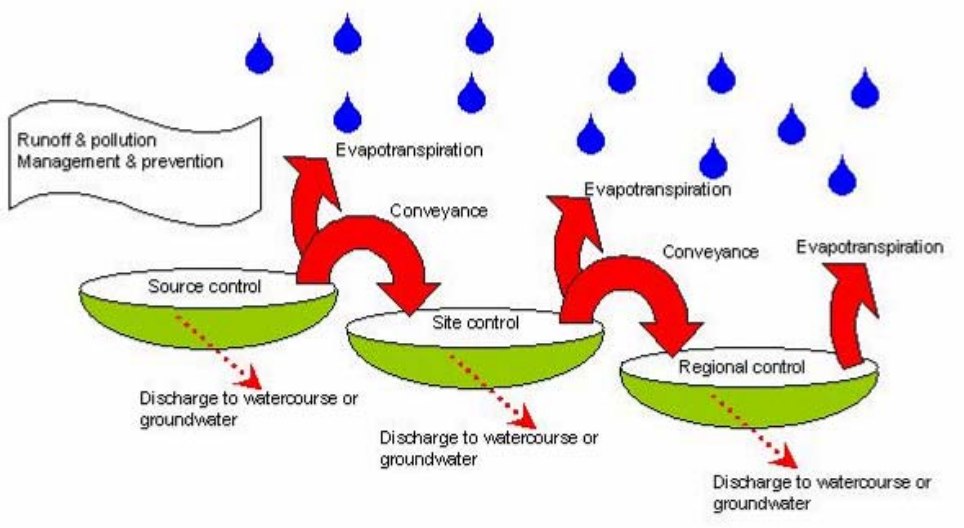


Figure 6-2: The SUDS Treatment (or Management) Train (www.ciria.org)

6.3.6 Rainwater Harvesting is aligned with the Code for Sustainable Homes and the ideals of a Water Cycle Strategy to avoid moving treated potable water and surface water runoff in opposite directions.

6.3.7 Green Roofs work on any site and also act to enhance air quality and reduce the heat rise associated with property construction. They provide some attenuation, particularly on smaller storm events. They are much less effective on the large events when ponds or similar would be needed to attenuate the vast bulk of the runoff.

Northstowe

6.3.8 Northstowe is situated on clay bedrock with intermittent riverine gravel overlaying this. The mixed geology, permeability, and the presence of a perched aquifer underlying the Northstowe site implies that infiltration SUDS will not be suitable as a site wide strategy for attenuation. Hence attenuation ponds are likely to be the main flood risk mitigation option applied at the site.

6.3.9 There is some permeable ground on the eastern boundary where infiltration tests undertaken within existing site surveys have shown that infiltration SUDS would be viable. Where infiltration techniques are practicable, the groundwater flows will discharge into existing outfalls at the northeast of the site. (Thus any infiltrated water would make its way after some delay into the watercourses.)

6.3.10 As the groundwater is protected by the underlying clay there is less risk of causing groundwater pollution. However due to the shallow nature of the groundwater table, with water levels within 5m of the ground, careful consideration plus a detailed risk assessment should be made before recommending the use of infiltration. SUDS Drainage Guidance regarding this issue is provided in Appendix E.

6.3.11 For further information regarding SUDS requirements within the Northstowe Area Action Plan, please refer to Appendix A.

Southern Fringe

6.3.12 High level analysis of Glebe Farm based on geology mapping shows it situated on chalk bedrock overlaid by riverine deposits. Based upon this, geology is very suitable for infiltration SUDS such as soakaways, infiltration trenches, and swales. For these sites a suitable combination of infiltration and non-infiltration SUDS may be selected

to balance flood storage and achieve other planning objectives. Further site specific analysis is recommended to confirm the geological mapping.

6.3.13 Clay Farm is based on clay topsoil and has infiltration tests have shown poor permeability indicating infiltration SUDS are not practical.

6.3.14 The majority of Trumpington Meadows is chalk bedrock, which is permeable and hence infiltration SUDS will be suitable. However the bedrock is only an indication of the surface permeability and further investigation is advised. Localised geological surveys are required to confirm suitable sites for infiltration SUDS in this area. An exception to this is the eastern extent of the site where it sits on permeable soils that may be suitable for infiltration.

6.3.15 It should be noted that based on hydrogeological mapping of the area, the water table is approximately 5 meters below the ground level and hence SUDS proposals need to be assessed in relation to risk to groundwater.

6.3.16 For further information regarding SUDS in relation to requirements within the Southern Fringe Area Action Plan, please refer to Appendix A.

North West Fringe and Arbury

6.3.17 The majority of the North West Fringe, and the Arbury site are situated on upper greensand and gault bedrock, with river terrace gravels on the surface. While the surface layer will be permeable, the bedrock is of limited permeability and hence it is advised that surveys are undertaken by developers to assess the depth of riverine topsoil, and the permeability of the underlying bedrock. Developer and LPA advice and guidance is provided in C and D to assist in attaining the correct SUDS for the sites' objectives.

6.3.18 The geological conditions and flood zoning of these sites will limit the variety of SUDS options available. For detention and balancing ponds, discharge into the Cam at restricted rates (see Section 5.7) would be acceptable. However further research is required to understand the impacts of all existing and proposed developments discharging to Cottenham Lode (See Section 5.5), hence the site run off and site storage strategies proposed will require further studies to identify appropriate SUDS.

Northern Fringe East

6.3.19 The site geology is the same as the North West Fringe and Arbury defined above, hence the site does not lend itself directly to infiltration. The presence of surface riverine gravels however does imply that if the layer is sufficiently deep, infiltration SUDS may be an option. Further localised analysis is required to understand what SUDS would be most suitable.

Cambridge East

6.3.20 Based on geological mapping, Cambridge East lies on a highly permeable site with a riverine gravel topsoil underlaid by permeable chalk. There are currently very low runoff rates from the Greenfield site; hence storage areas for the site are likely to be very large. However as mentioned in Section 5.6 this volume discharge is still high in relation to downstream Bottisham Lode flows.

6.3.21 It is advised that further investigation is undertaken to confirm the site permeability implied by geology, and to collectively assess impacts on downstream waterways with other relevant developments.

6.3.22 Guidance provided in Appendix C and E will assist the developer and LPAs in what information is required.

6.4 SUDS Maintenance and Adoption

6.4.1 Currently, no standard framework exists for adoption and maintenance of SUDS infrastructure, however in the DEFRA publication 'Making Space for Water' (2008) it is advised that a long term adoption strategy is crucial for the success of SUDS measures. This implies the involvement of "durable, accountable organisations that can be expected to have the financial capacity to meet their responsibilities in the longer term".

6.4.2 The planning, design, construction and initial maintenance of SUDS are the responsibility of the developer. The 'Interim Code of Practice for Sustainable Drainage Systems' developed by the National SUDS Working Group (2004) states that an adopting authority will require the SUDS to be developed to an appropriate standard, and that they are in an acceptable condition at handover. A developer must also provide comprehensive owners manual, covering annual maintenance tasks as well as long-term remedial solutions. For indicative costs associated with maintenance of specific SUDS infrastructure, see Appendix F.

6.4.3 The local water company will adopt SUDS elements that are in compliance with Sewers for Adoption (SFA) 6th Edition where the storage capacity does not exceed that required to attenuate storms any larger than a 1 in 30 year storm. The key clauses are:

- Part 1 – General
- Clause 1.14 covers flow attenuation and details the design parameters to be achieved. It also excludes any above ground items
- Clause 1.19 which relates to Sustainable Drainage Systems (SUDS)
- Part 2 – Design
- Clause 2.13 Hydraulic Design - Surface Water on Site
- Clause 2.14 Hydraulic Design – Protection against Flooding, which relates to sewer flow capacity and defines the 1 in 30 year no flood level of protection
- Clause 2.15 Control of Surface Water Discharges, which relates to PPS25 and the need to provide a sustainable solution

<u>Adopting agents and authorities</u>

6.4.4 The Highway Authority will adopt engineered grassed channels that are similar to swales and vegetated wetlands, so long as both are in accordance with the provisions of Design Manual for Roads and Bridges (DMRB).

6.4.5 Generally the design of such elements for the Highway Authority should follow the DMRB Volume 3 Section 2 Drainage. Particular reference should be made to HA119 Grassed Surface Water Channels for Highway Runoff and HA103 Vegetated Drainage Systems for Highway Runoff.

6.4.6 In Northampton a number of SUDS features have been incorporated into design undertaken by English Partnerships. The adoption of these elements is still not finalised. The most likely option being considered is that the local council will manage the maintenance work that is necessary. The council will be provided with appropriate

funding under Section 106 of the Town and Country Planning Act and will then arrange for a suitably qualified contractor, e.g. the Land Restoration Trust to undertake the actual work. This is partly made possible by the fact that there is a need to maintain an entire Country Park as well. The exact text that has been provided as part of planning applications is given below:

> *"The long term maintenance responsibility of the Country Park and other areas is currently under discussion between a number of parties. In the meantime English Partnerships, a government body will undertake any necessary maintenance. Eventually a Public Sector body, fully funded by commuted sums, will be established to undertake this role."*

6.4.7 However the adoption situation is currently under review by the government which recognises that adoption and maintenance have been obstacles to the widespread introduction of SUDS. The document Improving Surface Water Drainage, published by DEFRA in February 2008 sets out some alternatives that may be introduced in the future.

6.4.8 There are three options for the adoption and maintenance of sustainable drainage. These are:

- Local Authorities, which tier of local authority still to be determined, e.g. Borough Council or County Council or other
- Internal Drainage Boards
- Sewerage undertakers
- New specialist drainage undertakings or companies

6.4.9 It is possible that for different elements of the SUDS network there might be a preferred adopting authority due to specialist skills. For example sewerage undertakers would be more capable of maintaining a below ground structure that provided attenuation and allowed infiltration. A pond or wetland and the surrounding grassed/landscaped areas, within public open space, would be more suited to the current skills of a local authority.

6.4.10 Generally the more technical elements or where there is an inherent safety risk due to confined spaces should be adopted and maintained by the sewerage undertakers as they possess the skills required to manage this risk.

6.4.11 It would be most effective within the development areas of Cambridge for there to be locally agreed solutions detailing the organisation most appropriate to take on responsibility for the adoption and management of SUDS.

6.4.12 From the three options above, a specialist company is likely to provide the most flexibility in the short term because the contract can be negotiated, e.g. SUDS maintenance could be part of the drainage element of the work.

MUSCO examples

6.4.13 One type of specialist company that is already operating in the UK is a Multi Utility Services Company (MUSCO). Two examples of such companies are:

1. Multi Utility Joint Venture (MUJV)

6.4.14 This is a company established for maintenance and operation of SUDS on the Allenby-Connaught development for Aspire Defence Limited, with the ultimate client being the Ministry of Defence (MOD).

6.4.15 MUJV is made up of a part of Thames Water (which has now become Veolia Water) and EDF Energy and was formed to service the works required to modernise and operate 9 garrisons for the MOD. The arrangement relates to water and electricity supplies plus foul and surface water drainage provision.

6.4.16 Work during the construction phase includes terminating services as required, modifying the existing network to suit refurbishment works and provision of a suitable new network to service all building and areas. MUJV is responsible for operating and maintaining all of the services for a period of 35 years following completion. Some parts of the SUDS network, such as the ponds and swales, are maintained by Aspire Defence Limited whilst the soakaways, some of which include large volumes of infiltration, are the responsibility of MUJV. The contract only operates within private areas operated by the MOD and ownership of the water infrastructure rests with the MOD.

2. Ebbsfleet New Town

6.4.17 Ebbsfleet New Town is a new development where a large number of properties are being built adjacent to Ebbsfleet International Rail Station. A MUSCO has been formed between Thames Water (now Veolia Water) and EDF Energy for the provision of services to this site.

6.4.18 This company provides complete new water, drainage and electricity infrastructure as required by the site layout. The MUSCO will be responsible for procuring all bulk supplies and delivering these to each property. The MUSCO will be the local utility supplier and will bill customers directly.

7 Wastewater

7.1 Introduction

7.1.1 Anglian Water Services (AWS) is responsible for the operation and maintenance of the existing foul drainage network within the study area. AWS is also responsible for surface water drainage from roofs, driveways and hard standings relating to properties, if they are connected directly to the public sewer system or if the surface water system has been adopted by AWS. They are not responsible for soakaways, land drainage, highway drainage, SUDS or private water systems.

7.1.2 For new developments, the Developer may choose to offer the surface water system for adoption by AWS, in which case agreement must be reached regarding design standards (reference Sewers for Adoption; 6th Edition; March 2006).

7.1.3 AWS has been the main source of information relating to the existing foul drainage network and sewage treatment facilities for this study. It should be noted that 'The Cambridge Wastewater Capacity Study' has been running concurrently with this WCS and has been completed in draft format upon submission of this report. This study has assessed the implication of development across the entire Cambridge network with the aim of identifying the upgrade requirements to treat all flows from new development at Cambridge WwTW. Cambridge infill and windfall development (including Cambridge Biomedical Campus) has been included within the analysis.

7.1.4 Halcrow have previously undertaken the 'Southern Fringe Wastewater Capacity Study' (December 2007) which assessed options to enable flows from the Southern Fringe to be treated at Cambridge WwTW without the need of upgrading the sewer system through Cambridge City. The conditions applied by AWS for the Southern Fringe study required that no additional flow into the Cambridge sewer network was allowed.

7.2 Wastewater Treatment

7.2.1 The main wastewater treatment works (WwTW) currently serving the Cambridge urban area is Cambridge (Milton) WwTW. There are a several other existing WwTWs peripheral to the core study area, which have been considered to varying degree during the Phase 1 WCS. These are:

- Cambridge WwTW
- Haslingfield WwTW
- Sawston WwTW
- Uttons Drove WwTW

7.2.2 Figure 7-1 shows the drainage catchments for these treatment works in relation to the study area and strategic sites.

Cambridge WwTW

7.2.3 Cambridge WwTW serves the town of Cambridge and surrounding settlements of; Girton, Histon, Impingham, Rampton, Cottenham, Milton, Horningsea Fen Ditton, Great Shelford, Little Shelford, Stapleford. Its catchment incorporates the proposed infill development and strategic sites apart from Northstowe and Cambourne; which

will be dealt with separately. Cambridge WwTW comprises three secondary treatment streams served by five primary settlement tanks. All of the treated effluent and settled storm water overflows are discharged to the River Cam east of the WwTW.

7.2.4 The discharge consent for Cambridge WwTW is set by the Environment Agency to protect the quality of the receiving watercourse. This consent is based on the ecological sensitivity of the receiving watercourse and specifies a maximum flow and a minimum effluent quality that the WwTW has to achieve to meet water quality targets without causing environmental damage.

7.2.5 As the population connected to sewage treatment works increases, the amount of treated wastewater, or effluent, being discharged to the receiving water generally increases in proportion to the population increase. When this increased population causes the works to exceed the consented maximum discharge volume, improvements are likely to be required to the works to improve the standard of treatment and prevent failure of water quality targets.

7.2.6 'Appendix J suggests that the volumetric discharge consent limit at Cambridge WwTW will not require revision to accommodate the increased flow from the infill or strategic development sites within Cambridge before 2016. However, due to the resulting increase in actual flow, to meet the requirements of the Freshwater Fish Directive the EA may seek to tighten the discharge quality limits before this date. The extent of any future consent changes, including those to meet the requirements of the Water Framework Directive, would be assessed by means of modelling, which should be undertaken as part of the detailed WCS. The timing for any tightening of the consent limits would need to be agreed between Anglian Water and the EA.

7.2.7 There is headroom within the existing consent to accommodate the increased flows from then strategic development sites. This available headroom means that AWS are currently treating a higher than normal proportion of stormwater at Cambridge WwTW. As the development of the strategic sites progresses, this results in a higher ratio of wastewater to storm water being passed to full treatment. This will give rise to an increased volume of stormwater entering the storm tanks and ultimately the River Cam. It should be noted that this increase in storm volume discharge is not due to the increased stormwater from new developments which would be served by separate wastewater and stormwater sewer systems. It is also no more than has been planned for in the setting of discharge consents which specify flow rates, effluent quality and storm storage capacity. Please refer to Appendix J for a brief methodology on how the WwTW capacity and potential for growth has been calculated.

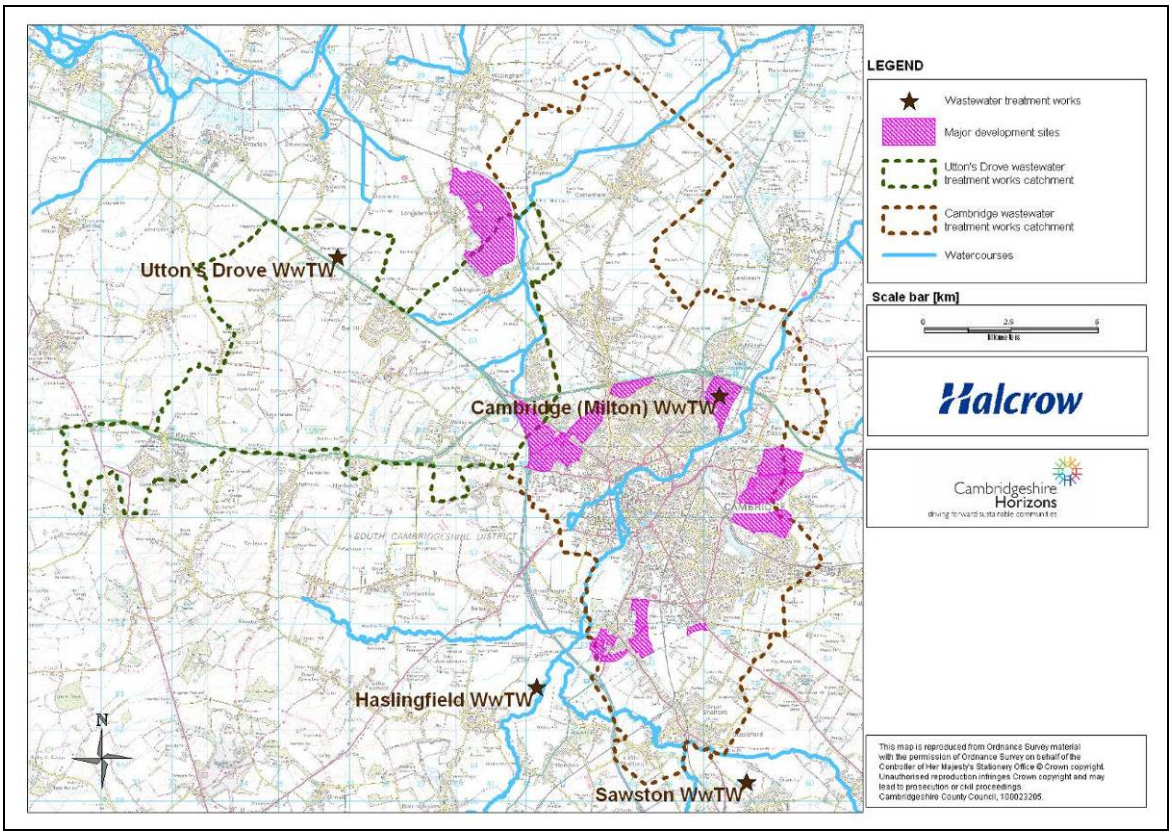


Figure 7-1: Existing drainage catchments for Cambridge WwTW

Improvements to Cambridge WwTW

7.2.8 No ultimate technical constraints have been identified that would prevent the expansion and improvement of Cambridge WwTW in order to accommodate the growth planned within its catchment up to 2021. The improvements which are required to protect the water quality of the River Cam are shown in Table 7.1.

Improvements required	Date required
Increase hydraulic capacity of the inlet works	Early in AMP 5 (2010/11)
Increase treatment capacity (Phase 1)	During AMP 5 (2010 – 2015)
Increase treatment capacity (Phase 2)	During AMP 6 (2015 - 2020)

Table 7.1: Improvements required to Cambridge WwTW

7.2.9 AWS will seek investment to facilitate these improvements through its regulatory periodic review process. The costs of upgrading Cambridge WwTW cannot be passed on to the developer.

7.2.10 The required improvements can be accommodated within the present site boundary and further additional land purchase will not be necessary.

Possible relocation of Cambridge WwTW

7.2.11 The site of Cambridge WwTW and the adjacent Chesterton Sidings are identified by Cambridgeshire Horizons as preferred sites for housing development. If the treatment works is relocated, the proposed site for a new works is at Honey Hill, Fen Ditton.

7.2.12 AWS are reviewing the options for the relocation of Cambridge WwTW as a separate project. It should be noted that consideration of relocating Cambridge WwTW is not included within Halcrow's scope for the Cambridge Wastewater Capacity Study. Current information from AWS is that there is no financial incentive for this relocation. In addition, this option has been deemed infeasible by the Cambridgeshire County Council and planning authorities as infeasible based on analysis to date. This issue has therefore not been considered as part of this Phase 1 Water Cycle Strategy.

7.2.13 The Swaffham IDB is opposed to relocation of the WwTW due to increased flood risk, however it should be noted that the works would be likely to discharge to the River Cam in a similar location to the current discharge from Cambridge WwTW.

7.3 Foul sewerage network

Existing network overview

7.3.1 The Cambridge WwTW catchment serves a population of approximately 130,000 and covers an area of approximately 3,099 hectares. The existing sewerage system consists of approximately 30% combined sewers (where wastewater and storm water use the same sewers) and 70% separate sewers. The combined and the separate foul sewers discharge to the Cambridge STW. The separate surface water sewer system ultimately drains to the River Cam via numerous tributaries and minor brooks. The combined system sub-catchments are clustered in Cottenham, Histon and in the north of Cambridge and at Shelford in the south of Cambridge.

7.3.2 AWS has a hydraulic model of the sewer network, which was built in 2004 and includes all public sewers which range between 100 mm to 2,100 mm diameter. There are 45 pumping stations in the Cambridge catchment, including the tunnel terminal pumping station at the WwTW. This model has been used to create a map of the Cambridge sewer network which is shown in Figure 7-2. This figure identifies the sewers over 400mm and 900mm in diameter.

Flow regime

7.3.3 The Cambridge WwTW is situated to the north-east of Cambridge. The works is flanked by the junction of the A14 and A10 to the south east. Flows arrive at the works though the gravity tunnel sewer (2,100 mm diameter), a 450 mm diameter sewer draining from the Arbury Catchments and a number of rising mains from terminal pumping stations (TPS) and is shown in Figure 7-2. The settlements which are served by these terminal pumping stations are shown in Table 7.2.

Settlements	Pumping station
Cottenham	Broad Lane TPS
Histon	Histon Holme TPS
Milton	Milton Park TPS, Milton Church End TPS and Milton Land TPS
Fen Ditton	Fen Ditton TPS

Table 7.2: Pumping stations pumping direct to Cambridge WwTW

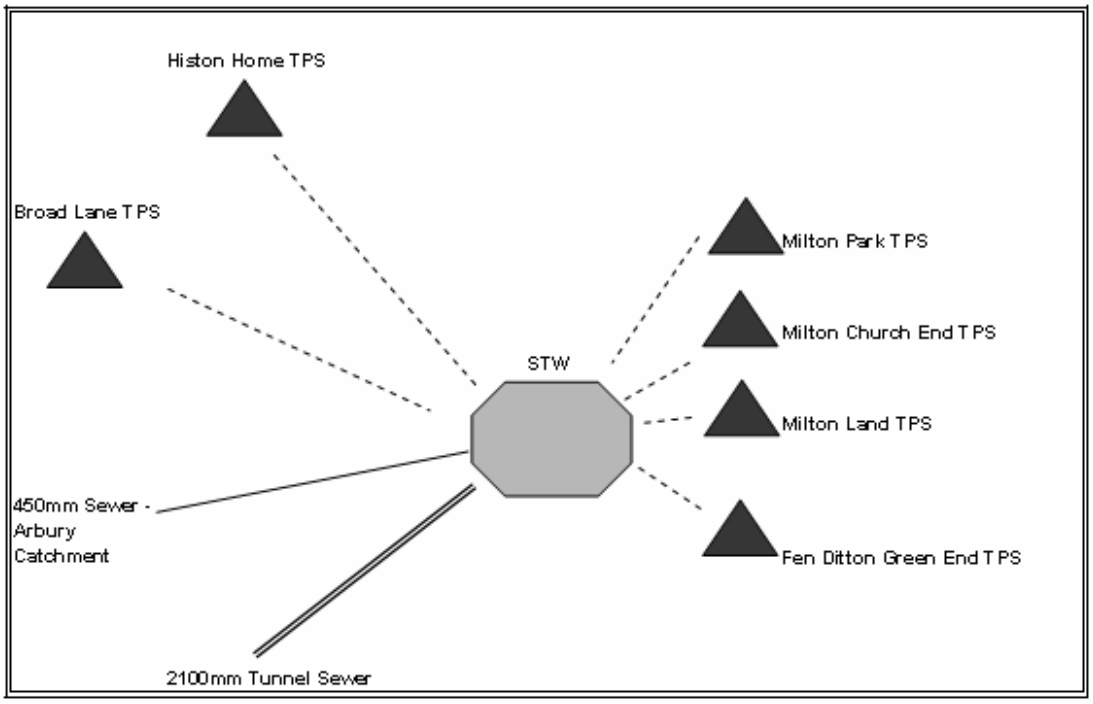


Figure 7-2: Schematic of flows entering Cambridge WwTW (taken from Cambridge DAP Stage 3 Report)

WwTW Inlet

7.3.4 All gravity and pumped flows from Milton Park, Milton Church Lane, Milton Land and Fen Ditton Green End arriving at Cambridge WwTW enter the works at the Tunnel TPS. These flows are pumped to the raised inlet works. All other rising mains entering the WwTW pump directly into the inlet works. All flows at the inlet works in excess of the 3 dry weather flow (DWF) value is passed via a weir to the two storm tanks.

Tunnel

7.3.5 The majority of flows entering the WwTW, at the tunnel TPS, are transported via a 2,100 mm diameter tunnel sewer which was constructed in 1997. Connections from the local combined sewer network enter the tunnel sewer at 13 known locations. The routes of the branches leading to the tunnel sewer can be seen in Figure 7-3. The Cambridge wastewater capacity study has established that this tunnel sewer network has capacity for growth and is not expected to require expansion to accommodate the planned growth up to 2021.

7.3.6 The route of the first branch of the tunnel commences in the west of Cambridge in Wilberforce Road as a 600 mm diameter sewer. It flows north to the junction with Madingley Road where it increases in size to 1200 mm diameter and flows east along Madingley Road, into Northampton Street and Chesterton Road where the branch from Histon Road joins.

7.3.7 The second branch starts in Histon Road as a 1200 mm diameter sewer and is routed south along Histon Road into Victoria Road. The tunnel then continues in an easterly direction to the Chesterton Hospital.

7.3.8 The third branch commences at the site of the former Cambridge Riverside PS, is routed to the junction of Chesterton Road and High Street and then on to the Chesterton Hospital.

7.3.9 The fourth branch commences south-west of the Elizabeth Way Bridge and is then routed north via a 2120mm diameter sewer to the branch from Riverside.

7.3.10 Finally the 2120mm diameter tunnel, is routed eastwards via Scotland Road, Green End Road and Green Park before entering the Cambridge STW.

Sewer flooding

7.3.11 Sewer flooding due to hydraulic overloading occurs where surface water entering the public sewer system exceeds design capacity. Flooding can then occur through manholes and road gullies in the highway and internally within properties.

7.3.12 AWS are aware of sewer flooding problems (recorded on a DG5 register for Ofwat) for properties in Windsor Road, Cambridge. Windsor Road is potential connection point for the Huntingdon Road / Histon Road development site. The DG5 report on the Cambridge sewer network written by Atkins (April 2006) for the Cambridge sewer network confirms that this area is at risk of sewer flooding and that the preferred mitigation option is to upsize the existing 225mm sewer to a 375mm or 450mm sewer. Atkins predicts that this would cause a minor increase is water levels downstream, but that it would not place any additional properties at risk of flooding (for a 1:30 year event).

7.3.13 Atkins suggested that upgrading the sewer in Windsor Road to a 600mm diameter would be sufficient to serve the new development and remove the risk of flooding from the existing properties in Windsor Road. This 600mm sewer would connect into the second branch of the tunnel sewer.

7.3.14 The SFRA for Cambridge City reports a risk of sewer flooding in Coldhams Lane. The interim results of the wastewater capacity study undertaken by Halcrow shows that this flooding risk will not be exacerbated by the connection of the strategic development sites; however, it is likely that the development of infill could worsen the situation.

7.3.15 The initial findings of the Cambridge wastewater capacity study have shown that the additional flows from infill and windfall development across Cambridge are likely to increase the risk of sewer flooding to existing properties within Cambridge. Halcrow is currently working with AWS to identify suitable mitigation measures to prevent this potential increased risk of sewer flooding. Where appropriate integrated urban drainage techniques will be applied to first keep surface water out of public sewers and then manage 'exceedance' flows effectively on the surface through identifying and maintaining flood pathways.

7.3.16 Further consideration is needed where new developments will connect into upper parts of a sewer network and have the potential to increase the risk of sewer flooding.

Any new property development will increase the base flow within the sewage system and increase the risk of foul flooding during wet weather events. AWS will model new developments to assess the impact on the existing system, and undertake this as part of their duty to maintain levels of service to existing customers.

7.3.17 There are a number of pumping stations in the study area. It is important that any developments upstream of existing pumping stations are assessed against the capacity of the pumping station for design rainfall events. For the Cambridge catchment AWS are able to undertaken this assessment with their existing drainage model. This assessment will serve to show whether proposed development sites will have an impact on either water quality; by causing an increase in intermittent discharge from emergency overflows at the pumping station as a result of insufficient capacity; or downstream of the pumping station as a result of prolonged operation.

Overflows

7.3.18 The Cambridge Local Area Management Plan (2003) report identified four combined sewer overflows (CSOs) and seven Emergency Overflows (EOs). The CSOs are located at Cambridge WwTW, Silver Street, Riverside and Magdalene Street Bridge and are shown on Figure 7-3. The discharge volumes from these CSOs is not expected to increase due to the strategic development sites, however it could increase due to the additional flows from the infill development. This issue is being investigated as part of the wastewater capacity study being undertaken by Halcrow. Water from the River Cam is used by a downstream abstratctor for irrigation of salad and vegetable crops. Water quality is of an increasing concern in respect of sewage works storm overflows. The CSO are as described below;

- Magdalene Street Bridge: This CSO no longer operates as a CSO as a flap valve has recently been installed to prevented foul water entering the storm system.
- Silver Street: The CSO is located opposite Fisher Court and consists of a high level 375 mm diameter pipe overflow into Mill Pond.
- Riverside: The CSO is located adjacent to a new housing development at the former Riverside Pumping Station site. The overflow consists of a high level 300 mm diameter pipe overflow into the River Cam.
- Cambridge STW: The CSO overflows to the lagoons when the two storm tanks are full. When these lagoons are full, flow drains to the River Cam via a series of French drains (gravel or rock filled drains). The AWS Operations team have undertaken works to allow the lagoon to overflow and flow overland to the First Public Drain watercourse.

Capacity issues

7.3.19 Figure 7-3 shows the Cambridge sewer network and the areas of limited capacity to accommodate additional flows from the proposed major development areas. Two of these areas of limited capacity are along Trumpington Road. The preferred option emerging from the Cambridge Wastewater Capacity Study is to connect the Trumpington Meadows development site into the Trumpington Road sewer. Sewer upgrades and two online storage tanks will be required in Trumpington Road to accommodate this development. For the other major sites adjacent to locations of limited capacity, connection into the sewer network will be required downstream of these locations and into the larger diameter sewer network. The major trunk sewers (over 400mm diameter) are shown in bold to highlight the principal sewer routes to Cambridge WwTW. It should be noted that this option is still under review by AWS.

7.3.20 The solution above is based upon an assumed average flow of 66l/s from the Cambridge Biomedical Campus (CBC), while flows of up to 170l/s have been suggested. The existing Cambridge network is unlikely to be able to support flows as excessive as this, and in this event the preferred solution derived in the Southern Fringe Capacity Study (December, 2007) would be the likely option, freeing up capacity in the Cambridge network by diverting flows from Great Shelford toward Sawston. Additionally, if the upgrades along Trumpington Rd prove infeasible, flows from Trumpington Meadows may be diverted toward Haslingfield WwTW. This solution is shown in Figure 7-4 below.

7.3.21 Please note that the Utton's Drove and Cambridge WwTWs' boundaries are yet to be updated based upon the new development sites. Northstowe will ultimately be entirely within the Utton's Drove WwTW catchment and the North-West Fringe will be within the Cambridge WwTW catchment.

Northstowe, Cambourne and Southern Fringe

7.3.22 For further detailed information regarding Northstowe, Cambourne and the Southern Fringe development sites, please refer to Appendix A.

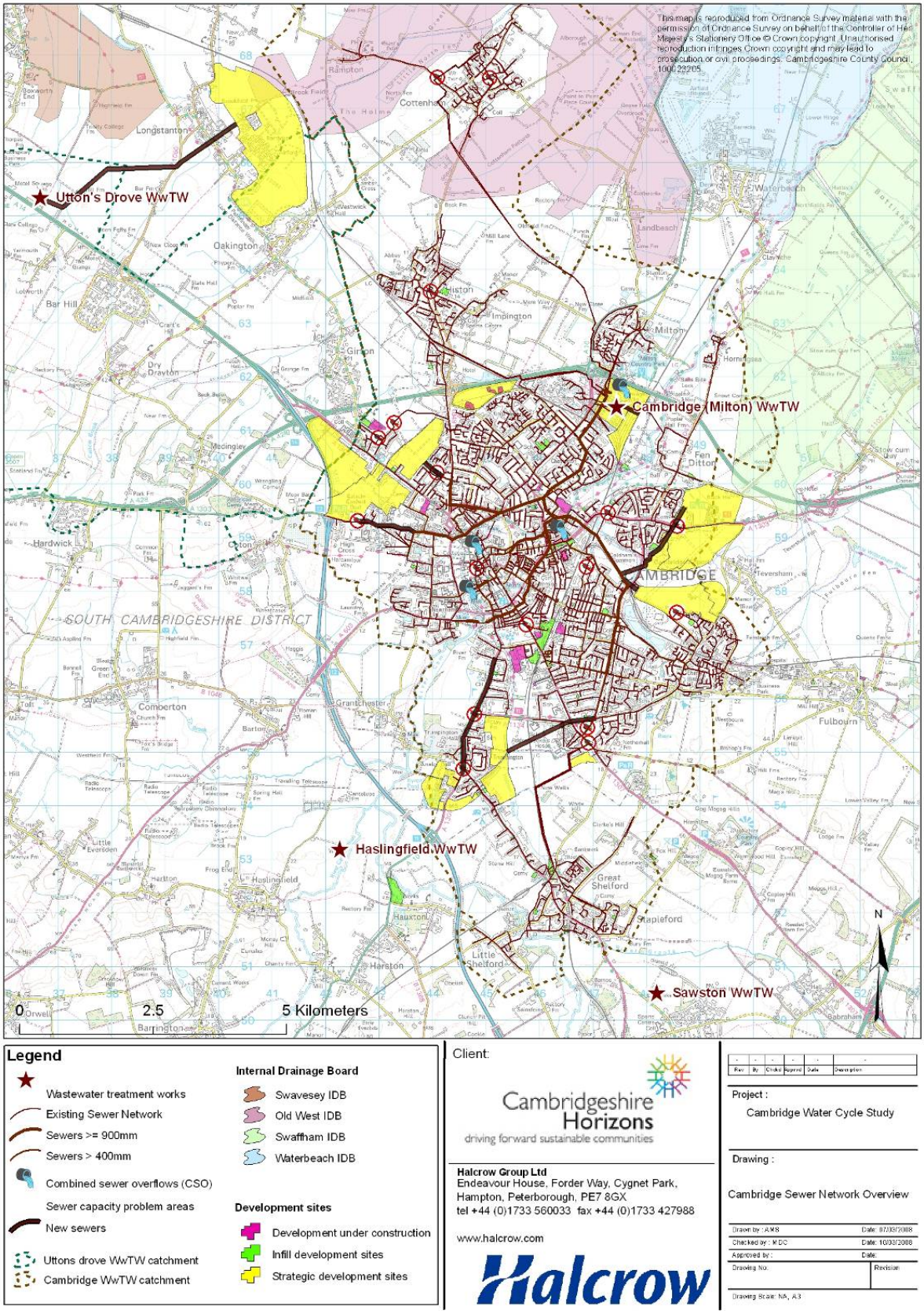


Figure 7-3: Proposed capacity upgrades to existing network (Cambridge Wastewater Capacity Study)

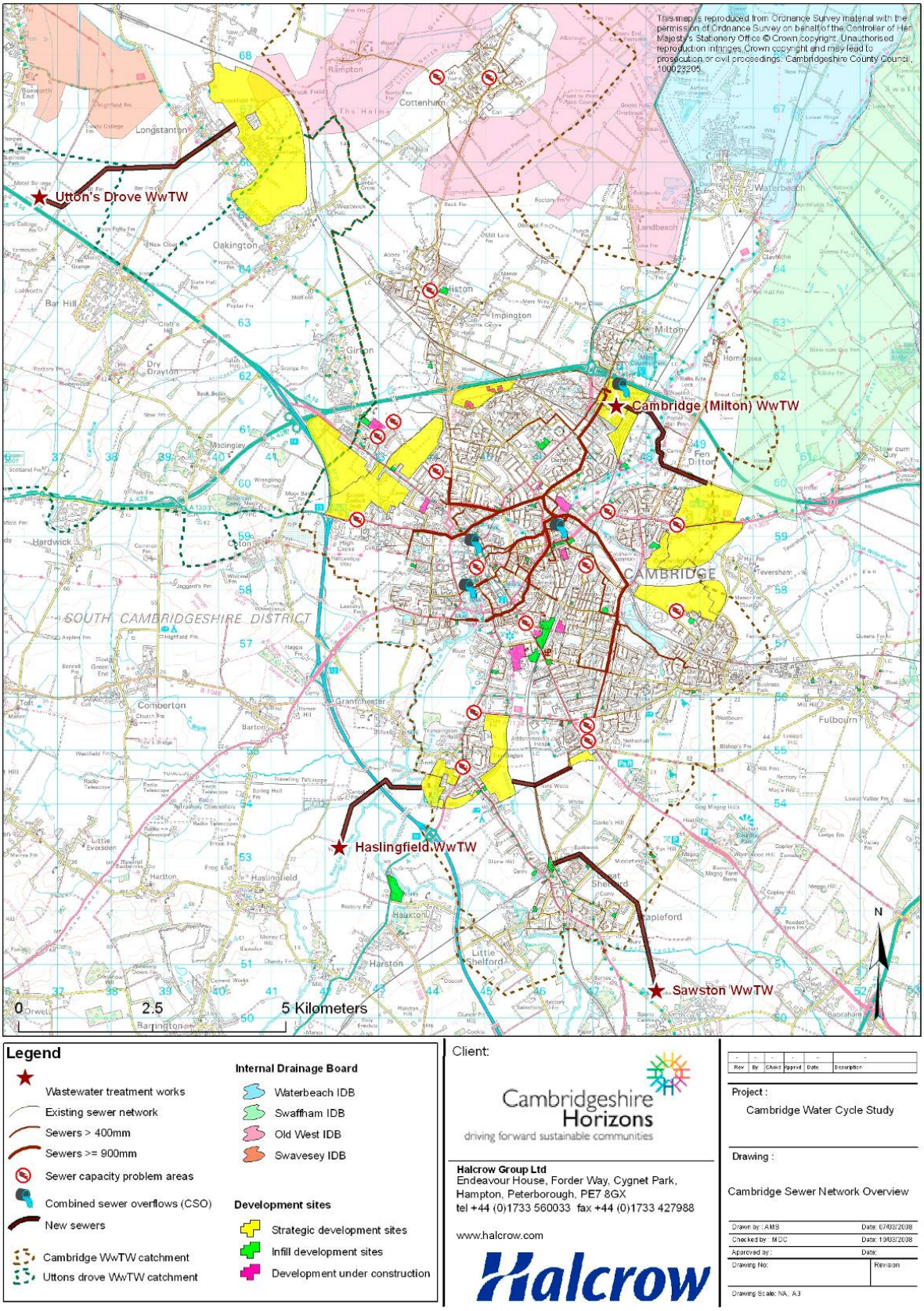


Figure 7-4: Proposed wastewater strategy (Southern Fringe Wastewater Capacity Study)

7.4 Impact of strategic development sites

7.4.1 The initial results of the Cambridge wastewater capacity study have allowed an

assessment of the likely impact of connecting the strategic development sites into the Cambridge network. The indicative sewer capacity is shown below in Table 7.3. The indication of 'No Capacity Available' is mainly based upon the lack of local sewer capacity which is usually smaller diameter sewers. Within Cambridge the large diameter sewer network has capacity to accommodate growth and therefore the developments will be required to connect to the larger diameter sewers downstream of the sewers with limited capacity. Please refer to Figure 2-1 for development site locations.

Development Site	Is sewer capacity available?	Impact upon sewer network and likely improvement requirements
A	No	This site would naturally connect into the sewer in Madingley Road which will significantly increase the risk of sewer flooding along Madingley Road. Local sewer improvements will be required to accommodate this site. Capacity is available downstream of the junction of Madingley Road and Wilberforce Road and this development will need to connect to the sewer network at this location.
B	No	This site would naturally drain towards the Cambridge network with the sewer in Windsor Road being an obvious connection point. The sewer in Windsor Road will require expansion to accommodate the development, allow connection into the second branch of the tunnel sewer and remove the sewer flooding problems currently experienced in Windsor Road.
C	Yes	This development is served by a 450mm trunk sewer which has capacity for the remainder of the development site.
D	N/A	Development is reliant upon relocation of the WwTW.
E	No	This site is adjacent to the WwTW and therefore a gravity connection to the tunnel TPS at Cambridge WwTW works would be required.
F	No	This site would naturally connect into the sewer in Newmarket Road however there is inadequate capacity to serve the entire site in the existing local sewer network to accommodate this site. A Strategic connection direct to the WwTW is likely to be the preferred option. There is capacity in the sewer crossing Coldhams Common to serve this development, however a direct route to the sewer may need to pass through the adjacent Airport Site G which is expected to be constructed after Site F.
G	No	This site would naturally connect into the sewer in Barnwell Road, which does not have sufficient capacity. Initial results show that there is capacity in the sewer network crossing Coldhams Common.
H	Yes	There is capacity in the sewer crossing Coldhams Common to serve this development. It is not expected that this will affected the issues regarding the sewer flooding issues reported in the Cambridge SFRA.
I	Maybe	This site would connect into the sewer in Hills Road which has capacity to accommodate this site. Initial results from the

		Cambridge Wastewater Study have shown that the sewers in Hills Road and Mowbray Road will not need upgrading to accommodate this site.
J	No	This site would naturally drain to the sewer in Shelford Road in which there is limited available capacity for growth. This capacity should be reserved for infill development. The preferred option from the wastewater capacity study shows that capacity is available at the junction of Long Road and Mowbray Road for this site. A new sewer will be required to connect into this location. No further upgrades downstream of Mowbray Road will be required. The suitability of this option and the effect of the potential higher flows from CBC is still under discussion with AWS, so it should be noted that the potential Southern Fringe wastewater option of using Sawston and Haslingfield WwTW has not yet been ruled out.
K	No	This site would naturally drain to the sewer in Shelford Road in which there is limited available capacity for growth. This capacity should be reserved for infill development. The preferred option from the wastewater capacity study shows that capacity is available at the junction of Long Road and Mowbray Road for this site. A new sewer will be required to connect into this location. No further upgrades downstream of Mowbray Road will be required. The suitability of this option and the effect of the potential higher flows from CBC is still under discussion with AWS, so it should be noted that the potential Southern Fringe wastewater option of using Sawston WwTW has not yet been ruled out.
L	No	This site would naturally drain to the sewer in High Street, Trumpington. Sewer upgrades along Trumpington Road and two online storage tanks will be required to accommodate this site. Further investigation by AWS is ongoing to refine the exact requirements of this upgrade and to determine what alternative upgrade requirements would be if this site was connected to Mowbray Road in addition to the flows from Sites J&K. The suitability of this option is still under discussion with AWS and therefore the potential southern Fringe option of using Haslingfield WwTW has not yet been ruled out.
2	No	This site will require a dedicated rising main to connect it to Uttons Drove WwTW.

Table 7.3: A summary of the available sewer capacity for the strategic development sites

7.5 Conclusion

7.5.1 Appendix J suggests that the volumetric discharge consent limit at Cambridge WwTW will not require revision to accommodate the increased flow from the infill or strategic development sites within Cambridge before 2016. However, due to the resulting increase in actual flow, to meet the requirements of the Freshwater Fish Directive the EA may seek to tighten the discharge quality limits before this date. The extent of any future consent changes, including those to meet the requirements of the Water

Framework Directive, would be assessed by means of modelling, which should be undertaken as part of the detailed WCS. The timing for any tightening of the consent limits would need to be agreed between Anglian Water and the EA.

7.5.2 AWS is aware of sewer flooding problems affecting existing properties in Windsor Road, Cambridge. A potential solution for connecting the NIAB site into the Cambridge network would also solve the sewer flooding problem in Windsor Road. The preferred solution for connection of the NIAB site is being developed within the wastewater capacity study.

7.5.3 The initial findings of the Cambridge wastewater capacity study have shown that the additional flow from infill and windfall (including Cambridge Biomedical Campus) development across Cambridge is likely to increase the risk of sewer flooding to existing properties within Cambridge. Halcrow is currently working with AWS to identify suitable mitigation measures to prevent this potential increased risk of sewer flooding. This issue will not affect the development of the strategic sites.

7.5.4 There are four combined sewer overflows (CSOs) in the Cambridge sewer network. The strategic development sites will not be connected upstream of these CSO's (except that of Cambridge WwTW) and therefore the discharge volume from these CSOs is not expected to increase due to the strategic development sites. However it could increase due to the additional flows from the infill development.

7.5.5 The Cambridge Wastewater Study has assessed the effect of an average flows of 66l/s to the Cambridge Biomedical Campus (CBC) and this has shown that the large diameter sewer network in Cambridge can accommodate all of the flow from the strategic developments without major upgrade. The majority of sites will need to provide strategic connection sewers to connect into the large diameter sewer network. Cambridge East will need to connect to the sewer in Coldhams Common, the Southern Fringe will connect to the sewer at the junction of Mowbray Road and Long Road and Northwest Cambridge will connect into the branches of the tunnel network on Madingley and Histon Road. The current preferred option for Trumpington Meadows site is to connect into the sewer in Trumpington Road which will require upgrade and two online storage tanks, however investigation into the possible connection into Mowbray Road and its associated upgrade requirements is still ongoing. Discussion with AWS is ongoing to refine this preferred solution and investigate the effects of higher flows from CBC upon the available sewer capacity for growth. For these reasons it is still not possible to completely rule out the potential use of Sawston and Haslingfield WwTW to serve the southern fringe development sites.

7.5.6 In the event that flows are excessive compared with the assumed 66l/s from the CBC, it may prove necessary to release capacity within the existing Cambridge network by diverting flows from Great Shelford toward Sawston WwTW.

7.5.7 Appendix A should be referred to for further detailed information on Northstowe and the Southern Fringe development sites.

7.6 20% extra growth

	Is sewer capacity available?	Impact upon sewer network and likely improvement requirements
North West	No	Further development to the northwest of Cambridge will increase the risk of sewer flooding to existing properties. Significant development in this area would need to connect to the large diameter branches of tunnel sewer in Histon Road or Madingley Road.
North East	No	Development in the north east of Cambridge would be suited to a direct connection Cambridge WwTW rather than connection into the existing network which has the potential to increase the risk of sewer flooding in the centre of Cambridge.
South East	Maybe	It is possible that sewer capacity is available in the large diameter sewers in Coldhams Lane or MowbrayRd/Perne Rd/Brooks road to accommodate development in this area. This will be investigated further within the wastewater capacity study. Alternatively development in this area may support the case for a strategic sewer direct to Cambridge WwTW to serve the Cambridge East developments.
South West	No	Development in the south west of Cambridge would have the greatest impact upon the Cambridge sewer network as there is currently very limited available sewer capacity in this area. It is likely that a new strategic sewer or additional sewer upgrades will be required to serve development in this location.

Table 7.4: Site summary for additional growth

7.7 Next stage of the WCS

7.7.1 The wastewater capacity study being undertaken by Halcrow has just been submitted in draft form and its outcomes have been incorporated into this document (section 7). The next phase of the water cycle strategy will incorporate the full results of this study. This will include a description of the local sewer improvements that will be required to reduce the risk of sewer flooding due to the increased flows from infill and windfall development.

7.7.2 It will be necessary to identify the preferred solution for connection of Cambridge East and Northwest Cambridge into the Cambridge sewer network so that the risk of sewer flooding is not increased for existing properties.

8 Water Resources and Water Supply

8.1 Management and Planning

Environment Agency

8.1.1 The Environment Agency manages water resources at the local level through the use of Catchment Abstraction Management Strategy (CAMS). Cambridge lies within the Cam and Ely Ouse catchment area outlined in Figure 8-1 below, and the majority of its water resource is taken from within the same CAMS area, although there are also several relevant abstractions within the Upper Ouse and Bedford Ouse CAMS area.

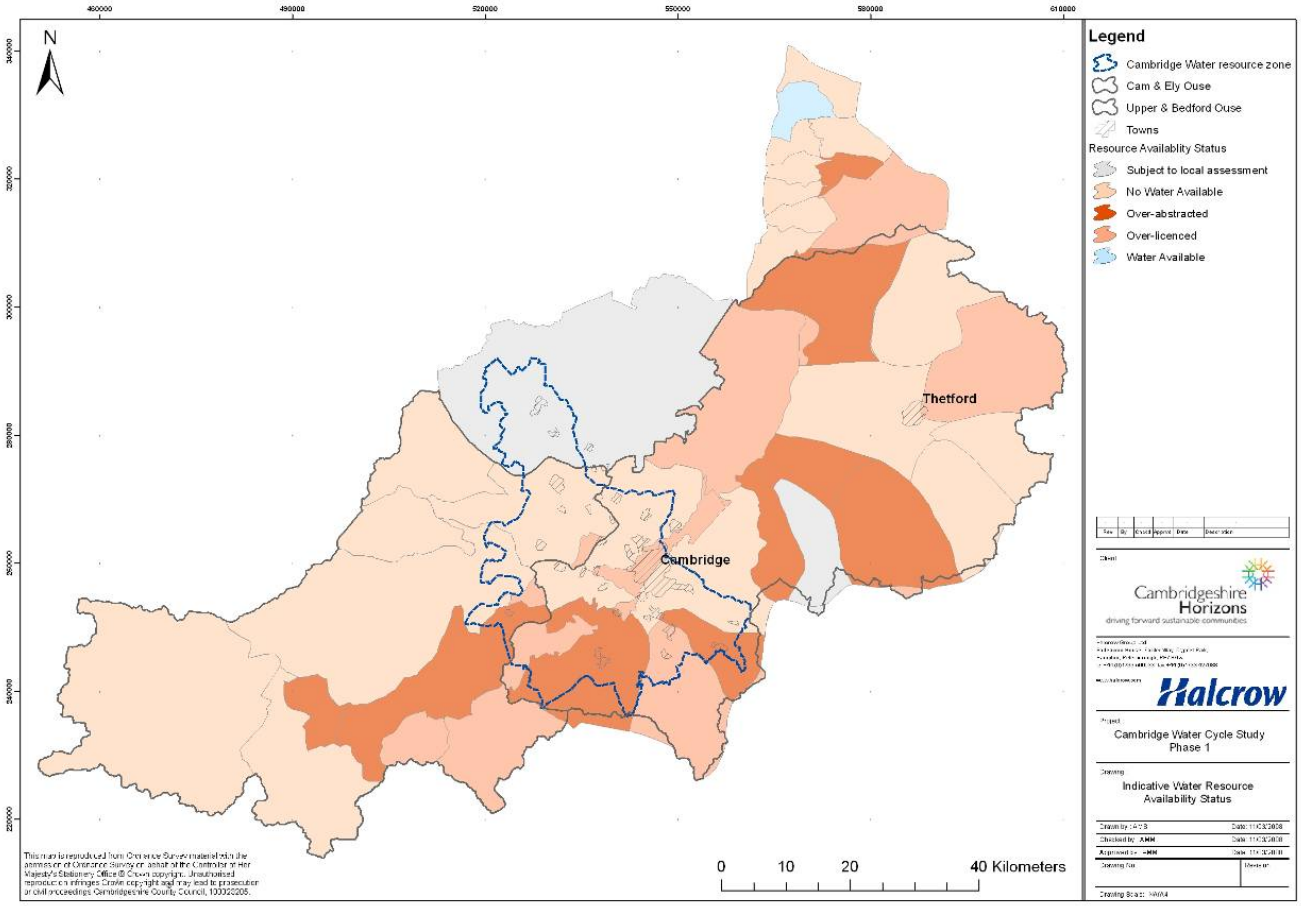


Figure 8-1: CAMS catchment areas

8.1.2 Within the CAMS, the Environment Agency's assessment of the availability of water resources is based on a classification system which states the perceived resource availability status, indicating:

- The relative balance between the environmental requirements for water and how much is licensed for abstraction;

- Whether water is available for further abstraction;
- Areas where abstraction needs to be reduced.

8.1.3 The categories of resource availability status are shown in Table 8.1. The classification is based on an assessment of a river system's ecological sensitivity to abstraction-related flow reduction.

Indicative Resource Availability Status	Licence Availability
Water available	Water is likely to be available at all flows including low flows. Restrictions may apply.
No water available	No water is available for further licensing at low flows. Water may be available at high flows with appropriate restrictions.
Over-licensed	Current actual abstraction is such that no water is available at low flows. If existing licences were used to their full allocation they could cause unacceptable environmental damage at low flows. Water may be available at high flows with appropriate restrictions.
Over-abstracted	Existing abstraction is causing unacceptable damage to the environment at low flows. Water may still be available at high flows with appropriate restrictions.

Table 8.1: CAMS resource availability status categories

8.1.4 This classification can then be used to help assess the potential for additional water resource abstractions.

Water company

8.1.5 The water supply for Cambridge and the surrounding area is provided by Cambridge Water Company. The strategic water resource for new development within the study area is also expected to be provided by Cambridge Water Company (CWC).

8.1.6 Strategic plans for meeting future demand over a 25 year period are detailed within CWC's draft Water Resource Management Plan 2009 (this draft plan was released for public consultation in May 2008 and will form the basis of the Company's final plan(WRMP09), to be published in Spring 2009); however, detailed design of schemes is not undertaken until works have been granted funding by Ofwat. This funding review occurs in 5 yearly cycles and we are currently in Asset Management Period (AMP) 4 (2005-10). CWC typically undertake a yearly review of their water resource plans as part of the June Return process. The draft WRMP has informed the relevant aspects of water resource analysis undertaken for this Phase 1 WCS.

8.1.7 Water companies are required by Defra to include headroom estimations, which act as a measure of uncertainty due to climate change, water efficiency targets. These issues have been considered in CWC's WRMP09 and a response from Defra is pending. This WCS includes a summary of CWC's water resource strategy for the study area, and takes the most recent June Return figures as a baseline for assessment of more ambitious consumption reduction scenarios.

8.2 Data and References

8.2.1 The data used for this section of the WCS has been sourced from the following locations:

- http://www.statistics.gov.uk
- Cambridge Water Company: Strategic Direction Statement 2007
- Draft Water Resources Plan 2008 and annual updates (Cambridge Water Company)
- Data provided by Cambridge Water Company
- Cam and Ely Ouse Catchment Abstraction Management Strategy (Environment Agency)
- Upper Ouse and Bedford Ouse Catchment Abstraction Management Strategy (Environment Agency)
- Areas of water stress: final classification (Environment Agency) – see Figure 8-2 below

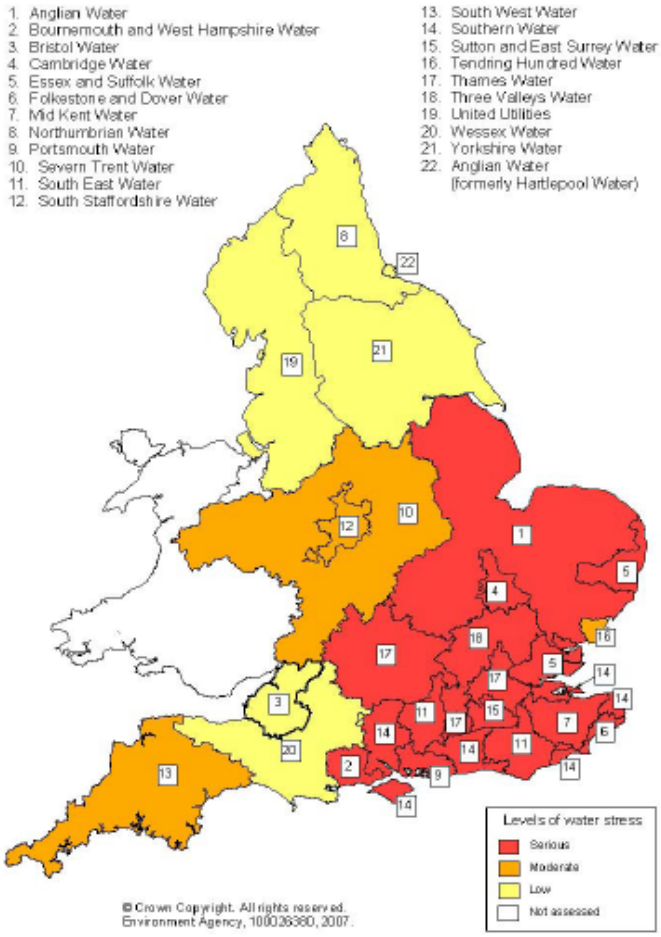


Figure 8-2: Water stress area classification map (Source: Areas of water stress: final classification)

8.3 Current Situation in Cambridge

Water resources

8.3.1 The water supply for the study area is currently sourced from groundwater abstractions, with the majority supplied from boreholes to the south and east of Cambridge City. Two major supply boreholes are located to the east of Thetford. Water is supplied to the Cambridge urban area from a reservoir to the east of the city, and also direct from boreholes into the network.

8.3.2 The CWC supply area is identified as an area of serious water stress by the Environment Agency (Areas of water stress: final classification). In addition, the Cam and Ely Ouse CAMS classifies most of the area from which CWC's water supply is drawn as either "over-licensed", "over abstracted", or "no water available". This means that no new consumptive licences (i.e. those which withdraw water without ultimately returning it to the same location) are likely to be granted and that any new non-consumptive licenses or upward variations that are granted will be time limited to the common end date of 2015.

Water supply

8.3.3 The water infrastructure for the study area is owned, operated and maintained by Cambridge Water Company. In relation to water transfer and distribution, the strategic development sites lie within the Cambridge Distribution Zone. Transfer mains carry water around Cambridge urban area and between storage units (shown schematically in Figure 8-3). A bulk transfer main running to the south of Cambridge will support the Northstowe and Southern Fringe sites. The transfer system as a whole is comprised of 400mm or above mains, and will require reinforcement in the future for sections of its route.

8.3.4 The proposed development sites and the ring main system (only partially complete) around Cambridge urban area lends itself to an obvious supply strategy for the proposed developments on the urban fringes. Ultimately, reinforcement of the existing ring main will act as the strategy for supplying the proposed developments.

8.3.5 Approximately 20Ml per day is supplies the north and west of Cambridge, while approximately 40Ml supplies Cambridge City. Water is pumped from a reservoir to the west of the urban area, northward along a 450mm main which downsizes to 300mm at the A14. This main continues north to pass to the west of the Northstowe site.

8.3.6 The northern arm of the ring main system around Cambridge is currently running at capacity and will require reinforcement with new development.

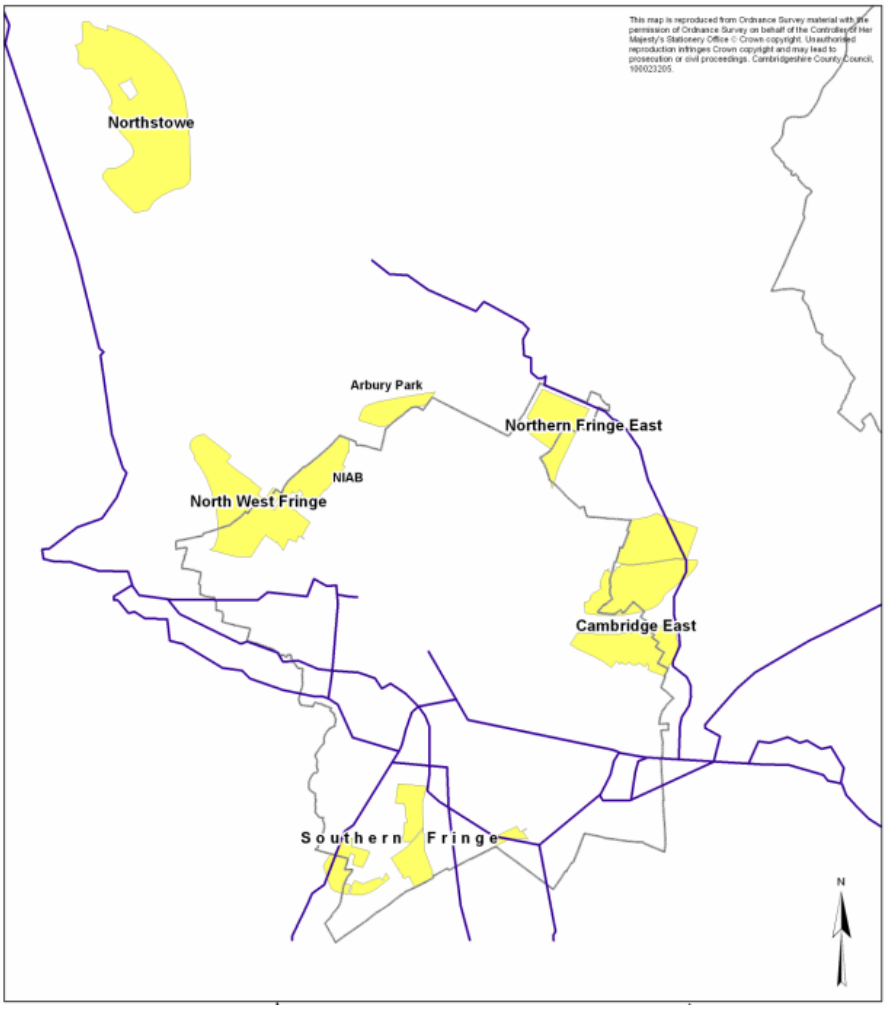


Figure 8-3: Existing transfer mains greater than 400mm diameter around Cambridge City

8.4 Water Resource Strategy

Water company plans

CWC's Strategic Direction Statement states that the Company's supply-demand projection is based on the following strategies:

- All currently un-metered properties will be metered by 2035.
- Control of leakage by the introduction of new technology in the monitoring of the distribution network and increasing the level of mains renewal.
- Deliver water efficiency for households and business in existing and new developments and promote water efficiency through customer education and communication.
- Support the development of rain and greywater use in new developments – all major new developments will incorporate appropriate water re-use technologies to reduce demand for mains water from each new house by an estimated 30% of typical current demand.

- Support for the development of new water resources in the Anglian region in partnership with other water suppliers.

8.4.1 The information below is summarised from CWC's draft WRMP 2008.

8.4.2 CWC takes a twin-track approach to the supply/demand balance to include demand management and supply development.

8.4.3 Significant growth in housing numbers is planned for the Cambridge sub-region over the next 15 years. CWC expects the recent trend of increasing new connections to continue throughout the WRMP period. The WRMP09 states that CWC has "*taken a view on the likely annual increase in housing numbers, based on the targets set out in the East of England Plan, experience of the planning process, and historic build rates. Per property consumption for the new homes is forecast to be lower than traditionally assumed, as the principles set out in the Code for Sustainable Homes are incorporated into planning and building policy.*"

8.4.4 CWC does not anticipate significant savings arising from the retro-fitting of water-efficient devices on a large scale, therefore modest growth in per capita consumption at existing properties is forecast in the WRMP09. In line with published guidance, overall demand for water has been assumed by CWC to increase by up to 2% over the planning period as a result of climate change alone.

8.4.5 CWC expects to maintain total leakage and unaccounted water levels at the current rate, which will equate to an overall reduction in per property leakage as its customer base increases with proposed new development.

8.4.6 The planned refurbishment of one of CWC's sources will allow its full licensed quantity to be abstracted, giving a small increase in deployable output. The increase is expected to be offset; however, by a small loss of deployable output as a result of an anticipated sustainability reduction applied by the Environment Agency. CWC has no plans for any significant investment in development of new resources during the WRMP09 period.

8.4.7 CWC states that it anticipates climate change may result in a small loss of deployable output, spread over a number of their sources, and that they will investigate the potential impacts of this when the Environment Agency's regional groundwater model is fully developed.

8.4.8 Deployable output is therefore expected by CWC to remain relatively static overall for the WRMP09 period.

8.4.9 For the purposes of this study, strategic water resource has been investigated at a level that encompasses the Cambridge urban area and the strategic development sites identified in Section 2.4.

Potential risks to supply

8.4.10 The main risk to the water company's supply strategy is that of limited resource availability. Maintenance of existing groundwater supply will depend upon the successful re-negotiation of licences with the Environment Agency. The CWC supply area is identified as an area of serious water stress by the Environment Agency.

8.4.11 Another potential risk to supply is that of sustainability reductions, because of the environmentally sensitive nature of some of CWC's groundwater sources. CWC has assumed, in accordance with Environment Agency guidelines, that the CAMS will have no impact on existing licence agreements or headroom allowances. The current CAMS

does not recommend any sustainability reductions on CWC licences, and the Environment Agency's water resources planning team has stated that it does not expect to introduce any until at least 2014 (when the next CAMS cycle is complete and the final document published). This means that the existing levels of abstraction are secure, to the best of current knowledge, until at least 2014.

8.4.12 If CWC's abstraction licences are not renewed to their current quota in 2015, this could reduce the water available for use. In addition, if demand were to increase beyond current projections, for example due to additional population growth or increasing consumption, this could also have serious implications for the availability of water resources. It is therefore highly recommended that all practicable measures are taken to reduce future consumption across the study area. The impact of various alternative demand management scenarios has been considered and is discussed in Section 8.5.

Box 1 Case study: Towards water neutrality in the Thames Gateway

The Thames Gateway is Europe's largest regeneration project and a major growth area which will help deliver the Government's house building targets, with 160,000 new homes by 2016. Like much of the South East, the Gateway area is seriously water stressed, and there are few water supply options without serious cost and environmental implications. The Environment Agency, in partnership with CLG and Defra, led a study to explore the feasibility of achieving water neutrality – where total water used after new development is no more than that used before the development, leaving water in the environment for wildlife and for people to enjoy. The study showed that, even with the forecast new development, population growth and increases in water demand, water neutrality is technically possible to achieve. This study demonstrated how growth and sustainable management of water resources can go hand in hand. The Environment Agency is working with CLG, Defra, Ofwat and water companies to explore further the costs and delivery mechanisms for achieving water neutrality in the Thames Gateway.

Source: Environment Agency, Defra, CLG (2007) Towards Water Neutrality in the Thames Gateway. : http://www.environment-agency.gov.uk/subjects/waterres/287169/1917628/?lang=_e

8.5 Future Demand Scenario Testing

8.5.1 CWC's draft WRMP09 identifies that the Cambridge WRZ has capacity within the licensed abstractions for the forecast development within the resource zone. The forecast population used by CWC is not derived directly from the LDF development plans, but is based on detailed historical data and water company information. All the analysis within the draft WRMP undergoes a rigorous testing and review process with Defra, Ofwat and the Environment Agency, as well as public consultation. This WCS does not, therefore, include any additional testing of the WRMP itself, but accepts for the time being the prediction of the WRMP that water resource availability is not expected to pose a constraint to the proposed level of development within the study area. This will need to be reviewed in the Phase 2 WCS in light of the results of the current WRMP consultation.

8.5.2 Regardless of the above, the study area is in an area of serious water stress and any increase in population numbers will lead to an unwelcome increase in the demand for water unless demand is managed.

8.5.3 Although the forecast demand can be met according to CWC planning scenarios, there are strong arguments for using the strongest planning means to limit the demand. These reasons are:

- The existing risk of sustainability reductions reducing the licensed capacity in the future.
- The high environmental cost of treating and supplying water (in terms of energy and carbon footprint).

8.5.4 Additionally, any further abstraction will have an impact on groundwater levels or river flows, even if these levels have been determined to be 'environmentally acceptable' by the EA by virtue of granting a licence.

8.5.5 The water company has a statutory requirement to supply water to a specific level of service. The way that it is regulated means that it cannot rely on promises by developers or local authorities to manage demand. Hence, the per capita consumption scenarios used by CWC in its demand assessment does not look at more aspirational demand management scenarios that can only be achieved with strong planning policies. This study has therefore considered demand management scenarios that go beyond CWC plans.

8.5.6 Ultimately, the best demand management planning scenario is one which is 'water neutral'. That is, over the entire study area the total demand for water does not increase with new development. This is difficult to achieve and often requires the retrofitting of extensive demand management measures within the existing urban area. However, some case studies have shown it is possible (see Box 1 Case Study).

8.5.7 The demand management scenarios below shows how various demand management strategies can affect the requirement for additional water in the study area, and what would need to be achieved in the existing urban area and the new development sites to achieve this.

- We have calculated the current total potable water demand for the WCS area by factoring the current total domestic population in the water resource zone to the domestic population in the WCS area. This factor was used to apportion all demand values, including non use (e.g. leakage) and non household demand.
- We have assumed that leakage is constant during the plan period. This is consistent with CWC's draft WRMP 2008.
- We have assumed that water taken unbilled remains constant during the plan period.
- We have assumed that non-household demand remains the same during the plan period. This is consistent with the WRMP09, which shows a very slight increase in non-household demand from 22.7 to 22.81 Ml/d.
- We have assumed incrementally decreasing occupancy rates based on government trend figures, which differ slightly from those assumed by CWC. The impact of this does not affect comparison of scenarios.

- We have used forecast dwelling numbers provided by Cambridgeshire Horizons for South Cambridge and Cambridge City District up to 2021. These may differ from the values in the WRMP, and there has been concern expressed by Cambridgeshire Horizons that the values used by CWC may underestimate the growth. As mentioned earlier, the draft WRMP undergoes a rigorous testing and review process with Defra, Ofwat and the Environment Agency, as well as public consultation. One of the key areas for scrutiny in this process is the forecast dwelling and population assumptions; therefore we are not undertaking any additional review of the accuracy of CWC's forecast population numbers.

8.5.8 The outcomes of these demand management scenarios are shown in **Figure 8-4** and Table 8.2 below.

Scenario 1: Business as usual

8.5.9 This scenario looks at how potable demand would change in the WCS study area should current per capita consumption (pcc) rates be maintained in the new development areas, assuming that all new properties are metered.

Scenario 2: Compulsory metering by 2015

8.5.10 The Environment Agency has proposed that compulsory water metering is adopted for water stressed areas by 2016. In this scenario we have assumed that the pcc for all metered homes (including new dwellings) remains at 142l/h/d, and Unmetered homes at 163l/h/d as per the WRP09.

Scenario 3: Code for sustainable homes and compulsory metering

8.5.11 This scenario looks at how implementation of CSH water efficiency targets reduces the overall increase in demand. All new homes built after 2016 will be required to achieve CSH level 6. This is a highly aspirational target and the water companies will still be expected to provide for worst case peak demands, so the anticipated consumption reduction is not currently used within CWC's planning. We have assumed for this scenario that all new properties achieve 105 l/h/d from 2008/09 (i.e. immediately), and 80 l/h/d from 2016 onwards.

Scenario 4: RSS 14 recommendation to 8% reduction in pcc new properties

8.5.12 This scenario follows the recommendation of the RSS 14 panel and reduces the pcc of all new houses by 8%, which reduces pcc to 130.5 l/h/d.

Scenario 5: RSS 14 recommendation to 25% reduction in pcc new properties

8.5.13 This scenario follows the recommendation of the RSS 14 panel and reduces the pcc of all new houses by 25%, which reduces pcc to 106.5 l/h/d.

Scenario 6: Water neutrality within WCS study area, Code for Sustainable Homes, and additional metering

8.5.14 This scenario adopts the EA position on compulsory metering by 2016, required targets under CSH, and looks at what additional demand management measures would be needed in the existing dwellings to ensure that the study area is water neutral between 2008 and 2021.

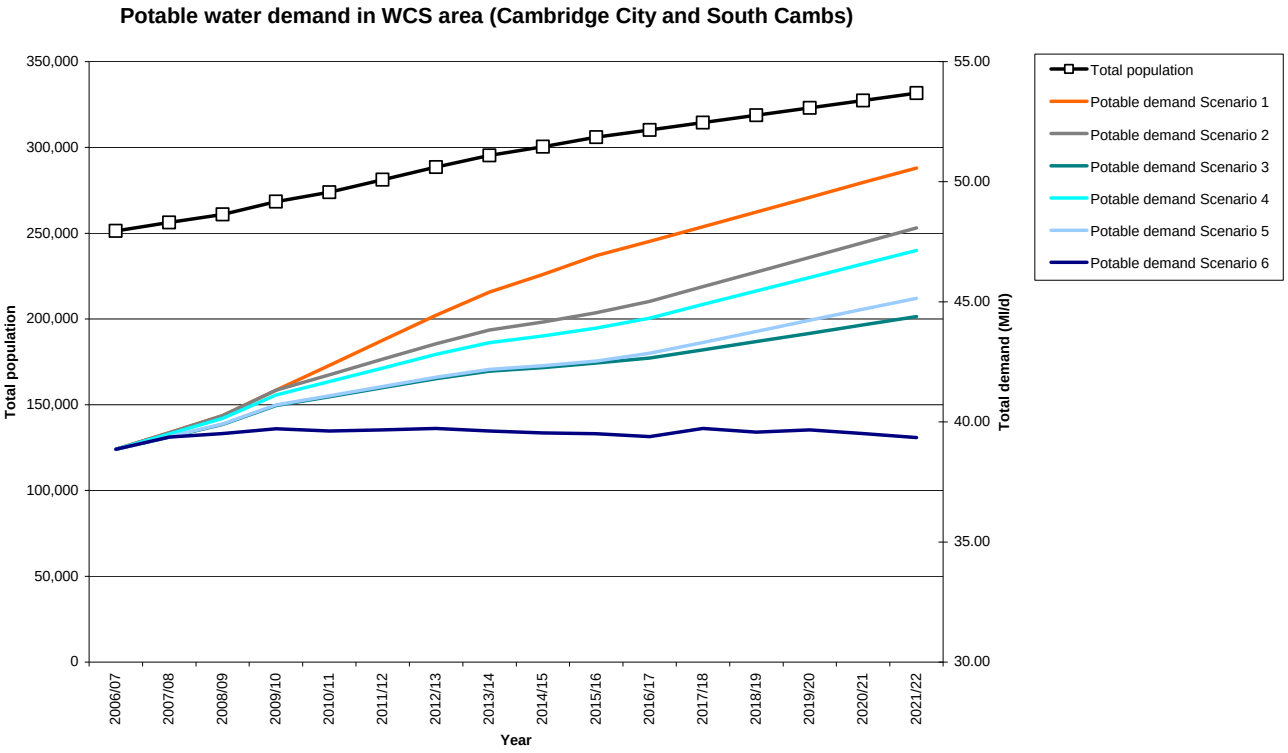


Figure 8-4: Potable water demand based on scenario analysis

				Potable water treatment		Wastewater treatment		Total treatment	
	Current demand (Ml/d)	2015/16 demand (Ml/d)	2020/21 demand (Ml/d)	daily energy requirement (MWh)	Carbon emissions (KgCO2/d)	daily energy requirement (KWh)	Carbon emissions (KgCO2/d)	daily energy requirement (MWh)	Carbon emissions (x1000 KgCO2/d)
Scenario 1	38.86	46.93	49.96	5.2	1086	4.9	1014	10.0	2100
Scenario 2	38.86	44.55	47.46	4.0	841	3.8	785	7.8	1627
Scenario 3	38.86	42.45	44.04	2.4	507	2.3	473	4.7	980
Scenario 4	38.86	43.91	46.58	3.6	755	3.4	705	7.0	1460
Scenario 5	38.86	42.54	44.69	2.7	570	2.5	532	5.3	1103
Scenario 6	38.86	39.5	39.51	0.3	64	0.3	59	0.6	123

Table 8.2: Associated sustainability figures associated with scenario analysis

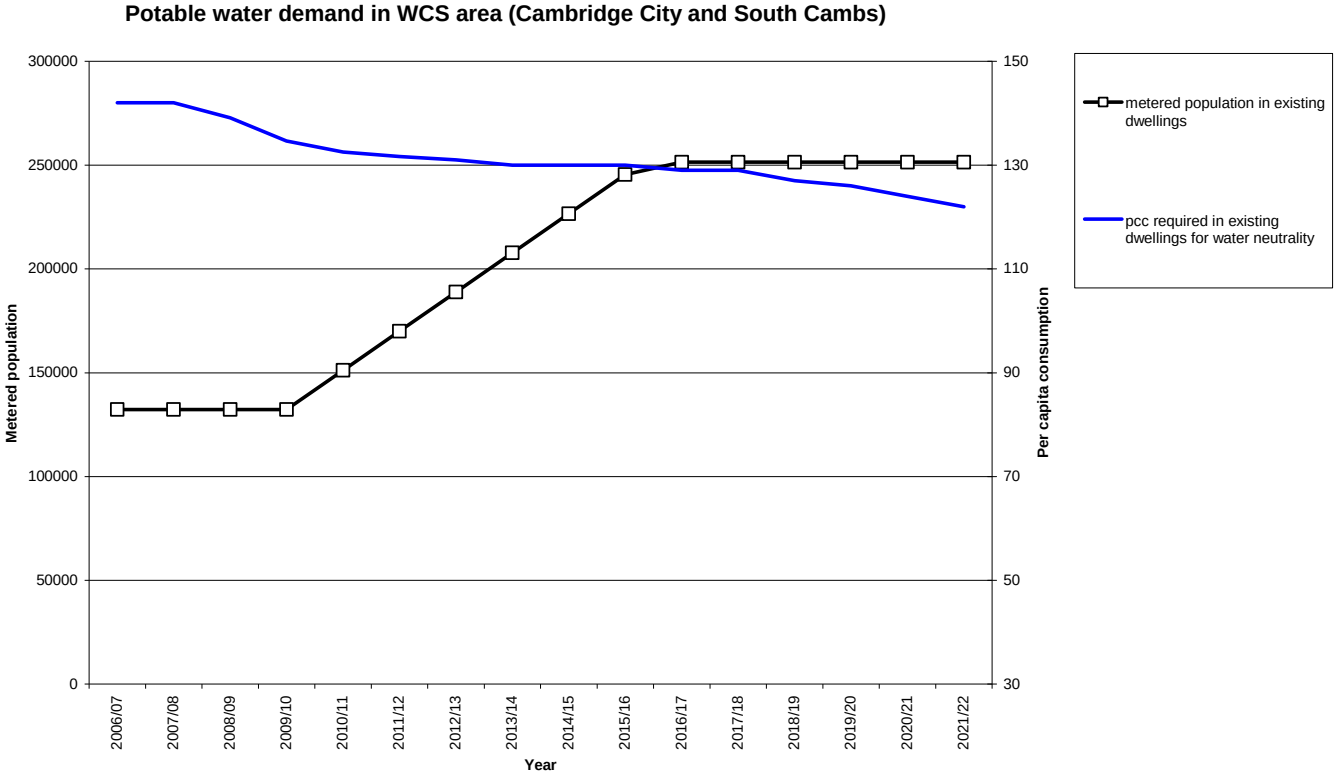


Figure 8-5: Assessment of water neutrality possibility

8.6 Water Resources Summary

8.6.1 The business as usual case shows that should we not implement any demand management measures in the future, an additional 11Ml/d of potable water will be required by the WCS area. This is approximately equivalent to 4 Olympic size swimming pools, or an increase in household demand of almost 30% between now and 2021.

8.6.2 By implementing compulsory metering and using the expected CSH implementation timetable, this increase is halved to 5 Ml/d, or an increase of only 15%.

8.6.3 If compulsory metering and the adoption of the planned CSH implementation timetable are combined with a reduction of per capita consumption in the existing dwelling stock to 120l/h/day by 2021, it is possible to negate the need for additional potable water in the WCS area altogether; i.e. water neutrality could in theory be achieved.

8.6.4 As well as benefits for the environment, minimising water demand has the potential to reduce infrastructure requirements for new development. The impacts on water supply network infrastructure requirements are considered in section 8.7. It is recommended that the implications for wastewater treatment and collection are considered in Phase 2 of this WCS.

8.6.5 Whilst the scenario testing undertaken for this Phase 1 WCS demonstrates the potential impact of various aspirational water efficiency scenarios, it has not investigated the practicability of the suggested measures to achieve these scenarios.

8.6.6 The Phase 2 WCS will need to advise on how the suggested consumption targets could be achieved in existing properties, whether this would be the most sustainable approach, and whether it is realistically achievable.

8.7 Water Supply Strategy

8.7.1 Cambridgeshire Horizons is using the Code for Sustainable Homes as a standard for defining a development's sustainability. Code Level 3 consumption is being targeted for new private homes and Level 4 for new affordable homes. Beyond 2016 Code Level 6 is the target for all new development. This constantly improving target of per capita consumption aligns with Policy WAT1 provided below.

Policy WAT1 – Water Efficiency (East of England Plan)

The government will work with the Environment Agency, water companies, OFWAT, and regional stakeholders to ensure that development provided for in the Spatial Strategy is matched with improvements in water efficiency, which will be delivered through a progressive, year on year, reduction in per capita consumption rates. Savings should be monitored against the per capita per day consumption target in the Regional Assembly's monitoring framework.

8.7.2 Water consumption is one of two mandatory sustainability categories within the Code, along with Energy efficiency. For water consumption, Figure 8-6 is taken from the Code for Sustainable Homes and shows the minimum requirements for the various Code Levels.

Achieving a sustainability rating

	Minimum Standards				
	Energy		Water		
Code Level	Standard (Percentage better than Part L[1] 2006)	Points Awarded	Standard (litres per person per day)	Points Awarded	Other Points[4] Required
1(★)	10	1.2	120	1.5	33.3
2(★★)	18	3.5	120	1.5	43.0
3(★★★)	25	5.8	105	4.5	46.7
4(★★★★)	44	9.4	105	4.5	54.1
5(★★★★★)	100[2]	16.4	80	7.5	60.1
6(★★★★★★)	A zero carbon home[3]	17.6	80	7.5	64.9

Notes
1. Building Regulations: Approved Document L (2006) – 'Conservation of Fuel and Power.'
2. Zero emissions in relation to Building Regulations issues (i.e. zero emissions from heating, hot water, ventilation and lighting).
3. A completely zero carbon home (i.e. zero net emissions of carbon dioxide (CO_2) from all energy use in the home).
4. All points in this document are rounded to one decimal place.

Figure 8-6: Code Level requirements for energy and water efficiency

(Source: Code for Sustainable Homes – A Step Change in Sustainable Home Building Practice. Crown Copyright, 2006.)

8.8 Infrastructure Requirements

8.8.1 Cambridge Water Company has undertaken detailed planning for Northstowe and Southern Fringe supply infrastructure. A higher level strategic plan exists for supplying the other development sites within the strategy area.

Northstowe

8.8.2 Before significant development can occur at the Northstowe site, a supply strategy needs to be put in place. The emerging strategy has the site supplied predominantly from the west from the existing transfer main that runs northward past the western extent of the site (see Figure 8-3). The current bulk storage and resource has been identified by Cambridge Water Company as being sufficient.

8.8.3 Reinforcements will be required to the Southern and Western Ring Mains around the urban area to support the Northstowe site. The required works have been identified as:

i. reinforcements of the Southern Ring Main to Trumpington (required for Northstowe and the Southern Fringe sites);

ii. two connections into the site from the existing transfer main to the west of the development site;

iii. upgrading of the local booster pump lifting the water to the site from the bulk storage to the west of the Cambridge urban area; and

iv. staged reinforcements of mains downstream of the booster pump to the development site connections.

8.8.4 See Appendix A for more information.

Southern Fringe

8.8.5 Upgrades to the southern ring main to Trumpington are the only works necessary to supply the Southern Fringe sites due to their close proximity to the Southern Ring Main. Distribution infrastructure into the development will be planned on a site specific basis with final master planning. Reinforcement of the ring main is planned to commence by 2010 and will be complete by 2012. The existing network can support any growth in the interim without risk to supply. Please see Appendix A for further detailed information.

Arbury and Cambridge North West

8.8.6 The Cambridge North West development sites require a new extension to the existing ring main to provide the required capacity. This proposed 450mm main will connect to the existing system approximately to the south/east of the reservoir facilities to the west of the urban area.

8.8.7 This reinforcement will be required in time to coincide with development at the proposed Cambridge North West development sites. The Arbury Park site lying directly to the north of Cambridge urban area is already half complete. The existing system will have the capacity to support the full development without requiring reinforcement. The developer has been required to contribute a cost per dwelling to Cambridge Water to contribute to the ring main extension as discussed in the previous

paragraph.

Cambridge Northern Fringe and Cambridge East

8.8.8 The preferred solution for connection of these sites has not yet been confirmed. The 450mm main running counter clockwise around the Cambridge urban area toward Histon is currently at capacity. Future developments will require reinforcement of this ring main in order to supply the proposed developments. The sizing of this main will be determined by the amount of development to go ahead at these sites and the volumes required.

Infill Development

8.8.9 Cambridge Water Company (CWC) incorporates infill development into its planning. The scale of this development generally means that major main reinforcement is not required. Strategically, this increased demand is incorporated into the sizing of the transfer mains as discussed above. Local upsizing is undertaken as sites reach requisition stage.

8.8.10 CWC will investigate opportunities for increased water efficiency measures on individual developments where practicable.

8.9 Infrastructure Cost Summary

8.9.1 High level cost estimates of strategic infrastructure to support the developments have been based on Ofwat industry standards obtained in the "Water and sewerage service unit cost and relative efficiency 2003-2004 report". This latest Ofwat information was updated using the Construction Output Price Index to represent present day figures. A 20% charge to cover design and contingency was assumed.

8.9.2 The cost of these new mains and reinforcements will be funded by developers based on a contribution per dwelling. A breakdown of infrastructure costs is provided below in Table 8.3. It should be noted that this infrastructure and its associated cost may vary in the future depending upon detailed planning and changes in consumer consumption patterns.

Site	Infrastructure Requirements	Estimated Cost (£K)*	£/ Dwelling
Southern Fringe & Northstowe	- 3.3km of 600mm along grasslands and 1km of 600mm along roadways	1,230	85 (assuming 14,250 dwellings)
Northstowe	- Upgrade local booster pumps - 1.2km of 300mm and 2km of 450mm main to connect Northstowe to the west (grassland) - reinforcement of mains from the local booster station to the Northstowe connections*.	100 590 1,444	215 (assuming 10,000 dwellings)
North West Fringe	- Approximately 3.2km of 450mm along roadways.	1,200	245 (assuming 4,900 dwellings)
Cambridge East	- Approximately 5.5km of 450mm main reinforcement of Eastern Ring Main	1,700	170 (assuming 10,000 dwellings ultimately)
Northern Fringe East	- Approximately 3.4km of 450mm main following the same ring main route beyond Cambridge East.	1,100	510 (assuming 2,000 dwellings)

*** May be reduced if water efficiency targets are met**

Table 8.3: Strategic infrastructure cost estimates

9 Ecological Constraints and Opportunities

9.1 Objectives

9.1.1 The primary objective of the ecological appraisal undertaken within this Water Cycle Strategy is to identify and summarise nature conservation issues, in terms of constraints and opportunities for the strategic development sites. Specifically, it is intended that the output could be used as part of a decision support toolbox to aid in the evaluation of development proposals for Cambridge LPAs.

9.1.2 The ecological appraisal aims to identify in particular the water and wetland ecological sensitivities in relation to the following:

- Physical impact of development upon ecological features;
- Drainage and flood defence associated with new developments;
- Water resources exploitation and protection associated with water supply for an increased population, as discussed in Section 9.6; and
- Water quality protection, in particular associated with wastewater treatment and disposal, as discussed in Section 9.6.

9.1.3 The appraisal has been based partly on the River Basin Biodiversity Framework concept developed by Natural England, the Environment Agency, and Halcrow in 2004/05 in support of the Water Framework Directive implementation in the UK. For more information on this process, please refer to Appendix H.

9.2 Significant Features Considered

9.2.1 The sites considered within this analysis are:

- European Sites – Special Areas of Conservation (SACs) and Special Protected Areas (SPAs);
- Ramsar sites;
- Sites of Significant Scientific Interest (SSSIs);
- Local Nature Reserves (LNRs);
- County and City Wildlife Sites (identified within LDF); and
- Sites identified within the Biological Action Plan for Cambridgeshire.

9.2.2 The ecological appraisal considered water and wetland features around Cambridge, as indicated below. These features were defined by considering three main types of impact that might result from development, i.e. (1) direct and adjacent off-site impacts of a development footprint; (2) hydrological and water quality changes resulting from

additional treated sewage effluent (and drainage) discharges; and (3) hydrological changes associated with additional abstraction for public water supply. For each feature listed below, the main potential impact is identified.

- The River Cam and its tributaries (Granta and Rhee) upstream, through and immediately downstream of Cambridge. The floodplains were considered as an integral part of the rivers. A number of these reaches of river have the potential for direct and off-site impacts of development.
- The Swavesey Drain network and floodplain system to the north-west of Cambridge. Potential for direct and off-site impacts of development.
- Wetland habitats and open water bodies within the Cambridge study area. Potential for direct and off-site impacts of development.
- The Cam and associated features downstream of Cambridge's main sewage treatment works at Milton, as far as the confluence with River Great Ouse. This included consideration of the possible hydrological links with other key water / wetland features, in particular areas of fen to the north-west of Cambridge. Potential sewage effluent impacts (primarily water quality, but potentially also hydrology).
- The Swavesey Drain downstream of Uttons Drove sewage treatment works as far as the River Great Ouse, and then the Great Ouse downstream to its confluence with the Cam. Again, wetland habitats in hydrological connection with these river systems were considered. Potential sewage effluent impacts (primarily water quality, but potentially also hydrology).
- Watercourses, wetland areas and open water bodies to the south of Cambridge between Melbourn and Linton, and around Thetford. The aquifers underlying both these areas are abstracted for public water supply for Cambridge, with the majority derived from the Thetford aquifer. Potential for changes in surface water and wetland features which are in connection with abstracted groundwater.

9.2.3 For specific information on the study area's biodiversity, please refer to Appendix H.

9.3 Designated Nature Conservation Areas

Breckland

9.3.1 Breckland SAC is mostly associated with dry grassland (59%) and heath (20%), plus various woodland types (19%). Water and wetland habitats are relatively limited, totalling only 1.5% of the area and comprising a mix of rivers, standing waters, fens, bog and marsh. Breckland SPA is designated for stone curlew, nightjar and woodlark, none of which are associated with water or wetland habitats. Some consideration of the potential for impacts on Breckland is warranted since it is probable that a proportion of additional public water supply for developments at Cambridge would be sourced from aquifers around Thetford, specifically boreholes at Brettenham and Euston to the east of Thetford.

Cam Washes and Wicken Fen

9.3.2 Cam Washes SSSI lies on the floodplain of the River Cam between Waterbeach and the confluence of the Cam with the River Great Ouse. The SSSI is designated for wet grassland and breeding waters, and includes washlands which flood in the winter, i.e. floodplain habitats inextricably linked with hydrological conditions in the river. Consideration of the potential for impacts on Cam Washes is warranted since a number of the proposed development sites would discharge treated sewage effluent to the Cam via Milton sewage treatment works, with consequent potential risks associated with water quality (and flows) downstream at Cam Washes.

9.3.3 Wicken Fen Ramsar site and SSSI is a wetland site to the east of the Cam valley downstream of Cambridge. However, examination of site details indicates that the fen drains towards the Cam, and is not fed by the Cam. Thus, there are no associated risks which could arise from additional sewage effluent discharge at Milton.

Ouse Washes and Berry Fen

9.3.4 Ouse Washes SAC, Ramsar site and SSSI lies between the New Bedford River and the Old Bedford River to the east of Earith. The site is seasonally-flooded washland, internationally important for birds. Recent reports identify that water levels across the Ouse Washes are increasingly too high in the Spring and Summer as a result of impeded seasonal drainage which itself is consequent upon siltation in the Hundred Foot Drain.

9.3.5 Berry Fen SSSI lies a short distance upstream of Ouse Washes, in the valley of the River Great Ouse at Earith. Like Ouse Washes it is floodplain washland used by wintering wildfowl, but Berry Fen being somewhat drier and used more when Ouse Washes is too deeply flooded.

9.3.6 Potential concerns associated with the Cambridge water cycle strategy are related to the discharge of sewage via the Uttons Drove sewage treatment works, which discharges to the Swavesey Drain which in turn feeds into the River Great Ouse upstream of both Berry Fen and Ouse Washes.

SSSIs at Cambridge

9.3.7 Designation details for each of the SSSIs within or around Cambridge itself have been examined to identify those that have water or wetland interests. The only ones are:

- Wilbraham Fens SSSI (which includes fen, reedbed and open water habitats), to the south of the A14 east of Cambridge and sufficiently distant from any potential development area not to be affected by them.
- Dernford Fen SSSI, near the A1301 at Little Shelford, and again sufficiently distant from any potential development area not to be affected by them.
- Stow-cum-Quy Fen SSSI, north-east of Cambridge and topographically higher than the River Cam, thus sufficiently distant from any potential development area not to be affected, and also not sensitive to any changes in the discharge at Milton sewage treatment works.

Regional and Local Designations at Cambridge

9.3.8 There are few water or wetland Local Nature Reserves (LNRs) within or around Cambridge itself. However, the main rivers around the city are designated as Wildlife Sites of local significance. Some of the development areas present some risks directly

or indirectly to some of these sites, and this risk is considered further within this section. LNRs within the vicinity of one or more proposed development sites include Barnwell East LNR (which has some ponds) and Bramblefields LNR (which includes ponds and seasonally flooded wet grassland).

9.3.9 Table 9.1 below shows the location of these sites within the study zone.

Significance	Feature	Designation	Information Source
International	Breckland Wiken Fen Ouse Washes	SAC, SPA Ramsar SAC, Ramsar	*Natural England* and *Joint Nature Conservation Committee*
National protected by statute	Wilbraham Fens Dernford Fen Stow-cum-quy Fen	SSSI SSSI SSSI	*Natural England*
National or regional	-	-	*MAGIC mapping web site*
Regional or local	Only reserves with water/wetland aspects are covered	LNR – Local Nature Reserves	*Cambridgeshire and Peterborough Biological Records Centre*
Local or greater	Ouse Washes Paradise & Skaters Meadow	Nature reserves managed by NGO	*RSPB, Wildfowl and Wetlands Trust, Wildlife Trust web sites*
Areas of nature conservation identified under LDF	Granta, Rhee, and Cam Rivers	County and City Wildlife Sites	*Cambridgeshire and Peterborough Biological Records Centre*

Table 9.1: Summary table showing sites of water/wetland significance in the study area

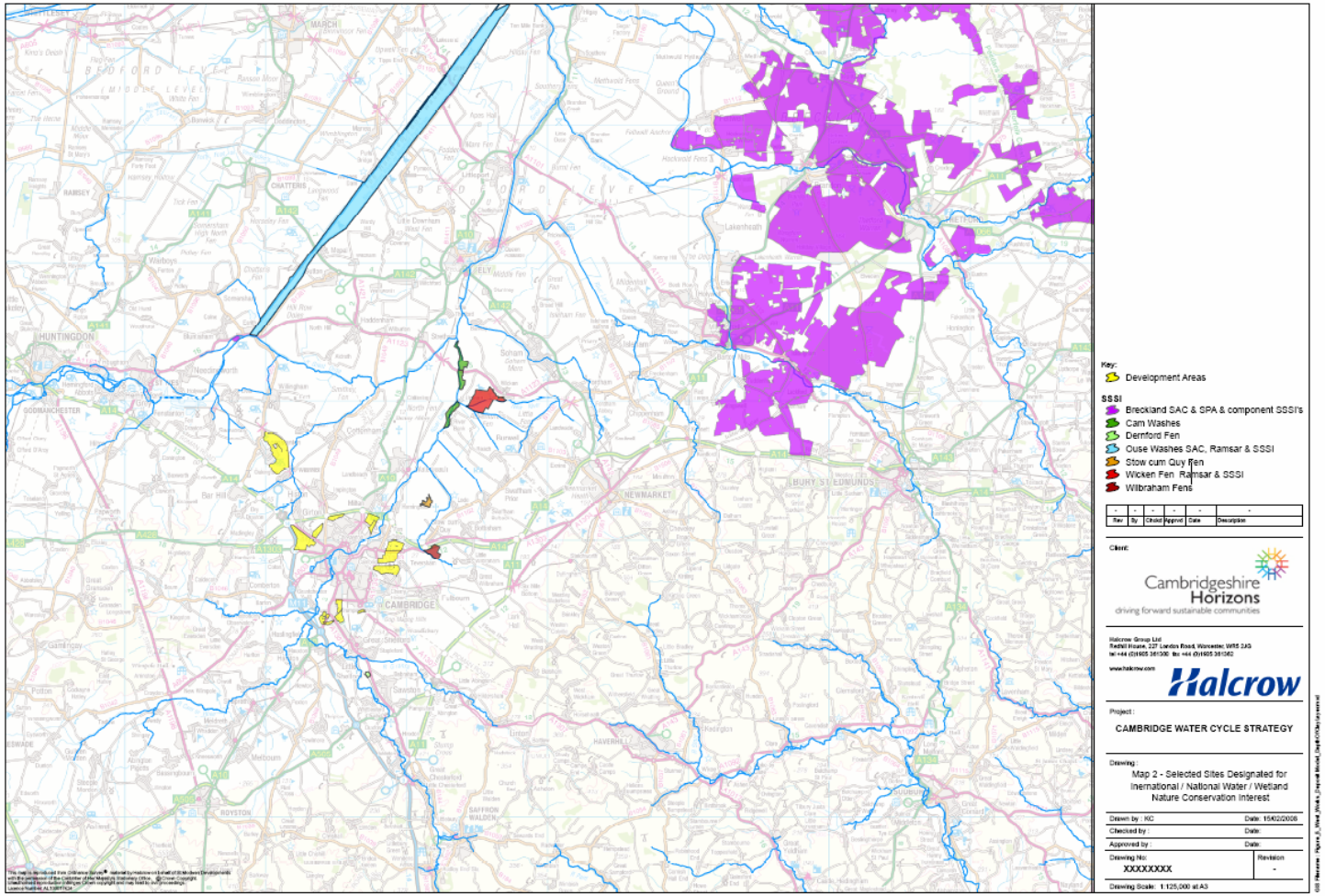


Figure 9-1: Designated sites within study area

9.4 Biological Action Plan (BAP) Habitats and Species

9.4.1 The full list of ecological constraints is drawn from the River Basin Biodiversity Framework model. This includes:

- Designated nature conservation areas
- Areas of Biodiversity Action Plan (BAP) habitat

9.4.2 The Cambridgeshire local Biodiversity Action Plan (BAP) identifies those habitats and species in the county which make the most notable contribution to biodiversity in the UK. Those relevant to the water cycle strategy – i.e. aquatic and wetland habitats and species – are shown in Table 9.2.

9.4.3 Table 9.2 below also indicates which of these are also listed as national priorities by the UK BAP. Limitations of this assessment are detailed in Appendix H.

UK BAP Broad Habitat Type	Cambridgeshire BAP Habitat Action Plan	UK BAP Priority Habitat Type
Rivers & Streams	• Rivers & Streams • Chalk Rivers	• Rivers *
Standing Open Water & Canals	• Standing Open Water & Canals • Ponds • Eutrophic Standing Waters • Drainage ditches**	• Oligotrophic & Dystrophic Lakes * • Ponds * • Mesotrophic Lakes • Eutrophic Standing Waters • Aquifer Fed Naturally Fluctuating Water Bodies
Broadleaved, Mixed & Yew Woodland	• Wet Woodland	• Wet Woodland
Improved Grassland	• Coastal & Floodplain Grazing Marsh	• Coastal & Floodplain Grazing Marsh
Fen, Marsh & Swamp	• Fens • Reedbeds	• Upland Flushes, Fens & Swamps • Purple Moor Grass & Rush Pastures • Lowland Fens • Reedbeds
Bogs		• Lowland Raised Bog • Blanket Bog
* These were confirmed as UK priority habitats in December 2007, and have not yet been incorporated into an updated Cambridgeshire BAP ** Locally important habitat not included in the UK BAP		

Table 9.2: Water and Wetland Habitats and Species in UK and Cambridgeshire BAPs

9.4.4 Examination of the Cambridge Biodiversity Strategy and other documents has not identified any specific water or wetland habitat nature conservation interests additional to these.

9.4.5 BAP species (and other nationally significant species) that are aquatic or primarily associated with water or wetland habitats and relevant to the study area include:

- otter;
- water vole;
- great crested newt.

9.4.6 For more extensive information on these species and comments on other water and wetland species that have been considered due to their mention within the BAP or presence in the study area, please refer to Appendix H, and Figure 9-2 below.

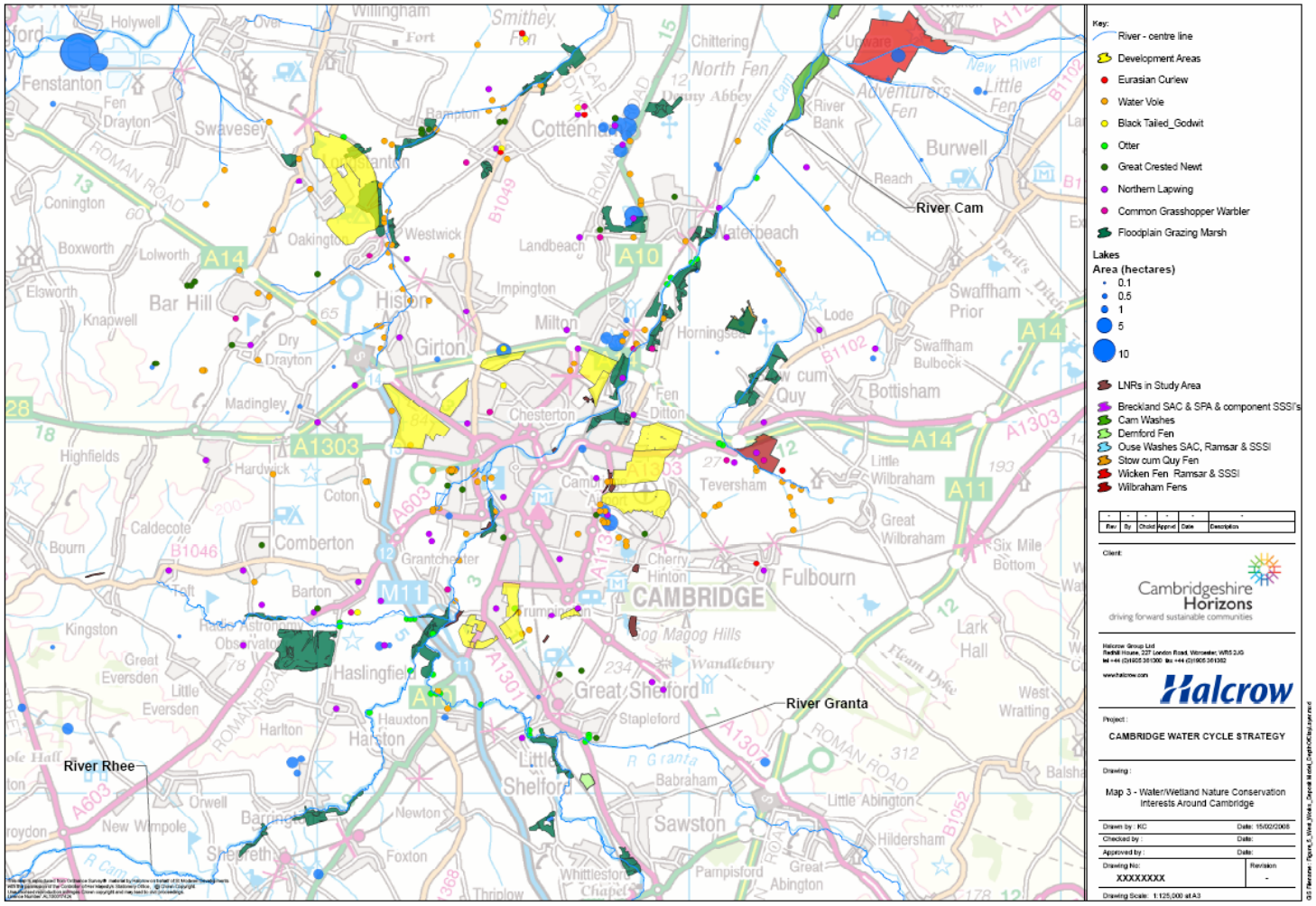


Figure 9-2: Water / Wetland Conservation Interests around Cambridge

9.5 Contribution to Nature Conservation

9.5.1 The River Basin Biodiversity Framework concept identifies nature conservation objectives as "critical" (C), "important" (I), or "desirable" (D). This is based on the value of a nature conservation feature ("international/national", "regional/county" or "local") and its sensitivity to impacts (see Table 9.1), as well as its status and threats to it.

9.5.2 In respect of the Cambridge WCS, realistic objectives for water and wetland nature conservation for the various development sites have been identified in Table 9.3 below. For more detailed information on the conservation features, values, objectives, please refer to Appendix H.

		Development Sites												
		a	b	c	d	e	f	g	h	i	j	k	l	2
Preserve Otter Populations	**C**	-	-	-	-	-	-	-	-	-	H	M	M	H
Preserve water vole population/habitat	**C**	M	-	-	H	-	-	H	H	-	M	-	-	H
Preserve great crested newts	**C**	-	-	-	-	-	-	-	-	-	-	-	-	-
Preserve existing floodplains marsh inc. fenlands	**C**	-	-	-	M	L	-	-	-	-	-	-	-	H
Preserve main river habitats and quality	**C**	M	M	M	M	M	H	H	H	M	H	H	H	M
Preserve open waters / ponds	**C**	U	U	U	U	U	U	U	U	U	U	U	U	U
Preserve Cyprinid Fishers in the Cam	**C**	M	M	M	M	M	H	H	H	M	H	H	H	M
Preserve integrity of Nature Reserves	**I**	-	-	-	-	M	-	M	-	-	-	-	-	-
Preserve existing drainage ditches	**I**	U	U	U	U	U	U	U	U	U	U	U	U	H

L = Low Risk, M= Medium Risk, H = High Risk, U = Unknown, C = Critical, I = Important

Table 9.3: Realistic objectives for water and wetland nature conservation

9.6 Pressures Associated With Development

Consideration of Appropriate Assessment under the Habitats Regulations

9.6.1 The European Union Habitats Directive (92/43/EEC) sets out the requirement for assessment of plans or projects affecting European designated sites, i.e. SACs and SPAs. It requires that any plan or project not directly connected with management of any such site, but likely to have a significant effect on it, should be subjected to an Appropriate Assessment of its potential adverse effects on the site's conservation objectives. A tiered approach is taken to the assessment, with the level of detail required depending on the level of perceived risk. At this stage of the Water Cycle Strategy, the assessments can only be preliminary. The potential concerns that exist

do not relate to the footprint of any development site, since these are all well removed from SACs and SPAs, but rather relate to the additional public water supply that will be needed, and to the additional treated wastewater that will be discharged in to the river systems. These are considered in the following sections.

Pressures associated with water supply

9.6.2 The Environment Agency's characterisation of river basins under the Water Framework Directive has apparently identified that a number of groundwater-dependent terrestrial ecosystems (GWDTEs, i.e. wetland systems that are supplied by groundwater as opposed to river water or direct rainfall and overland flow) exist within Breckland. Further details on these groundwater-dependent wetlands would be required to confirm whether or not they are components of the SAC. However, since the aquifer has been identified as vulnerable to over-abstraction, no new consumptive abstractions will be licensed by the Environment Agency. Cambridge Water Company's strategy to provide additional public water supply to developments at Cambridge would include abstracting the full licensed amount from the boreholes in the Thetford area, which remains in force until 2015. Additional abstraction over and above this is not foreseen , and would anyway require a full resource evaluation to be undertaken first, including appropriate assessment if any impacts on the Breckalnd European site were anticipated. Currently, there is no reason to consider that proposed developments at Cambridge would present a risk of impact on Breckland's water and wetland features of European value.

9.6.3 Additional abstraction may be associated with the area to the south and south-east of Cambridge. Currently there are approximately 20 groundwater abstraction locations within this area, as well as surface abstraction from the River Granta. However, there is the potential for reduced future rainfall in the region, associated with climate change, and any resource pressure on the chalk aquifer and associated aquifer-fed chalk streams can be expected to increase.

Pressures associated with treated sewage discharge

9.6.4 Under risk of impact are Cam Washes SSSI which lies on the floodplain of the River Cam downstream of Waterbeach. The site is essentially winter floodplain washlands, and could potentially be affected by poor water quality in the River Cam. However, the SSSI lies approximately 10 fluvial kilometres downstream of Milton sewage treatment works at its nearest point. This distance, and the level of dilution available in the Cam, reduces the risk of transport of undiluted and undispersed contaminants to the SSSI site. Furthermore, the SSSI floods in winter, when flows are high and available dilution at its maximum. Natural England's citation indicates that the SSSI is considered to be in favourable condition, and has not identified inadequate water quality (or quantity) as a particular concern for the site. Therefore, recognising also that any additional effluent discharge from Milton sewage treatment works will be subject to consenting to ensure protection of the River Cam's current river quality objective of 3 (i.e. "Fair" quality), development sites around Cambridge which would use this sewage works are not considered to present a significant risk to nature conservation interests at Cam Washes SSSI.

9.6.5 Ouse Washes SAC, Ramsar site and SSSI is seasonally-flooded washland associated with the River Great Ouse system, downstream of the Swavesey Drain tributary. The site's value is potentially at risk from impeded drainage via the Hundred Foot Drain as a result of siltation, which could change the habitat character of the washes. Thus, additional water across the site might be undesirable in the absence of appropriate remedial action (silt management).

9.6.6 Potential concerns associated with the Cambridge water cycle strategy are related to the discharge of sewage via the Uttons Drove sewage treatment works, which discharges to the Swavesey Drain. However, although the additional flow estimated to arise from further wastewater discharges via Uttons Drove (4575m^3/day as an average) is a 3-fold increase over the existing discharge, it is still insignificant when compared with existing cumulative flow in the river system. Flow data that are available for the River Great Ouse suggest that the additional flow would account for significantly less than one per cent of the average flow. Furthermore, no significant water quality risk is apparent, for much the same reasons as discussed above for Cam Washes SSSI including the similar distance of approximately 10 fluvial kilometres from Uttons Drove sewage treatment works to the nearest part of the designated site.

9.6.7 Berry Fen SSSI, a short distance upstream of Ouse Washes, is also floodplain washland used by wintering wildfowl. Berry Fen is somewhat drier than the Ouse Washes, and is used more when the latter are too deeply flooded, thus providing an off-site contribution to the quality of Ouse Washes. However, for the same reasons as discussed above, there are considered to be no significant water quantity or water quality risks associated with developments at Cambridge which would have an adverse effect on the SSSI and thus, indirectly, on the interest features of the European designated Ouse Washes.

9.6.8 Future declines in rainfall across the region which may be associated with climate change could result in declining river flows, with the potential for effects on the hydrology of washland sites. Arguably, any additional flow in the associated rivers might offset such effects. However, as indicated, the flow contributions that would result from the developments at Cambridge are considered to be insignificant compared to total river flows and, therefore, no incidental benefit can be claimed.

9.6.9 Table 9.4 provides a summary of the ecological sites of significance that may potentially be impacted upon by a deterioration in water quality.

WwTWs / Receiving Waterway	Development Sites	Sites of Potential Impact	Risk of Impact
Milton - River Cam	Combined	Cam Washes (SSSI)	Low
Uttons Drove - Swavesey Drain / Great Ouse	Northstowe	Ouse Washes (SAC, Ramsar, and SSSI), Berry Fen (SSSI)	Low

Table 9.4: Potential impacts of change in wastewater discharge associated with development

Pressures associated with development sites

9.6.10 The likely pressures, proposed mitigation measures and possible opportunities for enhancement associated with specific development site options around Cambridge are summarised the following Table 9.5.

9.6.11 It is stressed that these impacts only to water and wetland ecological constraints and are based on a high level strategic assessment, not supported by any specific ecological surveys. Recognising these caveats, it would appear that the ecologically significant aspects are potentially affected by the development sites.

Feature	Value / Sensitivity of Feature	Pressure(s) & Significance	Probability & Magnitude	Mitigation and (Responsbilities)	Opportunity	Relevant Development Areas
Designated Sites						
Designated fisheries	International / High	Reduced water quality in Cam & upper tributaries or in Great Ouse	**Probable** increase in habitat pressures and water contamination by wastewater and runoff from new development	High level wastewater treatment (AWS)	-	All
				Treatment of surface runoff before discharge to rivers (Developer, LPA and AWS)	-	F, G, H, J, K, L, (all)
				Ensure no incursion of hard development into river corridor - no impacts on channel structure (Developer and LPA)	-	F, G, H, J, K, L, (all)
River channel morphology (all main rivers are Wildlife Sites)	Local / Medium	Risk of new channel forms being "drowned out" or eroded by additional flow – minor impact	**Potential** outcome if no mitigation applied – effects likely to be localised	Ensure channel improvement design accounts for potential future increase in flow (Developer and LPA)	-	All
				Attenuation of surface runoff incorporated into all hard development (Developer and LPA)	-	All
Barnwell (East) LNR	Regional value / Low sensitivity	Risk of hydrological change resulting in impacts on pond to north of site (potential great crested newts) - minor impact on overall site quality	**Potential** for adverse effects on surface drainage / water quality (assuming development within the LNR boundary will not be permitted)	Buffer zone between development and pond. Maintain existing hydrology. (Developer and LPA)	Potential to create additional ponds (and great crested newt habitat)	G
Bramblefields LNR	Regional value / Low sensitivity	Risk of hydrological change resulting in drying out of seasonally-flooded wet grassland - moderate impact on overall site quality	New development **unlikely** to impact LNR as separated by railway	Confirm local hydrological connections and identify if appropriate mitigation measures required (Developer and LPA)	-	E

Habitats						
Floodplain grazing marsh habitat	National value / High sensitivity	Development pressures & drainage pressures in relevant floodplain areas – potential for significant impact (loss of UK BAP priority habitat)	**Confirmed** significant overlap with floodplain grazing marsh	Development to avoid floodplain grazing marsh and maintain existing hydrology (Developer and LPA)	-	2
			Potential for modified hydrology on adjacent floodplain grazing marsh	Maintain existing floodplain surface hydrology (Developer and LPA)	Potential to extend floodplain grazing marsh habitat	D, (E)
Rivers and streams	National value / Moderate sensitivity	Development pressures & drainage / water quality – moderate impact (decline in UK BAP priority habitat quality)	**Potential** for hydrological changes in floodplain and water quality impacts on channels	Maintain existing floodplain surface hydrology and ensure water quality protection measures in place (Developer, AWS and LPA)	Potential to improve on existing water quality protection measures	F, G, H, J, K, L, (all)
		Treated wastewater discharge into rivers.	**Potential** for adverse effects on water quality if wastewater treatment inadequate or fails. Rivers Rhee (Haslingfield sewage treatment works)& Granta (Sawston STW) more sensitive than other rivers	Ensure no relaxation in consented quality and no additional risk of failure of receiving water quality objective (EA)	Potential to improve wastewater treatment compared to existing	All but most notably K, L (R.Rhee)
		Additional public water supply abstraction from chalk aquifers to south of Cambridge	**Potential** for impact on quality of chalk stream headwaters, exacerbated by reduced future rainfall associated with climate change	Water conservation measures in all developments to minimise additional water resource demands (Developer and LPA)	-	All, potentially
Standing open water / pond habitat	National value / Medium sensitivity	Development pressures & drainage pressures – potential for significant impact (loss of UK BAP priority habitat)	**Potential** for direct loss of habitat or adverse effects on surface drainage / water quality	Development to provide buffer zone around open waters / ponds and protect hydrology and water quality (Developer and LPA)	Use surface drainage / wastewater to create new water bodies to complement existing	All

Drainage ditches	Regional value / High sensitivity	Development pressures & drainage pressures – potential for significant impact (loss of local BAP habitat)	**Potential** for direct loss of habitat or adverse effects on surface drainage / water quality	Development to provide buffer zone around drainage ditches and protect hydrology and water quality (Developer and LPA)	Integrate new SUDS / surface drainage to complement existing drainage ditch network	All, potentially, but most notably Northstowe
Species						
Water vole	National value / High sensitivity	Habitat damage resulting from development pressures & modified hydrology – significant impact	**Confirmed** minor overlap with water vole stronghold	Development to avoid river corridors & maintain bank habitat & hydrology (Developer and LPA)	Potential to improve river bank habitat and hydrology	D, G, H, 2
			Confirmed minor overlap with other water vole habitat	Ditto	Ditto	A, J
Otter	National value / High sensitivity	Habitat damage resulting from development pressures & modified hydrology	**Confirmed** minor overlap with otter range	Development to avoid river corridor (Developer and LPA)	-	J, 2
		Off-site disturbance from recreation, dog walking etc. along river banks	**Potential** for significant disturbance of otters	Development to discourage use of river banks for informal recreation (Developer and LPA)	-	J,K, L, 2
Great crested newt	National value / High sensitivity (needs to be confirmed by survey)	Risk of damage to existing populations / habitat	**Potential** additional pressures resulting from development & land use. Distribution to be confirmed.	Survey of all potential development areas; mitigate as agreed with Natural England (LPA, Developer)	Additional survey data. **Potential** to create new habitat. **Potential** to develop of a strategy to enhance newt meta-population	All (to be confirmed by site-specific surveys)
Local BAP species (white-clawed crayfish, breeding or wintering birds of river corridors)	Local value / sensitivity to be confirmed	Risk of damage to existing populations / habitat	**Potential** pressures resulting from development & land use. Distributions to be confirmed.	Survey of all potential development areas; mitigate as agreed with Natural England (LPA, Developer)	-	All (to be confirmed by site-specific surveys)

Table 9.5: Summary of Pressures, Mitigation and Opportunities for Water and Wetland Nature Conservation

10 Additional Growth Scenario

10.1 Future growth

10.1.1 The Cambridge sub-region will continue to grow beyond 2021 and it is possible that Cambridge City and South Cambridgeshire districts will be required to provide more than the 42,500 dwellings currently outlined within the East of England Plan. This section provides a high level assessment to identify which areas of the city would be suitable to accept future development purely in terms of water services infrastructure.

10.1.2 The scope for this strategy required consideration of a 20% increase in the number of dwellings currently required around Cambridge. As no sites have been identified for development, it was agreed by the stakeholder group that the most valuable approach would be to assess the general capacity of the water services in the city peripheries and gauge the likely affect of additional development. This approach follows the general development hierarchy by focusing initially on sustainable urban extensions, in this case the potential further extension of those already identified. Note that water resource has not been included in this table as it is not location specific.

	North / West	North / East	South / West	South / East
Flood Risk	Likely to drain into Cottisham Lode or Bin Brook increasing existing downstream flood risk. Opportunity exists for developer to fund mitigative improvements.	Would require careful site placement and sound flood risk strategies.	Incurs no unacceptable increase in flood risk if located out of Bin Brook catchment.	Incurs no unacceptable increase in flood risk.
Wastewater	Likely to increase the sewer flooding to existing properties. Opportunity to strengthen the case for a strategic sewer solution to serve Sites A&B which could connect into a branch of the tunnel sewer network.	This would be suited to direct connection to Cambridge WwTW rather than into the existing network. This has the potential to increase the risk of sewer flooding in the centre of Cambridge.	Potential available capacity in the large diameter sewers in Coldhams Lane or MowbrayRd/Perne Rd/Brooks road may accommodate development. Alternatively development in this area may support the case for a strategic sewer to serve Cambridge East.	Least sewer capacity of the options. It is likely that a new strategic sewer would be required to serve development in this location.
Water Supply	Possible	Possible	Possible connection	Possible

	connection to existing system	connection to existing system	to existing system	connection to existing system
Ecology	Unlikely to have significant negative impacts on water / wetland ecology.	Likely to lead to significant increase in negative impacts on otter / water vole populations in River Cam / Cherry Hinton Brook. Impacts on floodplain grazing marsh. Increased risk of river pollution. Potential risk to great crested newt in adjacent LNR.	Likely to present greatest risk to water / wetland species and habitats. This area is an otter stronghold due to lack of human disturbance. There are also water vole populations and areas of floodplain grazing marsh. Potential for great crested newt populations in Byron's Pool LNR.	Unlikely to have significant impacts on water / wetland ecology, although potential risk to water voles. Limekiln Close and West Pit LNR is located to the south east of the city but has no wetland ecology features.

11 Conclusions and Recommendations

11.1 Overview

11.1.1 This Phase 1 Water Cycle Strategy has considered the achievability of the proposed level of growth for Cambridge in terms of the Water Cycle, with specific reference to the relative feasibility of the proposed LDF development sites. The following aspects have been investigated:

- Flood risk management
- Groundwater and the use of sustainable drainage systems
- Wastewater
- Water resources and water supply
- Ecological constraints and opportunities
- Guidance for new developments

11.1.2 Each of these aspects has been considered in detail and the conclusions are summarised by category in the following sections.

11.2 Flood Risk Management

11.2.1 The majority of the proposed developments fall within the Environment Agency's Flood Zone 1 with the exception in the south west of the Northern Fringe which lies in Flood Zone 3. Defences reduce the flood risk however so that the proposed development is not within the SFRA Flood Zone 3.

11.2.2 Areas downstream of the developments sites with a history of flooding, or that fall within the EAs flood zones 2 or 3 include:

- The Beck Brook/Cottenham Lode catchment, and
- Properties on the bank of the Cam in the vicinity of Elizabeth Way and Mariner's Way.

11.2.3 Each development site has the potential to increase flood risk in their respective catchments, which include the Cam, Botthisham Lode, Hobsons Brook, and Beck Brook/Cottenham Lode. Developers should ensure storage space for water within their outline planning.

11.2.4 Runoff from sites should be controlled to the appropriate standards and demonstrate an adequate method of disposal to ensure the site runoff does not increase the risk of flooding elsewhere.

11.2.5 There is a site-specific flood risk assessment (FRA) for all development proposals larger than 1 ha in flood zone 1 and for all new development in flood zones 2 and 3. This is a requirement of PPS25. These should account for climate change. The FRA must show:

- Whether a proposed development is likely to be affected by current or future flooding from any source.

- Whether it will increase flood risk elsewhere.
- Whether the measures proposed to deal with these effects and risks are appropriate.
- Whether the site will be safe to enable the passing of part c of the Exception Test if this is appropriate. This demonstrates that the development is safe, does not increase flood risk elsewhere, and where possible reduces flood risk overall.

Northstowe and the North West Fringe

11.2.6 There is existing flood risk in the Cottenham Lode catchment hence sufficient attenuation and long term storage will be required to avoid exacerbating this risk. It is advised that developers pay for an independent hydraulic modelling study to:

- Assess the current standard of protection for Histon and Impington, by extending the hydraulic model to cover the tributary of Beck Brook through Histon and Impington.
- Demonstrate that the flood risk in the Cottenham Lode catchment will not increase as a result of the combined cumulative effect of developments in the catchment.
- Assess the opportunity for strategic flood risk mitigation options for the Cottenham Lode catchment.
- Assess the opportunity for enhancing the level of service to areas where there is a known flood risk.
- The developers adopt the recommendations of the study including contributing towards any measures that may enhance the level of service to areas where there is a known flood risk.

Cambridge East

11.2.7 The three developments within Cambridge East drain in four different directions. Flows into Bottisham Lode are likely to increase flood risk downstream due to the small scale of the waterway hence long term storage will be needed for controlled discharge. The discharge requirements will be defined by future EA policy regarding Bottisham Lode.

11.2.8 The developers of the Cambridge East sites should conduct site investigations to determine the infiltration rate and greenfield runoff rates from these sites, and these rates should be agreed with the Environment Agency.

11.2.9 The developers should produce site specific flood risk assessment to show there will be no increase in flood risk from development to Bottisham Lode, Coldhams Brook, and the East Cambridge Main Drain. The developers of the Cambridge Airport and North of Cherry Hinton sites should investigate the opportunity for ecological enhancement by increasing flows in Coldhams Brook using water released from storage.

11.2.10 Swaffham IDB should be involved as a consultee in the planning process.

11.3 Northern Fringe East and Arbury Park

11.3.1 These sites are both downstream of areas of flood risk in the First Public Drain. There are no opportunities for flood mitigation in these sites.

11.3.2 The developers of Arbury Park and the Sewage Works sites should produce site specific flood risk assessments to show that there will be no increase in flood risk to the First Public Drain.

11.3.3 As part of the Northern Fringe East development sites are in flood zone 2 and 3 the developer(s) of these sites should undertake a flood risk assessment to establish the extent of the flood zones 2, 3a and 3b for these sites, and the future extent of these flood zones with climate change. Land use within these sites should be allocated according to the appropriate uses for the flood zones according to in PPS25.

Southern Fringe

11.3.4 No obvious flood risk is associated with the development. An opportunity exists for stabilising erratic flows in Hobson's Brook via controlled discharges from long term storage.

11.3.5 The developers of sites Bell School, Clay Farm and Glebe Farm should produce a site specific flood risk assessment to show that there will be no increase in flood risk to Hobson's Brook.

All sites draining into the Cam

11.3.6 Excepting Northstowe and the North West Fringe, all sites ultimately drain into the Cam, where 50 domestic properties are in the SFRA and EA flood zones. It is unlikely releasing long term storage into the Cam will have any significant impact.

11.3.7 The developers of all sites draining into the Cam (all sites except the North West Fringe) should contribute to a modelling study to show that there will be no increase in flood risk from the Cam as a combined effect of the developments.

11.4 Groundwater and SUDS

11.4.1 The strategic development sites are situated on varying underlying geology, affecting the kinds of SUDS that are suitable for the respective sites. Additionally, the groundwater in Cambridge is relatively close to the surface. Risk assessment should be undertaken in all scenarios based upon the guidance provided in Appendix C and E, to ensure appropriate SUDS are implemented.

11.4.2 The Southern Fringe and Cambridge East development sites sit on permeable geology and hence infiltration SUDS may be an option pending localised surveys to confirm this.

11.4.3 The North West Fringe, Arbury, and Northern Fringe East are on variable geology of limited permeability, hence site specific surveys would be required to prepare a suitable SUDS strategy.

11.4.4 The Northstowe site is situated on underlying geology of limited permeability, however the superficial geology is intermittently permeable, hence localised surveys would be required to ensure suitable SUDS.

11.5 Foul Drainage, Sewage Treatment and Water Quality

11.5.1 The discharge consent at Cambridge WwTW will not require revision to accommodate the increased flow from the infill or strategic development sites within Cambridge. However improvements will be needed to the treatment works in order to

maintain the quality of the effluent discharged to the River Cam. AWS will seek investment to facilitate these improvements through its regulatory periodic review process for implementation in AMP5 (2010-15) and AMP6 (2015-20).

11.5.2 AWS are aware of sewer flooding problems for properties in Windsor Road, Cambridge. A potential solution for connecting the NIAB site into the Cambridge network would also solve the sewer flooding problem in Windsor Road. The preferred solution for connection of the NIAB site is being developed within the wastewater capacity study.

11.5.3 The initial findings of the Cambridge wastewater capacity study have shown that the additional flows from infill and windfall development across Cambridge is likely to increase the risk of sewer flooding to existing properties within Cambridge. Halcrow are currently working with AWS to identify suitable mitigation measures to prevent this potential increased risk of sewer flooding.

11.5.4 There are four combined sewer overflows (CSOs) in the Cambridge sewer network. The discharge volume from these CSOs are not expected to increase due to the strategic development sites, however it could increase due to the additional flows from the infill development.

11.5.5 The large diameter sewer network can accommodate all of the flow from the strategic developments without upgrade. The majority of sites will need to provide strategic connection sewers to connect into the large diameter sewer network. Cambridge East will need to connect to the sewer in Coldhams Common, Northwest Cambridge will connect into the branches of the tunnel network on Madingley and Histon Road and the Southern Fringe (except Trumpington Meadows) will connect to the sewer at the junction of Mowbray Road and Long Road. The current preferred option for Trumpington Meadows site is to connect into the sewer in Trumpington Road which will require upgrade and two online storage tanks, however investigation into the possible connection into Mowbray Road and its associated upgrade requirements is still ongoing.

11.6 Water Supply

11.6.1 No specific technical constraints have been identified preventing proposed growth in the study area. Key infrastructure for the Northstowe and Southern Fringe sites has been proposed by Cambridge Water Company and independently approved by Halcrow. Strategic infrastructure for the remaining development sites has been identified at a high level, and will require detailed modelling and planning so infrastructure commissioning may coincide with the construction at the development sites.

11.6.2 Achieving the water efficiency targets in future development should include implementation of the new 1APP development application system (see Appendix I), incorporating local development requirements laid down in the developer checklist in Appendix C. Achieving water efficiency targets has the potential to eliminate the need for the final phase of main reinforcement to Northstowe, resulting in a saving of approximately £340,000 that may be passed on to the developer.

11.6.3 It is recommended that the solutions provided in this strategy are reviewed in respect to changing growth trajectories for the various sites, and in relation to changing customer consumption patterns. A Phase 2 Water Cycle Strategy is recommended to detail infrastructure requirements for those strategic development sites that will have

planning applications lodged in the near future. Greater analysis of impacts of water efficiency measures may be investigated based on consumption trends.

11.7 Ecological Constraints and Opportunities

11.7.1 A summary of the relevant ecological features of significance potentially affected by the LDF development areas are provided in Table 11.1.

Feature	Value / Sensitivity	Probability of Threat	Mitigation & Opportunity	Responsibility
Designated Fisheries	International / High	Probable all sites	Mitigation identified	Anglian Water , LPA, (and developer)
River channel morphology	Local / Moderate	Potential	Mitigation identified	LPA (and developer)
Flood plain grazing marsh	National / High	Confirmed site 2 Potential sites D, E	Mitigation and opportunities identified.	LPA (and developer)
Rivers and streams	National / Moderate	Potential for all sites	Mitigation and opportunities identified	LPA, EA (and developer)
Standing open water / pond habitat	National / Moderate	Potential for all sites	Mitigation and opportunities identified	LPA (and developer)
Drainage ditches	Regional / High	Potential for all sites esp. Northstowe	Mitigation and opportunities identified	LPA (and developer)
Water vole	National / High	Confirmed for sites	Mitigation and opportunities identified	LPA (and developer)
Otter	National / High	Confirmed for Northstowe, Clay Farm. Potential for other Southern Fringe sites.	Mitigation identified	LPA (and developer)
Great crested newts	National / High	Potential for all sites	Mitigation and opportunities identified	LPA (and developer)

Table 11.1: Summary of ecological constraints and opportunities

11.7.2 It is recommended that existing Area Action Plan policy, and the Halcrow Developer Checklist in Appendix C be applied for future developer applications to ensure the identified mitigative actions and opportunities be incorporated into the development. Existing applications should have conditions incorporated to minimise ecological impacts.

11.8 Scope for Phase 2

11.8.1 Based upon the findings of this Phase 1 Outline Water Cycle Strategy, the following scope for Phase 2 has emerged:

- Review the findings of the Phase 1 WCS in light of any new information available at the time of commencement.
- Undertake detailed analysis for Cambridge East, North West Fringe, and the Northern Fringe East, including programme and indicative costs based upon the latest planning information.
- Incorporate into the Water Cycle Strategy additional information on any additional major development sites or increased growth targets, in the event that new information becomes available.

- Develop a schedule of tasks and activities for developers and relevant stakeholders to implement the Phase 2 WCS.
- Undertake detailed cost benefit analysis of the aspirational water efficiency scenarios outlined in Phase 1 WCS, including advice on how the suggested consumption targets could be achieved in existing properties, and whether this would be the most sustainable approach.
- Identify and cost detailed technical solution for Swavesey Drain mitigation works (Northstowe and Cambourne foul drainage), if still outstanding.
- Engage relevant stakeholders to develop an integrated and comprehensive Surface Water Management Plan for the study area, including a common SUDS Adoption Strategy.
- Incorporate the findings of the wastewater capacity study undertaken by Halcrow for AWS.
- Develop ecological design criteria for the sites yet to obtain planning permission, to maximise the appropriate water / wetland ecological benefits through relevant design of surface water and grey water management infrastructure.

11.9 Infrastructure Program

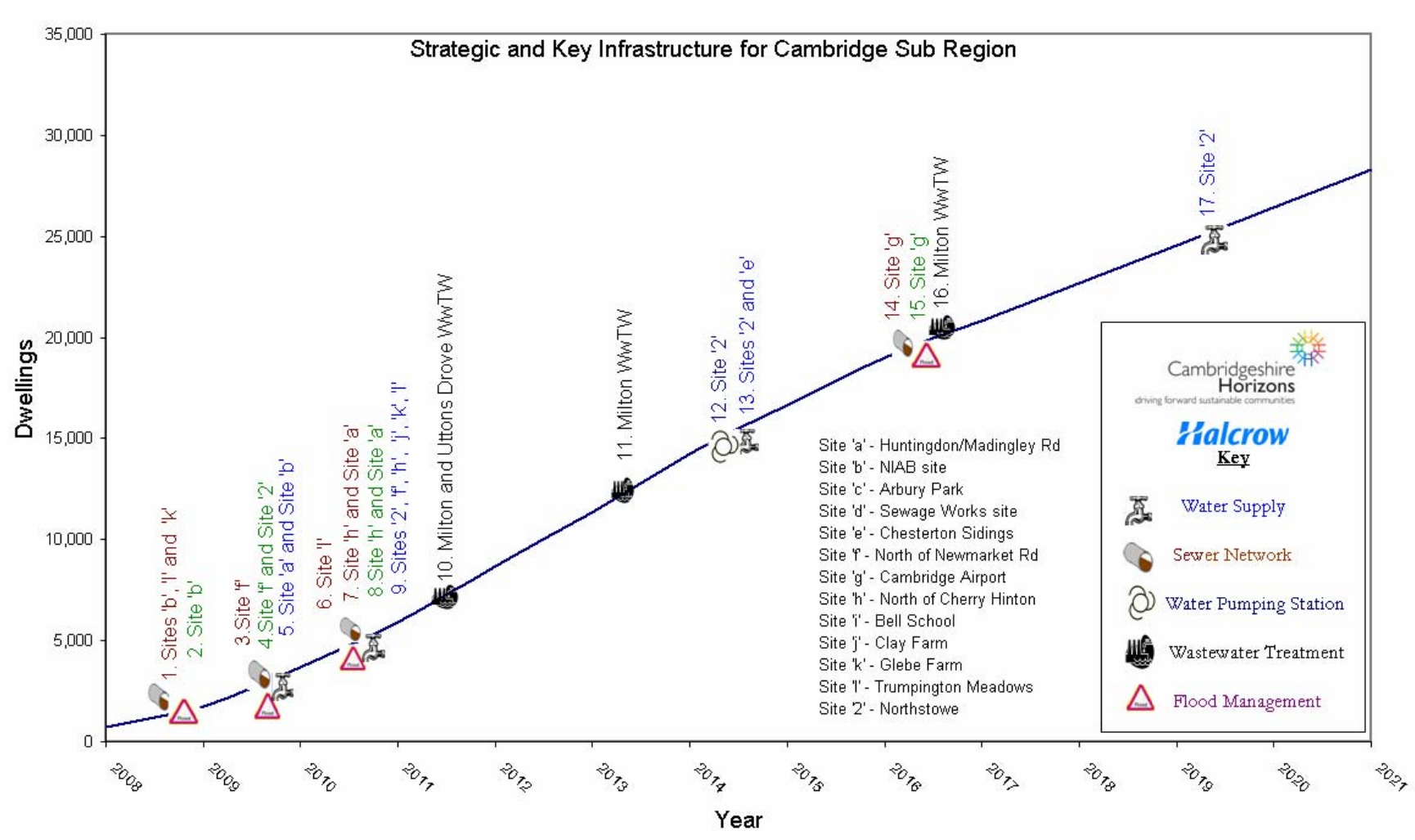


Figure 11-1: Timeline of Cambridge area infrastructure requirements to support LDF growth

I.D.	Year	Site	Aspect	Description of Infrastructure	Report Reference
1	2008/09	NIAB site Southern Fringe sites	Sewerage	Increased sewer capacity	Section 7.3
2	2008/09	NIAB site	Flood Risk	Flood risk mitigation measures	Section 5.6
3	2009/10	North of Newmarket Rd	Sewerage	Connection of site into existing system	Section 7.3
4	2009/10	Northstowe North of Newmarket Rd	Flood Risk	Flood risk mitigation measures	Section 5.6
5	2009/10	NIAB site Huntingdon/Madingley Rd	Water	New water transfer infrastructure	Section 8.8
6	2010/11	Trumpington Meadows	Sewerage	Increased sewer capacity and storage	Section 7.3
7	2010/11	North of Cherry Hinton Huntingdon/Madingley Rd	Sewerage	Increased sewer capacity required	Section 7.3
8	2010/11	North of Cherry Hinton Huntingdon/Madingley Rd	Flood Risk	Flood risk mitigation measures	Section 5.7 Section 5.6
9	2010/11	Southern Fringe sites North of Cherry Hinton/Newmarket Rd Northstowe	Water	Reinforcement of southern ring main Reinforcement of eastern ring main Connecting mains into Northstowe	Section 8.8
10	2011/12	Milton WwTW Uttons Drove WwTW	Wastewater Treatment Works	Capacity upgrades	Section 7.2
11	2013/14	Milton WwTW	Wastewater Treatment Works	Capacity upgrades	Section 7.2
12	2014/15	Northstowe	Water Pumping	Upgrading Coton Pump station	Section 8.8
13	2014/15	Northstowe Chesterton Sidings	Water	Reinforcement of transfer mains	Section 8.8
14	2016/17	Cambridge Airport	Sewerage	Increased sewer capacity	Section 7.3
15	2016/17	Cambridge Airport	Flood Risk	Flood risk mitigation measures	Section 5.7
16	2016/17	Milton WwTW	Wastewater Treatment Works	Capacity upgrades	Section 7.2
17	2019/20	Northstowe	Water	Reinforcement of transfer mains	Section 8.8

Table 11.2: Infrastructure programme supporting table

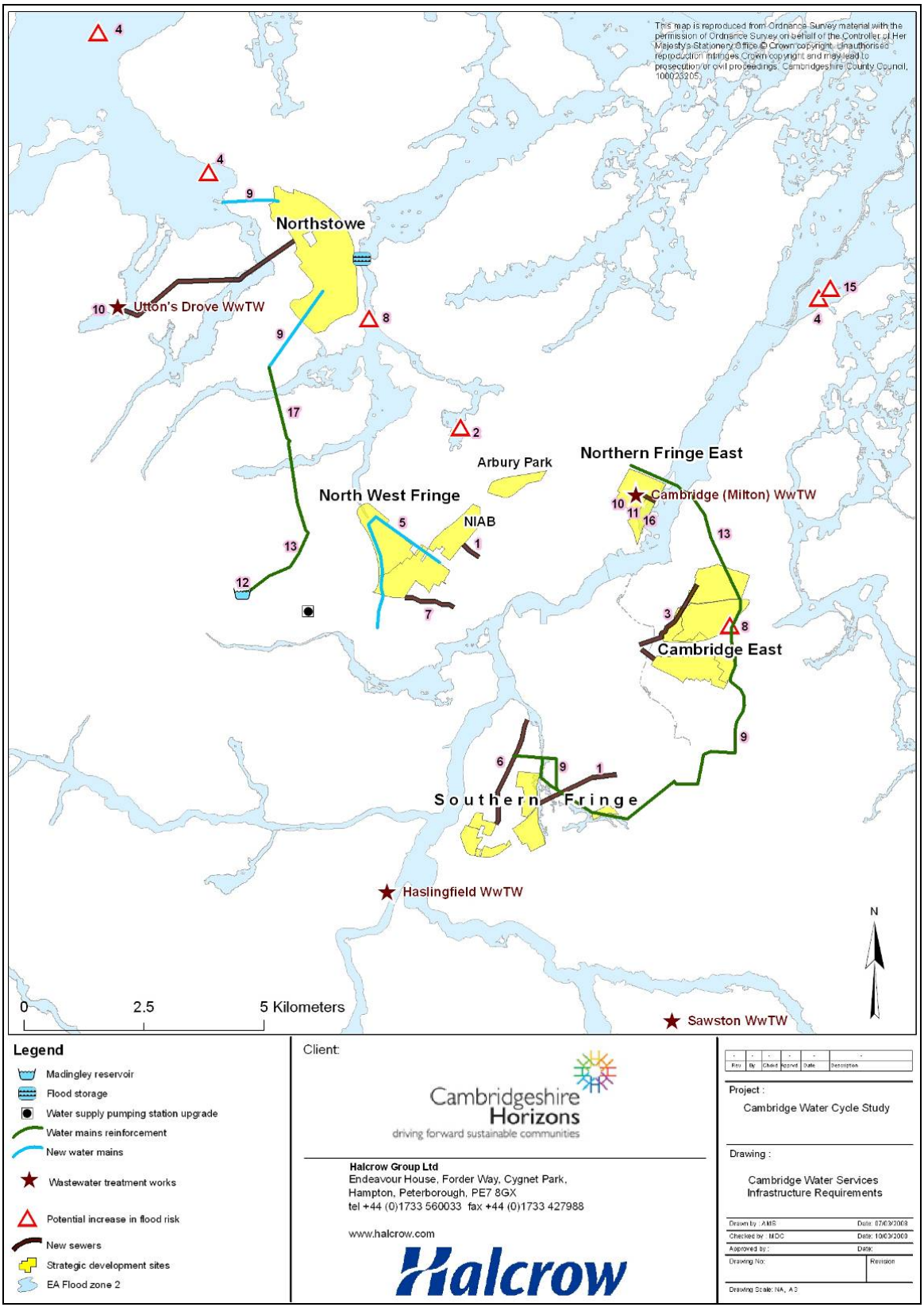


Figure 11-2: Water Services Infrastructure to support growth

12 Appendices

A Northstowe and Southern Fringe Detail

1. Background

Within the scope of this Phase 1 Water Cycle Strategy, the Northstowe and Southern Fringe developments required more detailed analysis due to the advanced state of their development applications.

The following information should be viewed as a supplement to information already provided within the body of this report. The context for this detailed analysis is defined within the relevant sections of the report. Please note that Cambourne wastewater analysis is included within the Northstowe section below.

2. Northstowe

2.1 Flood Risk and Surface Water Management

Northstowe drains into the Cottenham Lode catchment where there is a known flood risk to Oakington and Girton, and a potential flood risk to Histon and Impington. To ensure that flood risk in the Cottenham Lode catchment is not increased it is necessary for a single study to look at the combined effect of all developments in the Cottenham lode catchment.

The development of Northstowe provides an opportunity for planning gain by enhancing the current standard of protection for areas where there is a known flood risk. It is therefore recommended that conditions are attached to the development of these sites that requires the developer to undertake independent hydraulic modelling to consider flooding aspects of their development as outlined in the main report.

For more information regarding the drainage, flooding and surface water aspects of Northstowe please refer to the relevant section in the main body of this report.

2.2 Sustainable Drainage Systems (SUDS)

The Northstowe Area Action Plan has proposed piped systems in conjunction with greenways for drainage, balancing and detention ponds for storage with possible reedbeds for filtration. The ecological assessment in the main body of this report advises that wet drains are an integral part of SUDS solutions, due to the destruction of existing natural ditches and brooks that currently provide habitat on the site.

Further research is required to understand the impacts of all existing and proposed developments discharging to Cottenham Load, hence the site run off and site storage strategies implemented will require further studies.

WSP has developed a SUDS strategy for the Northstowe site to contribute to the Outline Planning Application submitted by English Partnerships and Gallagher Longstanton Limited. An independent Halcrow review of this strategy revealed it to be sound in principle.

2.3 Wastewater (including Cambourne)

As identified in the WCS Scoping Study, a strategy for wastewater disposal and treatment for the Northstowe and Cambourne developments needs to be resolved in order for a sustainable infrastructure solution to be developed. AWS has identified Uttons Drove WwTW as the preferred treatment location for the foul flows from these sites.

The Northstowe Technical Liaison Group (TLG) includes representatives from the Environment Agency, AWS, Swavesey IDB, developers English Partnerships and Gallagher, South Cambs DC, and Cambridgeshire Horizons. The TLG is currently considering the foul drainage solution for the site, amongst other issues. Modelling has been undertaken to identify the flood risk impact of additional effluent from the WwTW upon the receiving watercourse (Swavesey Drain). At the time of writing, this technical work has not yet been formally approved by the Environment Agency, and additional modelling is still required to enable the technical solution to be agreed in detail.

A temporary pumping station was provided by Anglian Water to address the foul flows from the original Cambourne development, but this does not have capacity for flows from the proposed Northstowe development or Cambourne extension and is licensed by the Environment Agency only until July 2009 (linked to the original planning application dwelling numbers at Cambourne).

Cambridgeshire Horizons is liasing with the TLG, both developers, South Cambs DC, AWS and the Environment Agency to agree an equitable approach in principle, which will enable development to proceed.

2.4 Water

Table A1 below identifies the necessary infrastructure to supply the proposed development at Northstowe, and:

- an indication of when the infrastructure will be required if water consumption remains at existing rates;
- how the infrastructure improvements can be delayed or avoided altogether if the Code for Sustainable Homes consumption targets are successfully achieved;
- when Cambridge Water Company has proposed the identified works; and
- an indication of required funding for the infrastructure.

Infrastructure	Dwellings Supported by Works*	Year Required (Existing)	Year Required (CSH)	Year Proposed +	Cost for N'stowe (£)	Cost (£)/ Dweling (10,000 dwellings)
Existing Network	200	2009/10	2009/10	2009/10	n/a	n/a
Supply from the existing network transfer main running along the west of Northstowe requiring: - Two connections from the existing network eastward into	3,000					

the development (i.e. 1.2km 300mm main to the north of the development and a 2 km 450mm main to the south of the development)		2010/11	2010/11	2011/12	590,000	60
Reinforcement of the existing southern and western ring main system and assets: - Augmenting the Southern Ring Main with 600mm main where required - Upgrade a local booster pumping station - Reinforcement of 4.5km of 450mm delivery main.	7,000	2010/11 2014/15 2014/15	2010/11 2016/17 2016/17	2010/11 2011/12 2011/12	1,232,000 (850,000 for N'stowe) 100,000^ 1,102,000	85 (cost shared with S. Fringe) 10 110
Further reinforcement of 1.5km of 450mm delivery main to Northstowe.	10,000	2019/20	Not Needed	2015/16	341,000	35
Total					**£3,365,000**	**£300 / dwelling**

* Cambridge Water Consultation + Northstowe Planning Application Utilities Report

Table A1: Infrastructure requirements for Northstowe at current consumption rates

2.5 Ecology

Submitted proposals for the Northstowe development site have been subjected to further assessment here. This review supplements the assessment of issues identified in previous sections and Appendix H. The following comments are made:

- The proposals would result in the net loss of a significant length of ditch habitat (some 8.5km, although 1.9km of this is currently dry). Although ditches are only a locally important habitat, and better ditch complexes are associated with fens and designated sites further from Cambridge, such a large loss of interconnecting ditches could be considered significant. It is not known if all affected ditches have been surveyed for the presence of rare species associated with this habitat type in Cambridgeshire.
- Reasonably detailed site drainage / SUDS proposals have been put forward. Most significant from an ecological point of view is the establishment of a "water park" to the eastern side of the development. This would create a new wetland complex, with net gains of 14.5 hectares of pond habitat and 14 hectares of marsh habitat. These could make significant local contributions to nature conservation.

- Unlike other development proposal sites, Northstowe drains into the River Great Ouse system. However, implications for the designated sites associated with the Ouse valley have been considered already and are not repeated here. There is no water quality objective set for the Swavesey Drain, so no comparison can be made with sewage treatment discharges at other locations.
- Appropriate baseline and impact assessments have been made within the Northstowe development proposals for significant water / wetland species and habitats (additional to those mentioned above), including wet grassland, otter, water vole, amphibians and fish and aquatic invertebrates. No significant adverse impacts were identified.

3. Southern Fringe

3.1 Flood Risk and Surface Water Management

No obvious flood risk is associated with the development. An opportunity exists for stabilising erratic flows in Hobson's Brook via controlled discharges from long term storage.

The developers of sites Bell School, Clay Farm and Glebe Farm should produce a site specific flood risk assessment to show that there will be no increase in flood risk to Hobson's Brook.

For more information regarding the drainage, flooding and surface water aspects of the Southern Fringe, please refer to the relevant section in the main body of this report.

3.2 Sustainable Drainage Systems (SUDS)

The Clay Farm and Glebe Farm sites are situated on chalk bedrock overlaid by riverine deposits. This geology is very suitable for infiltration SUDS such as soakaways, infiltration trenches, and swales. For these sites a suitable combination of infiltration and non-infiltration SUDS may be selected to balance flood storage and achieve other planning objectives.

The majority of Trumpington Meadows chalk bedrock which is permeable and hence infiltration SUDS will be suitable. However the bedrock is only an indication of the surface permeability and further investigation is advised. Localised geological surveys are required to confirm suitable sites for infiltration SUDS in this area. An exception to this is the eastern extent of the site where it sits on permeable soils that may be suitable for infiltration.

It should be noted that based on hydrogeological mapping of the area, the water table is approximately 5 meters below the ground level and hence SUDS proposals should be assessed in relation to risk to groundwater.

The Cambridge Southern Fringe Area Action (adopted February 2008) has advised the following SUDS are to be implemented:

Pervious surfacing of minor roads and parking areas;

Underground reservoirs (for example beneath urban squares) upstream of the main open water features, which can store water and release it at a controlled rate into the permanent water features;

Two-stage open drains in green corridors, which would serve as public amenity and a balancing function during storms;

A series of linked wetland features in the public open space part of the site, with adjacent land serving as washland for temporary storage of flood run-off;

Green roofs where appropriate to the urban design.

Developer proposed SUDS should include information as requested in the Developer Checklist provided in Appendix C. SUDS applied for flood risk mitigation should be assessed against the SUDS Drainage Guidance document provided in Appendix E.

3.3 Wastewater

Since the Southern Fringe wastewater capacity study was finalised, Halcrow were commissioned to review the entire Cambridge wastewater network. The initial results of this study have shown that the sewer network through the centre of Cambridge is able to convey greater flows that were envisaged during the Southern Fringe study. It should be noted that this solution is still undergoing review and approval by AWS, and in the event that the Cambridge Biomedical Campus discharges flows excessive to those assumed within the analysis (average of 66l/s), the option put forward within the Southern Fringe Capacity Study, diverting flows to Haslingfield and Sawston WwTWs may still prove to the necessary option.

The Cambridge Wastewater Capacity Study has assumed a 66l/s average discharge from the Cambridge Medical Campus, however flows as high as 170l/s have been suggested. It is likely that this significant increase in flows will overload the capacity of the existing Cambrige network, and the solution provided within the Southern Fringe Wastewater Capcity Study would emerge as the preferred option, diverting flows from Trumptington Meadows and Great Shelford toward Haslingfield and Sawston WwTWS, freeing up capacity for other Southern Fringe sites within the Cambridge network. Figure A2 below depicts this Southern Fringe strategy.

Although the preferred Southern Fringe solution is still viable, the need to divert the flows to Haslingfield and from Great Shelford to Sawston may be avoided under the emerging option. Sites I, J & K can be connected to the Mowbray Road sewer without the need for extensive upgrade along and downstream of Mowbray Road. Sites J & K will need to connect to a point of sewer capacity at the junction of Long Road and Mowbray Road which will require some construction works in either Long Road or Fendon Road depending on the sewer route chosen.

For the Haslingfield diversion to be completely avoidable, the latest results from the wastewater study suggest that sewer upgrades and storage will be required in Trumpington Road to serve the Trumpington Meadows site L. This upgrade and storage will prevent an increased risk of sewer flooding to properties in Trumpington Road. There is potential for these storage locations to be situated in the fields to the west of Trumpington Road. Discussion is ongoing with AWS to refine this solution and to investigate what the effect of connecting this site to the Mowbray Road sewer will have on the upgrade requirements.

The large diameter tunnel sewer underneath the River Cam and to Cambridge STW will not required upgrade to accommodate entire southern fringe development (including the existing flows from Great Shelford).

The figures below show the two proposed solutions (in bold lines) for the Southern Fringe development sites.

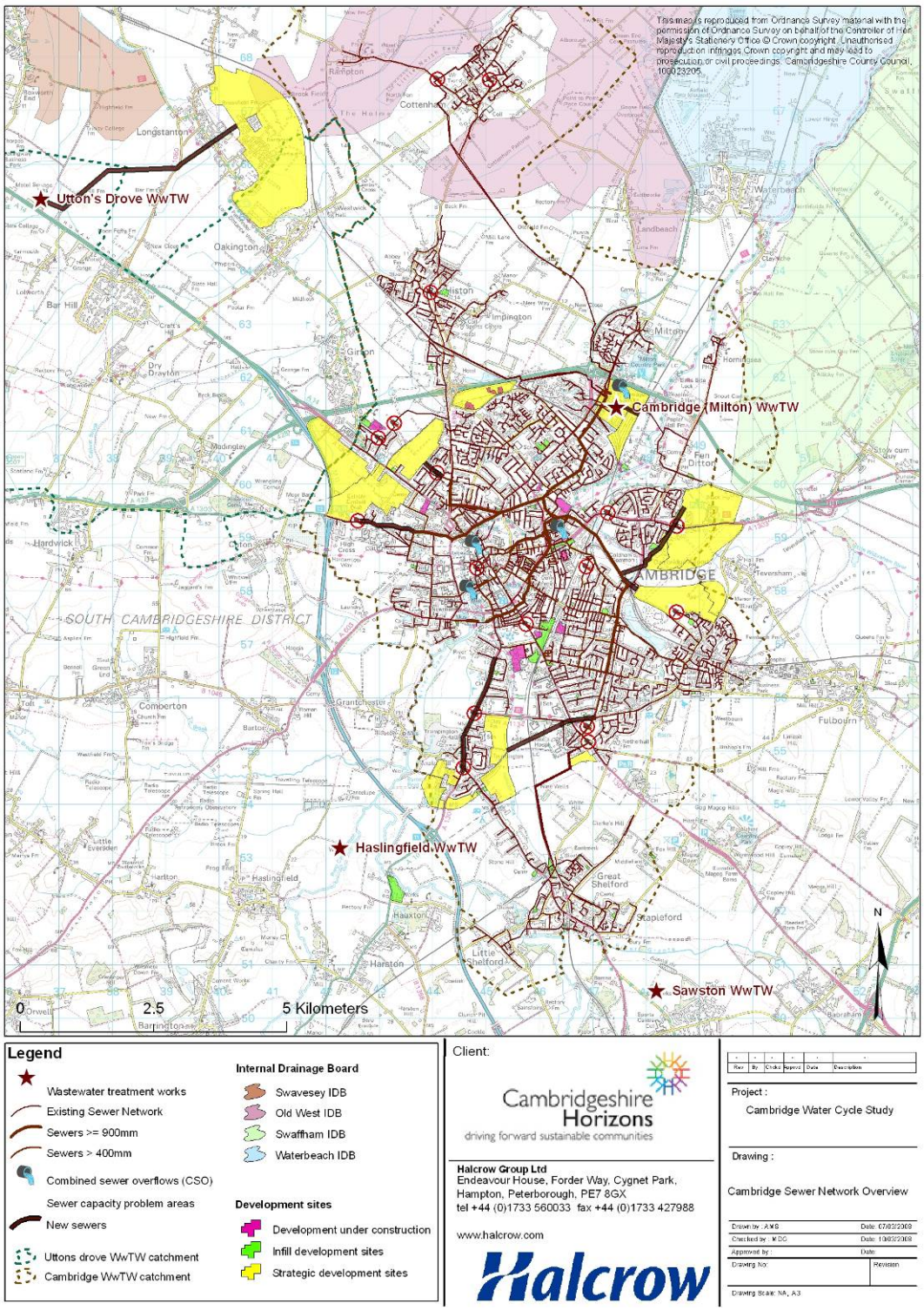
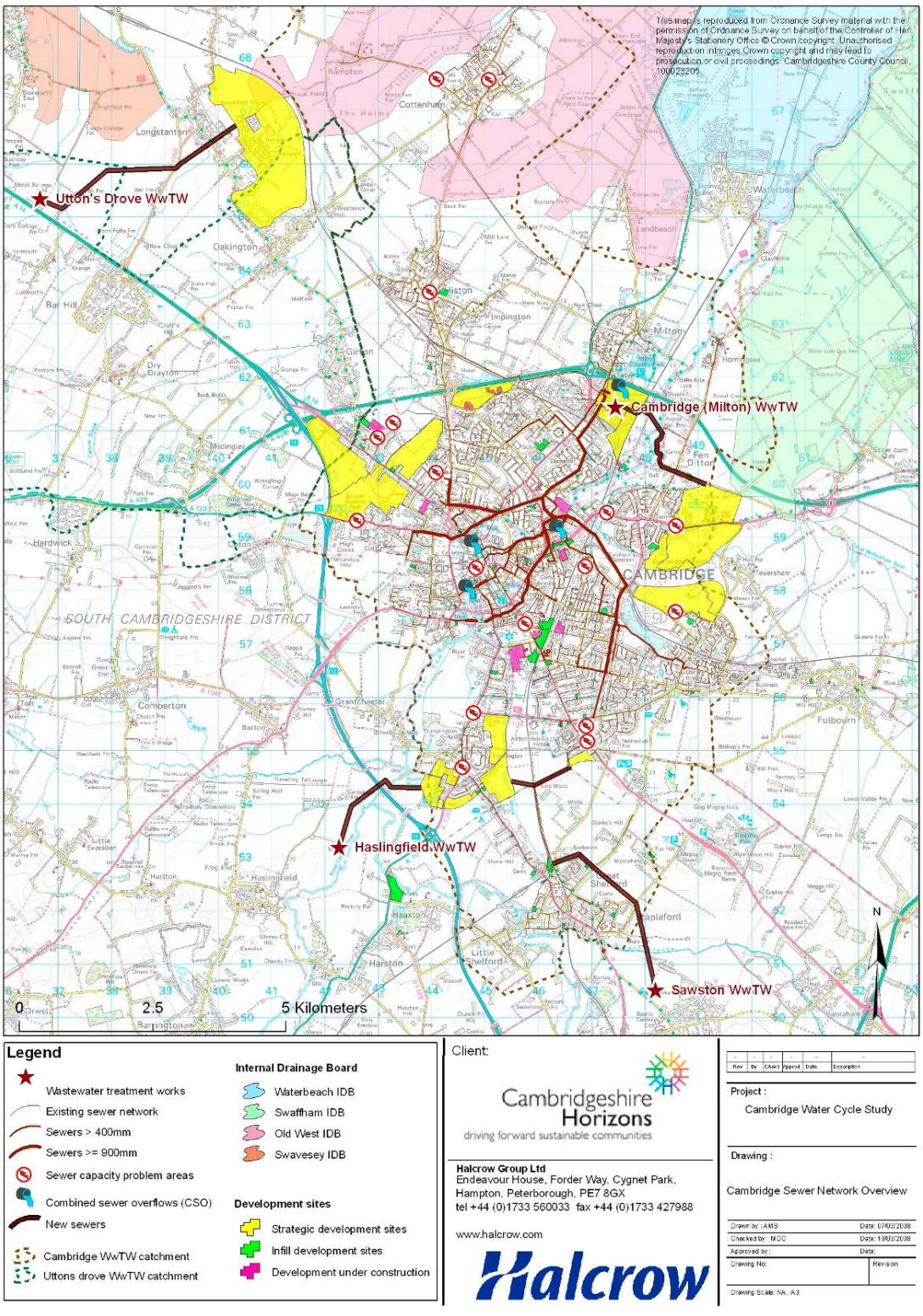


Figure A2: Wastewater network infrastructure to support growth (Cambridge Wastewater Capacity Study)



FigureA3: Wastewater network infrastructure to support growth (Southern Fringe Wastewater Capacity Study)

3.4 Water Supply

Upgrades to the southern ring main to Trumpington are the only works necessary to supply the Southern Fringe sites due to their close proximity to the Southern Ring Main. Distribution infrastructure into the development will be planned on a site specific basis with final master planning. Reinforcement of the ring main is planned to commence by 2010 and will be complete by 2012. The existing network can support any growth in the interim without risk to supply.

The estimated lengths of main for reinforcement are 3,100m across rural areas and 1,000m of main along suburban roads.

The cost of key infrastructure to support the Southern Fringe developments has been based on Ofwat industry standards obtained in the "Water and sewerage service unit cost and relative efficiency 2003-2004 report". This latest Ofwat information was updated using the Construction Output Price Index to represent present day figures. A 20% charge to cover design and contingency was assumed.

The cost (using industry standard pricing as detailed within the body of the report) of reinforcing the appropriate lengths of the Southern Ring Main has been estimated at £1,230,000. This reinforcement will have funding from both Southern Fringe and Northstowe developments. Based on final site dwelling capacities of 4,250 and 10,000 respectively this amount is equal to approximately £85/dwelling, amounting to a contribution of £360,000 from the Southern Fringe.

3.5 Ecology

Submitted proposals for the Southern fringe development sites at Trumpington Meadows / Clay Farm / Glebe Farm have been assessed to supplement the issues identified in Section 9 of this report and in Appendix H. The following comments are made:

- Overlap of the development proposals with Hobson's Brook (which is a Wildlife Site which shows some chalk stream characteristics, including a population of bullhead, and supports water voles) presents significant risk of adverse impact. However, the proposals have identified appropriate mitigation measures to reduce impact, notably appropriate SUDS design and design to limit public access. Further, opportunities for improving the brook and its riparian corridor have been identified, notably channel reprofiling and establishing ponds, reedbed and inter-connecting ditches. With appropriate future management (e.g. vegetation management to prevent over-shading) a net improvement could be anticipated.
- The proximity to both Byron's Pool LNR (at the northern boundary) and Nine Wells LNR (chalk river springs some 300m upstream of the proposed development area) presents some risk of both direct and indirect impacts, including additional public access pressures. However, these might be offset by contributions to the management of these sites, including wetland habitat improvements and remedial works to enhance chalk stream and ditch features.
- Proposals to modify and hopefully increase the value of the area to wintering wading birds (lapwing and golden plover) are reasonable, given that the site is used sporadically and is one of the less important Cambridgeshire wintering sites for these species.
- In combination, the new wetland area for birds (1.75 hectares of open water and adjoining wetland) and the wetland areas associated with SUDS balancing

ponds (total 1.65 hectares of permanent and seasonal wetland) would increase the total wetland habitat across the site.

- Proposals to increase public access to the Cam south of Cambridge could present a significant risk to this local stronghold for otters, although the proposals do include stated aims to direct people to least sensitive locations.
- The western part of the southern fringe is within the River Cam floodplain and although the proposals include mitigation measures to avoid water pollution risks associated with construction, there are also longer-term water quality risks associated with the proximity of development to the river, as well as potential flooding-induced pollution.
- Proposals to treat foul sewage at Haslingfield sewage treatment works present some risk of additional impact on the River Rhee. This tributary of the Cam has additional sensitivity to reduced water quality compared to river reaches further downstream (i.e. below Milton sewage treatment works), associated with its chalk river characteristics (including salmonid fish, white-clawed crayfish) and otter population. The River Rhee (and the Cam upstream of Cambridge) has a water quality objective of 2 (i.e. "Good") compared to 3 ("Fair") for the Cam at Milton.

In conclusion, the main risk is considered to be associated with disturbance impacts on the local stronghold for otters, whilst some benefits could be anticipated associated with riparian habitat improvement and wetland habitat creation.

4. Conclusions and Recommendations

4.1 Northstowe

A single study to look at the combined effect of all developments in the Cottenham Lode catchment is recommended to ensure that flood risk is not increased. The SUDS strategy prepared by WSP has proven to be comprehensive and well informed based upon initial review.

The increase in consent that will be required at Uttons Drove is yet to be approved by the EA. The effects of the extra flows from Uttons Drove into Swavesey Drain from the Northstowe and additional Cambourne development have been modelled and the results are now awaiting EA approval. A solution is currently being processed by relevant stakeholders. Technical work independent of this WCS is underway and a solution has been agreed in principal.

Under the requirements of PPS25, developers may be requested to fund mitigation against increased flood risk, however adoption and ongoing funding of mitigation measures required in Swavesey Drain needs to be agreed between by other stakeholders besides the developers.

A sound water resource and supply strategy has been planned by Cambridge Water Company to ensure no constraints are met with the proposed growth agenda.

No significant ecological constraints exist that will prevent Northstowe development. Opportunities have been identified that can enhance and add value to existing ecological value of the area.

4.2 Southern Fringe

No obvious flood risk is apparent for the Southern Fringe sites. The geology of the Glebe Farm and Clay Farm sites is suitable for infiltration SUDS as well as attenuation SUDS, hence it is advised that the SUDS objectives of the Area Action Plan be carefully considered when assessing the development sites. A strategic use of SUDS aligned with the Area Action Plan will also reduce impacts on local waterways and associated habitats.

Two viable wastewater strategies have been proposed. The solution emerging from the Cambridge Wastewater Capacity Study requires shows that all development flows may be absorbed within the existing Cambridge network without major upgrade. This option is still under review by AWS, and is yet to be approved. To allow connection of the Trumpington Meadows site to the sewer network, an upgrade to the sewer in Trumpington Road plus the provision of 2 online storage tanks will be required to prevent an increase in flood risk to the existing properties in Trumpington Road. At the time of writing, AWS are currently modelling alternative scenarios to this upgrade to determine the alternative upgrade requirements of other routes such as connection into Mowbray Road.

This wastewater strategy is based upon the assumption of an average flow 66l/s from Cambridge Biomedical Campus (CBC), while figures as high as 170l/s have been suggested. In the event that flows from CBC prove higher than what the existing Cambridge network can manage, the original option proposed within the Southern Fringe Capacity Study will be the likely option, freeing up capacity for development within the Cambridge network, by diverting flows from Great Shelford toward Sawston WwTW. If increasing capacity and installing storage tanks along Trumpington Road proves infeasible, Trumpington Meadows may be diverted toward Haslingfield WwTW.

The Southern Fringe development is located adjacent to the Southern Ring Main. Reinforcement of this main to enable the Southern Fringe and Northstowe development is commissioned for 2010. An approximate contribution of £360,000 would be required suggesting a possible contribution of £85 per dwelling for 4,250 dwellings.

No significant ecological constraints are present that cannot be mitigated by sensible planning. A number of opportunities exist for adding value to existing nature and habitats and consideration of these within developer applications is recommended.

B Strategic Site Growth Data

Comparison of Cambridge Sub-Region Housing Trajectories					
	2001-2006	**2006-2011**	**2011-2016**	**2016-2021**	**Total**
Cambourne (Cambridgeshire Horizons)	1,699	2,028	200		3,927
Cambourne RG (Published Forecast)*	1,750	2,100	100	50	4,000
Northstowe (Cambridgeshire Horizons)*		550	3,600	4,250	8,400
Northstowe (Published Forecast)		1,150	3,650	3,350	8,150
Northern Fringe (Cambridgeshire Horizons)				**1,300**	**1,300**
Sewage works (Milton Ward)				1,300	1,300
Chesterton (East Chesterton ward)					
Northern Fringe (Published Forecast)*			**600**	**1,600**	**2,200**
Sewage works (Milton Ward)				1,600	1,600
Chesterton (East Chesterton ward)			600		600
Southern Fringe (Cambridgeshire Horizons)*		**1,560**	**2,690**		**4,250**
Bell site / Addenbrooke's (Trumpington Ward)		225	225		450
Clay Farm / Show Ground, Glebe Farm (Trumpington Ward)		925	1,675		2,600
Trumpington Meadows (South Cambs)		410	790		1,200
Southern Fringe (Published Forecast)		**1,180**	**2,667**		**3,847**
Bell site / Addenbrooke's (Trumpington Ward)		220	127		347
Clay Farm / Show Ground, Glebe Farm (Trumpington Ward)		500	1,800		2,300
Trumpington Meadows (South Cambs)		460	740		1,200
Cambridge East (Cambridgeshire Horizons)		**350**	**2,850**	**3,000**	**6,200**
North of Newmarket Road (The Wilbrahams)		250	1,500		1,750
North of Cherry Hinton (Cherry Hinton Ward)		100	1,350	650	2,100
Airport (Teversham Ward)				2,350	2,350

Cambridge East (Published Forecast)*		**400**	**2,950**	**3,200**	**6,550**
North of Newmarket Road (The Wilbrahams)		400	1,350		1,750
North of Cherry Hinton (Cherry Hinton Ward)			1,600	500	2,100
Airport (Teversham Ward)				2,700	2,700
Cambridge North West (Cambridgeshire Horizons)*		**1,750**	**2,980**	**200**	**4,930**
Huntingdon / Madingley Road (Castle Ward)		50	2,000	200	2,250
Huntingdon / Histon Road (Castle and Arbury Ward)		800	980		1,780
Arbury Park (Histon and Impington Ward)		900			900
Cambridge North West (Published Forecast)		**1,775**	**2,355**	**550**	**4,680**
Huntingdon / Madingley Road (Castle Ward)		200	1,250	550	2,000
Huntingdon / Histon Road (Castle and Arbury Ward)		800	980		1,780
Arbury Camp (Histon and Impington Ward)		775	125		900
* Figures Used in this Analsys					

Client agreed figures applied for the Water Cycle Strategy

	2001-07	2007/8	2008/9	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	TOTAL
Strategic Sites	2,066	700	1,050	1,920	2,251	2,763	2,630	2,860	2,425	2,365	1,800	1,875	1,875	1,875	1,875	**30,330**
	0															
Cambourne	1,966	**400**	**450**	**561**	**350**	**273**										**4,000**
Northstowe	0			**150**	**400**	**600**	**650**	**650**	**850**	**850**	**850**	**850**	**850**	**850**	**850**	**8,400**
Northern Fringe	0							**200**	**200**	**200**	**100**	**375**	**375**	**375**	**375**	**2,200**
Sewerage Works	0										100	375	375	375	375	1,600
Chesterton Sidings*	0							**200**	**200**	**200**	0	0	0			600
Southern Fringe	0		**200**	**584**	**776**	**890**	**630**	**530**	**350**	**290**						**4,250**
Bell School	0			100	125	125	100									450
Clay Farm	0		200	300	300	350	350	350	250	200						2,300
Glebe Farm	0			50	75	75	50	50								300
Trumpington Meadows	0			134	276	340	130	130	100	90						1,200
Cambridge East	0			**75**	**325**	**450**	**600**	**600**	**625**	**625**	**650**	**650**	**650**	**650**	**650**	**6,550**
North of Newmarket Road	0			75	200	300	325	325	325	325						1,875
North of Cherry Hinton	0				125	150	300	300	300	300	300	300	50			2,125
Airport	0										350	350	600	650	650	2,600
Arbury Park	100	**300**	**300**	**200**												**900**
Cambridge North West	0		**100**	**350**	**400**	**550**	**750**	**880**	**400**	**400**	**200**	**0**	**0**	**0**	**0**	**4,030**
Huntigdon/Histon Road	0		100	350	350	350	350	280								1,780
Huntingdon/Madigley	0				50	200	400	600	400	400	200					2,250

C Developer Checklist

	Checklist Items	Complete
	Flood Risk Management	
1	Is a Flood Risk Assessment (FRA) submitted with the application in accordance with Annex E of Planning Policy Statement 25 (PPS 25), Planning Policy Guidance Note 25: Development and Flood Risk? For further information see 'Development and Flood Risk: A Practice Guide Companion to PPS25'. For EA standard guidance relating to PPS25 see www.pipernetworking.com/floodrisk.	Y/N
2	Is development proposed within flood zone 2 or 3? (Refer to the flood maps published on the Environment Agency website)	Y/N
3	If yes, is the Sequential test applied? (See Annex D of PPS 25)	Y/N
4	Have the three elements of the Exception test been passed? (See para. D.9, Annex D of PPS 25)	Y/N
5	If development is approved for an area with a medium/high probability of flooding, are the building ground levels, access routes and car parks above flood level? Has an appropriate assessment been undertaken of how the building will react to flooding? (See Chapter 4 of Code for Sustainable Homes (CSH): Technical Guide)	Y/N Y/N
6	Does the FRA assess all possible sources of flooding? Is the development located outside flood flow routes? The risks may be from groundwater, overtopping or breach of flood defences, surface water, overland flow, breached reservoirs or sewer flooding. (See Annex C, PPS 25) Has the design of the site been checked for exceedance flows. These occur when the capacity of the sewer network is exceeded. For guidance see CIRIA C635 "Designing For Exceedance In Urban Drainage"	Y/N Y/N
7	Does the FRA assess the implications of climate change and suggest ways the impact can be minimised? (See Annex B of PPS 25)	Y/N
8	Provide evidence confirming whether there will be a reduction in flood risk to upstream or downstream communities.	Y/N
9	Confirm that the development allows adequate access for maintenance of watercourses in accordance with the byelaw margin.	Y/N
10	Provide outline details and where relevant supporting manufacturer's data for any proposed flood mitigation measures for the development. (See Annex G of PPS 25)	Y/N
11	Do any proposed flood defence measures reduce performance of functional flood plains elsewhere?	Y/N

12	If the development involves the raising of ground levels within flood zones 2 and 3, provide details of any proposed compensatory flood storage areas.	Y/N N/A
	Surface water run off and Sustainable Drainage Systems (SUDS)	
13	Is the site over 1 ha? (If so a FRA is required to comply with PPS 25.) Note the FRA will need to be agreed by the Environment Agency. For other required data and consultation with the EA see www.pipernetworking.com/floodrisk. Is the site less than 1 ha? (If so a drainage strategy will be required by the Local Authority. This should comply with the design requirements of DEFRA/EA Preliminary Rainfall Runoff Management from Developments.)	Y/N Y/N
14	Confirm the previous use of the site, stating the extent of impermeable areas both before and after development.	% before % after
15	Confirm that the sizing of balancing facilities is in accordance with guidance in Preliminary Rainfall Run Off Management for Developments, Revision C. (Calculations must include adequate sensitivity tests to determine the effect of changing parameters).	Y/N
16	Confirm that any surface water storage measures are designed so that proposed outflows are equal to, or less than, the existing site runoff rates. The design should compare proposed outflow rates, including an allowance for climate change, to the existing 1in1 year, 1in30 year and 1in100 year return period rainfall events.	Y/N
17	Provide layout plans, cross section details and long section drawings of attenuation measures, where applicable.	Y/N
18	Is justification provided for any new crossings over watercourses and confirm that they are of clear span design. Any river crossings or weed screens are to be designed to minimise risk of blockage. For further advice please refer to your local area Environment Agency office guidance.	Y/N or N/A
19	The number of outfalls from the site should be minimised. Do any new or replacement outfall designs follow standard guidance form SD13, available from the local area Environment Agency office?	Y/N
20	Are details provided of any SUDS proposed with supporting information, for example, calculations for sizing of features, ground investigation results and soakage tests. (See CIRIA guidance for more information.)	Y/N
21	Confirm whether driveways and other hard surfaces are to be constructed from permeable paving.	Y/N
22	Quantify the percentage of surface water run-off to be attenuated by SUDS and rainwater holding facilities during the peak flow of an event. Does this satisfy the minimum standard requirements defined in Chapter 4 of CSH: Technical Guide? Does this % of attenuation satisfy the requirements of other statutory bodies,	% Y/N Y/N

	in particular the EA.	
23	Confirm whether the proposed SUDS are to be adopted as part of public open space, or by a wastewater undertaker and provide supporting evidence. Alternatively, provide details of the maintenance contributions to be provided over the life of the development.	Y/N Y/N
24	Are there any proposed measures to encourage public awareness of SUDS and increase community participation? If so, please provide details.	Y/N
	Water Consumption	
25	Confirm the development water consumption target of the dwellings: If this is private housing, does this satisfy Chapter 4 of CSH: Technical Guide, Code 3 requirements? If this is public housing, does this satisfy Chapter 4 of CSH: Technical Guide, Code 4 requirements? Is there a strategy provided, including details and calculations of how reductions will be achieved (e.g. water saving appliances, rainwater harvesting etc.)	l/h/d Y/N Y/N
26	Confirm whether grey water recycling is to be utilised and where applicable provide location and details of the measures.	Y/N
27	Confirm whether the development will utilise rainwater harvesting (minimum tank size 2.5m^3 per house, see Environment Agency Guidance).	Y/N
28	Has a practicable alternative strategy been included for the supply of water for fire fighting?	Y/N
29	Provide details of any proposed measures to increase public awareness and community participation for water minimisation measures.	Y/N
	Pollution prevention	
30	Provide details of measures to minimise pollution to watercourses during construction.	Y/N
31	Provide details of pollution prevention measures for the life of the development, such as oil and silt interceptors. Consider whether permeable pavement areas are protected from siltation.	Y/N
	Water Supply and Sewage Treatment	
32	Provide evidence to confirm that water supply capacity is available, and that demand can be met in accordance with the Outline Water Cycle Strategy.	Y/N
33	Provide evidence to confirm that sewerage and wastewater treatment capacity is available, and that demand can be met in accordance with the Outline Water Cycle Strategy.	Y/N
	Conservation / Enhancement of Ecological Interest	
34	Confirm that the green infrastructure, such as the surface water system, links to the neighbouring green infrastructure to assist the creation and maintenance	Y/N

	of green corridors?	
35	Confirm that at least 25% of flood attenuation ponds/wetlands will be designed for multifunctional uses, such as providing access, footpaths, cycleways, recreational uses, and submit outline details.	Y/N
36	Confirm that an environmental assessment, proportional to the size and nature of the development, has been undertaken. This should identify any impacts on wildlife habitats (include surveys) and detail suitable mitigation measures, where necessary.	Y/N
37	Confirm whether buffer zones are provided adjacent to watercourses and other sensitive zones, such as wetland areas.	Y/N
38	Confirm whether the development will impinge directly or indirectly on any Main River (Wildlife Site) and confirm the status of any Designated Fishery.	Y/N
39	Confirm all ponds within 500m of the site boundary have been surveyed for presence of great-crested newt populations.	Y/N
40	Identify whether opportunities exist to use surface drainage/grey water for creating or enhancing wetland habitat areas including: • Ponds for great crested newts • Wet drainage ditch networks • Wet grassland	Y/N
41	Identify opportunities for creating or improving watercourses and adjacent habitats for otter and water vole, where practicable.	Y/N
42	Confirm whether the Local Biodiversity Action Plan (LBAP) has been consulted and whether any habitats or species detailed within the LBAP are present or near the development site.	Y/N
43	Confirm whether any County / City Wildlife Sites are present or near to the development area.	Y/N

D Site Specific Flood Risk Tables

Release of water from long term storage into receiving watercourses by development site

Tributary	Contributing site area (ha)	Discharge at 2 $ls^{-1}ha^{-1}$ from long term storage (m^3s^{-1})	Flow in 2 year event in receiving watercourse (m^3s^{-1})
Hobson's Brook			
1i,j,k	78.0	0.2	
Total into Hobson's Brook	78.0	0.2	0.3
Coldhams Brook and East Cambridge Main Drain			
1g (west)	30.9	0.1	
1h (west)	38.7	0.1	
Total into Coldhams and East Cambridge Main Drain	69.5	0.1	0.58
Bottisham Lode			
1f (south west)	7.1	0.0	
1g (east)	59.5	0.1	
1h (east)	43.5	0.1	
Total into Bottisham Lode	110.0	0.2	0.08
Swaffham IDB			
1f (north east)	37.4	0.1	
1g (north east)	10.4	0.0	
Total into Swaffham IDB	47.8	0.1	2.5 m^3s^{-1} pumping station capacity at Upware
Cam			
1l	32.0	0.1	
Total into Cam downstream Hobson's Brook Confluence	110.0	0.2	
Infill	94.0	0.2	
Total into Cam downstream Coldhams Brook and East Cambridge Main Drain	273.5	0.5	
1f (west)	30.3	0.1	
1c	32.0	0.1	
1d,e	73.0	0.1	
Total into Cam downstream Cambridge	408.8	0.8	
Total into Cam downstream of Bottisham Lode	518.8	1.0	18.6
Unnamed drain in Histon			
1b	53.0	0.1	
Total for unnamed drain	53.0	0.1	1.2
Washpit Brook			
1a	165.0	0.3	
Total for Washpit Brook	165.0	0.3	2.4
Reynold's Ditch			
Northstowe (north)	109.5	0.2	
Total for Reynold's Ditch	109.5	0.2	0.3
Beck Brook			
Northstowe (south)	203.3	0.4	
Total d/s Washpit Brook confluence	421.3	0.8	4.5
Total d/s Reynold Ditch Confluence	530.8	1.1	8.2

Total discharge from long term storage by individual development sites into receiving watercourses compared with Q_{bar} in the channel downstream of the development sites. A rate of discharge of $2ls^{-1}ha^{-1}$ from long term storage has been assumed. Discharge from long term storage is assumed to be into the same water courses as predevelopment.

Greenfield runoff rates into receiving watercourses by development site

Tributary	Contributing site area (ha)	Greenfield rate 1 year (m^3s^{-1})	Greenfield rate 30 year (m^3s^{-1})	Greenfield rate 100 year (m^3s^{-1})	flow in channel 2 year (m^3s^{-1})	flow in channel 30 year (m^3s^{-1})	flow in channel 100 year (m^3s^{-1})	Return period at which flooding of existing property is expected.
Hobson's Brook								
1i,j,k	78	0.02	0.05	0.08				
Total into Hobson's Brook	78	0.02	0.05	0.08	0.3		1.0	> 100 years. Channel capacity $2m^3s^{-1}$ from Atkins' modelling.
Coldhams Brook and East Cambridge Main Drain								
1g (west)	31	0.001	0.002	0.004				
1h (west)	39	0.002	0.004	0.007				
Total into Coldhams and East Cambridge Main Drain	70	0.002	0.007	0.010	0.6	1.7	3.1	Assumed > 1000 years
Bottisham Lode								
1f (south west)	7	0.000	0.000	0.000				
1g (east)	59	0.002	0.005	0.007				
1h (east)	43	0.002	0.005	0.007				
Total into Bottisham Lode	110	0.004	0.010	0.015	0.1	3.6	6.5	10 – 25 years
Swaffham IDB								
1f (north east)	37	0.000	0.001	0.001				
1g (north east)	10	0.000	0.001	0.001				
Total into Swaffham IDB	48	0.001	0.002	0.002	2.5 m^3/s capacity of pumping station at Upware			10-25 years. Flooding occurs from overtopping of Bottisham Lode.
Cam								
1l	32	0.006	0.02	0.03				

Total into Cam downstream Hobson's Brook Confluence	110	0.03	0.07	0.1				
Infill	94	0.04	0.1	0.2				
Total into Cam downstream Coldhams Brook and East Cambridge Main Drain	274	0.1	0.2	0.3				
1f (west)	30	0.000	0.001	0.001				
1c	32	0.08	0.2	0.3				
1d,e	73	0.2	0.6	0.9				
Total into Cam downstream Cambridge	409	0.3	1.0	1.5				
Total into Cam downstream of Bottisham Lode	519	0.4	1.0	1.5	18.6	56.0	70.8	Unknown
Unnamed drain in Histon								
1b	53	0.1	0.3	0.4				
Total for unnamed drain	53	0.1	0.3	0.4	1.2	2.8	4.2	Unknown
Washpit Brook								
1a	165	0.6	1.7	2.5				
Total for Washpit Brook	165	0.6	1.7	2.5	2.4	4.8	7.0	1 in 10 years in parts of Girton
Reynold's Ditch								
Northstowe (north)	110	0.4	1.0	1.5				
Total for Reynold's Ditch	110	0.4	1.0	1.5	0.3	0.8	1.2	Unknown
Beck Brook								
Northstowe (south)	203	0.7	1.8	2.8				
Total d/s Washpit Brook confluence	421	1.4	3.8	5.7	4.5	5.1	7.5	1 in 10 years in parts of Girton and Oakington.
Total d/s Reynold Ditch Confluence	531	1.7	4.8	7.2	8.2	13.8	16.2	Unknown

Greenfield run of rate into receiving water courses, and flows in the receiving water courses, by development site. These figures should be used for guidance only.

Sources of data used to determine flows in the rivers

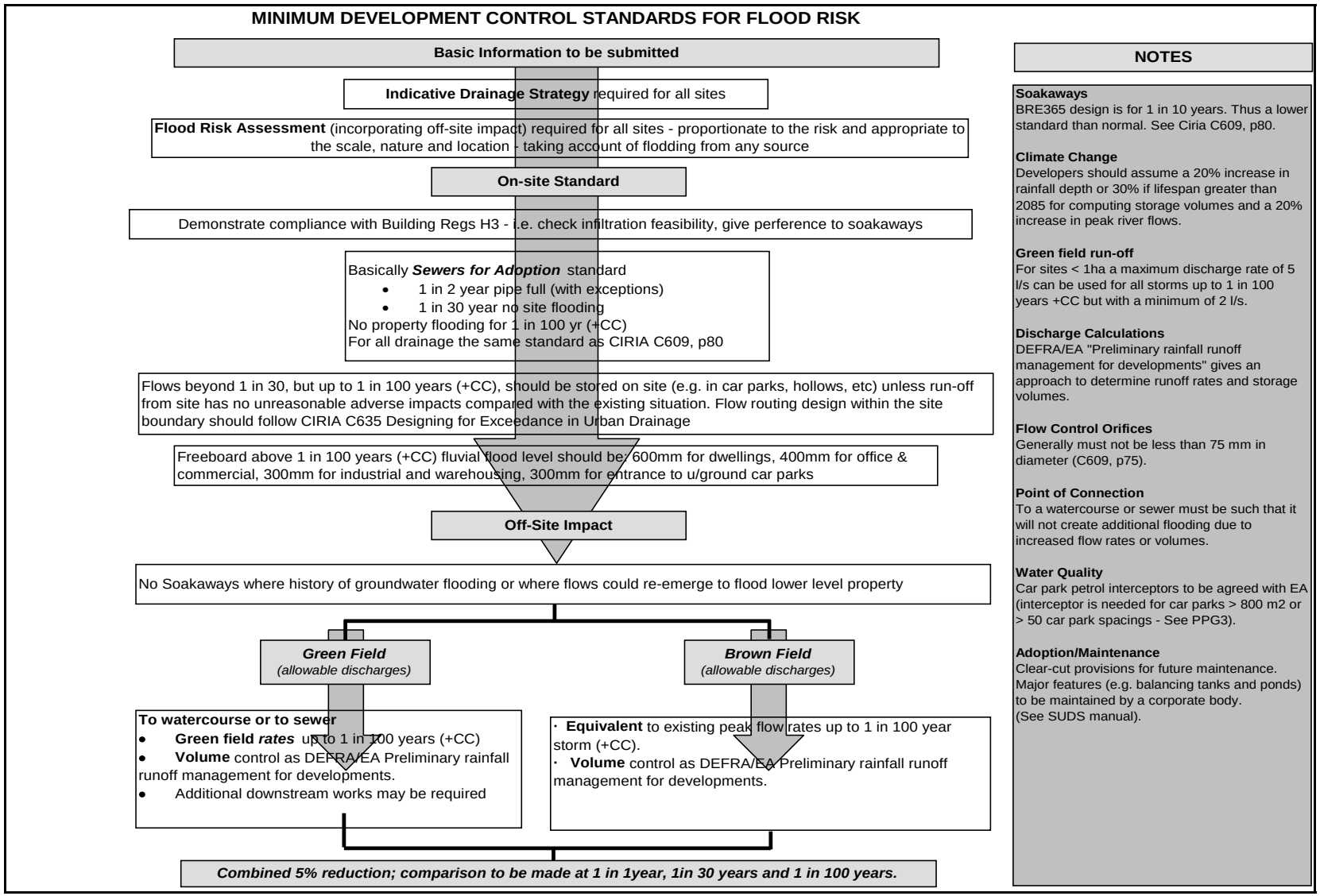
Tributary	Data Source
Hobson's Brook	Q_{med} from Addenbrooks Access Rd FRA.
Coldhams Brook and East Cambridge Main Drain	FEH boundary, 6 hour storm. Data from FEH CD-ROM. 6 hour storm recommended in Defra guidance
Bottisham Lode	Upstream FEH boundary in Ely Ouse Lodes SOP model.
Swaffham IDB	Ely Ouse Lodes SOP report
Cam	Flow at downstream boundary of Cam and Granta model[i]
Unnamed drain in Histon	FEH boundary where unnamed tributary joins Beck Brook in the Cottenham Lode Pre-Feasability model.
Washpit Brook	Model results in Cottenham Lode Prefeasibility report. Q_{med} from 5 year event scaled by regional growth curve factor.
Reynold's Ditch	FEH boundary in Cottenham Lode Prefeasibility model.
Beck Brook	Model results in Cottenham Lode Prefeasibility report. Q_{med} from 5 year event scaled by regional growth curve factor.

Runoff rates by development site assuming a value of Q_{bar} of 1 $ls^{-1}ha^{-1}$ as per the Defra guidance for permeable sites.

Tributary	Runoff rate 1 year (m^3s^{-1})	Runoff rate 30 year (m^3s^{-1})	Runoff rate 100 year (m^3s^{-1})	Q_{bar} or Q_{med} (m^3s^{-1})
Hobson's Brook				
1i,j,k	0.07	0.18	0.28	
Total into Hobson's Brook	0.07	0.18	0.28	0.3
Coldhams Brook and East Cambridge Main Drain				
1g (west)	0.03	0.07	0.11	
1h (west)	0.03	0.09	0.14	
Total into Coldhams and East Cambridge Main Drain	0.06	0.16	0.25	0.58
Bottisham Lode	0.00	0.00	0.00	
1f (south west)	0.01	0.02	0.03	
1g (east)	0.05	0.14	0.21	
1h (east)	0.04	0.10	0.15	
Total into Bottisham Lode	0.09	0.26	0.39	0.084
Swaffham IDB	0.00	0.00	0.00	
1f (north east)	0.00	0.00	0.00	
1g (north east)	0.01	0.02	0.04	
Total into Swaffham IDB	0.01	0.02	0.04	2.5 m3/s capacity of pumping station at Upware

Runoff rate, for individual development sites, using a value of Q_{bar} of 1 $ls^{-1}ha^{-1}$ as per the Defra guidance for permeable sites.

E LPA and Developer Guidance for Flood Risk



SURFACE WATER MANAGEMENT – CALCULATION & DRAWING REQUIREMENTS

Purpose: To assist developers in demonstrating that they are complying with latest guidance on managing surface water run-off the following calculations and drawings shall be submitted:

1) General Drainage Information

A summary sheet (1 page max) showing the global variables which have been used in the design of the surface water sewerage system.

For Cambridge, the following values are typical: M5_60 = 20.0mm, Ratio_R = 0.45,
Cv (Summer) = 0.750, Cv (Winter) = 0.840.

Note: The values of Cv may be increased by 20% or 30%, as appropriate, to model the effects of climate change, if there is not other provision in the developer's software.

Pipe roughness: As per *Sewers for Adoption* guideline values.

The Following Key Data must be provided:
(a) The total impermeable area of the whole development
(b) The existing impermeable area and the allowable peak discharge from the site.
(See Notes on previous page)
(c) The total volume of attenuation storage which will be provided both above and below ground.

Provide a drawing showing a schematic of the drainage layout, with all pipes, manholes, ponds, etc clearly numbered or referenced to the model output.

On-Site Standards

2) No Surcharge up to 1 in 2 year return period
Provide a *summary sheet* demonstrating compliance

3) No Flooding up to 1 in 30 year return period
Provide a *summary sheet* demonstrating compliance

Off-Site Standards

4) Maximum Discharge
Provide results of peak flow from site, which must be < allowable discharge

5) No Additional Run-off from site up to 1 in 100 years + Climate Change
Provide results showing the peak water level in any ponds, or tank (and hence volume). Provide a drawing showing the size and location of all the attenuation storage provided. Where attenuation storage is located above ground, provide details of finished ground levels and demonstrate flood pathways to the storage areas.

Note: There is no need to provide reams of hydraulic calculations. There is a need to demonstrate compliance with the parameters given in *Minimum Development Control Standards for Flood Risk*, which are based on the provisions of PPS25.

SUDS TREATMENT CONSIDERATIONS

Table 5.6 *Number of treatment train components (assuming effective pre-treatment is in place)*

Taken from The SUDS Manual CIRIA report C697

Receiving water sensitivity → Runoff catchment ↓ characteristic	Low	Medium	High
Roofs only	1	1	1
Residential roads, Parking areas, commercial zones	2	2	3
Refuse collection/ industrial areas/ loading bays/lorry parks/highways	3	3	4

Other Issues to be Considered

Source protection zones in proximity of the site
Geological mapping
Sensitive sites mapping as given in the appropriate Water Cycle Strategy

Choosing the right SUDS system

The choice of SUDS system will depend on a number of factors such as:

- the pollutants present in run-off;
- the size of and drainage strategy for the catchment area;
- the hydrology of the area and infiltration rate of the soil;
- Groundwater Source Protection Zones or contaminated land.

Large-scale ponds and wetlands are generally more appropriate for sites larger than 5ha. Infiltration trenches, swales, filter strips and porous pavements are suitable for both large and small sites. The best drainage solution for a site will often incorporate a mix of mechanisms.

F SUDS Maintenance Program and Costs

SUDS Element	ACTIVITY	FREQ.	STAFF	Unit	Time (day)	No. of times per year
Swale	Grass cutting - to retain grass height within specified design range	Monthly during the growing season (6 months).	2 people	1 Km	1	6
	Litter and debris removal	Monthly and after severe storms	2 people	3 Km	1	6
	Manage other vegetation and remove nuisance plants	Monthly (at start, then as required)	2 people	12 Km	1	12
	Check for poor vegetation growth due to lack of sunlight or dropping of leaf litter, and cut back adjiacent vegetation where possible	Annually	2 people	4 Km	1	1
	Re-seed areas of poor vegetation growth. Alter plant types to better suit conditions, if required.	Annually, or if bare soils is exposed over 10% or more of the swale treatment area	2 people	4 Km	1	1
	Inspect inlets, outlets and overflows for blockages and clear if required.	6 month interval and after severe storm	2 people	6 Km	1	2
	Inspect infiltration surfaces for ponding, compaction silte acculmulation. Record area where water ponding is for > 48 hours.	Monthly, or when required	2 people	8 Km	1	12
	Inspect bar screen	Monthly and after severe storm	2 people	8 Km	1	12

SUDS Element	ACTIVITY	FREQ.	STAFF	Unit	Time (day)	No. of times per year
	Inspect and repair side and base erosion to ensure sheet flow	6 month interval and after severe storm	2 people	4 Km	1	2
	Inspect inlet and facility surface for silt accumulation. Establish appropriate silt removal frequencies.	Twice a year	2 people	8 Km	1	12
	Inspect internal overflow to bypass	Annually	2 people	8 Km	1	1
Pond	Grass cutting - public areas	Monthly, during growing season (6 months)	2 people	4 ha	1	6
	Grass cutting - meadow grass	6 months interval (in spring before nesting season and in autumn)	2 people	4 ha	1	2
	Inspect vegetation to pond edge and remove nuisance plants (for first 3 years).	Monthly at the start and then as required	2 people	4 Km	1	10
	Hand cut submerged and emergent aquatic plant (at minimum of 0.1 m above pond base; include max 25% of pond surface)	Annually	2 people	500 m^2	1	1
	Remove 25% of bank vegetation from water edge to a minimum of 1 m above water level	Annually	2 people	2 Km	1	1

SUDS Element	ACTIVITY	FREQ.	STAFF	Unit	Time (day)	No. of times per year
	Tidy all dead growth before start of growing season	Annually	2 people	2 ha	1	1
	Remove sediment from forebay	1-5 years, or as required	2 people	500 m^2	1	0.3
	Remove sediment from one quadrant of the main body of ponds without sediment forebays.	2-10 years	2 people	500 m^2	1	0.15
	Remove sediment from the main body of big ponds when pool volume is reduced by 20%	> 25 years (usually)	2 people	500 m^2	1	0.04
	Inspect structures for evidence of poor operation	6 months interval	2 people	4 ha	1	2
	Inspect banksides, structures, pipework etc for evidence of physical damage	6 months interval	2 people	4 ha	1	2
	Inspect bar screen	monthly and after severe storms	2 people	4 ha	1	12
	Inspect and clear solid waste	monthly and after severe storms	2 people	4 ha	1	12
	Inspect water body for signs of eutrophication	Monthly (May- October)	2 people	4 ha	1	6

SUDS Element	ACTIVITY	FREQ.	STAFF	Unit	Time (day)	No. of times per year
	Inspect silt accumulation rates and establish appropriate removal	7 to 10 year interval	2 people	4 ha	1	0.1
	Check penstocks and other mechanical devices	Twice a year	2 people	4 ha	1	2
Wetland	Litte / trash / debris and surface scum removal	Monthly	2 people	2 ha	1	2
	Grass cutting - public areas	Monthly (during growing season)	2 people	4 ha	1	6
	Grass cutting - meadow grass	6 months interval (in spring before nesting season and in autumn)	2 people	4 ha	1	2
	Inspect vegetation edge and remove nuisance plants (for first 3 years).	Monthly at start and then as required	2 people	4 Km	1	10
	Hand cut submerged and emergent aquatic plant (at minimum of 0.1 m above pond base; include max 25% of pond surface)	Annually, or as required	2 people	500 mq	1	1
	Remove 25% of bank vegetation from water edge to a minimum of 1 m above water level	Annually, or as required	2 people	2 Km	1	1
	Tidy all dead growth before start of growing season	Annually	2 people	2 ha	1	1

SUDS Element	ACTIVITY	FREQ.	STAFF	Unit	Time (day)	No. of times per year
	Remove sediment from one quadrant of sediment forebay	Annually, or as required	2 people	500 mq	1	1
	Remove sediment from one quadrant of the main body of wetlands without sediment forebays.	2-5 years	2 people	500 mq	1	0.3
	Remove sediment from the main body of wetland when its volume is reduced by 20%.	> 25 years (usually)	2 people	500 mq	1	0.04
	Inspect structures for evidence of poor operation. Take remedial action if required.	Monthly or after severe storms	2 people	4 ha	1	2
Infiltration Trench	Litter and debris removal from trench surface, access chambers and pre-treatment devices	Monthly, or as required	2 people	1 Km	1	1
	Removal and washing of exposed stones on the trench surface	Annual (bi-annual the first year) or when silt is evident on the surface	2 people	400 m	1	1.5
	Trimming of any roots that may be causing blockages	Annual (semi-annual the first year)	2 people	1 Km	1	1.5
	Remove weeds on the trench surface	Monthly at the start and then as required	2 people	1 Km	1	12

SUDS Element	ACTIVITY	FREQ.	STAFF	Unit	Time (day)	No. of times per year
	Removal of sediment from pre-treatment devices	6 months	2 people	1 Km	1	2
	At locations with high pollution loads, remove surface geotextile and replace, and wash or replace filter media.	5 years	2 people	400 m	1	0.2
	Inspect inlets, outlets and overflows for blockages and clear if required.	Monthly	2 people	1 Km	1	12
	Inspect pre-treatment systems, inlets, trench surfaces and preforated pipework for silte accumulation. Establish appropriate silt removal frequencies.	6 months	2 people	400 m	1	2

G World Wildlife Fund Fiscal Incentives for Water Efficiency

Incentive	Targeting Sustainability	Likely Size of Impact	Government Acceptability	Best Options
Abolition of zero percent % VAT rate on new buildings	***	***	*	X
Vacant land value taxation and/or Greenfield levy	***	**	*	
Reduced VAT rate on accredited supplies	***	**	**	X
Product charges on non-sustainable building materials and equipment	***	**		
Subsidies for the installation of sustainable equipment	***	**	*	
Tax free savings for sustainable home mortgages/re-introductions of MIRAS for sustainable home mortgages	***	*	*	
Stamp duty relief for sustainable homes	***	**	***	X
Discretionary abolition of 50% council tax relief on second homes	**	-	***	
Capital allowances for expenditure on sustainable conversions	***	**	**	X
Increase of rent-a-room relief	**	-	**	

H Ecology Further Information

Study Methodology and References

The appraisal has been based partly on the River Basin Biodiversity Framework concept developed by Natural England, the Environment Agency, and Halcrow in 2004/05 in support of the Water Framework Directive implementation in the UK. Key features of this framework include:

- Compilation of information on existing nature conservation features, objectives and targets;
- Distinctions between critical, important and desirable contributions to nature conservation; and
- Display of information on a GIS mapping platform and a level of detail appropriate for understanding by a non-ecologist;

This appraisal goes further in that it also aims to identify possible impacts and associated mitigation measures associated with development, as well as opportunities for ecological enhancement.

The information collated for the ecological appraisal was obtained from various sources, including:

- Cambridgeshire and Peterborough Biological Records Centre;
- Cambridgeshire Biodiversity Action Plan and Cambridge City Nature Conservation Strategy;
- Cambridgeshire Horizons, South Cambridgeshire District Council and Cambridge City Council published reports and web sites;
- The local development framework for Cambridge;
- Natural England, Environment Agency and Joint Nature Conservation Council published reports and web sites;
- The local development framework for Cambridge; and
- Wildlife Trust for Bedfordshire, Cambridgeshire, Northamptonshire and Peterborough.

Study area and biodiversity overview

The study area was defined by the locations of strategic sites around Cambridge as defined by the client, plus additional consideration of:

a. areas from which public water supply might be sourced

b. river corridors at, and downstream of, probable wastewater effluent discharge locations.

Thus the study area was defined to allow the assessment of direct impacts of development, off-site impacts (e.g. encouraging public access into areas which currently have none), and any more distant impacts associated with the water cycle.

The ecological appraisal considered water and wetland features around Cambridge as indicated below. These features were defined by considering three main types of impact that might result from development:

a. direct and adjacent off-site impacts of a development footprint;

b. hydrological and water quality changes resulting from additional treated wastewater effluent (and drainage) discharges; and

c. hydrological changes associated with additional abstraction for public water supply.

Biodiversity Overview

Cambridge is centrally located in the sub-region at the junction of three main landscape types; to the north east lie the Fens, to the south east the Chalklands and to the west the Claylands.

The main study area around Cambridge lies on the boundary between two joint character areas as described by Natural England: *Joint Character Area JCA87: East Anglian Chalk* lies to the south-east and *JCA88 Bedfordshire and Cambridgshire Claylands* to the north-west, with the boundary between the two running approximately south-west to north-east through Cambridge. That part of the study area around Thetford lies within *JCA85 Breckland.*

East Anglian Chalk is typified by large arable fields with scattered chalk grassland. Woodland is largely restricted to ancient woodland on the heavier soils and extensive secondary woodland shelterbelts in the Newmarket area. The chalk hills are most pronounced in the south and flatter in the north, with spring-fed fens and meadows along the northern scarp spring line. *Bedfordshire and Cambridgshire Claylands* is typified by a lowland plateau dissected by a number of shallow valleys, including the rivers Great Ouse and Ivel. It is largely open arable farmland, contained either by sparse trimmed hedgerows, open ditches or streamside vegetation. Scattered woodlands are important wildlife features. *Breckland* is dominated by light sandy soils and semi-continental climate with a slightly undulating dry terrain with contrasting shallow, wooded river valleys (some having fast-flowing chalk river character). The area is largely arable, but areas not farmed include heathland and Thetford Forest, which is the largest area of lowland woodland in England.

Further information on Bio-diversity Action Plan species

Limitations of analysis

- There is no detailed mapping data available for Drainage Ditches (a locally significant habitat);
- Mapping is incomplete for Standing Open Waters, in particular Ponds, although notable pond sites listed in the City Nature Conservation Strategy include Adams Road bird sanctuary, Barton Road pool, Norman cement pits, Bramblefields LNR, Logan's Meadow LNR, Barnwell East LNR and Byron's Pool LNR;
- Whilst all rivers and streams are both national priority habitats and local BAP habitats, chalk rivers and streams have attracted particular attention and are a long-standing UK priority habitat type. Within the study area, chalk streams are limited to

the upper tributaries of the River Rhee, including chalk springs at Nine Wells Local Nature Reserve.

Detailed Consideration of Species within Plan

Otter. The National Otter Survey of England[4] conducted by The Vincent Wildlife Trust indicates that in the Anglian region during 1977-79 otters were present at 3% (20 of 623) survey locations, falling to 1% (8 of 725) during 1984-86 but recovering to 8% (58 of 725) during 1991-94. This increase apparently reflected continued successful breeding and range expansion, largely derived from otter releases. Within the study area, otters are known to use Bourn Brook. Otter spraints have been recorded at Logan's Meadow LNR and an otter holt has been built on this reserve, within 5m of the River Cam. The lack of access to much of the River Cam south of the city has been put forward as a significant contribution to this area being a hotspot for otters. Otters have also been recorded at Hobson's Brook and along the Rivers Cam, Rhee and Granta[5].

Water vole. According to the Cambridge City Nature Conservation Strategy (December 2006), water voles have been recorded in Bin Brook, Cherry Hinton Brook, First Public Drain, Garret Hostel Lane drain, Adams Road Sanctuary and Madingley Road Park and Ride. The Strategy states that water voles are now absent from Coldham's Brook; however CPBRC has a record of water vole in this brook dated 2000. Outside of the city limits, water voles have been recorded in the Washpit Brook, north of the north-west Cambridge urban extension. The strategy states that water voles are in decline in the city and under threat of local extinction. However, urban sites may offer important long-term sites since relatively few mink are found in the city compared to rural areas, where mink predation is the most significant pressure on water vole populations.

Great-crested newt. Cambridgeshire BAP states that great crested newts are widespread within the county. Intermittent occurrences are recorded in the study area, but detailed records are not available and, therefore, the map of their distribution must be considered incomplete. Within the study area, Barnwell (East) LNR has a confirmed population whilst Bramblefields LNR and Nine Wells LNR both require further survey to ascertain their presence/absence. A pond just outside the NE boundary of Byron's Pool LNR may hold great crested newts. CPBRC has records of great crested newt at Cherry Hinton, Oakington and Rampton (both of the latter close to the proposed Northstowe development). One of the objectives of the Cambridge City Nature Conservation Strategy is to increase the number of ponds in the city.

Fisheries

The River Cam catchment has a number of reaches designated as Cyprinid Fisheries under the EC Freshwater Fish Directive (78/659/EEC). There are also Salmonid Fisheries, which are potentially more sensitive to water quality and other changes, but these are primarily associated with upper (chalk) river reaches upstream of Cambridge. As a designated fishery, the river attracts Protected Area status under the Water Framework Directive. Any such Protected Area needs to be managed via the river basin management plan to achieve compliance with "….*any standards and objectives*…." necessary to achieve favourable conservation status. Thus, compliance with the Directive will require future maintenance of appropriate water quality and habitat conditions to sustain the fishery.

[4] Cambridgeshire Biodiversity Action Plan, September 2003

[5] Cambridgeshire and Peterborough Records Centre, 2008

Other Species. In addition to these key species, a number of other water and wetland species have been considered here, either because they are priorities in the local BAP or because they are otherwise notable and have been recorded in the study area.

- The local BAP includes Veteran Trees which although not generally related to water or wetland sites does include old pollarded willows. These are notable features along the River Cam, especially between Stourbridge Common and Baits Bite Lock, in the north of the city.
- White-clawed crayfish. Although not in the local BAP, this is a UK priority species. A small survey of selected watercourses in 1997 in the Cam catchment (River Rhee) recorded native crayfish at 38% of sites, often in numbers suggesting healthy populations. In the Barrington area the River Shep and nearby streams were found to hold very strong populations. The Environment Agency has recorded crayfish incidentally during other survey work but the majority of the older records do not specify which species (it is only the native white-clawed crayfish that is protected). Overall there is insufficient information to determine the local status; no records for white-clawed (native) crayfish were obtained for the study area from CPBRC.
- Wintering bitterns were recorded on Wicken Fen up until 1997 [6] . Bitterns are included in the Cambridgeshire BAP and are a national priority species.
- The glutinous snail is a local BAP species but has not been recorded in Cambridgeshire since 1833.
- Desmoulin's whorl snail is listed on Annex II of the EC Habitats Directive. It is also listed as rare on the GB Red List. It is included in the Cambridgeshire BAP. It inhabits long established, calcareous wetlands and open fens with damp surfaces beneath. Desmoulin's whorl snail is found on Wicken Fen.
- The shining ram's horn snail is a local BAP species and is listed as endangered in the Red Data Book. It inhabits unpolluted, usually calcareous water in the ponds and drains of grazing marshes. There are only a small number of records for this species in Cambridgeshire, but none of these is recent.
- The large copper butterfly requires fen habitat. It is included in the Cambridgeshire BAP and is listed as a globally threatened species by IUCN/WCMC. It was re-introduced to Woodwalton Fen but the population was never self-sustaining and finally went extinct in the wild in 1992.
- Ribbon leaved water plantain is included in the Cambridgeshire BAP and is protected by Schedule 8 of the Wildlife and Countryside Act 1981. It has not been recorded in Cambridgeshire for 20 years.
- Greater water parsnip is a species of wet ditches and tall-herb fens and swamps. No records (positive or negative) have been identified for the study area, but the species is in significant decline nationally.

Thus, the most relevant consideration for any of these species would appear to be whether proposed development at Cambridge has the potential for hydrological or water quality

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impacts at Wicken Fen. The absence of significant risk at Wicken Fen has already been noted.

Other significant wetland species for which there **are** positive records within the study area (CPBRC) include:

- Birds: Bewick's swan, black-tailed godwit, common grasshopper warbler, Eurasian curlew, northern lapwing, kingfisher, reed bunting. There are no indications whether these are breeding records or other observations, and the data are not precise to a location (being, instead, a positive record within a particular mapping quadrat). Therefore, only a qualitative consideration can be made of these records.
- Amphibians: common toad, common frog. Both species have the potential to be present at any location with appropriate micro-habitats, and their recorded distribution does not warrant mapping.
- Mammals: brown rat. A mobile species associated with a range of habitats including river corridors, and therefore its recorded distribution has not been mapped.

Further Information on Contribution to Nature Conservation

The River Basin Biodiversity Framework concept identifies nature conservation objectives as "critical", "important" or "desirable". This is based on the value of a nature conservation feature ("international/national", "regional/county" or "local") and its sensitivity to impacts (see Table 3), as well as its status and threats to it.

In respect of the Cambridge WCS, realistic objectives for water and wetland nature conservation have been identified as follows:

- "**Critical**" contributions relate to the **preservation of existing** international / national interests :
    - Preserve otter populations (national value) **– the greatest risk of impact is associated with development areas J, Hauxton and 2, which impinge on sites where otters have been recorded; however, areas K and L are also of concern, as development will increase access to the River Cam south of Cambridge.**
    - Preserve water vole habitats and populations (national value) **– the greatest risk of impact is associated with development areas which directly impinge on or are adjacent to water vole habitat, especially local stronghold sites for water voles (D, G, H, 2) but also other sites (A, J, Hauxton).**
    - Preserve great crested newt habitats / populations (national value) **– none of the potential development areas correspond with confirmed great crested newt records and there are no apparent newt strongholds around Cambridge; thus all areas offer the potential for impact or enhancement, dependent on survey outcomes.**
    - Preserve existing floodplain grazing marsh (national value) **– the greatest risk of impact is associated with development area 2 which impinges directly on this UK priority habitat in the Swavesey Drain catchment; area D (and possibly E) presents some risk of off-site hydrological**

change but also a potential opportunity to improve or expand adjacent floodplain habitat along the Cam.

- Preserve habitats and water quality associated with the main rivers (Cam, Granta and Rhee) and streams (national value) **– all areas but in particular those which impinge on river/stream corridors (f, g and h and j, k and l – Please see main technical report, Figure 5.2) present risk of impact through local changes in drainage hydrology and downstream effects on water quality, as well as direct physical impact through development.**
- Preserve standing open waters / ponds (national value) **– confirmation of the distribution of ponds etc is needed; until then assume that all development areas offer the potential for impact or enhancement.**
- Preserve Cyprinid Fishery in the River Cam (international value) **– all area present some risk of impact through downstream effects on water quality, but in particular those that impinge on river corridors, i.e. f, g and h and j, k and l (please see main report, Figure 5.2);**

- "**Important**" contributions will **protect existing** regional/county interests whilst further promoting international/national interests:
  - Preserve integrity of all Local Nature Reserves and County / City Wildlife Sites (regional/county value) **– potential for off-site hydrological effects on Bramwell (East) and Bramblefields LNRs (G and E, respectively); all major river are Wildlife Sites (i.e. Cam, Granta and Rhee) – see comments related to main river habitats under critical contributions, above.**
  - Preserve existing drainage ditches (regional/county value) - **confirmation of the distribution of drainage ditches is needed; until then assume that all development areas offer the potential for impact or enhancement; however, the drainage ditch network is known to be extensive to the north of Cambridge, and site 2 is therefore particulary relevant.**
  - Improve habitat for otters, water voles and great-crested newts (national value) – **see comments under critical contributions, above.**
  - Improve floodplain grazing marsh, river and stream, standing open water and pond habitats (national value) - **see comments under critical contributions, above.**

- "**Desirable**" contributions will **protect local** interests and further contribute to regional/county and local value.
  - Increase the extent and quality of standing open waters, and the quality of main rivers and streams (regional/county value).

Further information on potential nature contributions and value definitions are provided in the tables below. Please see main report, Figure 5.2 for site locations.

Potential Opportunity (& Value of Contribution)	Location	Relevance to Potential Development Sites
Important contributions		
Create new areas of wet grassland in floodplain, in particular to link existing sites and provide habitat continuity	Main opportunities lie along the Quy Water, at Teversham and Fulbourn (see Map 4)	Not physically related to any development site
Ensure appropriate habitat conditions for water vole	Any riverine location	**Potential associated with any sites encroaching on / near water vole habitat, i.e. 2, G, H, J and possible A and D**
Ensure appropriate habitat conditions for otter	Cam downstream of Cambridge	Not physically related to any development site
	Cam and tributaries upstream of Cambridge	**Potential associated with southern fringe sites, in particular L**
Desirable contributions		
Create new areas of standing open water, adding to existing groupings	Any location	**Potential associated with any development site**
Establish great crested newt ponds and associated habitat	Any location	**Potential associated with any development site**

Nature Conservation Opportunities ("Habitat Visioning") Associated with the Cambridge Water Cycle Strategy

Sensitivity	Nature Conservation Value (water & wetland only)		
	International/National	Regional/County	Local
High	• NNR, SAC, SPA, Ramsar site, SSSI • Important for UK BAP priority habitat or species • Large pop'n of protected species • Feature designated under a European Directive	• LNR or NGO reserves • CWS	• Local BAP habitat or species significant locally
Medium	• Limited area of UK BAP priority habitat or small pop'n of priority species • Limited pop'n of protected species	• Local BAP habitat or species outside of LNR/CWS/etc. • Major river or other open water body	• Minor watercourses including ditches & ponds with ecological value
Low	• UK priority species which is locally common but locale is a national stronghold • Small pop'n of protected species	-	• Ponds

Conservation Value of Features in the Study Area

I Implementing Change through the Planning Process

New application systems and processes already exist to achieve sustainability targets. It is the responsibility of the planning authority to use these tools to their full advantage.

The 1APP national standard application form developed under the Town and Country Planning Act 1990 is already implemented in Cambridgeshire. To be valid, this standardised application form must be completed and submitted with any requested additional information or 'Planning Application Requirements'.

The mandatory information required within the application submission is set out within the 1APP application form and its statutory procedures. Foul sewage, assessment of flood risk, biodiversity, and geological conservation are already included at a high level in the standard form. Local Authorities are encouraged to consult and adopt their own advanced list of requirements as an appendix to the basic form, so they can guide the applications they receive toward their own specific planning goals. One might be to achieve a Code 6 CSH rating on all new development, or to implement rainwater harvesting tanks on a percentage of houses within the development.

Halcrow's Developer Checklist in Appendix C may be referred to and adapted for this purpose to include the requisite information within Cambridge application forms. This allows aspects like SUDS and water efficiency strategies to be required as part of the submission. The information provided within the Halcrow developer checklist, will provide a further level of detail and rigour to the existing Sustainable Development Checklist referred within the policy shown below. It is advised that the Halcrow checklist is applied to add quantification, detail, and ensure the desired outcomes.

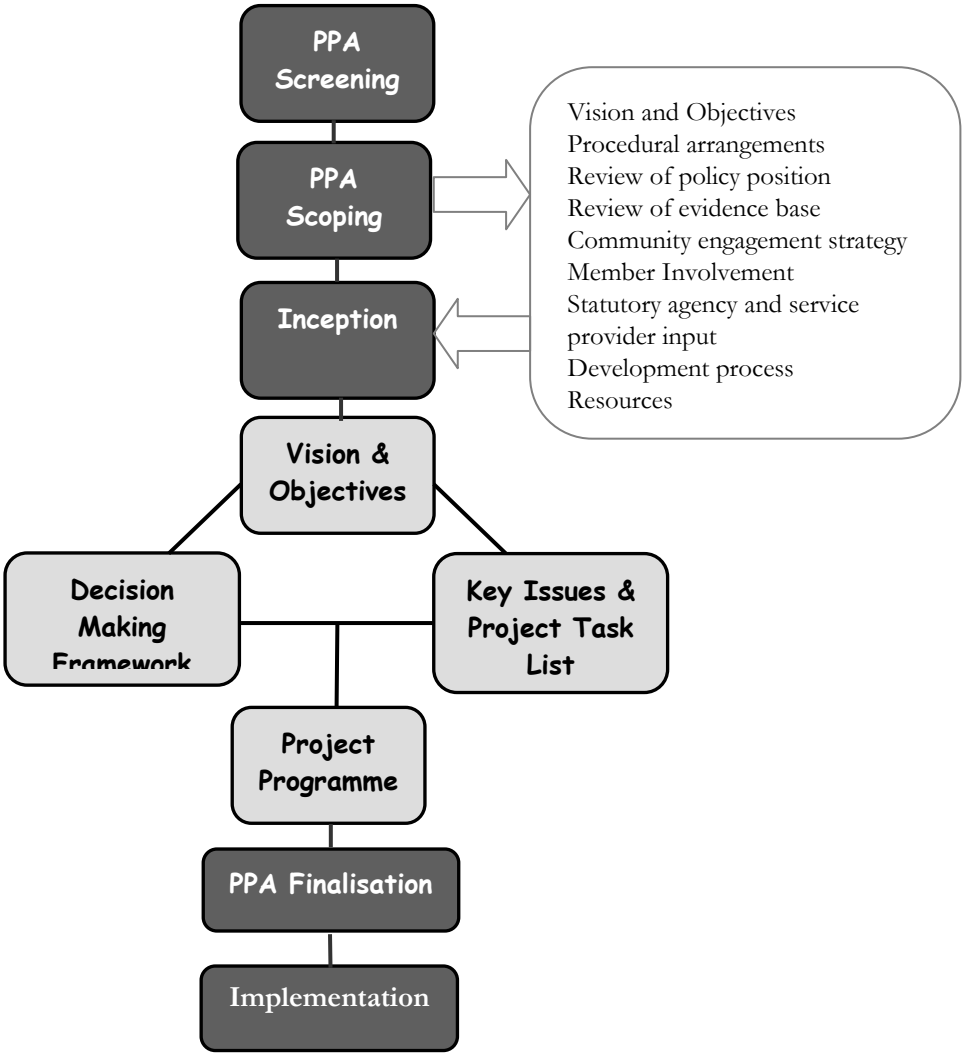
Policy 3/1 – Sustainable Development (Cambridge Local Plan, 2006)

Development will be permitted if it meets the principles of sustainability. Where major development is proposed, developers should complete the Council's Sustainable Development Checklist and prepare a Sustainability Statement and submit both with the planning application.

An iterative process between the planning authority and developer has traditionally been established following a development submission in order for both parties to achieve a satisfactory (if compromised) development plan.

A collaborative process between the developer and planning authorities is now emerging as a more effective and efficient way for all parties to achieve their goals. The Advisory Team for Large Applications (ATLAS) hosted by English Partnerships has developed the guidance document 'Implementing Planning Performance Agreements (PPA)' (June, 2007). This document provides a process within which local authorities, developers and other key stakeholders may work together in the preliminary stages of a planning application, so that it can build in the respective objectives from the beginning.

The following flowchart, adapted from the ATLAS publication mentioned above, shows the recommended process for planning applications.



Planning applications need to incorporate LPA planning objectives for water efficiency. Planning Policy is already in place that supports the Code for Sustainable Homes' (CSH) standards. These may be relied on to assist in achieving water efficiency targets. The Sustainable Design and Construction SPD published by Cambridge City Council is currently based on policy that does not incorporate water efficiency standards. Hence alternative policy must be relied on to encourage water efficiency before the LDF is adopted in 2009.

The detailed policy within the strategic site Area Action Plans is sufficiently comprehensive that the LPA may define the efficiency measures required by developer, in reference to the Code for Sustainable Homes. Other higher level policy may be applied to ensure developers provide the evidence and strategies that show how water efficiency targets may be met.

J Calculating the Cambridge WwTW Capacity for Growth

The projected load on the Cambridge treatment works corresponded to the major development trajectory supplied by Cambridgeshire Horizons (see Appendix B), infill data provided by the Local Planning Authorities, and assumptions for the Cambridge Biomedical Campus as defined in Appendix A (Section 3.3). The projected load is as follows:

Projected Load On Treatment Works		**2008**	**2011**	**2016**	**2021**	**2026**	**2031**
BOD - p.c. cons. 0.065 kg/h/d	kg/d	9733	10266	11546	12221	12503	12967
BOD after primary settlement	kg/d	6731	7100	7985	8452	8646	8967
PG - 95% usage to drain	m3/d	21011	22243	24939	26416	27032	28050
Infiltration (I)	m3/d	6059	6428	7314	7782	7976	8298
Trade Flow (E)	m3/d	3231	3231	3231	3231	3231	3231
PG+I+E (DWF)	m3/d	30301	31902	35484	37428	38239	39579
	l/s	350.7	369.2	410.7	433.2	442.6	458.1
Peak flow to trt (3DWF)	m3/d	109987	109987	109987	109987	109987	109987
	l/s	1273.0	1273.0	1273.0	1273.0	1273.0	1273.0
Formula A	m3/d	152581	156877	166546	171739	173900	177467
	l/s	1766.0	1815.7	1927.6	1987.7	2012.7	2054.0

The above table is based upon calculated flows using AWS default values for per-capita consumption and all new dwellings are assumed to be served by a metered supply. The stated flow to full treatment is the consented value until such time as this is exceeded, when a calculated value based upon 3PG + I + 3E is used.

The measured DWF for the year 2007, based on the lower ten percentile is 20670m^3/d against the calculated value of 30000 and the consented value of 36000 m^3/d. This is a significant discrepancy, and it seems unlikely that this amount of headroom would have been allowed for in the consent application.

It is estimated that the flow recorder was under recording by approximately 15% during this period, and if this is taken into account the corrected DWF is 23770m^3/d.

For the purposes of this report, the higher, calculated data has been used, since it is essential that the treatment works is able to accommodate the peak incoming load from the catchment.

Compliance with standards

The treatment works is presently compliant with its consented DWF, based on calculated data; revised conditions to reflect increasing DWF would be required during the period 2016-2021.

As the present legal consent requires the treatment works to provide full treatment to approximately 3.5 X consented DWF, against the "normal" 3 X DWF, a future consent revision to accommodate an increase in DWF may not entail a proportionate increase in FFT. Indeed, if the normal 3PG + I + 3E yardstick is used to calculate future flow to full treatment, the current consented value is adequate for the projected flow beyond the year 2021.

Any works improvements, therefore need not provide additional hydraulic capacity to accommodate the projected growth, although improvements will be required to address existing constraints to passing the consented flow to full treatment.

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