Kent Thameside Regeneration Partnership

Kent Thameside Water Cycle Study Phase 1

Final Report

March 2009










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Executive Summary

Background and Objectives

Kent Thameside is located on the south bank of the Thames encompassing the towns of Dartford and Gravesend and the land lying between them. The Kent Thameside Regeneration Partnership aims to promote sustainable growth, encourage investment and improve the standard of living in the area which has been identified as a priority for long-term sustainable economic, social and environmental regeneration. The Partnership has agreed in its Regeneration Framework a target of 30,000 new homes and 50,000 new jobs for the period 2001-2026. The majority of these new homes will be on redundant chalk quarries and redeveloped industrial land.

The broad aim of this Water Cycle Study is to assist in the sustainable development of the area ensuring that water infrastructure and interventions are clearly programmed. The study has involved working with the key stakeholders, the Water Companies, the Environment Agency and the Local Authorities to establish the key constraints within the water cycle to identify integrated solutions in order to achieve sustainable development. The outcome is a strategic overview of the impacts and requirements for the proposed development for the period to 2026.

The original objectives of this Water Cycle Study for Kent Thameside were to:

- Evaluate the initial findings of the scoping study to establish if there is sufficient environmental capacity to receive runoff/wastewater and provide water resources;
- Establish the requirements for water infrastructure to meet the needs of proposed development;
- Identify optimum solutions to deliver solutions that integrate the different elements of the water cycle to achieve sustainable development across the area;
- Establish whether the required strategic infrastructure can be provided in an appropriate timeframe;
- Provide the evidence base to support the development of Local Development Frameworks for Dartford and Gravesham Borough Councils;
- Provide the guidance to developers to meet the objectives of the Water Cycle Study.

Key to this process is the collation and utilisation of existing research and information through continued engagement with stakeholders. However, it should be pointed out that it has not been possible to address all of these objectives in full through difficulties in obtaining detailed specific information from the water companies (Southern Water and Thames Water). Much of the information requested from the water companies is considered commercially confidential, especially that pertaining to wastewater, which has made it difficult to fully integrate options relating to potable water supply and wastewater. However, assurances have been provided that the required strategic infrastructure can be delivered within the timescales of the proposed development. This study has utilised mainly existing sources of information to carry out an assessment of the environmental and infrastructure capacity

for: water resources and supply; sewage treatment and disposal; flood risk management, and; surface water drainage. Further analysis has been undertaken to validate statements and assumptions provided in key planning documents including water company draft management plans where possible. The key findings and recommendations of this study are summarised below.

Due to the timing of this study, calculations in support of the conclusions made have been based on the housing numbers given in the Draft South East Plan which identified the need for 15,700 and 9,300 new dwellings, respectively in the Boroughs of Dartford and Gravesham. However, The Secretary of State's Proposed Changes to the South East Plan in July 2008 increased the housing numbers for Dartford by approximately 10% to 17,340. Whilst it is considered that this increase in unlikely to have a significant impact on the conclusions regarding water supply and treatment, it is essential that any potential further impacts due to this increase should be addressed through the next AMP cycle.

Water Resources and Water Supply

There will be sufficient water resources available to allow the delivery of new development in Gravesham and Dartford, if Southern Water and Thames Water are allowed to implement their PR09 Water Resources Management Plans in full. Thames Water's plan includes the need for a new reservoir (most likely located near Abingdon) to be operational by 2026 in order to maintain supplies in a number of its supply areas, including Kent Thameside. No permissions for either the construction or operation of this reservoir have currently been granted.

Thames Water will also need to make significant investments in local water supply infrastructure to enable the delivery of sufficient network capacity to support new development in Dartford Borough. These improvements will need to be delivered early in AMP5 and may require funding under the OFWAT early start programme for that AMP period.

The following recommendations are made:

- The authorities responsible for delivering new development should engage with the water companies early to ensure that the necessary water supply infrastructure is provided at a timescale to meet demand from new development.

- The sustainable housing agenda should be promoted to minimise demand from new developments in Kent Thameside. It is recommended that **all new homes** should be built to CSH level 3/4 in terms of water use, as this is considered achievable at relatively little additional cost to house builders.

- There is no explicit evidence to support the construction of new homes to CSH level 5/6 standards with respect to water use, given the current uncertainty and relatively high costs associated with rainwater or greywater systems. However, it is recommended that a small percentage of new homes (e.g. 5%) should be built to CSH level 5/6 (in terms of water use) in the next 2-3 years. These properties could be built as exemplars and used to inform stakeholders of the issues associated with such water efficient dwellings.

- This percentage could be increased in future years as technology improves. Based on the current technology, rainwater harvesting (rather than greywater recycling) should be incorporated into new

homes built to CSH Level 5/6, however this may change over time as these systems become more widely used and better understood.

- At present it is considered that there remains a lack of clear guidance on methods and mechanisms for delivery of water neutrality and therefore it is not considered appropriate to set out recommendations for water neutrality aspirations at present.

- However retrofitting should be promoted where cost-effective (e.g. as part of ongoing refurbishment by social landlords) to offset a proportion of the demand from new development. Local authorities should support and encourage retrofitting schemes in households and other buildings, working with other stakeholders (e.g. water companies) where appropriate.

- New non-household developments should be constructed to meet the BREEAM excellent rating for water efficiency and, where appropriate, the collection of rainwater should be implemented in new developments.

Wastewater Management and Water Quality

The Strategic Direction Statements of both Thames and Southern Water highlight that projected population growth will increase demand for sewerage services, placing increasing pressure on the treatment works and sewerage network. Both water companies have provided assurances that the proposed growth in Kent Thameside has been considered in their draft Business Plan Submissions to OFWAT and that there are no major barriers to development associated with the wastewater infrastructure. However, existing or planned headroom was deemed to be commercially confidential and as a result it has not been possible to identify the timing when existing / planned capacity will be exceeded; therefore no potential temporary barriers that may require phasing of the development were identified.

The following recommendations are made:

- In the absence of any detailed analysis of the hydraulic headroom we recommend that the Kent Thameside Partnership Board proactively engage with Thames and Southern Water and OFWAT. This continued dialogue is essential to provide certainty surrounding development outside existing sewer networks and to agree the future capacity requirements, based on the analysis of future capacity required under the different water efficiency (CSH) scenarios.

- The adoption of water efficiency measures in new build developments offers the potential to return significant savings in terms of the required capacity of the sewer network and may, together with the optimisation of treatment processes, enable additional properties to be connected within the existing headroom compared to estimates derived using higher consumption rates.

In considering capacity of the receiving water environment, the additional pollutant load derived from the population increase in Kent Thameside to 2026 is expected to be a relatively small contribution to total sewage treatment works loads discharged to the Thames Estuary. Considering the large dilutive capacity of the outer Thames Estuary, the three sewage treatment works are regarded as being well positioned to receive additional

loads. In addition, the construction of the Tideway Tunnel will also serve to virtually eliminate overflows from the sewer network so improving the dissolved oxygen levels in the estuary.

Where development is outside the existing drainage network (i.e. Ebbsfleet) due to the close proximity, foul drainage could be accommodated at either Northfleet or Long Reach sewage treatment works and both water companies have made provision for this in their Business Plans. It is also possible that an inset agreement (or arrangement) could be made, without direct involvement of the water companies.

Flood risk and surface water management

Flood risk within Kent Thameside has been studied as part of the Kent Thameside Strategic Flood Risk Assessment. The study has therefore focused on how to manage surface water flows as a result of the proposed development. An assessment of the runoff from potential developments has been undertaken, along with the necessary attenuation volumes for the developments in line with guidance within Planning Policy Statement 25(PPS25), the Pitt Review and with reference to the London Plan for comparative purposes. As part of this assessment recommendations have been made on the use of Sustainable Drainage Systems (SuDS) to manage the attenuation volumes:

- For larger sites, or where there will be several developments in one area, it is advised that the SuDS "management train" (a series of progressively larger scale practices to manage runoff from prevention, source control, site control and regional control) is adopted.

Adopting the management train approach will ensure that the natural catchment process is mimicked; it will also mean that there is a more efficient use of land, by -for example- having a regional control feature which serves several localised sites. Risks associated with adopting SuDS can be mitigated by ensuring that a suitable management procedure is established to make sure that the SuDS features are suitably maintained; this is particularly pertinent if a SuDS feature will be serving several sites. Long term maintenance procedures must be supported by legal agreements with the identified SuDS undertakers.

Conclusion

This study has identified no ultimate environmental or water infrastructure constraints to the proposed growth within Kent Thameside. However, the findings have been inhibited by the limited data and information provided by each of the water companies due to concerns regarding commercial confidentiality. This has not made it possible to determine the current and future water infrastructure capacity under the proposed growth scenarios that form the basis of this report (15,700 dwellings in Dartford and 9,300 in Gravesham), although the future capacity requirements have been ratified by each water company. Due to this uncertainty there does remain a small risk that water company assets may present a constraint to the phasing of the growth. This risk is exacerbated by the increase in growth to 17,340 dwellings by the Secretary of State's proposed changes to the South East Plan in July 2008.

This study has identified technical and planning issues that will need to be overcome to provide the sustainable and

integrated water management solutions, although none are considered insurmountable and for many there are a number of potential options. Continued and proactive engagement with key stakeholders, particularly the water companies and the Environment Agency is considered to be essential in order to reduce the uncertainty in key areas, largely due to a lack of data regarding future implementation of new legislation. This partnership working will also help to facilitate the selection and implementation of integrated water management solutions that will allow growth to be achieved in a sustainable fashion. Uncertainty should also be reduced as capital schemes are implemented thorough the AMP cycle.

Contents

Glossary

Abstraction license	a licence granted under the Water Resources Act 1991, as amended by the Water Act 2003, to abstract untreated water from a source of supply.
Biochemical Oxygen Demand (BOD)	a widely used measure of polluting potential - a measure of oxygen use, or demand, by bacteria breaking down the biodegradable load in sewage treatment plants or environmental waters.
Biodiversity Action Plan Priority Habitat	each Local Biodiversity Action Plan works on the basis of partnership to identify local priorities and to determine the contribution they can make to the delivery of the national Species and Habitat Action Plan targets.
Catchment Abstraction Management Strategy (CAMS)	the assessment of how much water can be extracted to meet its many economic uses – agriculture, industry, and drinking water supply – while leaving sufficient water in the environment to meet ecological needs.
Catchment Flood Management Plan (CFMP)	a strategic planning tool through which the Agency will seek to work with other key decision-makers within a river catchment to identify and agree policies for sustainable flood risk management.
Code for Sustainable Homes	signals a new direction for building standards. Wherever practical DCLG intend to develop and introduce a system of sustainable building standards based on voluntary compliance.
Core Strategy	a Development Plan Document setting out the spatial vision and strategic objectives of the planning framework for an area, having regard to the Community Strategy (see also DPDs).
County Council	the local authority that is responsible for waste and minerals planning functions in non-unitary, and non-national park, local authority areas. A county council may provide advice and proposals on strategic planning issues to the Regional Planning Body.
Department for Environment, Food and Rural Affairs (DEFRA)	department that brings together the interests of farmers and the countryside; the environment and the rural economy; the food we eat, the air we breathe and the water we drink.
Development Plan Document (DPD)	details the spatial representation of housing and employment land allocations in response to the regional spatial strategy.
EA flood zone	flood zones on the maps produced by Environmental Agency providing an indication of the likelihood of flooding within all areas of England and Wales, assuming there are no flood defences.
EC Freshwater Fisheries Directive	protects and improves the quality of rivers and lakes to encourage healthy fish populations.
Environment Agency (EA)	A government body that aims to prevent or minimise the effects of pollution on the environment and issues permits to monitor and control activities that handle or produce waste. It also provides up-to-date information on waste management matters and deals with other matters such as water issues including flood protection advice.
Environmental capacity	the ability of the physical environment to accommodate urban development and population growth without causing a deterioration in environmental quality.

Flood Estimation Handbook (FEH)	document produced by Centre for Ecology and Hydrology, Wallingford (formerly the Institute of Hydrology).
Flood Risk Assessment (FRA)	An assessment of the likelihood of flooding in a particular area so that development needs and mitigation measures can be carefully considered.
General Quality Assessment (GQA) Programme	the Agency's method for classifying the water quality of rivers and canals is known as the General Quality Assessment scheme (GQA). It is designed to provide an accurate and consistent assessment of the state of water quality and changes in this state over time.
Geographical Information System (GIS)	is a system for capturing, storing, analyzing and managing data and associated attributes which are spatially referenced to the earth.
Habitats Directive	an EU Directive which seeks to ensure the conservation or restoration of habitats.
Hydro-ecology	the science of water in relation to wetland wildlife habitats and of how plant and animal communities interact with their supporting soil water, surface water and ground water systems.
Interim Code of Practice for SUDS	document produced by CIRIA, which aims to facilitate the implementation of sustainable drainage in developments in England and Wales by providing model maintenance agreements and advice on their use. It provides a set of agreements between those public organisations with statutory or regulatory responsibilities relating to SUDS.
Local delivery Vehicle (LDV)	partnership that brings the public and private sectors together to deliver large-scale social, economic and environmental change to deliver the Government's Sustainable Communities Plan.
Local Development Framework (LDF)	a folder of local development documents that outlines how planning will be managed in the area.
Local Planning Authority (LPA)	the local authority or council that is empowered by law to exercise planning functions. Often the local borough or district council. National parks and the Broads authority are also considered to be local planning authorities. County councils are the authority for waste and minerals matters.
Natural England	is formed by bringing together English Nature, the landscape, access and recreation elements of the Countryside Agency and the environmental land management functions of the Rural Development Service.
OFWAT	The Water Services Regulation Authority. Ofwat regulate how much money a water company can is required to spend over each five year planning period, and regulate the amount of money the water companies can charge from their customers.
OSPAR	The Convention for the Protection of the Marine Environment of the North-East Atlantic.
Per capita	a Latin phrase meaning 'for each head'
Periodic Review or price review (PR)	One of Ofwat's main tasks is to set price limits for the water and sewerage companies in England and Wales. Ofwat do this in order to protect consumers from the monopoly providers of these services. However it is also our duty to enable efficient companies to finance their functions. They make sure that consumers receive reliable services and value for money and that each company is able to meet its environmental obligations now and in the future. We review price limits every five years. Prices were set at the price review in 2004 for the 2005 – 2010. This current price review (PR09) covers the five years from April 2010.

Planning Gain Supplement Obligations	the planning gain supplement is a proposed mechanism by which landowners or land developers will contribute to off site infrastructure.
Planning Policy Statements (PPS) and Planning Policy Guidance (PPG)	set out the Government's national policies on different aspect of planning. The policies in these statements apply throughout England and focus on procedural policy and the process of preparing local development documents.
Receiving water	watercourse, river, estuary or coastal water into which the outfall from Combined Sewer Overflow (CSO), surface water or other sewer discharges.
Regional Assembly	each of the English regions outside of London has a regional chamber that the regions generally call Regional Assemblies (not to be confused with the term Elected Regional Assemblies). They are responsible for developing and coordinating a strategic vision for improving the quality of life in a region. The assembly is responsible for setting priorities and preparing certain regional strategies, including the Regional Spatial Strategy.
Regional Development Agency	the nine Regional Development Agencies (RDAs) set up in the English regions are non-departmental public bodies. Their primary role is as a strategic driver of regional economic development in their region.
Regional Spatial Strategy (RSS)	a broad development strategy for a region for a 15 to 20 year period prepared by the Regional Planning Body.
Restoring Sustainable Abstraction Programme (RSAP)	identifies abstraction licences causing problems, and reviewed them with the purpose of rectifying the problems by reducing the volume extracted, altering licence conditions, and relocating abstraction points.
River Ecosystem class (RE)	classification which uses a six-fold classification (five RE classes and an unclassified level for the very polluted rivers). This classification reflects the chemical status of the water, as an indication general health of the water.
River Quality Objective (RQO)	agreed by Government as targets for all rivers in England and Wales when the water industry was privatised in 1989. The targets specify the water quality needed in rivers if we are to be able to rely on them for water supplies, recreation and conservation.
RQP	Environment Agency River Quality Planning Software
S106	a legal agreement under section 106 of the 1990 Town & Country Planning Act. Section 106 agreements are legal agreements between a planning authority and a developer, or undertakings offered unilaterally by a developer, that ensure that certain extra works related to a development are undertaken.
Sewage Treatment Works (STW)	separates solids from liquids by physical processes and purifies the liquid by biological processes. Discharge from sewage treatment works may contain a range of pollutants and need to be carefully monitored.
SIMCAT	catchment based water quality model developed by Environmental Agency.
Site of Special Scientific Interest (SSSI)	a site identified under the Wildlife and Countryside Act 1981 (as amended by the Countryside and Rights of Way Act 2000) as an area of special interest by reason of any of its flora, fauna, geological or physiographical features (basically, plants, animals, and natural features relating to the Earth's structure).
Special Areas of Conservation (SAC)	a site designated under the European Community Habitats Directive, to protect internationally important natural habitats and species.

Special Protection Area (SPA)	sites classified under the European Community Directive on Wild Birds to protect internationally important bird species.
Strategic Flood Risk Assessment (SFRA)	document that informs the planning process of flood risk and provides information on future risk over a wide spatial area. It is also used as a planning tool to examine the sustainability of the proposed development allocations.
Strategic Water Resources Plan, or statutory water resources management plan	It is now a statutory duty for water companies to prepare, consult, publish and maintain a water resources management plan under new sections of the Water Industry Act 1991, brought in by the Water Act of 2003. This plan is then kept under yearly review.
Super Output Areas (SOA)	a new national geography created by the Office for National Statistics (ONS) for collecting, aggregating and reporting statistics.
Sustainable Urban Drainage Systems (SUDS)	Sustainable drainage systems or sustainable (urban) drainage systems: a sequence of management practices and control structures designed to drain surface water in a more sustainable fashion than some conventional techniques (may also be referred to as SuDS or SDS).
The First Secretary of State	the lead Minister for all policies relating to Town & Country Planning, having powers of intervention on Development Plans and Planning Casework under certain circumstances.
United Kingdom Technical Advisory Group (UKTAG)	supporting the implementation of the European Community (EC) Water Framework Directive (Directive 2000/60/EC). It is a partnership of the UK environment and conservation agencies. It also includes partners from the Republic of Ireland.
Urban Regeneration Company	a dedicated body through which different people combine to co-ordinate the delivery of urban regeneration projects such as major mixed-use developments.
Water Framework Directive (WFD)	A European Union directive which commits member states to making all water bodies (surface, estuarine and groundwater) of good qualitative and quantitative status by 2015.
Water resource zone	defined by the water supply/demand balance in the region such that all customers within it receive the same level of service in terms of reliability of water supply.

1. Introduction

1.1 Background to this Report

The Kent Thameside Partnership Board (since renamed Kent Thameside Regeneration Partnership) was established in 2003 from the Kent Thameside Association to promote sustainable growth, encourage investment and improve the standard of living in the area. The Kent Thameside area covers the boroughs of Dartford and Gravesham between the Thames Estuary and the A2. This study is for the entire boroughs of Dartford and Gravesham, including those areas to the south of the A2. The location of the boroughs is shown in Figure 1.1. The area has been identified as a priority for long-term sustainable economic, social and environmental regeneration. The Water Cycle Study will assist in the sustainable development of the area ensuring that water infrastructure and interventions are clearly programmed.

A Water Cycle Study is the process of assessing environmental capacity and determining the most sustainable water services infrastructure solutions. It leads to a water cycle strategy which provides a plan and programme of water and environmental infrastructure implementation. The strategy is determined through an assessment of the environment and infrastructure capacity for:

- Water resources and supply;
- Sewage treatment and disposal;
- Flood risk management;
- Surface water drainage.

A Water Cycle Study can be undertaken in three stages; an initial scoping study, an outline study and a detailed study leading to a Water Cycle Strategy. This study follows on from the initial scoping study (Halcrow, July 2007), which outlined the key issues in Kent Thameside and provided a scope for further work. This study aims to build upon the scoping report and clearly outline the impact of the water cycle on the projected growth in Kent Thameside and highlight any potential problems that may need addressing in order to achieve this growth sustainably. A decision whether or not to undertake a more detailed study will be made on the basis of the findings of this report.

The study has worked with the key stakeholders, the Water Companies, the Environment Agency and the Local Authorities to establish the key constraints within the water cycle and identify integrated solutions in order to achieve sustainable development. The outcome is a strategic overview of the impacts and requirements for the proposed development for the period to 2026.

1.2 Water Cycle Study Objectives

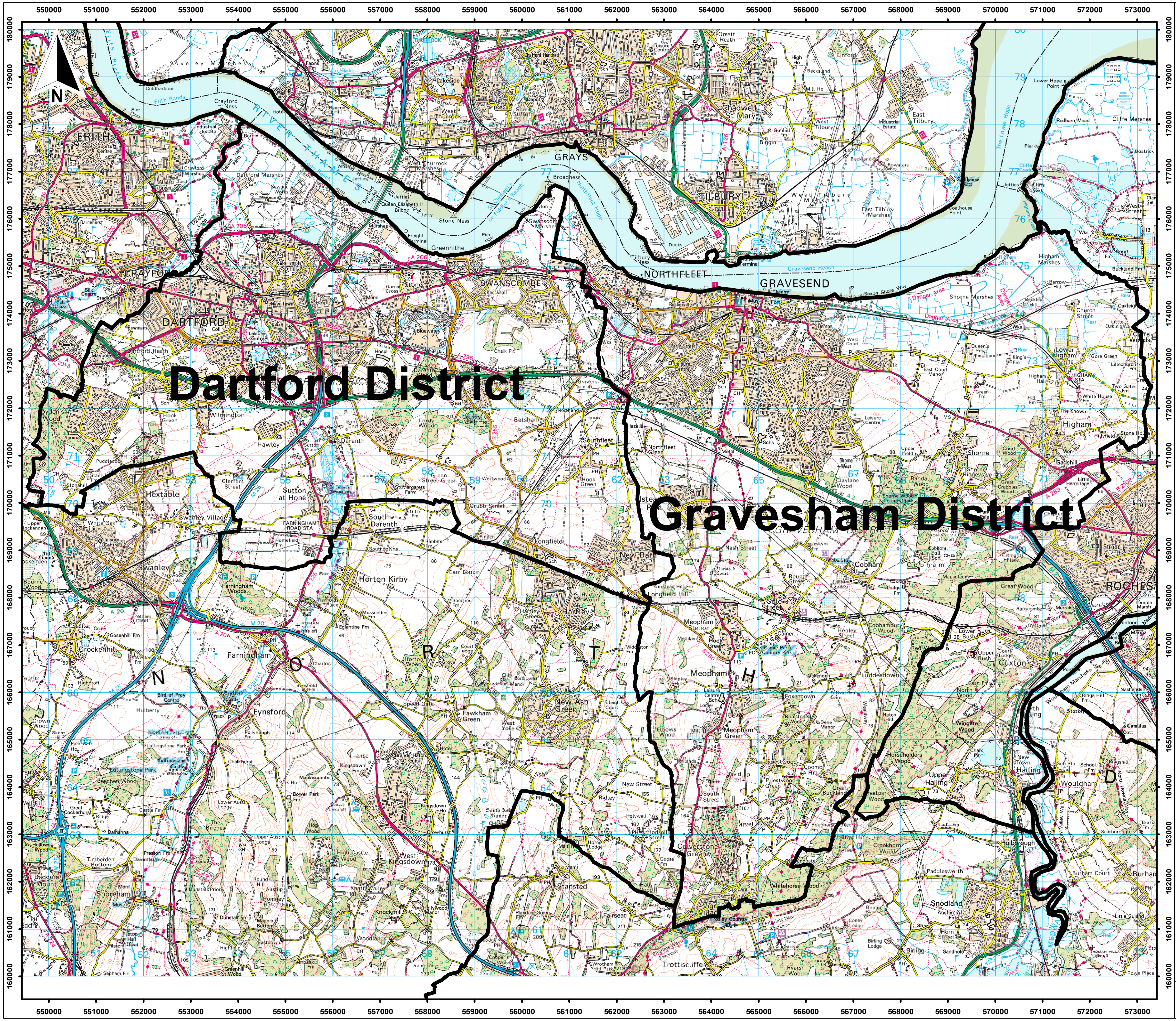
The original objectives of this Water Cycle Study for Kent Thameside were to:

- Evaluate the initial findings of the scoping study to establish if their is sufficient environmental capacity to receive runoff/wastewater and provide water resources;
- Establish the requirements for water infrastructure to meet the needs of proposed development;
- Identify optimum solutions to deliver solutions that integrate the different elements of the water cycle to achieve sustainable development across the area;
- Establish whether the required strategic infrastructure can be provided in an appropriate timeframe;
- Provide the evidence base to support the development of Local Development Frameworks for Dartford and Gravesham Borough Councils;
- Provide the guidance to developers to meet the objectives of the Water Cycle Study.

Key to this process is the collation and utilisation of existing research and information through continued engagement with key stakeholders. However, it should be pointed out that it has not been possible to address all of these objectives in full through difficulties in obtaining detailed specific information from the water companies (Southern Water and Thames Water). Much of the information requested from the water companies is considered commercially confidential especially pertaining to the wastewater side, which has made it difficult to fully integrate options as a whole across clean and dirty water areas for example. However, assurances have been provided that the required strategic infrastructure can be delivered within the timescales of the proposed development.

Key:

Local Authority Areas



0 500 1,000 1,500 2,000 2,500 3,000 3,500 4,000 Meters

Scale: 1:77,500 @ A3

Kent Thameside Water Cycle Strategy

Figure 1.1
Local Authority Areas

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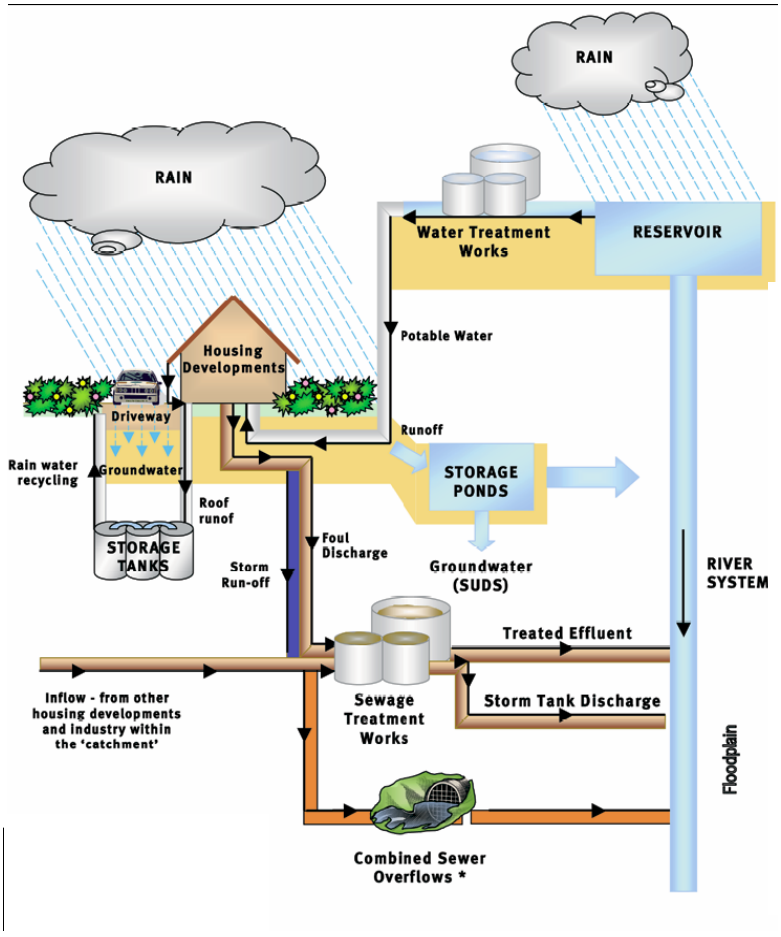
2. Water Cycle and Development

2.1 Water Cycle

The urban water cycle describes the pathways and processes that the water we use together with rainfall runoff moves through the natural and built environment, as well as the hidden above and below ground infrastructure on which the domestic population and industry depend. Rainfall is collected and removed from settlements, foul effluent is collected and treated and fresh water is treated and pumped to homes and offices. The capacity of the 'water' infrastructure needs to be sized appropriately to ensure the sufficient supply of clean water to homes and industry and to receive foul drainage, but also to prevent the discharge of polluted runoff and untreated foul drainage in order to protect the quality of the receiving water and water dependant habitats. Figure 2.1 summarises the water cycle and how water enters, leaves and returns to the river system.

Figure 2.1 Schematic of the Urban Water Cycle



New development increases the demand for potable water, results in increased flows to the sewage treatment works and increases the risk of flooding as rainwater runs off new houses, driveways and roads as the impermeable area is

increased. This study considers all these elements and how they interact, in order to highlight potential integrated sustainable solutions that will enhance the ecology of the receiving water and the area earmarked for development. It looks at the measures to ensure that water is properly managed and that the infrastructure necessary for new development can be provided without compromising existing resources.

2.2 Development

2.2.1 Housing

This growth is driven by the need to provide additional housing and employment opportunities and the planning system, in particular the Development Plan, is seen as the means of delivering these objectives.

The emerging South East Plan identifies the need for 15,700 and 9,300 new dwellings, respectively in the Boroughs of Dartford and Gravesham, and 58,000 new jobs in the Kent Thames Gateway Sub-Region for the period to 2026. In addition the Plan recognises that issues of matters of water management, infrastructure and flood risk need to be addressed in directing this growth to appropriate locations.

Table A.1 in Appendix A shows the proposed development sites and the completion projection for these sites. The number of homes in Kent Thameside will have a significant impact on the water cycle. Each home will bring more people into the area, increasing the requirement for clean water and sewerage provision. Additionally, many of the developments will be on Greenfield sites, increasing the impermeable area in Kent Thameside and thus runoff during storms. Since this study was commissioned, The Secretary of State has proposed changes to the South East Plan (July 2008) which includes an increase in the number of houses in the Borough of Dartford to 17,340. It should be recognised that this will further increase the demand for water supply and waste water treatment capacity over and above the original housing levels used in the calculations in this study. This increase will lead to a slight increase, in relative terms, in water and wastewater demand but is not considered significant to represent a signifciant constraint to growth over and above the original calculations. In addition to this, further updated information on the revised phasing and distribution of housing has been has been provided by Dartford Borough Council. A comparison of the revised data against the original data has been undertaken and this is presented in Appendix B.

2.2.2 Floor Space

Accompanying the proposed new housing growth will be commercial, retail, leisure and industrial developments to provide employment and local amenities and facilities for the new population. Table A.2 in Appendix A shows the amount of floor space growth projected for Dartford and Gravesham for each use type. These developments will also have an impact on the water cycle, but the nature of the impact will vary with the intended use of the site. For instance a shop will use relatively little water compared to an office block, even if they have a similar floor space.

3. The Kent Thameside Water Cycle

3.1 Introduction

Kent Thameside comprises the urban areas of Dartford and Gravesham north of the A2. Kent Thameside Regeneration Partnership has agreed in its Regeneration Framework a target of 30,000 new homes and 50,000 new jobs for the period 2001-2026. The housing target will be reviewed following the conclusion of the Examination in Public for the draft South East Plan, which currently sets a target for 24,700 dwellings in the period 2006-2026 . The majority of these new homes will be on redundant chalk quarries and redeveloped industrial land.

Water supply and sewerage undertakers serving Kent Thameside are Thames Water, Southern Water and South East Water. Since this report was commisoned the Secretary of State has proposed marginally higher housing figures outlined in the South East Plan (numbers for Dartford have increased from 15,700 to 17,340). This increase will lead to a slight increase, in relative terms, in water and wastewater demand but is not considered significant to represent a signifciant constraint to growth.

3.2 Environmental Receptors

Sensitive receptors and protected areas identified in the Thames Estuary may be found in Figure 3.1. These include:

- Thames Estuary & Marshes SPA and Ramsar site (including South Thames Estuary and Marshes SSSI and Mucking Flats and Marshes SSSI);
- Benfleet & Southend Marshes SPA and Ramsar site (including Benfleet and Southend Marshes SSSI and Southend-on-Sea Foreshore LNR);
- Holehaven Creek SSSI, Canvey Wick SSSI, Vange and Fobbing Creek SSSI, Pitsea Marshes SSSI;
  - Bathing Waters (9);
  - Shellfish Waters (4);
  - Nitrate Vulnerable Zone;
  - North Kent Marshes Environmentally Sensitive Area (ESA);
  - Essex Coast ESA.

3.3 Legislation and Regulation

3.3.1 Introduction

Legislation, guidance and supporting evidence for water related issues, such as water quality, flood risk

management and urban drainage, have a significant impact on the water cycle and are often the cause of changes in water infrastructure, as much as development pressures. Any adaptations to the water cycle must be compliant with such legislation and some are undertaken within the regulatory framework.

There is currently an unprecedented level of change in the legislation and guidance for water related issues. Some of these changes are driven by European directives, as with the Water Framework Directive, others are in response to national pressures, from last summers floods for instance. These changes are either currently being implemented, soon to be applied or likely to change in next five to ten years. Given that the timetable for the Water Framework Directive spans the next 18 years in three six-year cycles, the water companies expect to use the first period to carry out the majority of investigations to establish the necessary investment. This will provide an opportunity to assess the improvements delivered through other quality investments. Southern Water and Thames Water are already making significant investment to achieve the standards required by other directives, such as the Habitats Directive. This investment will need to continue in the short term so they achieve these obligatory standards.

The primary pieces of legislation which set the context for understanding the environmental capacity in the Kent Thameside region are summarised below.

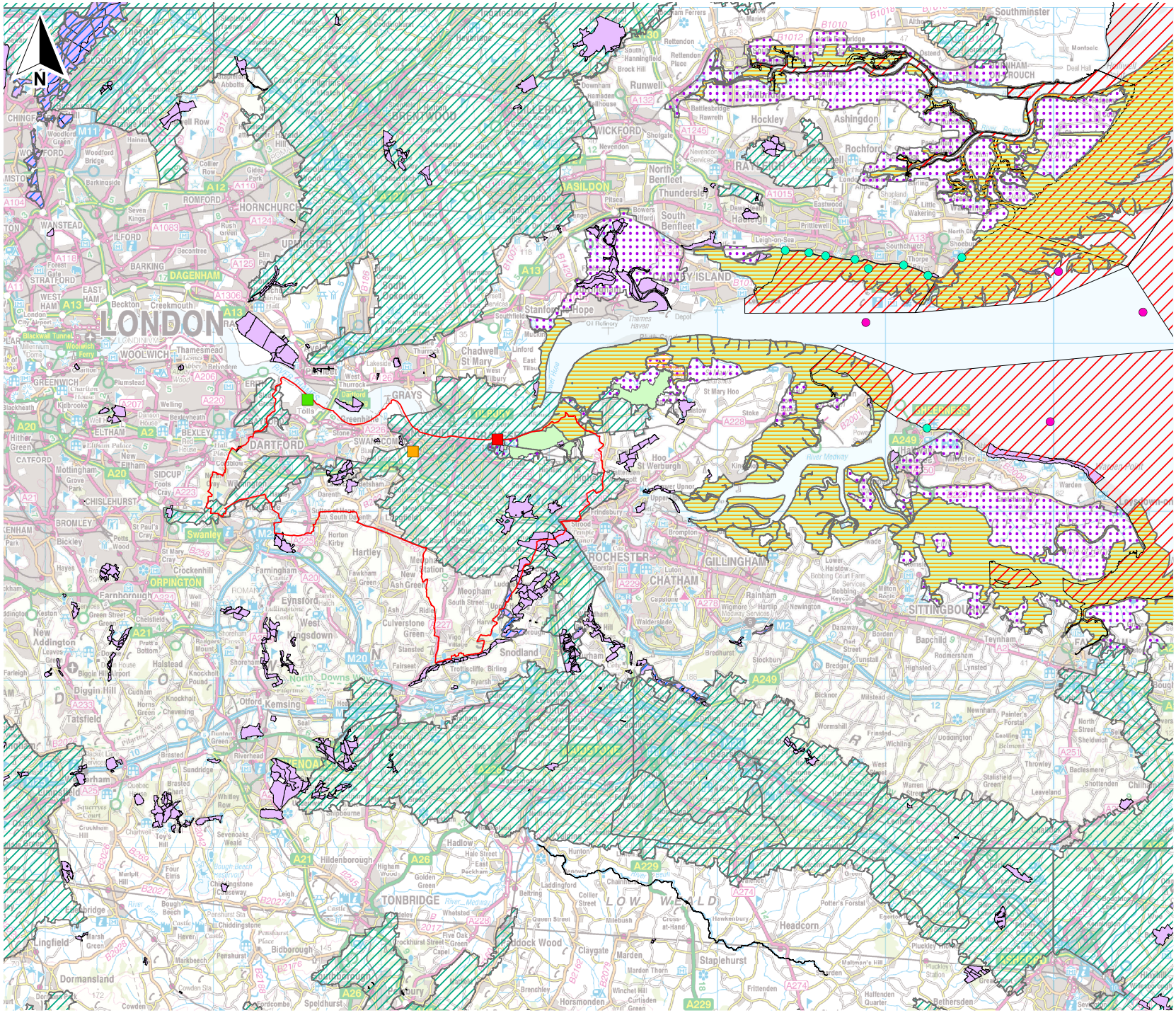
3.3.2 Water Framework Directive

The Water Framework Directive sets out a requirement to achieve good ecological status in rivers, estuaries and coastal waters, together with good status of groundwater by at least 2027. It presents a unique opportunity for holistic environmental management for all users of the water environment.

Standards for coastal and transitional (estuaries) waters brought in to meet the requirements of the Water Framework Directive require that thermal conditions, oxygen conditions, transparency and nutrients are considered. A cross body Technical Advisory Group (UKTAG) has recently published a set of environmental standards. Whilst there is no certainty that these standards will become statutory in the current form, they form the best current knowledge of how the standards may change. It is considered likely they will be finalised later this year. The environmental quality standards of key concern in transitional waters are temperature, suspended solids and nitrogen.

Temperature

UKTAG proposes that the existing Guideline standard of a 2^{o}C temperature increase (existing Shellfish Waters Directive; proposed under Review of Consents for the Habitats Directive) continues. This would be applied as part of the preliminary assessments, for example, of the impact of a new discharge into a pristine stretch of water.



Key:

- Kent Thameside Area
- Gravesend STW
- Longreach STW
- Northfleet STW
- **Bathing Waters**
- **Shellfish Waters**
- **Bivalve Mollusc Harvesting Areas**
- **Special Protection Area**
- **Special Area of Conservation**
- **Ramsar site**
- **Site of Special Scientific Interest**
- Nitrate Vulnerable Zones
- Environmentally Sensitive Area

0 1,500 3,000 6,000 9,000 12,000 Metres

Scale: 1:225,000

Project Path: H:/Projects/HM-255/21000/21916 Thames Water Cycle/GIS

Kent Thameside Water Cycle Study

Figure 3.1
Designated Sites and Sensitive Waters

June 2008
21916-S01 frede

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Suspended Solids

Measured values for suspended solids in transitional waters can vary naturally in space and time, and UKTAG recognise that it is difficult to set up a general standard for use in classification. Therefore where the plant and animal communities are at risk from increased sediment or suspended solids, the Environment Agency will undertake monitoring with a view to assessing the likelihood and scale of impact and determining the causes.

Dissolved Inorganic Nitrogen

Under the WFD UKTAG proposes that coastal waters be assessed using the winter mean of dissolved inorganic nitrogen (DIN) and the proposed thresholds for high and good status are based on the thresholds developed for UK assessments made for the OSPAR Convention (OSPAR). For transitional waters a salinity gradient and the level of turbidity (according to type of water body) have been used to determine nutrient thresholds. Using the UK TAG methodology the Thames Estuary is classified as 'TW3: Fully mixed, polyhaline, macrotidal, sand or mud substratum, extensive intertidal'. This results in thresholds for High and Good status to be 30 and 20 micromoles (µM) of DIN per litre. If the threshold for good status is exceeded, then the turbidity related value is brought in, for the Thames Estuary (TW3) this is 270 µM at the 99th percentile and the water body downgraded to moderate only if this parameter is also failed, see Appendix C for further details.

An assessment of the water infrastructure required to meet tighter standards and the impact of these on the development, including phasing will be required following the publication of the of the River Basin Management Plan, which will outline the programme of measures required to achieve the objectives of the Water Framework Directive. Where there is insufficient information available to determine the appropriate measures, further investigations maybe required during the first River Basin Planning cycle. These investigations could be undertaken by the Environment Agency or the water companies, with funding approved by OFWAT. For example investigations could be required to determine the contribution between different sources or establish a link between ecological and chemical status. In meeting tighter standards there is also a requirement for the Environment Agency to undertake a cost benefit analysis to ensure the costs are not disproportionate compared to the environmental benefits. Where there is a clear case to reduce the pollutant load derived from an individual or a number of STWs and / or intermittent discharges the water company would bid to OFWAT for funding to undertake the necessary improvements through the Periodic Review process. Therefore the tightening of Environmental Quality Standards under the Water Framework Directive or any other legislation should not present an absolute barrier to development in Kent Thameside although the rate of growth maybe affected.

3.3.3 Birds and Habitats Directive

As people make increasing demands on the environment our wildlife habitats are coming under more and more pressure. The Birds Directive and the Habitats Directive recognise this and aims to protect the wild plants, animals and habitats that make up our diverse natural environment. The European Directives created a network of protected areas of national and international importance. These are called 'Natura 2000' sites and include:

- Habitats Directive Special Areas of Conservation (SACs)

- Birds Directive Special Protection Areas (SPAs)

The Habitats Directive has been transposed into English law as the Conservation (Natural Habitats &c) Regulations 1994, now known as the Habitats Regulations.

Existing and future water management has the potential to affect a number of these designations and the Environment Agency Review of Consents process has identified a series of amendments that will be required to existing abstraction licences and discharge consents if adverse effects on the European Sites are to be avoided. The detail and implications of theses are considered in Sections 4 and 5 of this report.

3.3.4 Bathing Waters Directive

The Bathing Waters Directive sets out water quality standards to protect the environment at bathing waters throughout the bathing season. It requires popular bathing waters to be 'designated' and monitored for water quality, particularly for human waste from sewage treatment works. In England and Wales the bathing water season runs from mid-May to September. There are 9 identified and monitored bathing waters in the Thames Estuary. The directive is implemented through the Bathing Waters (Classifications) Regulations 2003.

A revised Bathing Water Directive became law in the UK in March 2008. As well as stricter water quality standards, it contains a requirement to provide more detailed and standardised information about bathing waters across Europe.

There are 9 identified and monitored bathing waters in the Thames Estuary and coastal zone, the closest (Leigh Bell Wharf) is located more than 20km downstream of Gravesend STW outfall.

3.3.5 Shellfish Waters Directive

The Shellfish Waters Directive aims to protect shellfish populations and contributes to the high quality of shellfish products. It sets water quality standards in areas where shellfish grow and reproduce, these are mainly in estuaries. The directive requires that certain substances are monitored in the water in which the shellfish live and grow. These substances can threaten the survival of shellfish, inhibit their growth or make them too expensive to treat before they can be used as a food source. In the UK, the directive is implemented by the Surface Waters (Shellfish) (Classification) Regulations 1997 and the Surface Waters (Shellfish) Directions 1997.

The directive will be repealed in 2013 by the EC Water Framework Directive, which must provide at least the same level of protection to shellfish waters (which the WFD classifies as protected areas) as the Shellfish Waters Directive does. There are 4 Shellfish Waters in the in the Thames Estuary and coastal zone, the closest (Southend) is located more than 20km downstream of Gravesend STW outfall.

3.4 Key Dates

3.4.1 Asset Management Planning

On a five yearly basis the water companies in England and Wales set out their requirements for maintaining and enhancing their water supply and wastewater infrastructure in their Strategic Business Plans. These plans are submitted to the financial regulator, the Water Service Regulation Authority (Ofwat).

The Strategic Business Plans form part of the Periodic Review (PR) process whereby Ofwat, in consultation with other organisations including Defra, the Environment Agency, Natural England and consumer organisations, determines the expenditure that the water companies can make to maintain and enhance their infrastructure. The outcome of this determination is an Asset Management Plan (AMP) for the following five-year period (Figure 3.2).

The current (fourth) AMP period finishes in 2009 and the water companies are currently in the process of preparing their Strategic Business Plans covering the next AMP Period (AMP5), setting out their funding requirements for the period 2010 to 2015.

Figure 3.2 Asset Management Plan timescales

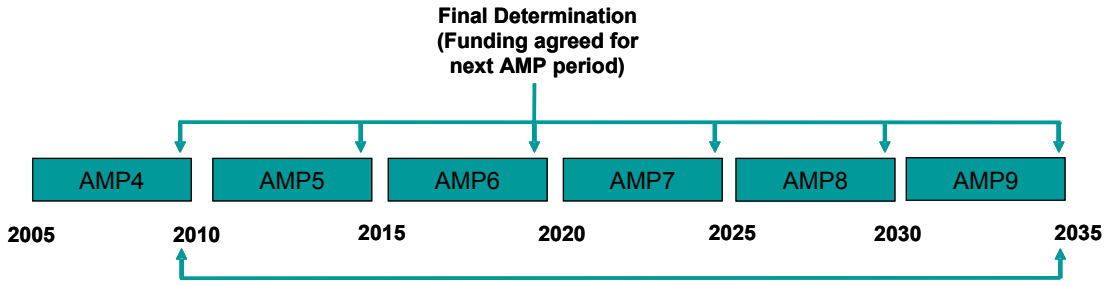


Table 3.1 Key Dates for the AMP5 Period

Date	Action
May 2008	Draft Water Resources Management Plans published for consultation
August 2008	Draft Strategic Business Plans produced by Water Companies
April 2009	Final Water Resources Management Plans and Strategic Business Plans submitted by water companies
December 2009	Final Determination
April 2010	AMP5 period commences

The Periodic Review process is an important consideration in developing a Water Cycle Study as it determines the amount of money that water companies have available to meet the water and wastewater needs of new developments. If development is not captured within water company plans then there may be insufficient funds

available to provide the required water infrastructure, resulting in the need to delay or phase developments until after the next periodic review period.

3.4.2 Water Framework Directive Implementation

The Water Framework Directive (WFD) was entered into force in December 2000. Actions on Member States remain and the Environment Agency have consulted on an interim overview of significant water management issues for each river basin district. The timetable for the implementation of the WFD is presented in Table 3.2.

Table 3.2 Timetable for Implementation of the Water Framework Directive

Date	Action
22 December 2008	Publish and consult on drafts of the river basin management plans (at least 6 months to be allowed for comments in all the above cases) (article 14) establish programmes of measures in each river basin district in order to deliver environmental objectives (article 11)
22 December 2009	Publish first river basin management plan for each river basin district, including environmental objectives for each body of surface or groundwater and summaries of programmes of measures (article 13)
2010	Ensure proper water pricing policies are in place (article 9) make operational programmes of measures in each river basin district to deliver environmental objectives (article 11)
22 December 2012	Interim progress reports to be prepared on progress in implementing planned programmes of measures (article 15)
22 December 2015	Main environmental objectives to be met (article 4)
22 December 2015 and every six years thereafter	Review and update plans (with same consultation and interim reporting arrangements described above) (articles 13,14 and 15)

3.5 Planning Policy Context

Planning policy at the national, regional and local level is the means by which housing and employment growth will be delivered in a sustainable manner and, in doing so, ensure that issues relating to water management, infrastructure and flood risk are adequately addressed. A review of the relevant policy has been undertaken to identify the planning policy context within which these issues will need to be considered as they relate to Kent Thameside. The full review of planning context may be found in Appendix D.

3.5.1 National policy

The Government provides guidance on a range of planning issues through a series of Planning Policy Guidance notes (PPGs) and more recent Planning Policy Statements (PPSs).

PPS 1 – Delivering sustainable development

PPS 1 sets out the Government's planning policies on the delivery of sustainable development and advises regional planning bodies and local planning authorities to ensure that development plans promote outcomes in which environmental, economic and social objectives are achieved together over time and contribute to global sustainability by addressing the causes and potential impacts of climate. In protecting and enhancing the environment planning authorities should seek to enhance the environment as part of development proposals; avoid significant adverse impacts and pursue alternative options.

Specifically development plan policies should take account of environmental issues such as the protection of groundwater from contamination and the potential impact of the environment on proposed developments by avoiding new development in areas at risk of flooding and sea-level rise, and as far as possible, by accommodating natural hazards and the impacts of climate change. The policies should also minimise the consumption of new resources by making more efficient use or reuse of existing resources. The PPS advises that regional planning authorities and local authorities should promote amongst other things the sustainable use of water resources and the use of sustainable drainage systems in the management of run-off

PPS 25 – Development and flood risk

PPS25 aims are to ensure that flood risk is taken into account in the planning process to avoid inappropriate development in areas at risk of flooding and to direct development away from areas at highest risk. Where, in exceptional circumstances, new development is necessary in such areas then the aim is to make it safe without increasing flood risk elsewhere and, where possible, to reduce flood risk overall.

In preparing planning strategies LPAs are advised to adopt the principle whereby *Local Development Documents (LDDs) set out policies for the allocation of sites and the control of development which avoid flood risk to people and property where possible and manage it elsewhere, reflecting the approach to managing flood risk in this PPS and in the RSS for their region.*

3.5.2 The Development Plan

Regional Planning Guidance for the South East (RPG9) is currently being replaced by the South East Regional Spatial Strategy (The South East Plan) and this will establish the broad development strategy for the region and provide a regional framework within which Local Planning Authorities should prepare their Local Development Frameworks (LDF) for the period to 2026. Until such time as the South East Plan is finalised and the Development Plan Documents (DPDs) have been adopted the Kent and Medway Structure Plan 2006 and the Dartford and Gravesham Local Plans will, as far as their saved policies, continue to be the Development Plan for Kent Thameside.

3.5.3 The Draft South East Plan

The draft Plan recognises that flood risk is a particular issue in the Kent Thames Gateway Sub-Region and states

development will not be permitted if it would be subject to an unacceptable risk of flooding or increase the risk elsewhere; or prejudice the capacity or integrity of flood plains or flood protection measures.

More generally the draft Plan includes policies relating to sustainable water resources, groundwater and river water quality management; strategic water resources development and sustainable flood risk management. It requires that policies are included in the LDDs to address these issues and planning applications are determined in accordance with the Plan policies. In particular there is a requirement to:

i. Ensure compatibility with River Basin Management Plans and take account of other plans and strategies (Policy NRM 1);

ii. Ensure that the rate and location of development does not lead to unacceptable deterioration of water quality and is in step with current and planned provision of adequate water supply, sewerage and waste water treatment infrastructure capacity (Policy NRM 1);

iii. Require development that would use significant quantities of water to incorporate measures to achieve high levels of water efficiency and where appropriate, sustainable drainage solutions where these are consistent with protection of groundwater quality (Policy NRM 1);

iv. Work with water and sewerage companies and the Environment Agency to identify infrastructure needs, allocate areas and safeguard these for infrastructure development (Policy NRM 1);

v. Encourage winter water storage reservoirs and other sustainable farming practices which reduce summer abstraction, diffuse pollution and runoff, increase flood storage capacity and benefit wildlife and recreation (Policy NRM 1);

vi. Not permit development that presents a risk of pollution or where satisfactory pollution prevention measures are not provided in areas of high groundwater vulnerability (Policy NRM 1);

vii. Adopt the sequential approach to development in flood risk areas set out in PPS25. Inappropriate development should not be allocated or permitted in zones 2 and 3 of the floodplain or areas with a history of groundwater flooding, or where it would increase flood risk elsewhere, unless there is over-riding need and absence of suitable alternatives. Where development is proposed for parts of zones 2 and 3, local authorities (in the case of plan allocations) and developers (in the case of specific proposals) with advice from the Environment Agency should undertake a Strategic Flood Risk Assessment (SFRA) to provide a comprehensive understanding of the flood risk and options for managing that risk in a cost effective manner. This should have regard to climate change and identify appropriate types of development and suitable mitigation and adaptation measures in scheme design and layout (Policy NRM 3).

It should be noted that since this report was commissioned the Draft South East Plan has been updated (in July 2008) and a number of policies have changed their number and title based on The Secretary of State's Proposed Changes to the South East Plan. The implications of these changes are that bullet points ii, iii, iv and vi above are no longer directly applicable. The Policy changes (relating to the policies mentioned above) are summarised below:

- Policy NRM1 now refers to sustainable water resources and groundwater only;
- There is a new policy (NRM2) on River Water Quality Management which clarifies the distinction

between physical waste water treatment capacity and the capacity of the receiving water and specifies the need to address the additional work required to address potential Habitats and Water Framework Directive implications. As a new issue, reducing diffuse agricultural pollution is included;

- Policy NRM2 is now NRM3 and the title remains Strategic Water Resources Development;
- Policy NRM3 is now NRM4 and the title remains Sustainable Flood Risk Management.

Local Development Framework

Both Dartford and Gravesham are in the process of preparing their Core Strategy DPDs and these emerging documents are obliged to conform to the Regional Spatial Strategy. As such they are the means by which strategic policy will be transposed to the local level and, when adopted, then they will provide local policy and replace the relevant parts of the Structure and Local Plans. The Core Strategy DPD is the key development plan document which will provide the overarching strategy for policy and development within the Boroughs for the Plan period. Other Local Development Documents will build on this strategy and deliver the detail although within this framework there is a degree of flexibility on how this is done.

The Borough of Gravesham published its Core Strategy Key Issues and Options in a consultation document dated October 2007. It identifies the key issues and options relating to LDF[1] policy on the topics of location of new development and managing flood risk; water supply and water quality; and specifically Thames Riverside and the need to take into account the implications of flood risk.

The Borough of Dartford published its Core Strategy Preferred Options for consultation in January 2008. The Council identifies that with regard to balanced housing growth the issue of phasing of water supply and waste water treatment is a critical. It aims when identifying land for development to ensure that the risk from flooding is acceptable in relation to the type of development proposed and that the residual risk can be adequately managed. The Council states that its preferred approach is to seek a higher standard for water efficiency than required under the proposed amendments to Building Regulations, where the costs of efficiency measures are proportionate to the benefits achieved.

Minerals and Waste Development Framework

The Minerals and Waste Development Framework (MWDF) sets out the spatial strategy for future minerals and waste development at the county level. It also details the consultation procedures that the County Council will undertake in fulfilling its planning functions, together with the timetable for the preparation and adoption of new minerals and waste policy documents.

The 2006 Minerals and Waste Development Scheme (MWDS), which sets out the programme for preparation of

[1] It should be noted that with regard to the LDF for Gravesham – the Local Development Scheme is now approved by GOSE. Regulation 25 consultation on the Core Strategy and Development Control Policies DPD will take place in the summer of 2009 with submission in the summer of 2010 (from information supplied by Gravesham February 2009)

Minerals and Waste Development Plan Documents (DPDs), was revised and submitted to the Government Office for the South East (GOSE) in March 2007. However, this was not adopted due to uncertainties over the future programme for the previously submitted Minerals DPDs. A revised Minerals and Waste Development Scheme is under consideration and will be submitted to the Government Office for the South East (GOSE) in the near future.

The Minerals and Waste Development Framework (MWDF) will be taken forward in accordance with the revised scheme, once adopted. As part of the MWDF waste specific DPDs will be produced that identify sites for waste and minerals related development. This should include new wastewater and sludge treatment facilities or upgrades to existing infrastructure in Kent Thameside and is thus directly relevant either where upgrades to existing infrastructure require planning permission or where new facilitates are proposed.

In summary the MWDF will:

- identify specific sites for waste and minerals management facilities within the county;
- set out any specific considerations in the location of waste and minerals development; and
- set out the framework for implementing and measuring the success of the DPDs.

In addressing the above, the Site Allocations Locations for Waste Development DPD will replace the site specific elements of the Waste Local Plan 1998 and identify sites in line with the spatial strategy that will deliver the required waste management capacity to support growth within Kent to cover the period to 2026.

The Water Cycle Study

The Water Cycle Study is intended to inform the Plan process and provide an evidence base for the production of the Core Strategy and other DPDs and, thereby, assist in delivering objectives relating to water in a timely and structured manner when bringing forward development. In effect it provides the detail on how Local Authorities, and ultimately developers, will meet the strategic water requirements of the South East Plan. The Boroughs of Dartford and Gravesham will need to address the South East Plan policies in their LDFs and, where necessary, include appropriate policies within their documents. There are, however, options as to how this is best achieved but it is fundamental that there is an appropriate policy base included in the Core Strategies.

4. Water resources and water supply

4.1 Water Resources Management

- **Kent Thameside lies within an area of "serious" water stress**
- **There is little or no water available locally for further new resource development to meet demand from new development**
- **Existing resources should be used efficiently to make best use of available resources**
- **If further resources are required, additional storage or transfers from outside the Medway and Darent and Cray Catchments (e.g. from Thames Water's proposed 'Abingdon' Reservoir) will be necessary**

Water resources are managed by the Environment Agency in England and Wales, who are responsible for granting abstraction licences that enable water to be taken from the environment for various purposes. Kent Thameside lies within the Environment Agency's Southern Region.

Expanding on the fourth key point above, it has been assumed that there will be sufficient water resources available to allow the delivery of new development in Gravesham and Dartford, if Southern Water and Thames Water are allowed to implement their PR09 Water Resources Management Plans in full. Thames Water's plan includes the need for a new reservoir (most likely located near Abingdon) to be operational by 2026 in order to maintain supplies in a number of its supply areas, including Kent Thameside. No permissions for either the construction or operation of this reservoir have currently been granted.

4.1.1 Regional Context

In its 2001 Water Resources Strategy the Environment Agency concluded that there is no additional surface water available for abstraction in the summer months in the Southern Region, and that the current abstraction regime is unacceptable, based on licensed volumes being utilised during a dry summer (Environment Agency, 2001). The same document included an assessment of regional groundwater resources and classified all of the groundwater units in the eastern part of the region (including those in the Kent Thameside area) as having an unacceptable flow regime.

This means that at the regional level, there is unlikely to be significant further volumes of water available for abstraction. The Agency strategy at the regional level seeks to reduce the volumes licensed for abstraction across the region. However, it should be noted that the Agency states in the 2001 strategy that "there may still be some limited opportunities for further abstraction in the region, but detailed studies are often necessary".

The Environment Agency is currently updating its water resources strategy at the regional level (Environment Agency 2007b). The updated strategy is yet to be published and has not been available for the current study.

In 2007 Environment Agency (Environment Agency, 2007a) assessed much of the South East (including Kent Thameside) as being of a level of "serious" water stress.

4.1.2 Catchment Abstraction Management Strategies (CAMS)

CAMS (Catchment Abstraction Management Strategies) are documents produced by the Environment Agency. Under the CAMs process there is a framework used when considering abstraction licence applications, helping us to balance abstractors' reasonable needs for water with environmental needs.

The CAMS assessment process determines how much water is available for abstraction and how much water is required by the environment in each catchment. Where the CAMS process identifies that the current volume of water licensed for abstraction (or the actual volume that is abstracted) exceeds the environmental requirements, the CAMS sets out how the Agency will seek to redress this balance.

The CAMS documents are reviewed on a six yearly cycle to tie in with the requirements of the Water Framework Directive, which requires that a River Basin Management Plan be produced and reviewed at the same six yearly frequency.

Local CAMS documents need to be considered within a Water Cycle Study. The documents detail the availability of water resources within the strategy area, identifying where there may be more water available to meet the needs of new development, or where there is no water available and the demands of new developments may need to be met from elsewhere. CAMS are also important to wastewater service provision, since the availability of water within rivers is important for maintaining sufficient dilution of wastewater discharges.

There are two CAMS documents that cover the Kent Thameside area. The eastern part of Kent Thameside lies within the Medway CAMS, whilst the western part falls within the Darent and Cray CAMS. In summary, both documents identify that there are little or no further water resources available in these catchments and emphasise the requirement to use existing sources as efficiently as possible. If development within Kent Thameside requires significant additional resources to be developed, further storage (reservoirs) or transfers from outside the catchments will be required.

The Darent and Cray CAMS Consultation Document (October 2006) stated that:

All new licences and variations (other than downward variations or minor variations having no environmental impact) will have a time limit imposed, which will indicate whether the licence should be renewed and, if so, on what terms. Where possible, the intention is to have all time limits on licences within a CAMS area expiring on the same date (known as the "common end date"). However, there may be situations where shorter or longer time limits may be justified. The next common end date for the Darent and Cray CAMS is ***31 March 2014.*** *The normal duration for a renewed licence will be 12 years.*

The Environment Agency will notify licence holders before the expiry of their licence, who will then have to apply

for a renewal their licence. There is a presumption that time limited licences will be renewed if:

- Environmental sustainability is not in question.
- There is a continued justification of need for the water.
- The water is used efficiently.

The Environment Agency will take into account any objections received to renewal of the licence, and will endeavour to give six years notice if a licence will not be renewed or is to be renewed but on terms that are more restrictive which impact significantly on the use of that licence.

The Environment Agency are unlikely to allow water company licences to be varied upwards as the Gateway area is 'Over Abstracted' in terms of CAMS.

A more detailed review of water resource availability is provided in Appendix E.

4.1.3 Restoring Sustainable Abstraction Programme

In 1999 the Environment Agency established the Restoring Sustainable Abstraction (RSA) Programme to identify sites that are designated (such as EU Habitats Directive and Sites of Special Scientific Interest) and locally important sites that may be at risk from unsustainable water abstraction. If investigations show detrimental effects on these sites from water abstraction the Environment Agency will attempt to reduce the impact. This may be through actions such as helping to develop alternative sources away from the affected sites. The RSA Programme may be important to a water cycle study where locally important water supply sources are subject to investigations and possible reductions in licensed volumes.

4.1.4 Potential for future licence reductions

The water companies and the Environment Agency have been undertaking investigations during AMP4 to determine if some existing sources identified by the Environment Agency are having a detrimental impact on the environment. The North Kent Marshes Investigation may result in reductions in groundwater sources in Southern Water's Kent Medway WRZ. There is no indication of the potential volume of reduction at this stage, or when any reduction would need to be implemented (Southern Water, 2008). Thames Water sources in Orpington are under investigation during AMP4. The output of these investigations will inform whether any reductions are required (Thames Water, 2008). The implications of potential licence reductions on water supplies are discussed further in Section 4.2.1.

4.2 Water Company Planning

Under the Water Act 2003, water companies must submit a Water Resources Management Plan (WRMP) to Defra. These plans set out in detail how the water companies plan to balance supply and demand for water in their supply area over a 25 year period and take into account the economic, environmental and social implications of these

plans. These plans, previously known as Water Resources Plans (WRPs) are reviewed and updated on a five yearly basis and submitted to the Environment Agency and Ofwat for scrutiny. The last WRP was produced in April 2004. Since that time the plans have become a statutory requirement. The next WRMP is due to be completed in 2009, although the water companies have prepared and published a draft WRMP for consultation in May 2008.

Table 4.1 AMP Timetable WRMPs

Date	Action
May 2008	Draft Water Resources Management Plans published for consultation
August 2008	Draft Strategic Business Plans produced by Water Companies
April 2009	Final Water Resources Management Plans and Strategic Business Plans submitted by water companies
December 2009	Final Determination
April 2010	AMP5 period commences

4.2.1 A summary of technical considerations in water company resource planning

In the WRMPs, the water companies set out their plans for water resource provision at the sub-company level, in areas called water resource zones (WRZs). A WRZ is defined as *"the largest possible zone in which all resources, including external transfers, can be shared and hence the zone in which all customers experience the same risk of supply failure from a resource shortfall"* (Environment Agency, 2007e, p24-3).

WRMPs consider the balance between supply and demand, taking account of the uncertainty that exists within the analyses within the plans as well as other future uncertainties that might affect this balance. This uncertainty is called 'headroom' in water resource planning terminology. Headroom takes account of a range of uncertainties associated with the estimation of various components of supply and demand. The uncertainty associated with climate change, and its potential impacts on supply and demand are also included in headroom. Companies estimate a level of target headroom that they include in their plans on the demand side of their supply demand balances.

The supply demand balance is considered in the 'baseline' situation, based on the water company's current understanding of supply and demand forecasts and headroom over the 25 year period of the plan. This takes account of licences that may be reduced or revoked if it is proven that they are having a detrimental effect upon the environment. If the company forecasts a deficit, then a 'final plan' supply demand balance must be established that includes measures that resolve the forecast deficit. These measures could be supply-side options such as new reservoirs or demand-side options such as water efficiency programmes. The water company must consider a full range of possible options and demonstrate that the preferred solution to resolve any deficits is the least cost solution, taking account of capital and operating costs, as well as social and environmental costs.

The analyses initially present supply demand balances in theoretical 'dry year' scenarios, which, put simply,

consider the availability of water supplies and demand in a worst case situation. Therefore a supply deficit in these scenarios does not mean that supplies will fail, but that there is an increased risk of this occurring in a drought event. Water companies plan to maintain supplies to a specified level of service, usually described in terms of the frequency of supply interventions (e.g. hosepipe bans). A deficit in the supply demand balance within a WRMP indicates that the specified water company level of service cannot be maintained during the deficit period.

When planning future water resources the water companies aim to achieve 'levels of service' for customers, which are agreed with the water regulator, Ofwat. Each company has its own levels of service, which state how frequently the companies can impose water use restrictions during periods of water shortage. For example, Thames Water plan to impose hosepipe bans no more frequently than once in twenty years (Thames Water, 2008). Levels of service are important as they determine the investment required to maintain secure supplies of water and prevent more frequent restrictions than the companies' stated levels of service. The presence of a supply demand deficit in a Water Resource Zone indicates that the water company are unable to maintain the agreed level of service for that area.

The water companies produce plans under a 'dry year' scenario, ensuring that demand for water can be met for the agreed levels of service during a dry or drought period. All water companies produce plans to ensure that the annual average demand for water can be met during a dry year. Where water companies identify that the ability to meet short-term peaks in demand in a dry year is a driver for additional water supply investment, companies may also submit plans for a WRZ under peak or 'critical period' conditions.

WRMPs are subject to review by the Environment Agency and Ofwat, who must be convinced that the water company proposals present the 'least cost' and most sustainable water resource management options. The Environment Agency will also scrutinise the technical methods used by the water companies in the preparation of their plans. The work required by the water companies to meet these regulatory requirements is extensive and is fundamental to further promotion of any major capital scheme via the planning process (including Environmental Impact Assessment and any likely public inquiry). There remains uncertainty both within the plans (e.g. that planned demand management schemes will deliver the estimated savings) and in the success of the plan itself (e.g. that large capital schemes such as Abingdon Reservoir will fail to get planning permission). Water company plans include the consideration of alternative options (that may be less cost effective or sustainable than the 'preferred solution') which may have to be implemented in the event that their plans fail to result in the desired outcomes. It should be noted that water companies have a statutory duty to maintain water supplies to the agreed levels of service, and significant failures in supplies below these standards are socially and politically unacceptable.

4.2.2 Regional Water Supply Plans

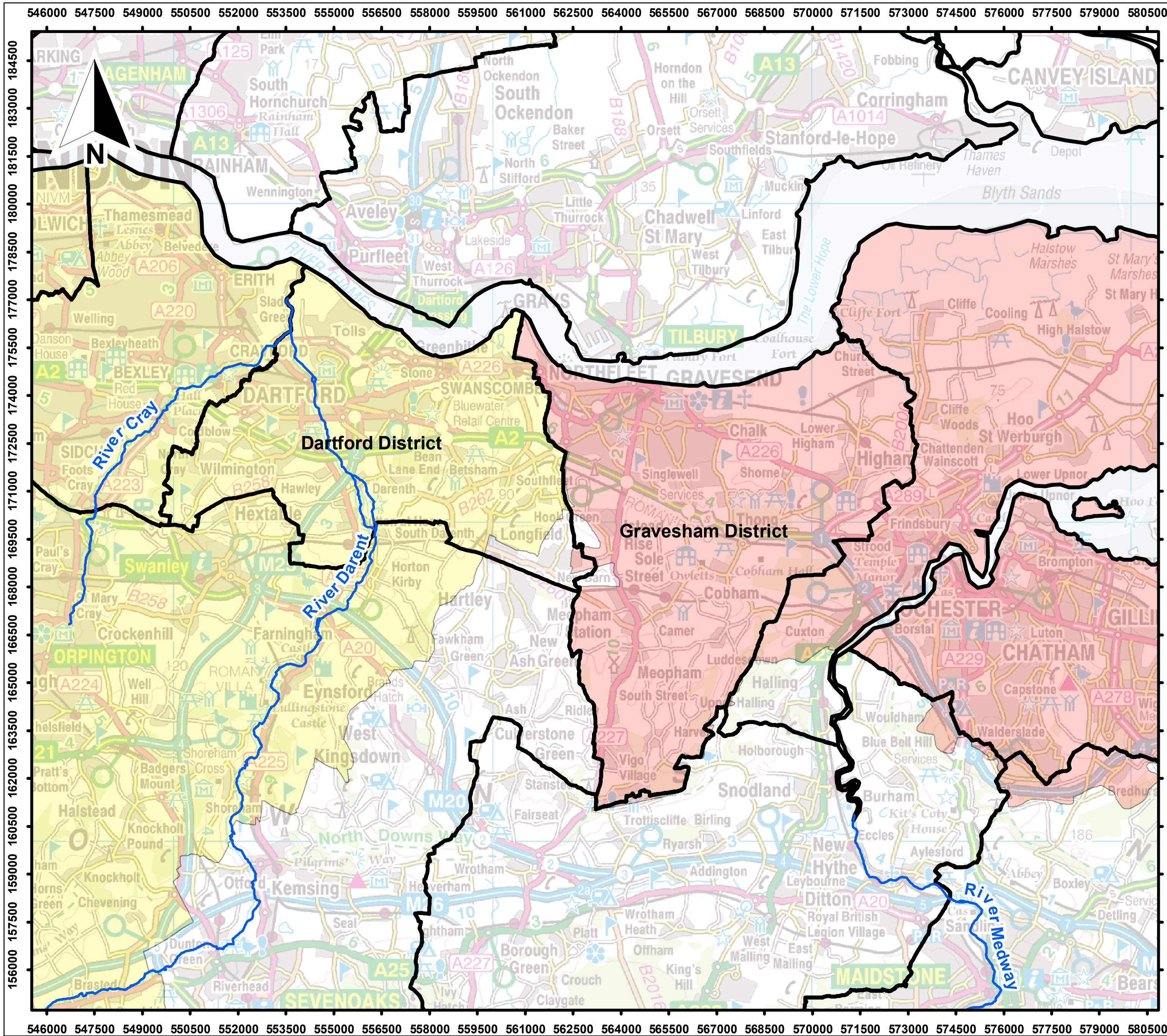
- **Kent Thameside is supplied by Thames Water and Southern Water**
- **Thames Water currently have a supply demand deficit in their London WRZ, planned to be closed by 2012/13**
- **The water companies plan to meet demand through a "twin-track" programme of demand management and sustainable water resource development**

Current Supply Arrangements for Kent Thameside

Thames Water and Southern Water are the public water supply undertakers for Kent Thameside. Kent Thameside is within Southern Water's Kent Medway WRZ and Thames Water's London WRZ. A small area at the south of the District of Dartford around Longfield and New Barn is supplied by South East Water. South East Water also supplies two small rural areas within Gravesham District around Longfield Hill. This is shown in Figure 4.1. Both areas lie within South East Water's WRZ 6. The Strategic Water Resource requirements for Thames Water and Southern Water are described in detail below as they supply the majority of water in Dartford and Gravesham. South East Water's supply demand balance in WRZ 6 and the Company's plans for managing this are reviewed briefly.

Baseline Situation

The companies have recently (May 2008) set out their strategic water resources plans in their draft Water Resources Management Plans (dWRMPs) for each of their WRZs. The dry year annual average supply demand balances for the London WRZ and Kent Medway WRZ are shown in Figures 4.2 and 4.3. The figures show the baseline demand and final plan demands, i.e. the forecast demand for water before and after the implementation of the leakage reduction, metering and water efficiency programmes planned by the companies. The deficit shown in Figure 4.2 indicates that the specified water company level of service cannot be maintained during the deficit period, i.e. Thames Water is unable to maintain its preferred levels of service in the London WRZ before 2013/14. This means that there is an increased risk of hosepipe bans in a drought. The supply-demand balance in this zone is then just in surplus until 2020/21, when the proposed new Upper Thames Reservoir is brought into operation.



Key:

- Local Authority boundaries
- Rivers

Water Resource Zones

- Kent Medway (Southern Water)
- London (Thames Water)

0 1 2 4 6 8 km

Scale: 1:180,000 @ A4

H:\Projects\HM-255\21000\21916 Thames Water Cycle\GIS\W01_21916.mxd

Kent Thameside Water Cycle Study

Figure 4.1
Water Resource Zone and Local Authority Boundaries

May 2008
21916-W01 jacks

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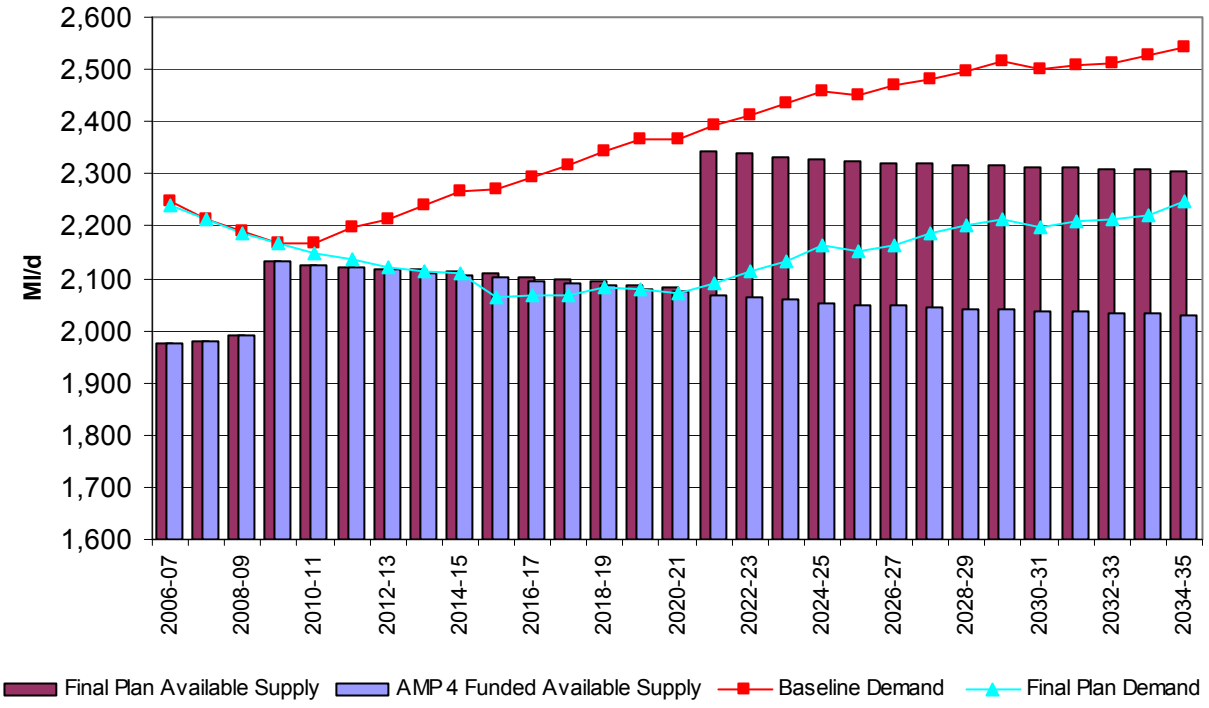
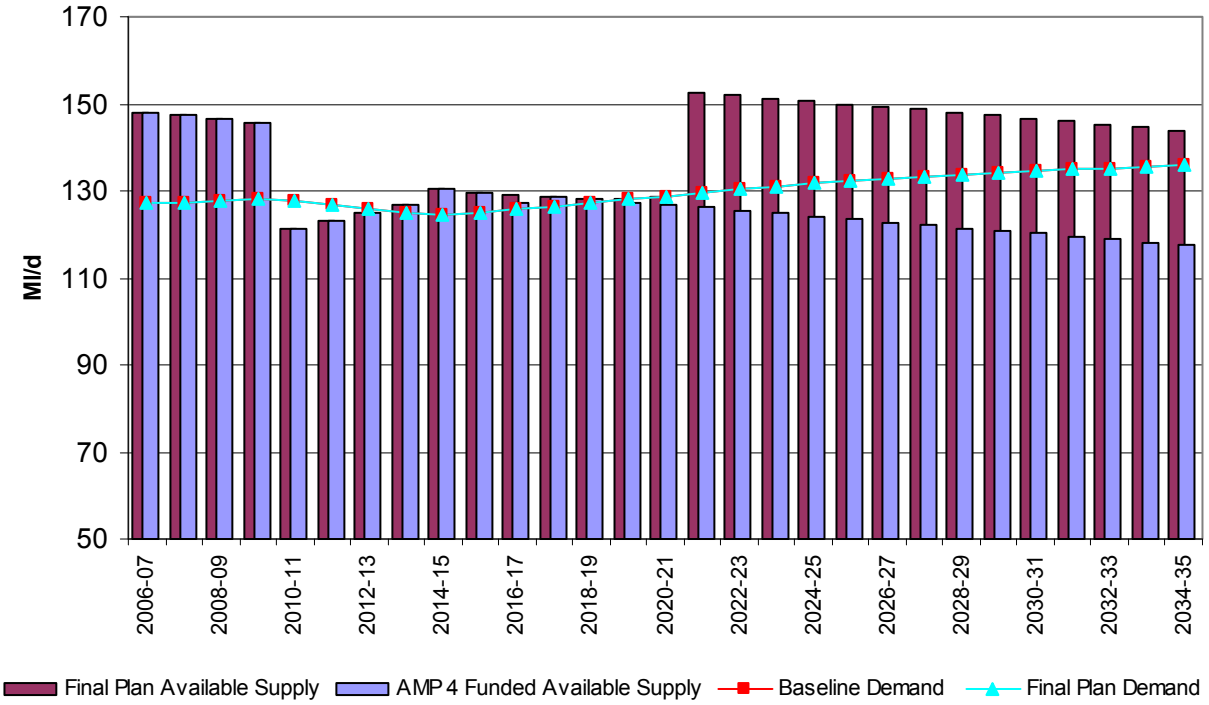
Figure 4.2 Annual Average Supply Demand Balance, London WRZ (Thames Water)



Based on information presented in Thames Water's draft WRMP 2008

Figure 4.3 Annual Average Supply Demand Balance, Kent Medway WRZ (Southern Water)



Based on information presented in Southern Water's draft WRMP 2008

Final Plan Situation

In 2007 Environment Agency (Environment Agency, 2007a) assessed much of the South East (including Kent Thameside) as being of a level of "serious" water stress meaning that the area requires the highest level of water efficiency activity, which could include allowing compulsory metering of properties across the area, if the water companies are able to demonstrate that this option is part of a least cost, sustainable solution to managing water resources, as discussed further in Section 4.2.1. Currently, only Southern Water plan to implement a programme of compulsory metering as part of their investment strategy, with the aim of achieving 'universal metering' by 2015.

Both companies will manage their supply demand balance using the "twin-track" approach, by managing the demand for water whilst implementing a programme of sustainable water resource development. The key plans for Southern Water and Thames Water are summarised in Table 4.2 and 4.3.

Thames Water plan a significant programme of leakage reduction, targeted domestic metering and two significant water resource developments, the Thames Gateway desalination plant in AMP5 and a new reservoir near Abingdon to be commissioned in AMP7. The company plans to remove the supply demand deficit by 2013. Southern Water plan to implement compulsory metering by 2015, whilst focussing on optimising the use of existing resources. A small deficit develops early in AMP5, although the company notes in its Draft WRMP that this is due to changes to the configuration of inter-zonal and inter-company water transfers and that it will be possible to meet demand by optimising the operation of these transfers. A large new resource will be required early in AMP7 and the company

plans to implement a large scale wastewater recycling scheme on the River Medway.

Table 4.2 Key elements of Thames Water Draft Water Resources Management Plan, 2008 (London Water Resource Zone)

Date Planned	Element of Plan	Description
AMP5 (2010-15)	Supply side measures	Small groundwater source developments
		Desalination scheme in the Thames Gateway area
	Demand Management	Leakage savings through mains replacement and active leakage control
		Metering and tariffs
		Water efficiency measures
AMP6 (2015-20)	Supply side measures	
	Demand Management	Leakage savings through mains replacement and active leakage control
		Metering and tariffs
		Water efficiency measures
AMP6 and beyond (2020 -)	Supply side measures	Reservoir - Abingdon
	Demand Management	Leakage savings through mains replacement and active leakage control

Based on information presented in Thames Water's Draft WRMP

Table 4.3 Key elements of Southern Water Draft Water Resources Management Plan, 2008 (Kent Medway Water Resource Zone)

Date Planned	Element of Plan	Description
AMP5 (2010-15)	Supply side measures	Optimisation of inter-zonal transfers
		Groundwater source improvements
	Demand Management	Universal compulsory metering (by 2015)
AMP6 (2015-20)	Supply side measures	Continued optimisation of inter-zonal transfers
		Source improvements to groundwater sources
		Abstraction licence variation
	Demand Management	-
AMP6 and beyond (2020 -)	Supply side measures	Commissioning of wastewater recycling scheme
	Demand Management	

There is currently no deficit in South East Water's WRZ 6. From 2016 the company plans to make changes to existing groundwater licences and develop a new groundwater source at Thurnham, to the east of Maidstone, outside the study area. The company also has plans for a new winter storage reservoir at Broad Oak in WRZ 8. The draft Plan includes a strategic transfer main to transfer water into WRZ 6 from WRZ 8 from 2025, which will be reliant on the completion of the reservoir. On the demand side, South East Water plans to implement universal domestic metering by 2020 and maintaining leakage levels at the economic level. The company also plans to continue with its current programme of water efficiency measures and water efficiency trials such as seasonal tariff trials.

The companies have only included allowances in their plans for licence reductions where the Environment Agency has confirmed the volumes of the required reductions. No allowance for licence reductions has been made in the draft WRMPs at sites where investigations are ongoing. This means that if a reduction is required, the companies will need to source water from alternative sources, either through additional resource development or through demand management measures. The water companies will need to be given sufficient time to implement a suitable response to ensure that demand from new development can be met.

4.3 Regional Water Resource Plans in the Context of Kent Thameside

4.3.1 Reconciling housing growth forecasts

► **The housing growth forecasts from the South East Plan were used in investigations by the Water Resources in the South East Group.**

- **The housing growth forecasts from the South East Plan have been used in the water companies' draft WRMPs.**

The South East Plan

Policy H1 within the Draft South East Plan core document (Section D3) sets out requirements for a total of 28,900 homes to be built each year over the period 2006 to 2026 in South East England. The same document also details annual average and total housing provision targets by District for the same period. The District targets relevant to this study area are shown in Table 4.4.

Table 4.4 Housing provision for the Dartford and Gravesham, as provided in the Draft South East Plan core document

District	Annual Average new homes (2006-2026)	Total number of new homes (2006-2026)
Dartford	785	15,700
Gravesham	465	9,300

Taken from Policy H1, The South East Plan Core Document, Draft Plan for Submission to Government (South East England Regional Assembly, March 2006, p82)

Investigations undertaken by the 'Water Resources in the South East' group

Previous work to assess the impact of housing scenarios on Regional water resource availability has been undertaken by the Environment Agency and the Water Resources in the South East (WRSE) group. WRSE was set up in 1996/97 to help plan and co-ordinate the management of water resources between seven (now six) different water companies across the Environment Agency's Thames and Southern regions. The group is chaired by the Environment Agency and is attended by Ofwat and Defra, in addition to the six water companies. As part of the WRSE group's work, the Environment Agency has developed an economic model of the water resources in the region to model the best options for water resource management, taking account of housing growth and the need for new water resources. The group recognises the need to compare the solutions proposed by individual companies with those that might be possible on a regional basis. Work is ongoing in the context of Ofwat's Periodic Review of Water company business plans, due for final determination by Ofwat in 2009.

The WRSE group submitted modelling outputs to the South East Regional Assembly as supporting evidence to the South East Plan (Environment Agency, 2006). All of the relevant WRSE studies consider the impact of different housing projections on the balance between water resources supplies and demand. Housing projections are combined with water company estimates of household occupancy rates and a range of per capita consumption estimates to determine the effect of different housing growth scenarios on the total demand for water. The WRSE uses consistent estimates of occupancy, taken from the companies' 2004 water resource plans, to ensure consistency. Therefore population only varies as a result of different household projections.

It should be noted that the occupancy rates used by the WRSE group are at the water resource zone level (and are therefore averages across a large area e.g. the whole of London). Reconciling population growth forecasts between Gravesham and Dartford and the work of the WRSE needs to be considered in this context. For example, there may be parts of the water resource zones where occupancy figures will be over-estimated and other parts where they will be under-estimated.

The housing projections investigated in this work were subject to some iteration as the South East Plan developed however, the latest version of the WRSE report published in May 2006[2] used the same annual target of 28,900 new homes per year to 2026 as presented in Table 4.5. The study also used a higher growth rate scenario of 40,000 new homes per year to 2026 to test the robustness of water company plans to these higher growth rates.

The work of the WRSE group showed that under the scenario of an additional 28,900 new homes per year growth could be accommodated provided water company plans are implemented in full. The higher growth rate of 40,000 households per year could be accommodated provided that water company plans are delivered in full and that more than 8% water efficiency is achieved in new homes and/or there is more integration of water supply infrastructure.

The growth scenario being investigated within this water cycle study uses the same housing provision totals as set out in Table 4.5, and is therefore consistent with the lower growth scenario investigated by the WRSE group.

The effect of accelerated housing growth rates on water resource provision

The draft WRMPs use the latest growth estimates for households, and both companies refer to the latest government forecasts in their draft Water Resource Management Plans. Thames Water based their forecasts on information available in September 2007 (Thames Water, 2008). Although not explicitly stated in Thames Water's plan, the growth figures available at that time were those presented in Table 4.5. Southern Water's plan does not explicitly state the growth allowances for Gravesham. However, the Company does state that it is using Regional growth rates based on the delivery of 30,000 new homes per year, the level indicated in Table 4.5. These are the levels indicated in the Draft South East Plan and reconcile with the numbers used in this study. It can therefore be concluded that at the strategic level, the draft WRMPs have accounted for the household growth rates being assessed within this WCS.

Further liaison with planning officers has indicated that the Dartford LDF Core Strategy Draft Preferred Options document is supported by an Interim Strategic Housing Land Availability Assessment (SHLAA) which is based on delivering dwellings at a much accelerated rate that the SE Plan requirement – i.e. about 97% of total within the first 10 years. This means that the demand for water from new housing may occur earlier in the study period, resulting in an additional 1 Ml/d of demand above the forecast for Dartford, based on South East Plan projections. The total additional demand over the full study period will remain unchanged.

The front loading of the development, as set out in the SHLAA, will result in an additional demand of 1Ml/d above the Thames Water forecast, which has been undertaken using South East Plan data across the whole of the London Water Resource Zone. This is small in the context of both total water resource availability (i.e. approximately 2000

[2] Response to latest South East Plan housing provision and distribution received from Seera (Environment Agency, 2006)

Ml/d dry year demand in the London zone in 2008/09) and the local infrastructure capacity requirements (i.e. the need for approximately 40 Ml/d additional capacity). Local area issues are detailed in Thames Water's Darent Area Strategic Plan (2005), which is discussed further in Section 4.4.

4.4 Local Network Requirements

Thames Water, Southern Water and South East Water are the statutory water supply undertakers to the study area. This section describes how these companies and (possibly) others are currently planning to supply the developments within Kent Thameside. The incumbent water companies have a statutory duty to maintain water supplies within their area, including new and existing development. In general, there is no opportunity for water companies to supply domestic properties that are within another company's supply area. The exception, in the case of Kent Thameside, is the 'Ebbsfleet Valley' development, which is (for the purposes of water resource planning) a greenfield development. This means that it is possible that this particular development could be supplied by an 'inset appointee', as described further below.

Thames Water

- **Thames Water is providing new local resources to maintain the supply-demand balance in South East London and to meet additional demand from development in Kent Thameside.**
- **Thames Water is planning significant investment in network capacity to meet demand from new developments. This investment is needed early in AMP5 to ensure that demand from new development can be met.**
- **Kent Thameside Regeneration Partnership should liaise closely with Thames Water to ensure that the company can meet demand from new development at the rate proposed.**

The demand forecasts used to determine the local network requirements were produced for the WRP 2004 and will be updated as part of the current draft WRMP. Based on the WRP 2004 forecasts, Thames Water will need to plan to develop additional local supplies and the trunk mains network in the Dartford and Kent Thameside areas in order to meet demand.

Local resource development is required to ensure that demand can be met in the Kent Thameside and wider South East London area. This requirement is in addition to new sources developed in the area over the last 10 years. These new sources have been built primarily as a result of the loss of several sources in the Darent Valley, following the 'alleviation of low flows' (ALF) programme undertaken in the 1990s. The sources abstract water from the Swanscombe Chalk via boreholes. Abstraction is possible because it makes use of water that would have otherwise been pumped out of Eastern Quarry (in a process known as dewatering), in order to keep the quarry suitably dry to enable operations to continue. Boreholes developed to date have not delivered the expected yields of water. As a result, Thames Water is planning to develop further boreholes near the village of Bean to supply

approximately 11 Ml/d of water to Lane End Water Treatment Works.

This resource development is a pre-requisite to network improvements that are required to strengthen the existing water supply infrastructure in the area generally, as well as providing additional capacity to meet the additional demand from the development in Kent Thameside. These infrastructure improvements are summarised in Table 4.5.

Table 4.5 Planned network improvements (based on 2004 Water Resources Plan forecasts)

Investment Period	Network scheme	Description
AMP4 (2005-2009)	Thames Water Ring Main (TWRM) extension to Honor Oak	An extension of the existing TWRM enabling the transfer to Honor Oak service reservoir.
AMP5 (2010-2014)	Southfleet ring main	A new main planned to be constructed in the Southfleet area to supply the Thameside developments. Commencing AMP5 but completing after 2020.
	Wilmington Link main	To enable the transfer of water eastward from the Wilmington area to Southfleet
AMP6 and beyond (2015 onwards)	Darenth service reservoir	To replace an existing service reservoir (and provide additional storage capacity to meet demands from the Thameside area).

The Thames Water Ring Main (TWRM) is a large diameter tunnel that takes water from the four treatment works in the Thames Valley and transfers it eastwards. Water is pumped out at various locations around the ring main and put into the local distribution networks. One of the developments is an extension of the existing Ring Main from 'Brixton shaft' to Honor Oak service reservoir. This scheme is programmed for 2009 as part of the resilience enhancements to London's supply network in the AMP4 Strategic Business Plan submission (i.e. investment for this scheme is already secure and in place). This extension provides additional transfer capacity to SE London above the existing 200 Ml/d via the surface trunks mains to support additional growth. This will include the transfer of water from the Thames Valley east to Honor Oak and support growth in Kent Thameside.

, Thames Water have confirmed that the timing of the delivery of the network enhancements is subject to the rate of development in the area. Currently (March 2009) the Wilmington link main is likely to be required in the latter part of AMP5 (by 2015), with the Darenth service reservoir needed early in AMP6. The Southfleet ring main will be a phased scheme, with construction likely to commence in the 2009 and keeping pace with development and thus is not expected to be completed until after 2020.

The company has previously confirmed that it may be possible to bring the delivery of the Wilmington link main and Darenth service reservoir forward for completion in the early part of AMP5, subject to the funding being agreed and granting of the relevant planning permissions. However, based on the current rate of development in the area there are no plans accelerate delivery.

Thames Water has focussed on ensuring that sufficient water has been available to the sites that have recently been developed, and those on which development has commenced or is about to commence. These sites include;

- Ingress Park,
- The Bridge
- Phoenix Park
- Bluewater Park
- The Ebbsfleet Valley

Thames Water's current demand forecasts include allowances for sites at Ebbsfleet Valley and Ebbsfleet Channel Tunnel Rail Link. The other developments that are being progressed are currently not included within the network planning that Thames Water has undertaken.

The resource and network developments outlined above should enable demand from the new developments in Kent Thameside to be met, regardless of the specific supplier arrangements discussed in the following section. However it is recommended that Kent Thameside Regeneration Partnership liaise with Thames Water regarding the planned accelerated growth in the SHLAA for Dartford. It is possible that the company will have to amend the schemes planned at present, implement them earlier, or provide further network improvements.

Water Supplies in Eastern Quarry (Ebbsfleet Valley) - Options

Eastern Quarry is a major development that is central to the delivery of the Kent Thameside vision in the context of the wider Thames Gateway. The plan is to create around 10,000 new homes set in a series of urban villages. This development is predominantly within Thames Water's supply area. This means that water supplies to this new development may be developed in three ways:

- Thames Water could provide supplies as the existing incumbent supplier for the area around the development (from their London WRZ);
- A new inset appointee could provide supplies; or
- The development could be supplied by a new multi-utility company, established specifically to provide utility services to the development.

Thames Water could supply Eastern Quarry by extending their supply network into the new development and utilising their existing resources to supply the area.

An inset appointment is made when an existing water undertaker (e.g. Thames Water) is replaced by another as the supplier of water and/or sewerage services within a specified geographical area. An inset appointment is possible for the Eastern Quarry site as it is not served by an existing supplier (i.e. the development area is within Thames Water's supply area but the site is not currently supplied with water by the Company). Inset appointees are licensed to operate in their specified area and have the same legal obligations as other water companies. New entrants and/or other water companies may compete for the right to become an inset appointee, but once the appointment is made then the inset appointee effectively becomes a monopoly supplier, at least for the duration of its licence.

Inset appointees must have access to water supplies, either directly, from their own abstractions, or via a bulk supply purchased from an existing water company. It is likely that an inset appointee in Eastern Quarry would need to agree a bulk supply agreement with Thames Water, so that in effect, water for this development would be sourced from Thames Water in either case.

A multi-utility company would effectively operate as an independent water supplier to the development, outside the legislative and regulatory framework of the Water Industry Act and Ofwat. Such an organisation would still need to obtain a supply of water, in similar ways to an inset appointee.

The rules around inset appointments and multi-utility companies means that any such new entrant will only be able to supply a predefined and clearly specified geographical area.

Water Supplies in Eastern Quarry (Ebbsfleet Valley) – Current Status

An interim agreement with Land Securities is in place for a multi-utility joint venture company called 'Ebbsfleet Valley Utilities' to supply water, sewerage and power to Ebbsfleet, Eastern Quarry and Swanscombe[3]. At present, the individual organizations that will make up this multi-utility service company (MUSCO) are not finalized, however, it is understood that Veolia will provide water and wastewater services. An energy / electricity provider is still to be identified. Although the agreement has not been finalized, Veolia and Land Securities are fully committed to the implementation of this MUSCO.

Southern Water

- **Southern Water currently has not identified any requirements for strategic network improvements to meet demand in the Kent Thameside area**
- **There is sufficient water available in Southern Water's supply area, assuming that developers fund the required network enhancements**

Development in the Northfleet Embankment area could result in pressure problems to existing customers supplied by Singlewell service reservoir. To avoid such problems and prior to any development on the Northfleet Embankment, just under 3000 metres of new main is required from Singlewell service reservoir. The study identified that the first stage of the Embankment East development (approximately 550 homes and 11,000 m^2 of business development) could then be supplied. For any later stages of development in the Embankment East, identified as a school and a further 1,300 homes and 14,000m^2 of business development, an additional 600 metres of main would be required. To supply the Embankment West development of 1,000 homes and 40,000m^2 of business development a further 1500 metres of main would be required.

[3] Pers. Comm with Andy Freeman at Land Securities

In response to developer enquiries for the Northfleet Embankment, Swanscombe Peninsula West and Ingress Park, and Canal Basin sites, Southern Water undertook a study of the supply area in 2007. This study identified that a number of network improvements would be required to meet demand from new development if the area was to be supplied by Southern Water. The improvements would be required as a direct result of the new developments and hence would be developer funded. Such enhancements are not usually funded by Ofwat in the water company business plans, which are produced to fund maintenance and strategic water service enhancements for the benefits of new and existing customers.

4.5 Demand Management in Dartford and Gravesham

- **Demand from new development in the two Districts is estimated to total 11 Ml/d by 2026**
- **Increased levels of water efficiency in line with those in the Code for Sustainable Homes could reduce demand from new homes by almost 50%**

4.5.1 Estimating Current and Future Demand

The previous sections show that water company plans are robust to the levels of housing growth being considered in this study at the regional level and local level, although the planned development of the water supply network will need to be delivered in a timely manner in order to meet demand from new developments in Thames Water's supply area. The forecasts presented in this section have been produced to illustrate the demand for water that may result from development within Gravesham and Dartford and to illustrate how this demand may be managed by the construction of new homes to the greater standards of water efficiency set out in the Code for Sustainable Homes. Water company demand forecasts for the local supply areas that incorporate Kent Thameside have not been made available to this study.

The potential demand from the development within Kent Thameside has been assessed using the approach set out in Appendix G. This approach is consistent with that applied within the water industry for assessing household demand for water. This method uses estimates of the number of people that will live in the development, and multiplies this by an allowance of water use per person (known as per capita consumption, or pcc) to calculate a total water demand. For non-household properties allowances have been made for water use using published data and assumptions about demand for water for these property types. This is a necessary departure from water company practice, and is explained in more detail in Appendix G.

Current annual average demand within the Districts of Dartford and Gravesham is estimated to be approximately 61 Ml/d. Using the assumptions set out in Appendix G this is forecast to increase by 7 Ml/d to around 68 Ml/d by 2026, the net effect of demand from new development (11 Ml/d) and a decrease in demand from existing homes (-4 Ml/d), This is shown in Table 4.10.

In 2006-07, demand in Dartford is around 37 Ml/d and demand in Gravesham is estimated to be approximately 24 Mld. This equates to 60% and 40% of total demand in the two Districts respectively. By 2026, demand is forecast

to increase by 5.4 Ml/d in Dartford and by 1.2 Ml/d in Gravesham. This is an increase in demand of around 15% and 5% above 2006-07 levels. The greatest rate of increase in demand would occur over the period between 2010 and 2015 in line with the greatest rate of house building.

4.5.2 Code for Sustainable Homes

The Code for Sustainable Homes (CSH) is a national standard for the sustainable design and construction of new homes. This is an important consideration when assessing the water demand from new homes, and thus the demand from new developments, as there is now a commitment to construct a proportion of new homes to minimum performance standards for water use.

There are six performance levels in the Code for Sustainable Homes with "water performance" against the CSH being measured in terms of three per capita consumption (pcc) standards. These are shown in Table 4.6

Table 4.6 Water Performance Standards in the Code for Sustainable Homes

Code Level	Per Capita Consumption (l/h/d)*
Level 1 and Level 2	120 l/h/d
Level 3 and Level 4	105 l/h/d
Level 5 and Level 6	80 l/h/d

Note that the performance standards in the Code for Sustainable Homes exclude water use outside the home (e.g. garden watering)

In February 2008, the Government confirmed that a mandatory rating will be implemented against the Code from the 1st May 2008. This means that all new homes planned after this date will include one of the following in their Home Information Pack (HIP):

- A Code certificate, indicating which level of the Code the new home has achieved; or
- A nil-rated certificate of non-assessment[4].

In addition to this blanket introduction of the CSH for all new homes, there are more stringent standards for certain types of new homes:

- All social housing developments funded by the Housing Corporation's (now the Homes and Communities Agency) National Affordable Housing Programme must meet Code level 3 from April 2008;
- All residential developments on surplus public sector land disposed of by English Partnerships must be

[4] 'Greener Homes for the Future, located at: http://www.communities.gov.uk/documents/planningandbuilding/pdf/803784.pdf

built to Code level 3 from April 2008.

Following the publication of the CSH, the Government has committed to the introduction of a minimum regulatory standard for water consumption in new homes which will be introduced through amendments to the Part G of the Building Regulations in 2009. The regulatory minimum has been set at 125 l/h/d including water use outside the home and is approximately equal to the least stringent standard of the Code for Sustainable Homes (Levels 1/2). **Table 4.7** summarises the current and proposed national water use standards for new homes.

Table 4.7 Summary of current and proposed national water use standards for new homes

Type of new home	Requirement	Standard (litres per person per day)	CSH Standard	Implementation Date
All new homes	Mandatory rating against CSH or nil-certificate of non-assessment	120, 105 or 80	All standards	1 May 2008
All new homes	Compliance with proposed revision to Part G of Building Regulations	125	Equivalent to CSH Level 1/2	2009 (no exact date set)
Social housing	Code level 3	105	CSH Level 3/4	April 2008
Housing developed on public land	Code level 3	105	CSH Level 3/4	April 2008

The Government has set out a timetable for the achievement of tighter standards for **all new homes** against the code over time, so that all new homes will be zero carbon by 2016. This will be delivered via step-by-step tightening of Part L of the Building Regulations, as follows:

- 2010 Code Level 3;
- 2013 Code Level 4; and
- 2016 Code Level 6.

This applies specifically to energy efficiency and the reduction of carbon emissions. At present there is no equivalent timetable for other aspects of the code (including water). However the heating of domestic hot water requires significant amounts of energy and results in notable carbon emissions. Therefore the timetable for reducing carbon emissions is likely to result in reductions in the use of domestic hot water.

4.5.3 Impact of improvements in water efficiency in new households

The assessments presented below show how changing the assumptions over the efficiency levels of new homes have the potential to reduce demand from development within the study area when compared to the allowance made by the water companies in the draft WRMP 2008.

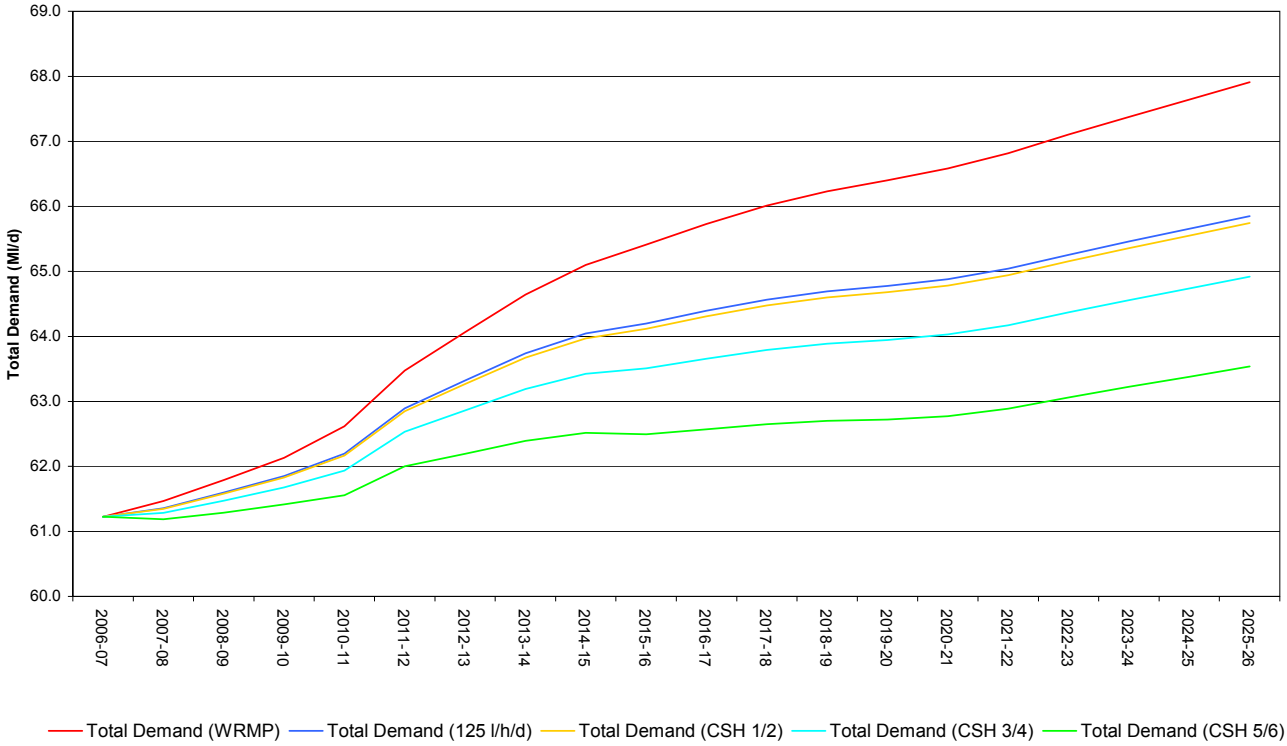
It should be noted that these scenarios are for illustrative purposes, as constructing all new homes to the more

challenging levels of efficiency from the outset would not be achievable in practical terms. It is also important to note that the Code for Sustainable Homes sets design standards for new homes. Actual consumption rates (once the new homes are occupied) depend to some extent on householder behaviour, and therefore there has to be a large degree of uncertainty placed around forecast consumption rates in new homes. The house-building industry would need time to implement improvements in design to enable these standards to be achieved, especially in the private sector where there will be no requirement to deliver housing to a standard more efficient than 125 l/h/d. No allowance has been made in this assessment for the construction of publicly funded housing to CSH Level 3 standard (all new social housing will be constructed to this standard from April 2008). No information was available to this assessment of the number of publicly funded houses to be built on the site.

It should be noted that the demand assessment presented in this study is an estimate based on published information. The uncertainties associated with this assessment are discussed further in Appendix G.

The assessment shows that constructing all new homes to the standard allowed by the water companies would result in an additional demand for water from households of around 9 Ml/d. If all new homes were constructed to CSH Level 5/6 standard the increase in demand would be almost halved, at around 4.6 Ml/d. The construction of new homes to the CSH Level 1/2 standard would result in an increase in demand of around 7 Ml/d by 2026.

Figure 4.4 Range of demand in Dartford and Gravesham under different household water efficiency scenarios,



Indicative costs have been produced for the housing scenarios based on work published by the Environment Agency and summarised in Table 4.8 (Environment Agency, 2007g). Further detail on the derivation is presented

in Appendix F. This shows that constructing an individual house to a standard equivalent to the water consumption standard in Level 3/4 of the Code for Sustainable Homes costs around £82 more than constructing a new home to a standard equivalent to CSH Level 1/2. The cost of constructing a new home to the most challenging level of water efficiency would cost around £2,560 more than CSH Level 3/4[5].

Since the Environment Agency published their study (Environment Agency, 2007g), the department of Communities and Local Government has published further information on the costs of achieving the water consumption standards in the CSH (CLG, 2008a). The study showed that the costs of achieving CSH Level 3/4 were £125 and CSH Level 5/6 were £2,650 compared to CSH Level 1/2. Although the costs in this study are based on the earlier Environment Agency study, the marginal increase in costs shown by the CLG report would not significantly impact on the findings of this report.

Table 4.8 Indicative cost estimates for building homes for the efficiency scenarios

Code for Sustainable Homes Standard	Cost per house (£)	Present value cost of scenario (£000's)[6]
Level 1/2	£1,385	£23,109
Level 3/4	£1,467	£24,477
Level 5/6	£4,024	£67,141

Based on information presented in Environment Agency (2007g).

4.5.4 Rainwater Harvesting

Rainwater harvesting systems collect and store rainwater from roof areas or hard standing to replace mains water use within the home where potable-standard water is not required (usually toilet flushing, washing machines and outdoor use). Other benefits include the attenuation of stormwater flows, and thus rainwater systems can form part of an integrated approach to water management in new developments.

The simplest form of rainwater harvesting is a water butt to provide water in the garden, and where water is not being collected within another system these should always be installed in properties with gardens. However savings achieved from water butts are relatively small in relation to total household consumption, and these savings are not included in the Code for Sustainable Homes rating, which only counts internal household consumption.

Rainwater harvesting can be installed for individual households, or on a larger scale where water is collected from

[5] The water companies, although fully supportive of the Code for Sustainable Homes, maintain that standards higher than level 1/2 are currently not supported by proposed changes to building regulations and, therefore, there are no guarantees that their implementation will be achieved.

[6] Discounted at 4.5% over the period 2006-2026, rounded to nearest £100,000

a number of properties (for example one or more streets), treated centrally then pumped to individual households for reuse. The advantages of a collective scheme are that surface water runoff from the development site is collected, so increasing the volumes of recycled water, and reducing flooding impact during high rainfall events. There may also be a cost saving by installing a collective system rather than individual household units (discussed further below). A disadvantage is that if surface water runoff is collected this will require additional treatment to remove pollutants from roads, whereas if water from roofs only is collected a simple filtration system is usually all that is required.

Rainwater harvesting has been incorporated in the design of an increasing number of new build non-domestic buildings such as schools, community centres and other similar buildings. The water companies are also highly supportive of rainwater harvesting initiatives. The technology is less well advanced in domestic new builds mainly due to long payback periods and issues over maintenance once the systems are installed. The constraining factors in the development of rainwater systems are the availability of rainfall and catchment area for the system (e.g. roof and or hardstanding area). If insufficient rainfall is available and the catchment area too small the system will not meet demand and thus will need to be supported by additional mains water.

An indicative assessment of the potential yield from rainwater harvesting in the Kent Thameside area is presented in Table 4.9. The long term average rainfall in Kent can be as low as 550 to 650mm, and the central value of 600mm/year has been taken for this assessment[7]. The potential rainwater available for harvesting has been estimated for three property types with differing assumptions about roof area. It should be noted that the average rainfall figure does not take into account rainfall variability over the year; during summer months there will be some periods when no rainfall is available, and conversely during periods of heavy rainfall and depending on the storage capacity of the system installed, it may not be possible to collect all the rainwater. Further detailed analysis will be needed at design stage to specify the systems required, and determine their reliable supply.

Table 4.9 Rainwater harvesting, indicative yield assessment

Property type	Assumed roof area (m^2)	Potential rainwater available (l/head/day)
Terraced house	47	27.0
Semi detached house	65	37.6
Detached house	90	52.1

Assessment is based on a runoff factor of 0.9 and a filter loss factor of 0.9. The household occupancy rate of 2.3 persons per property has also been used.

[7] Rainfall data taken from: Environment Agency (2001) Water resources for the Future – A strategy for Southern Region. These high level estimates are appropriate for this level of analysis and are comparable and consistent with the long term average source data used in Section 6.5.3 (SUDS outline modelling). The later section on SUDS uses the Wallingford Method to derive runoff estimates during storm events of different magnitudes. This technique is not appropriate for the estimation of rainwater harvesting yields.

The incorporation of rainwater harvesting systems into larger new developments such as those in the Kent Thameside area does present the opportunity for economies of scale when compared to the implementation at the individual property level. In addition, development-scale systems present the opportunity for more reliable systems than at the household level as a suitable maintenance contractor could be appointed. These economies of scale are often referred to within published documentation[8], although recent studies have found no published data to support this[9]. It should be noted that the available area for rainwater catchment will not necessarily be significantly greater at the development-level when compared to the individual household level.

Other issues that need to be considered include the energy and carbon footprint of the systems. Studies have demonstrated that in theory the pumping requirements for rainwater systems could result in a greater energy demand from these systems than that required to provide mains water to a site. However, it may be possible to generate the energy required from renewable sources.

To determine the feasibility of rainwater systems in Kent Thameside it is recommended that the following work (outside the scope of this study) is undertaken, which requires detailed knowledge of the site development plans:

- Assessment of the potential catchment area for rainwater systems; and
- Estimation of long term (i.e. 30 years) monthly rainfall patterns in the Kent Thameside area.
- Estimation of energy requirements and the need for renewable energy to make this technology zero carbon.

It is likely that relevant rainfall data will have to be purchased from the Met Office. A brief search of their website (www.metoffice.gov.uk) indicates that the nearest location with freely available monthly rainfall data is Greenwich, with a period of record available from 1961 to 2004.

If it is determined that there is sufficient rainfall and catchment area within the developments, a rainwater harvesting system manufacturer/installer should be consulted to determine site-specific costs and the wider implications to integrated water management within the development.

4.5.5 Greywater Recycling

Grey water recycling systems capture and store water that has been used for bathing (either shower or bath use) and from hand basins. The water is filtered and treated using a simple disinfectant treatment process so that is can be used for non-potable purposes such as toilet flushing and, in some cases, garden watering.

New build houses probably offer the greatest opportunity for grey water recycling technology as the system can be

[8] Market Transformation Programme (2007) BNWAT 19: Alternative sources of water – greywater and rainwater reuse: Innovation Briefing Note

[9] Environment Agency (2007) Towards neutrality in the Thames Gateway – Modelling baseline, business as usual and pathway scenarios

designed into the property. There are a number of issues that recur in published documentation on grey water systems, the main ones being high costs and high maintenance requirements[10]. Costs of the systems are comparable to those of rainwater harvesting systems at the individual property level, although the requirement for simple treatment means that the ongoing maintenance costs are likely to be higher than those for rainwater harvesting systems.

A report by the Environment Agency[11] concluded that if grey water systems are to be acceptable to the general public then reliable systems that operate on a "fit and forget" basis will be required. It is unclear whether current designs can be considered a reliable, cost-effective and publicly acceptable solution.

Based on the information presented above, it is recommended that rainwater harvesting systems (rather than greywater recycling systems) should be incorporated into new homes being built to CSH Level 5/6 standard. As the uptake of the more challenging levels of the CSH is required (and thus the technology is better developed) this recommendation may need to be reviewed.

4.5.6 Improvements in water efficiency in new non-household buildings

Non household buildings vary widely in nature and include buildings such as schools, hospitals, offices, hotels and retail units. The buildings have very different functions and water uses, with some buildings having an element of "residential" or "domestic" type water uses (e.g. hospitals and hotels), and others having "industrial" or "commercial" water uses (e.g. manufacturing process water use). For these reasons, the Government is not minded to set a whole building standard for non-domestic buildings (equivalent to the Code for Sustainable Homes) and is instead intending to rely on setting standards for key fittings via the Water Supply (Water Fittings) Regulations[12].

New non-household buildings present an opportunity for the implementation of water efficiency measures to ensure that demand from new non-household buildings is minimised. For "domestic-type" water uses in non-household buildings such as drinking, washing and cleaning and toilet flushing many of the fixtures and fittings that can be implemented in the home can also be installed in non-household buildings. The Government maintains a website providing information about the Enhanced Capital Allowance Scheme for Water Technologies. This scheme enables businesses to claim 100% first year capital allowances on investments in technologies and products that encourage sustainable water use, and the website lists those technologies that attract the ECA.[13]

The application of rainwater harvesting technologies can be better suited to non-household buildings as they present greater opportunities for the implementation of rainwater harvesting. These buildings often have large roof

[10] Southern Water's view of greywater recycling technology is that it is not robust enough yet to guarantee sustainable savings.

[11] Environment Agency (2005) A Study of Domestic Greywater Recycling

[12] Communities and Local Government (2007a). Water efficiency in new buildings. A joint Defra and Communities and Local Government policy statement. London: Department for Communities and Local Government.

[13] http://www.eca-water.gov.uk/

areas and areas of hardstanding (such as carparks) where rainwater can be captured.

The information available to this study for non household development has been used to estimate demand based on allowances for water consumption by floorspace (see Appendix E), and is not sufficiently detailed to enable an assessment of the reduction in demand that might be achieved through the implementation of water efficiency measures. Demand reductions and the cost of implementing the measures will vary due to the scale of the building being constructed and the number of fixtures and fittings within the building. For these reasons, it is not possible to estimate the costs for constructing an "average" non-household building to improved standards of water efficiency. However, research undertaken by the Cyrill Sweet consultancy[14] indicates that the BREEAM 'excellent' standard could be achieved with only an additional 2.5% capital cost for a building with a 'good' site location (i.e. on a brownfield site with good public transport links) and 3.4% for an average location. Achieving the excellent standard via building design is very difficult without these other factors and costs escalate significantly for less favourable building locations. The capital costs of water related equipment for a two-storey office with 500 m^2 of floorspace is presented in Table 4.9.

Table 4.10 Estimated Capital Costs of Low Water Use Technologies for a new 500m^2 office building

Equipment	Incremental cost above standard
Rainwater harvesting system	£6,263
6/4 dual flush toilets	£0
9-12 litres per minute showers	£0
Aerated taps	£0
Proximity detection shut-off for toilets	£1,351
Water meter with pulsed output	£231
Mains leak detection system	£462
TOTAL	£8,307

It should be noted that these costs are indicative only and each individual site and development must be evaluated on a case-by-case basis. These costs are relatively small compared to those likely to be incurred to reduce CO_2 emissions and create improved indoor environments, and if installed and maintained correctly, should result in lower operational costs via reduced mains water consumption.

The BREEAM Assessment methodology has been updated in 2008, with more stringent standards in sustainable building methods required to achieve the highest possible ratings (e.g. BRE, 2008). This revision includes the requirement for minimum standards for water (*inter alia*) in order to achieve certain BREEAM standards. For example, new offices require at least one water consumption related credit to achieve the 'Good', 'Very Good' and 'Excellent' standards and two water consumption related credits are required to achieve the new 'Outstanding' standard. One credit is awarded to offices when water consumption is calculated to be between 4.5 m^3 and 5.5 m^3

[14] http://www.cyrilsweett.com/pdfs/18datafile.pdf

per employee per year (equivalent to 17.8 l/hd/d – 21.7 l/hd/d).

Entec is currently undertaking a study for the Department for Communities and Local Government into water use standards for new non-household buildings. This study indicates that the usage rate required to achieve one BREEAM 2008 water consumption credit can be achieved through the installation of dual flush toilets, water efficient urinals, low-flow taps and showers.

There is also a minimum requirement for one water meter related credit (for the installation of a water meter with a pulsed output) from the 'Good' standard and above.

4.5.7 Demand management in existing properties

The Environment Agency has published a number of studies examining the potential for the retrofitting of water efficiency measures to existing buildings. Of particular relevance to this water cycle study are the studies investigating the potential for making new development in the Thames Gateway water neutral (i.e. no net increase in demand for water after development is completed, Environment Agency, 2007h) and the study looking at retrofitting water efficiency measures to homes in the South East of England (Environment Agency 2007i).

Both studies demonstrated that there is potential to achieve significant savings in water through the implementation of simple retrofitting options (such as low flush toilets, low flow showerhead and tap inserts) in existing homes, at a cost comparable to other water resource developments and demand management options (Environment Agency, 2007h).

The Water Neutrality study showed that for an estimated cost of £100 per house a dual flush toilet device, a low flow showerhead and low flow tap inserts could be retrofitted in an existing home. This could result in a saving of approximately 40 litres per property per day, or around 10% of existing household demand[15].

In Dartford and Gravesham there are approximately 77,600 households. Applying the data from the Environment Agency studies indicates retrofitting existing homes could have the potential to deliver up to 3.1 Ml/d in the Districts at a cost of £6.1 million[16].

It should be noted that there are a number of limitations to this assessment that result in considerable uncertainty in the delivery of savings for retrofitting. The high level assessment presented here is based on the assumption that all houses are using the same volume of water and that they would make the same demand reduction on installation of the devices. In reality, water use varies with the number of people in a house and the appliances, fixtures and fittings installed in the property. A further consideration is that the retrofitting of existing homes would require the consent of the owners of the building to install water efficient devices, and that once installed, the owners would not replace them with fixtures and fittings that consume a larger volume of water. This led the Environment

[15] Based on a household occupancy of 2.3 persons and a per capita consumption of 160 litres/head/day.

[16] Based on 7,600 houses per year being retrofitted over a 10-year period at a cost of £100 per property. Discounted to a present value at a rate of 4.5%

Agency studies to conclude that household retrofits may best be delivered through organisations such as Housing Associations, where access to larger numbers of properties could be gained through a central organisation (Environment Agency, 2007i).

In the case of existing non-household buildings there is published information available from organisations such as Envirowise that indicate that savings of 20-50% could be achieved through the implementation of simple water efficiency measures in non-household buildings (*www.envirowise.gov.uk*). The Water Neutrality study also acknowledged the limited information available on which to base an assessment of the potential savings in that study area, and adopted a conservative approach assuming a 10% reduction in existing non-household demand through retrofitting. Applying the same approach to this study, it may be possible to reduce demand in Gravesham and Dartford by up to 3 Ml/d. The uncertainties about building types mean that it is very difficult to assess the likely costs for implementation of measures. However, costs are unlikely to be significant (tens to hundreds of pounds per property, rather than thousands) for smaller retail, commercial or industrial buildings.

The overview assessment presented in this section illustrates that there may be potential to offset demand from new development through the retrofitting of existing buildings. However, issues over accessing buildings to install devices and maintaining the savings mean that there is considerable uncertainty in delivery of the estimated demand savings. There is likely to be greater potential for retrofitting low water use technologies when refurbishing social housing as part of routine/ongoing maintenance programmes at very little additional cost (CSH Level 3/4 fittings are only slightly more expensive than standard fittings, although it must not be assumed that the funds will be available). This is likely to be a more cost effective means of reducing the demand for water than requiring new homes to be built to CSH Level 5/6 in the short to medium term (the next 5-10 years is an indicative period over which this kind of retrofit activity might be more cost-effective than building new homes to Level 5/6. It should be reiterated that whilst the Government has set out a timetable for the achievement of tighter standards for **all new homes** against the code over time so that all new homes will be zero carbon by 2016, this applies specifically to energy efficiency and the reduction of carbon emissions with no equivalent timetable for other aspects of he code including water).

At present it is considered that there remains a lack of clear guidance on methods and mechanisms for delivery of water neutrality and therefore it not considered appropriate to set out recommendations for retrofitting requirements at this stage.

4.5.8 Impact on the provision of new infrastructure

The analysis presented above shows that by constructing new homes to greater standards of water efficiency it may be possible to reduce the demand from new development significantly. The implementation of similar measures in non-household buildings could be result in the achievement of a 10% reduction in demand when compared to the implementation of new homes at the standard level.

The implication of reduced demand from new development is that it may delay or remove the need for new water infrastructure. However, in the context of Kent Thameside this is unlikely to be the case for the following reasons:

- In Kent Thameside there is a requirement for significant water supply infrastructure in the short term (within the next 5 years) to meet demand from new development. Constructing **all** new homes to the

more efficient standards in the Code for Sustainable Homes (particularly CSH Level 5/6) is unlikely to be deliverable over this period.

- Research shows that it is possible to construct new homes to the water consumption standards set out in the CSH using fixtures and fittings currently available on the market. However, the achievement of these consumption standards in practice relies on the occupants of the homes using the fixtures and fittings at the frequency and duration modelled. Any deviation from this could result in greater water consumption.

- Homeowners could remove the water efficient fixtures and fittings and replace them with fixtures and fittings that consume more water. An example would include the replacement of a low-flow shower with a power shower.

Water companies have a statutory duty to supply new homes with water. The companies therefore have to plan for demand from new developments at an appropriate level. The water companies could not plan on the basis of the assessments presented above.

4.6 Conclusions and Recommendations

There will be sufficient water resources available to allow the delivery of new development in Gravesham and Dartford, if Southern Water and Thames Water are allowed to implement their PR09 Water Resources Management Plans in full. Thames Water's plan includes the need for a new reservoir (most likely located near Abingdon) to be operational by 2026 in order to maintain supplies in a number of its supply areas, including Kent Thameside. No permissions for either the construction or operation of this reservoir have currently been granted.

Thames Water will also need to make significant investments in local water supply infrastructure, as well as some new local resources, to enable the delivery of sufficient water supplies to support new development in Kent Thameside. These improvements will need to be delivered early in AMP5 and may require funding under the Ofwat early start programme for that AMP period. Dartford should consult with Thames Water regarding the feasibility of delivering the accelerated housebuilding programme described in the SHLAA.

From the assessment presented in this section the following recommendations are made:

- The authorities responsible for delivering new development should engage with the water companies early to ensure that the necessary water supply infrastructure is provided at a timescale to meet demand from new development.

- The sustainable housing agenda should be promoted to minimise demand from new developments in Kent Thameside. It is recommended that **all new homes** should be built to CSH level 3/4 in terms of water use, as this is considered achievable at relatively little additional cost to house builders.

- There is no explicit evidence to support the construction of new homes to CSH level 5/6 standards with respect to water use, given the current uncertainty and relatively high costs associated with rainwater or greywater systems. However, it is recommended that a small percentage of new homes (e.g. 5%) should be built to CSH level 5/6 (in terms of water use) in the next 2-3 years. These properties could be built as exemplars and used to inform stakeholders of the issues associated with such water efficient dwellings.

- This percentage could be increased in future years as technology improves. Based on the current technology (as described in section 4.5.4 and 4.5.5), rainwater harvesting (rather than greywater recycling) should be incorporated into new homes built to CSH Level 5/6, however this may change over time as these systems become more widely used and better understood.

- At present it is considered that there remains a lack of clear guidance on methods and mechanisms for delivery of water neutrality and therefore it is not considered appropriate to set out recommendations for water neutrality aspirations at present.

- However retrofitting should be promoted where cost-effective (e.g. as part of ongoing refurbishment by social landlords) to offset a proportion of the demand from new development. Local authorities should support and encourage retrofitting schemes in households and other buildings, working with other stakeholders (e.g. water companies) where appropriate.

- New non-household developments should be constructed to meet the BREEAM excellent rating for water efficiency and, where appropriate, the collection of rainwater should be implemented in new developments.

Table 4.10 Forecast household and non-household demand within Dartford and Gravesham, 2006-07 to 2025-26 (Ml/d)

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Dartford (Thames Water)	36.9	37.1	37.3	37.5	37.9	38.7	39.3	39.9	40.4	40.5	40.7	40.9	41.0	41.1	41.3	41.5	41.7	41.9	42.2	42.4
Gravesham (Southern Water)	24.3	24.4	24.5	24.6	24.7	24.7	24.7	24.7	24.7	24.9	25.0	25.1	25.2	25.3	25.3	25.4	25.4	25.4	25.5	25.5
Total	61.2	61.5	61.8	62.1	62.6	63.5	64.1	64.6	65.1	65.4	65.7	66.0	66.2	66.4	66.6	66.8	67.1	67.4	67.6	67.9

Note that this assessment includes water company customer demand only (leakage is not included)

Table 4.11 Forecast household and non-household demand within Gravesham, 2006-07 to 2025-26

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Existing Household Demand	18.2	18.0	17.9	17.7	17.4	17.1	16.7	16.4	16.1	16.0	15.9	15.8	15.8	15.8	15.7	15.7	15.7	15.7	15.7	15.7
New Household Demand	0.1	0.4	0.6	0.8	1.2	1.5	1.8	2.0	2.2	2.5	2.7	2.8	3.0	3.0	3.1	3.2	3.2	3.3	3.3	3.4
Existing non-household Demand	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
New non-household Demand	0.0	0.0	0.0	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Total	24.3	24.4	24.5	24.6	24.7	24.7	24.7	24.7	24.7	24.9	25.0	25.1	25.2	25.3	25.3	25.4	25.4	25.4	25.5	25.5

Note that this assessment includes water company customer demand only (leakage is not included)

Table 4.12 Forecast household and non-household demand within Dartford, 2006-07 to 2025-26

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Existing Household Demand	14.8	14.7	14.6	14.6	14.5	14.4	14.2	14.1	14.0	13.6	13.4	13.3	13.2	13.0	13.0	13.0	13.1	13.1	13.2	13.3
New Household Demand	0.0	0.3	0.5	0.7	1.1	1.7	2.3	2.9	3.4	3.8	4.1	4.3	4.5	4.7	4.9	5.0	5.1	5.3	5.4	5.6
Existing non-household Demand	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0
New non-household Demand	0.1	0.1	0.1	0.2	0.3	0.6	0.8	0.9	1.1	1.1	1.2	1.2	1.3	1.3	1.4	1.4	1.5	1.5	1.5	1.5
Total	36.9	37.1	37.3	37.5	37.9	38.7	39.3	39.9	40.4	40.5	40.7	40.9	41.0	41.1	41.3	41.5	41.7	41.9	42.2	42.4

Note that this assessment includes water company customer demand only (leakage is not included)

5. Waste Water Management and Water Quality

5.1 Introduction

This section assesses the capacity of the existing wastewater infrastructure (sewage treatment works and their drainage areas) and that of the receiving waters to which they discharge.

The overall aim of the wastewater capacity assessment is to determine whether the existing wastewater assets have sufficient capacity to accommodate the planned development and services growth in the Kent Thameside area, without resulting in deterioration in the water quality of receiving waters.

This is achieved through the following objectives

- Determine whether the provision of significant new wastewater infrastructure is required to mitigate any shortfall in existing capacity;
- Whether or not there is sufficient existing environmental capacity to support the planned growth;
- The identification and high level assessment of any options that may be required, and more sustainable solutions that are integrated with other the elements of the water cycle.

The detail of this technical analysis is dependant on the data / information provided by key stakeholders and in particular, as owners / operators of the wastewater infrastructure, the water companies (Thames and Southern Water). Both water companies have provided high-level position statements that give the necessary assurances that the existing capacity or planned upgrades during the next AMP period (2010-2015) will ensure there is sufficient capacity is in place to meet the expected increase in demand. However, both companies have not been in a position to release the detail behind this assessment. This is due to concerns regarding the commercial confidentiality as both companies could compete to provide the sewerage services to the proposed development areas not currently connected to foul drainage network. In addition the timing of the data request coincided with water companies preparing their business plans for the next AMP period. Draft business plans were submitted in August 2008 and once finalised by OFWAT will be available in April 2009. These reports will detail the investment planned for the wastewater infrastructure in Kent Thameside and thus provide further confidence in the capacity assessment and improvements planned by each water company.

The following data / information was requested from both Thames and Southern Water:

- future population forecasts to 2026;
- phasing of population increase;
- existing headroom at each sewage treatment works;
- approximate date when headroom is forecast to be breached;
- improvements required to treatment process to accommodate future growth;
- investment requirements in AMP5 and beyond;

- effects of population growth on sludge management;
- perceived effects of the Water Framework Directive (WFD), Urban Waste Water Treatment Directive (UWWTD Sensitive Areas) and the Habitats Directive on future sewage treatment works effluent consent limits;
- any known constraints to improvement plans.

The individual responses from the two water companies were as follows:
Southern Water stated that their

> *'...Corporate Strategy regarded this information as commercially sensitive that could not be made available'.*

They

> *'...provided assurance that all of the above bullet points were included in Southern Water's analysis to determine investment and confirmed that the development and population increase figures being used are the same as (or at least not significantly different to) those provided by Entec at a progress meeting'.*

Southern Water also confirmed that

> *'...the analysis for the draft asset planning has been completed; this identified and quantified the improvements and investment needs for the AMP5 period to accommodate the new development, whilst not causing deterioration to the level of service currently provided. However, the details behind this (such as magnitude of sewer upsize, cost of providing infrastructure, sewage treatment works headroom and non-infrastructure cost) are considered confidential and commercially sensitive at this stage'.*

Details of the approach, methodology and major assumptions used to carry out analyses of the capacity of their assets was provided by Southern Water.

Thames Water were also willing to share the assumptions and methodology used in their assessment of capacity issues and also some basic information about population growth projections in the catchment of Long Reach sewage treatment works, together with a broad description of proposed works on sewerage network and wastewater treatment processes. However, detailed calculations or specific local information (e.g. capacity issues with particular branches of the network), including maps or schematics of the sewerage network and sewage treatment works location, was considered confidential. Financial data (e.g. costings of infrastructure and investment estimates) were also unavailable. Statements and views were provided by Thames Water specialists on a number of other issues, such as the effect of the Water Framework Directive and the potential designation of the Thames Estuary as a Sensitive Area on consent limits, and future sludge management issues.

5.2 Current Situation

5.2.1 Wastewater collection and treatment

There are three operating sewage treatment works within the Kent Thameside area – Long Reach sewage treatment works, owned and operated by Thames Water, and Gravesend and Northfleet sewage treatment works owned and operated by Southern Water. A fourth, Swanscombe sewage treatment works was closed in April 1999, with the effluent now transferred to Northfleet sewage treatment works. In addition, Whitewall Creek sewage treatment

works (Southern Water) has part of its drainage catchment within the Kent Thameside serving some of Gravesham. However, this area is not proposed for development and so has not been considered in this report. Long Reach, Gravesend and Northfleet sewage treatment works operate activated sludge treatment, while Whitewall Creek operates percolating filters. Discharges from these sewage treatment works are regulated by discharge consents set by the Environment Agency. These detail the effluent flow and quality standards that are required to help meet water quality targets in the receiving water, as well as to minimise any adverse effects of pollution from spills / overflows of untreated sewage following heavy rainfall. The location and outline catchments for the main sewage treatment works are shown in Figure 5-1.

Long Reach is one of five principal sewage treatment works that serve London and discharges to the tidal Thames. The other four principal works, Mogden, Beckton, Crossness and Riverside, discharge upstream of Kent Thameside. These five principal sewage treatment works serve a total combined population[17] equivalent (PE) of 8.7 million. The total combined PE for Long Reach, Gravesend and Northfleet is 939,000. The proposed development in the Kent Thameside is anticipated to result in an increase in the domestic population of 58,081 (2006 -2026). This represents only 0.7 % of the 8.7 million PE served by the five principal sewage treatment works discharging to the tidal Thames, or 6.2 % of the combined 939,000 PE served by Long Reach, Gravesend and Northfleet sewage treatment works. However, this does not account for any increase in non-household demand associated with the significant additional employment planned for Ebbsfleet and other mixed use sites. The increase in demand associated with the non-domestic water use will be dependant on the type of the employment / industry that is attracted to these sites. Based on the forecast non-household demand within the London and Kent Medway Water Resource zones (1.522 and 0.517 Ml/d, respectively) and assuming a per capita consumption of 200 l/h/d (as used in the WRMP) the equivalent population is estimated to be 10,195. This equates to an additional 1.1% of combined STW's serving Kent Thameside.

Table 5.1 shows the relative size and contributions of sewage treatment works serving Kent Thameside and the consented flows from the principal sewage treatment works into the River Thames.

[17] Population is defined here as a 'Population Equivalent' or PE, an estimate derived from assumptions on occupancy of residential properties (domestic users) and also makes allowances for trade users and tourism (seasonal users).

Table 5.1 Contributions from principal sewage treatment works (STW) and those serving Kent Thameside

STW	Population Equivalent	DWF (m^3/d)	Max Flow (m^3/d)	Average Flow (m^3/d)
Mogden	1.8 million	420,000[1]		
Beckton	3.5 million		1,800,000 (to 2012)	1,010,000
Crossness	2.2 million	982,000[1]	1,500,000	700,000
Riverside	400,000	50,000	216,000[1]	105,000
Long Reach	837,000	170,000[1]	311,000	180,000
Gravesend	54,000	11,000	24,278[1]	
Northfleet	48,000	9,300		

Source: Environment Agency
1: Appropriate assessment of the Thames Estuary and Marshes SPA

Long Reach, Gravesend and Northfleet sewage treatment works all discharge into the Thames Estuary. Overflows from the sewer network associated with the Northfleet and Gravesend also spill to the Thames, either directly or via a surface water drain. This is also considered to be the case for the overflows associated with the Long Reach sewer network due to its proximity to the Thames Estuary. There are 57 Combined Sewer Overflows (CSOs) in the London area, of which 36 are considered 'unsatisfactory' in terms of frequency of discharge and/or environmental impact. Even during periods of moderate rainfall, these CSOs discharge a mixture of runoff and sewage into the River Thames on average once a week. CSOs serving London area are known to cause a sag in dissolved oxygen concentrations, particularly during the summer.

To address this problem, the government has given the go-ahead for the Tideway Tunnel, 32.2km long and seven metres wide, from Chiswick in the west to Beckton in the east for treatment. The tunnel will capture overflows from London's sewerage system following rainfall, helping to protect wildlife and users of the river. The project also includes a 5.5km spur from Abbey Mills pumping station to Beckton.

Figure 5.1 presents the limit of the tidal excursion and therefore the maximum upstream limit of the Long Reach discharge (the furthest upstream sewage treatment works serving Kent Thameside). The sewage treatment works discharges will also influence water quality outside of the tidal excursion in a seaward direction, however this influence will be increasingly diluted and reduced with time (as pollutants are assimilated). The seaward limit of the de-oxygenation sag, largely attributed to intermittent discharges, has been identified by the Environment Agency to be around Purfleet and the Dartford Crossing. Those unsatisfactory CSOs on the north bank in Essex downstream of London rather than the Kent Thameside area are considered to make the main contribution.

Other influences include the River Lee, which joins the Tidal Thames at Bow in London and contributes flows from several large sewage treatment works. Tilbury sewage treatment works (PE 30,000) discharges in to the Thames Estuary on the north bank across from Gravesend (TQ656755). Southend sewage treatment works and Canvey sewage treatment works also make considerable contributions to the outer Estuary.

Crossness STW

Beckton STW

Identified downstream limit of deoxygenation sag

Maximum upstream Tidal Excursion from Longreach STW

Maximum upstream Tidal Excursion from Gravesend STW

PTTR0013 PTTR0015 PTTR0016 PTTR0017 PTTR0018 PTTR0019 PTTR0072 PTTR0020 PTTR0021 PTTR0022 PTTR0023 PTTR0024 PTTR0025 PTTR0026 PTTR0027

11904 11902 11900 11850 11830 11800 11780 11770 11950 11900 11902 11950 11904

Key:

- Gravesend STW
- Longreach STW
- Northfleet STW
- Bathing Waters
- Shellfish Waters
- EA (Thames) monitoring points
- Kent Thameside Area

0 1,000 2,000 4,000 6,000 8,000 10,000 Meters

Scale: 1:200,000 @ A3

H:\Projects\HM-255\21000\21916 Thames Water Cycle\GIS

Thames Water Cycle - 21916

Figure 5.1
Waste water and water quality

June 2008
21916-S01 frede

Entec

5.2.2 Receiving water environment – Thames Estuary

Kent Thameside borders the Thames Estuary, an estuary that is recognised as a unique waterway of national and international importance, combining a rich historical and cultural resource, and a major focus for industry, commerce, transport and recreation. In additional the extensive macrotidal areas[18] support a diverse range of habitats and wildlife. Water quality in the Thames has significantly improved over the last 40 years, particularly since improvements made at the two main sewage treatment works at Crossness in southeast London and Beckton in east London. The chemical and physical condition of water in the estuary is crucial to ecological quality, as well as supporting the anthropogenic uses of the river.

The Water Framework Directive based water management obligations relating to the River Thames are defined in the final Thames River Basin Management Plan (TRBMP). A draft version of this plan has recently been published and is available on the Environment Agency website (http://wfdconsultation.environment-agency.gov.uk/wfdcms/en/thames/Intro.aspx). The management of the estuary, as far as water quality and the protection of aquatic ecology are concerned, will be centrally focussed around this document.

The Thames Estuary is also designated under the following national and international initiatives:

- Thames Estuary & Marshes SPA and Ramsar site (including South Thames Estuary and Marshes SSSI and Mucking Flats and Marshes SSSI);
- Benfleet & Southend Marshes SPA and Ramsar site (including Benfleet and Southend Marshes SSSI and Southend-on-Sea Foreshore LNR);
- Holehaven Creek SSSI, Canvey Wick SSSI, Vange and Fobbing Creek SSSI, Pitsea Marshes SSSI;
- Bathing Waters (9);
- Shellfish Waters (4);
- Nitrate Vulnerable Zone;
- North Kent Marshes Environmentally Sensitive Area (ESA)
- Essex Coast ESA.

More details of these designations may be found in Appendix C. Natural England describe the intertidal mudflats key sub-feature of both the Thames Estuary and Marshes and Benfleet and Southend Marshes European Marine Sites (SPAs) as having high vulnerability to nutrient enrichment and synthetic toxins, with medium vulnerability to non-synthetic toxins and organic loads. The saltmarsh key sub-feature has a medium vulnerability to synthetic and non-synthetic toxins.

The outcome of the appropriate assessment (under the Habitats Directive Review of Consents) of both the Thames

[18] Tidal ranges can be defined as the difference between mean high and mean low spring tides. Where the mean spring tide range is between 4 and 6 metres the range is termed macrotidal.

Estuary and Marshes SPA and Benfleet SPA for water quality showed that there is a risk of adverse effects on intertidal mudflats from toxic contamination by discharges through 'in combination' effects from 12 discharges. Long Reach sewage treatment works and Gravesend sewage treatment works are identified in these lists. The adverse effects relate to measured or predicted (headroom) exceedance of saline EQS standards for copper on the intertidal mudflats. These discharges have an overlapping / combined effect on the intertidal mudflats due to additive interaction of their copper inputs.

5.2.3 Current Environmental Quality Standards and Compliance

Historic water quality standards and targets for the Thames Estuary have been largely based on dissolved oxygen (DO) standards used for the EC Freshwater Fish Directive (78/659/EEC) to ensure that the river supports sustainable fisheries (see Table C1 in Appendix C). There have been failures of DO according to both these standards and when UKTAG DO standards developed for the WFD are applied to monitored water quality data.

Past dissolved oxygen monitoring data show failures of draft UKTAG DO standards at monitoring locations that are within one tidal excursion for all three Kent Thameside sewage treatment works discharges. Failures of DO standards are usually a result of the many CSO discharges, which can also result in the sag in dissolved oxygen concentrations described in Section 5.2.1. Failures have also occurred at Thames at Gravesend (EA monitoring site PTTR0021) and Thames at Ovens Buoy (PTTR0022) see Figure 5.1. DO starts to meet UKTAG standards at monitoring points to the east of these monitoring locations.

UKTAG have proposed additional standards to address more extreme events. These would be tailored to meet individual situations such as the Thames Tideway where it is clear that intermittent discharges are likely to cause the biology to fail to meet objectives under the Water Framework Directive.

Following completion (estimated to be 2020), the operation of the Tideway Tunnel will capture overflows from London's sewerage system following rainfall significantly reducing the impact on DO levels in the estuary.

Other standards and targets are set to meet designated Bathing and Shellfish Waters (see Appendix C) (both the Bathing and Shellfish Waters Directive will be repealed under the Water Framework Directive). The risk of contamination by pathogenic organisms is assessed using faecal indicator organisms. Standards are set for Bathing Waters and Shellfish waters in order to protect public health. The Bathing Waters identified as part of this study were all compliant in 2007 and of 'Excellent' or 'Good' quality. In some cases, 20 years monitoring data illustrates that these beaches have all consistently exhibited excellent/good quality over the last ten years. Four Shellfish Waters have been considered as part of this study (these are shown in Figure 5.1 and described in Appendix C). Pollution reduction plans for the identified Shellfish Waters show general compliance over the last 7 years.

Standards for other water quality parameters such as nutrients have not currently been set for the Thames Estuary. This is despite elevated concentrations and the current hyper-eutrophic status of the estuary. However, the EC are applying pressure on the Environment Agency to consider the Thames Estuary under the EC designation as Nutrient Sensitive. This potential designation is being resisted by water companies, and a decision on this matter will be issued by the European Court (expected by end of 2009).

The Habitats Regulations 1994 established a requirement to review existing permissions to ensure that no discharge

consents set by the Environment Agency result in an adverse effect on Special Protection Areas (SPAs) or Special Areas of Conservation (SACs). A summary of compliance with identified standards and targets is provided in Appendix C.

5.2.4 Environmental Capacity

Increasing population should not have an adverse impact on water quality. While some of the water quality parameters (DO, Dissolved Inorganic Nitrogen, Copper and Ammonia) fail current EQSs, the influence of the proposed development is not considered significant until the consented flow is breached (or approached). If the consented flow were to be exceeded (i.e. a revised consent would have to be agreed with the EA), it is likely that the EA would impose tighter water quality standards to ensure no overall increase in the consented effluent load ('no deterioration' or 'constant load' approach). Therefore this approach should ensure that there is no reduction in the quality of the receiving water compared to fully consented conditions.

The additional pollutant loads derived from the population increase in Kent Thameside to 2026 is expected to be a relatively small contribution to total sewage treatment works loads discharged to the Thames Estuary. Considering the large dilutive capacity of the outer Thames Estuary, the three sewage treatment works are regarded as being well positioned to receive additional loads with respect to the receiving environment.

5.2.5 Future Legislation and Potential Changes in Standards

Water Framework Directive

Statutory environmental quality standards (EQSs) have been established for compounds identified in the EC Dangerous Substances Directive (67/548/EEC) and its 'daughter' directives (which will be superseded by the WFD). Ammonia in the aquatic environment can be toxic to fish at high concentrations; unionised ammonia is the major toxic component with toxicity varying with salinity, temperature and pH. Unionised ammonia standards have been exceeded in the past for the Thames. Copper has also been identified as a significant issue in the Thames estuary and frequently fails the 5 µg/l limit (annual average) in the water column (as set under the Dangerous Substances Directive).

It is anticipated that by 2015 the prevalent standards applicable to the Thames Estuary will be the standards for transitional and coastal waters brought in to meet the requirements of the WFD. EQSs are likely to cover not only conventional water quality parameters, such as BOD and Ammonia, but also a number of controlled priority substances[19].

The UK Technical Advisory Group (UKTAG) has recently published a set of draft environmental standards, including standards for dissolved oxygen varying with salinity (due to the solubility of oxygen declining with increasing salinity) and set as annual 5-percentiles. Using the UKTAG information the receiving waters would have a DO standard of approximately 4.3mg/l (see Appendix C for further details). In addition, in order to protect

[19] WFD Priority Substances include heavy metals, phthalates, polyaromatic hydrocarbons and other organic compounds

against more extreme events and to regulate intermittent discharges, UKTAG propose basing standards on the principles of Fundamental Intermittent Standards, which specify return periods for particular thresholds of dissolved oxygen. UKTAG also propose that coastal waters be assessed using the winter mean of dissolved inorganic nitrogen (DIN) and the proposed thresholds for high and good status are based on the thresholds developed for UK assessments made for the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR). Using the UK TAG methodology the Thames Estuary is classified as 'TW3: Fully mixed, polyhaline, macrotidal, sand or mud substratum, extensive intertidal'20.

The River Basin Management Plan for The Thames River Basin District (due for publication at the end of December 2008) will identify the status of the relevant section of the Thames, the objectives for this stretch and any measures required to meet the required objectives. Objectives will be set taking into consideration social and economic requirements (including growth) and it considered unlikely that the additional homes identified will constitute a "showstopper" in this context.

Urban Waste Water Treatment Directive (Sensitive Areas)

The nutrient / eutrophic status of the Thames Estuary is periodically assessed under the Urban Waste Water Treatment Directive, with sites currently or at risk of becoming eutrophic designated as Sensitive Areas [Eutrophic]. The Thames is considered to be hyper-nutrified although there is little evidence of ecological damage. A recent review of Sensitive Area [Eutrophic] did not result in the designation of Thames Estuary. However, the Environment Agency has discussed the potential for it to be designated in the future. The implications of the Thames Estuary being designated as a Sensitive Area [Eutrophic] would be the requirement to install nutrient stripping at the qualifying sewage treatment works upstream that can be demonstrated to contribute to the eutrophic status. Sewage treatment works serving a population equivalent (pe) of 10,000 would be required to install nutrient removal, with even tighter standards required at discharges over 100,000 pe. This would include all the existing sewage treatment works serving Kent Thameside each water company would bid for funding for any improvements / upgrades through the periodic review process.

5.3 Water Infrastructure Capacity and Proposed Growth

There are two main ways in which the new development / population growth in Kent Thameside could impact water quality:

- Alteration of surface runoff flow and quality impacting on the hydro-ecology and quality of the receiving water systems (diffuse sources).
- Increase in sewage treatment works effluent discharges (point sources) and storm-induced discharges from the sewer systems (CSOs – intermittent sources) affecting the hydro-ecology and quality of the receiving waters.

[20] This results in thresholds for High and Good status to be 30 and 20 micromoles (µM) of DIN per litre. If the threshold for good status is exceeded, then the turbidity related value is brought in, for the Thames Estuary (TW3) this is 270 µM at the 99th percentile, the water body downgraded to moderate only if this too is failed (see Appendix B for further details)

This section assesses the capacity of the existing wastewater infrastructure (i.e. wastewater treatment and drainage network assets) and the future demand (wastewater supply demand balance) associated with predicted growth in Kent Thameside. An overview of the Water Company plans to meet this demand is also provided.

None of the sewage treatment works serving Kent Thameside were identified in the annual M109 returns to OFWAT, indicating they were all operated within their respective consent conditions during 2006. Further analysis of the observed quality of the final effluent over the last 5 years (2002 – 2007) confirms the consistent compliance with maximum standards for Biological Oxygen Demand (BOD) and Ammonia. This indicates that there is some headroom within the existing consents to accommodate additional growth.

Headroom in the sewerage network and the sewage treatment works can be defined as the capacity to accommodate additional sewage effluent load without breaching the consent conditions. As the population connected to a sewage treatment works increases, there is generally a proportional increase in the amount of raw sewage. Sewage treatment works discharge consents are set to a certain design horizon and as a result there is often a population and flow headroom allowance available in the effluent consent. However, as the population increases this headroom is eroded and the risk of non-compliance and failing to meet the water quality objectives is also increased. As a result headroom is not an absolute value but is defined as the difference between the assessed probability of failure (of a particular asset or level of service) and the maximum acceptable probability of failure.

Both water companies have provided assurances that there are no issues regarding current capacity of the sewerage infrastructure[21]. The proposed development and services growth in the area will require some upgrade works / extensions to the drainage area and will form part of their PR09 Business Plan Submissions to OFWAT. The close proximity of three relatively large sewage treatment works, together with the dilutive capacity of the Thames Estuary, present a number of options to meet this increase and accommodate sustainable growth.

Southern Water

Southern Water has undertaken assessments of the impact of population growth on wastewater treatment and network assets; including the Gravesend and Northfleet sewage treatment works catchments. The Southern Water minimum design standard is for all sewers to be able to cope with 6DWFs (the current design standard for drainage networks).

The sewer network models for Gravesend and Northfleet, updated with population and trade flow data, formed the basis of this assessment. Where available, both known development scheme data (i.e. locations and number of households) were included together along with long-term population forecasts. The co-ordinates and sizes of defined future developments were inputted to the appropriate model nodes, while undefined growth population was added at the top end of the model to simulate the worst case scenario[22]. In the absence of development certainty

[21] The actual and predicted headroom of the existing sewerage network was considered to be commercially confidential and not made available by either water company. Both water companies have based much of their sewer network analyses on the outcome of the Long Term - Least Cost Planning for Wastewater Supply/Demand study for UKWIR.

[22] Information on known development schemes to 2026 ('defined' growth) and long term forecasts of household and population numbers and occupancy ratios ('undefined' growth)

Southern Water's current proposals for Northfleet do assume that the Ebbsfleet developments will discharge into the Northfleet sewerage system. A wastewater consumption rate of 170 litres/head/day has been used, while infiltration has been applied either as specific measured locations of inflow or as 40% of the per capita flows. The model was then used to determine the locations of unacceptable decrease in sewerage system performance (i.e. CSO spills, sewer flooding). The peak storm intensity of the design rainfall was increased by 20% to provide a climate change allowance.

From this model based assessment Southern Water has been able to target investment to reduce flood risk (greater than $1m^3$) at new or existing locations[23] and avoid any increase in the incidence of CSO spills.

Thames Water

Thames Water have indicated that there is no foreseen major upgrading of main sewers in the drainage area for Long Reach, but rather localised work in the network in direct vicinity of proposed developments. In particular additional pumping capacity would be required as sewage flow from the Ebbsfleet Valley developments is likely to be received by Long Reach sewage treatment works.

Thames Water has also undertaken a similar modelling based assessment to inform the development of their asset management plans. Future sewer capacity requirements were assessed based on the additional flows associated with confirmed and unconfirmed development numbers provided by the Local Authorities. Developments of less than 100 units were screened out from further calculations as they are not seen as critical to sewer system capacity. The sewer network model was used to highlight the 'pinch-points' where capacity will be exceeded as new developments are connected. The next steps in the assessment are a preliminary cost-effectiveness analysis and improvement plans to address the 'pinch-point' assets (e.g. CSOs, pumping stations etc).

Thames Water's calculations are based on the assumption that all sewage generated in the proposed Ebbsfleet Valley developments will drain to Long Reach sewage treatment works. Thames Water has commented that their estimates of future household figures for Ebbsfleet broadly agree with data available to Entec as part of this project (i.e. 8,366 households draining to Long Reach sewage treatment works by 2026).

5.3.1 Wastewater Supply Demand Balance

Both water companies have confirmed that they are confident that the existing treatment processes at all sewage treatment works in Kent Thameside have the capacity, or can be further optimised / upgraded, to provide the necessary level of treatment to increased inflows to support the projected growth in the Kent Thameside area. This analysis is therefore focused of the future hydraulic demand the development will place on existing wastewater infrastructure.

The hydraulic capacity of wastewater infrastructure is a function of the physical / hydraulic capacity of assets (both

[23] The driver behind Southern Water's modelling exercise was growth; consideration is, therefore, only given to upsizing improvements and no schemes to resolve reported flooding incidents are considered, as these will be assessed by the PR09 Flooding Workstream (part of their Drainage Area Planning).

the sewer network and wastewater treatment processes) to receive additional flows. A fundamental factor describing capacity is a sewage treatment works Dry Weather Flow (DWF). This is a measure of the flow influx to a sewage treatment works that is derived from human activity (both domestic and trade) and excludes any storm-induced flows. The mechanism for deriving DWFs has evolved over recent years. All sewage treatment works should now have certified flow monitoring equipment installed that enables effluent flows to be accurately monitored. The DWF is calculated based on the 20th percentile flow (on the basis of 12 months daily data), i.e. the flow that is exceeded 80% of the time. The design capacity of sewage treatment works is generally governed by DWF.

For water quality planning purposes, dry weather flow can be estimated based on the following equation:

DWF = PG + I + E

P = Population served

G = Water consumption (per head per day)

I = Infiltration allowance

E = Trade Effluent flow to sewer as applicable

Estimates of the additional wastewater flow associated with the growth in Kent Thameside area have been made using above equation.

These estimates were derived using:

- the housing completion data presented in Appendix A;
- the occupancy rates used by each Water Company that operates the sewage treatment works in question as provided in their WRP 2004;
- a wastewater consumption rate of 170 l/day waste discharge per person, which has been assumed to be representative of the whole Kent Thameside area, as verified by both Southern Water and Thames Water assumptions;
- a fixed infiltration rate of 20% of consumption (i.e. PG) has been assumed representative of the Long Reach catchment (Thames Water's own estimates were 17.3% to 16.3% for the years 2006-2021) and 40% of consumption in Northfleet and Gravesend (this figure is also used by Southern Water);
- the water efficiency scenarios based on the water supply demand balance appraisal presented in Section 4 and assuming 100% of the water supply is returned to the sewer. Code of sustainable homes level 5/6 have not been used since wastewater flows would be likely to exceed water supply due to the adoption of water efficiency measures such as rainwater harvesting;
- Non household and trade consumption is **NOT** included in this assessment.

Both Thames Water and Southern Water indicated that they have undertaken a similar analysis to determine the future capacity requirements. However, the detail this analysis is considered commercially confidential. As a result it was not possible to indicate by how much these additional flows would erode the current headroom. However,

the water companies have had the opportunity to compare these additional flow estimates, which were presented in the draft report, to the current and forecast sewage flows and have not indicated that they perceive the potential increases will create unforeseen capacity problems.

In mapping the growth to a specific sewage treatment works it was assumed that **all** development within the existing waste water treatment boundary will drain to the existing sewage treatment works, and any new development in the Gravesend area will drain to Gravesend sewage treatment works. However, the Swanscombe and Ebbsfleet developments are on the border of the catchments for two sewage treatment works Northfleet and Long Reach and therefore 2 potential scenarios were assessed as follows:

- Scenario 1 assumes the Swanscombe and Ebbsfleet developments all drain to Northfleet sewage treatment works (as per Southern Water worst case scenario), and
- Scenario 2 assumes the Swanscombe and Ebbsfleet developments all drain to Long Reach sewage treatment works (as per Thames Water worst case scenario).

Results from this analysis are presented in the following figures.

Table 5.2 Additional wastewater flow estimates (DWF in m^3/d) from proposed growth in Kent Thameside (2026)

STW catchment	Scenario 1 DWF	Scenario 2 DWF
Long Reach STW	3,294	7,480
Northfleet STW	6,427	1,544
Gravesend STW	2,874	2,874
Total additional flows to Kent Thameside STWs*	12,595	11,898

* The difference in total additional flows reflects the different infiltration rates used by each water company and therefore in the analysis

Figure 5.2 Additional capacity required at Long Reach STW under Scenario 1

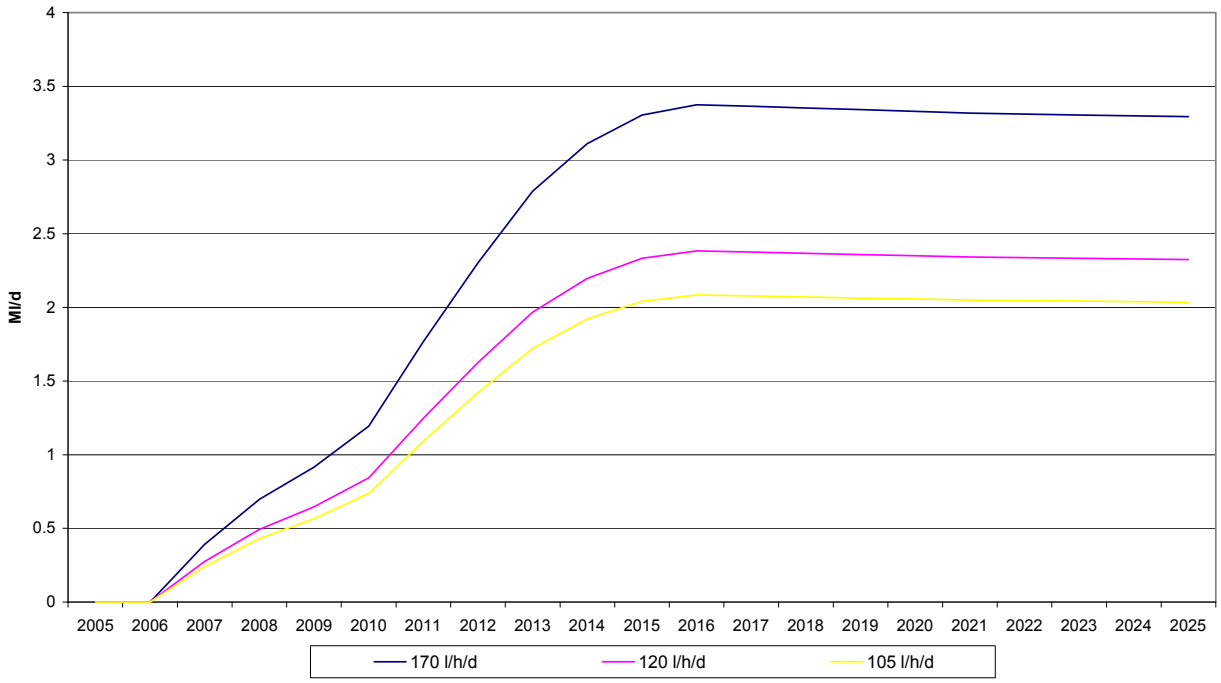


Figure 5.3 Additional capacity required at Long Reach STW under Scenario 2

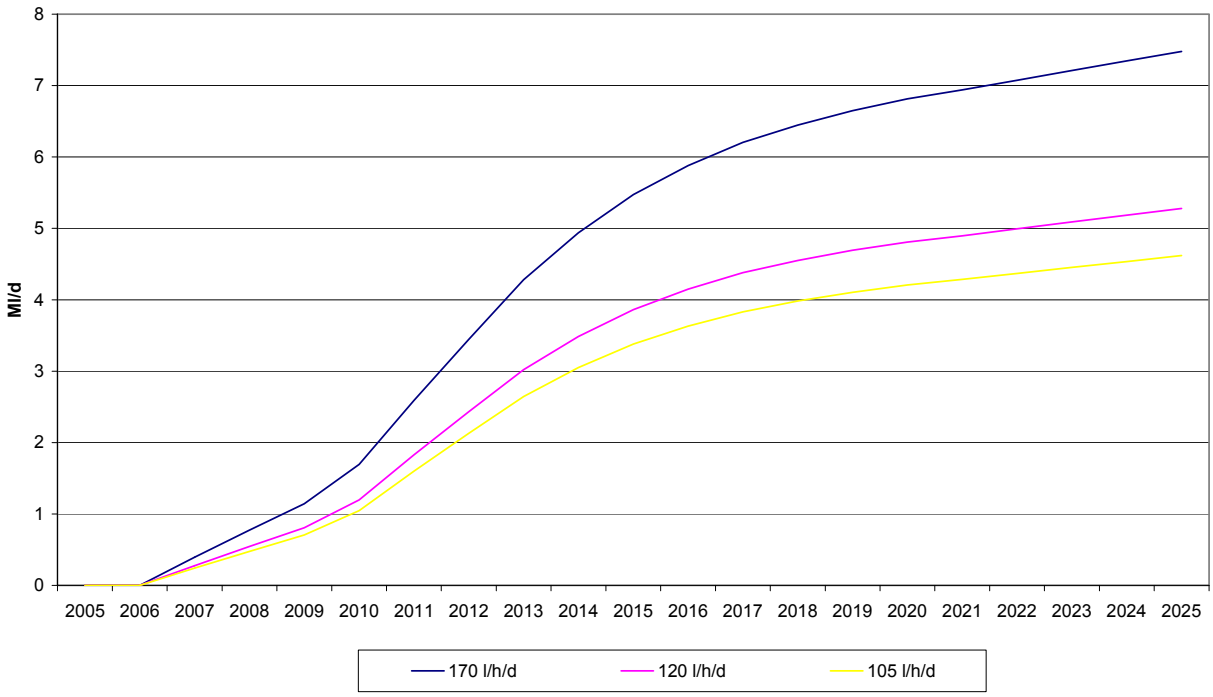


Figure 5.4 Additional capacity required at Northfleet STW under Scenario 1

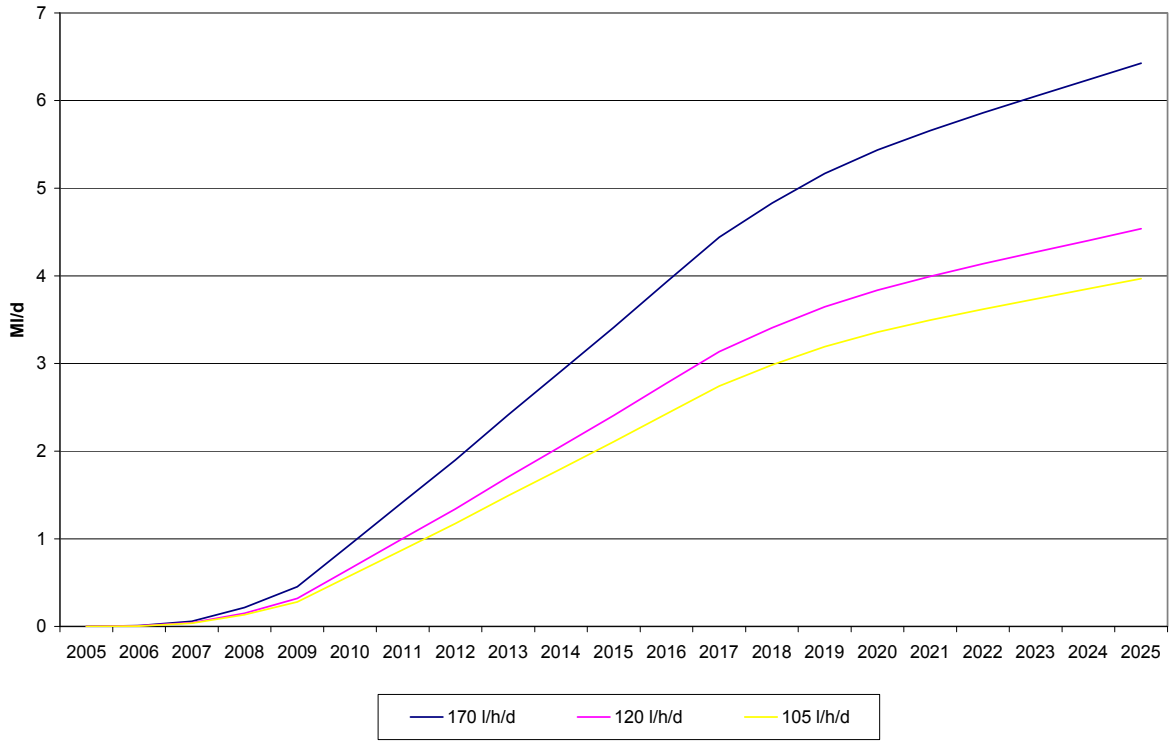


Figure 5.5 Additional capacity required at Northfleet STW under Scenario 2

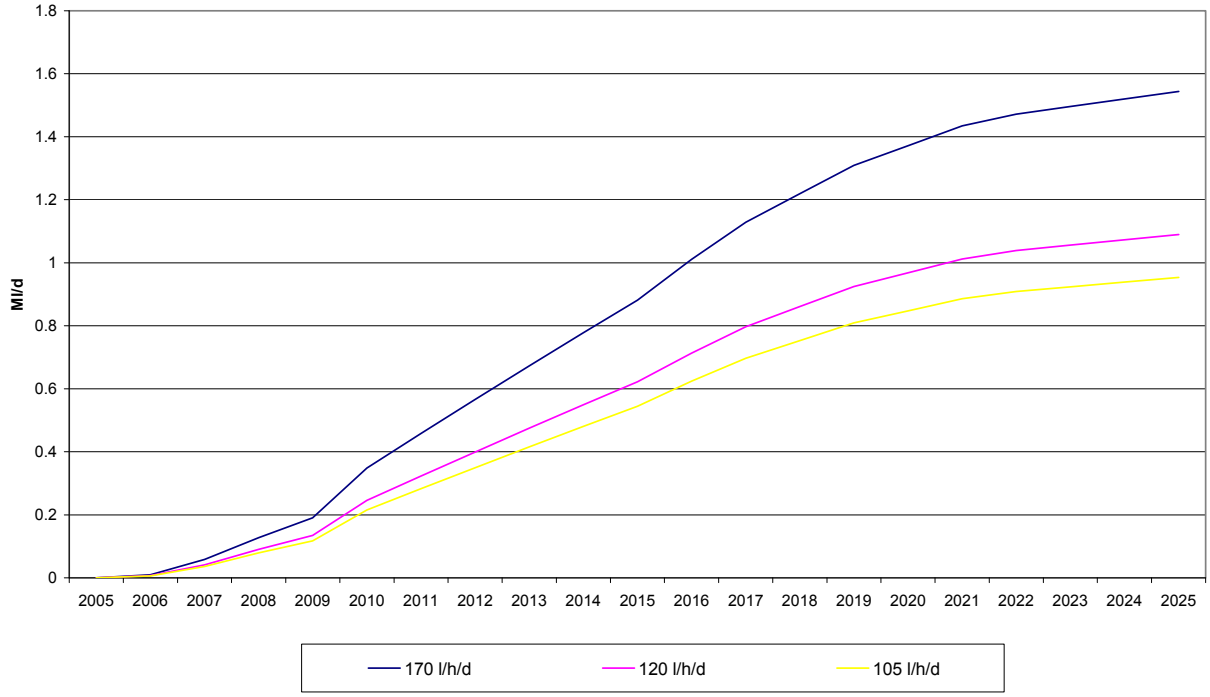
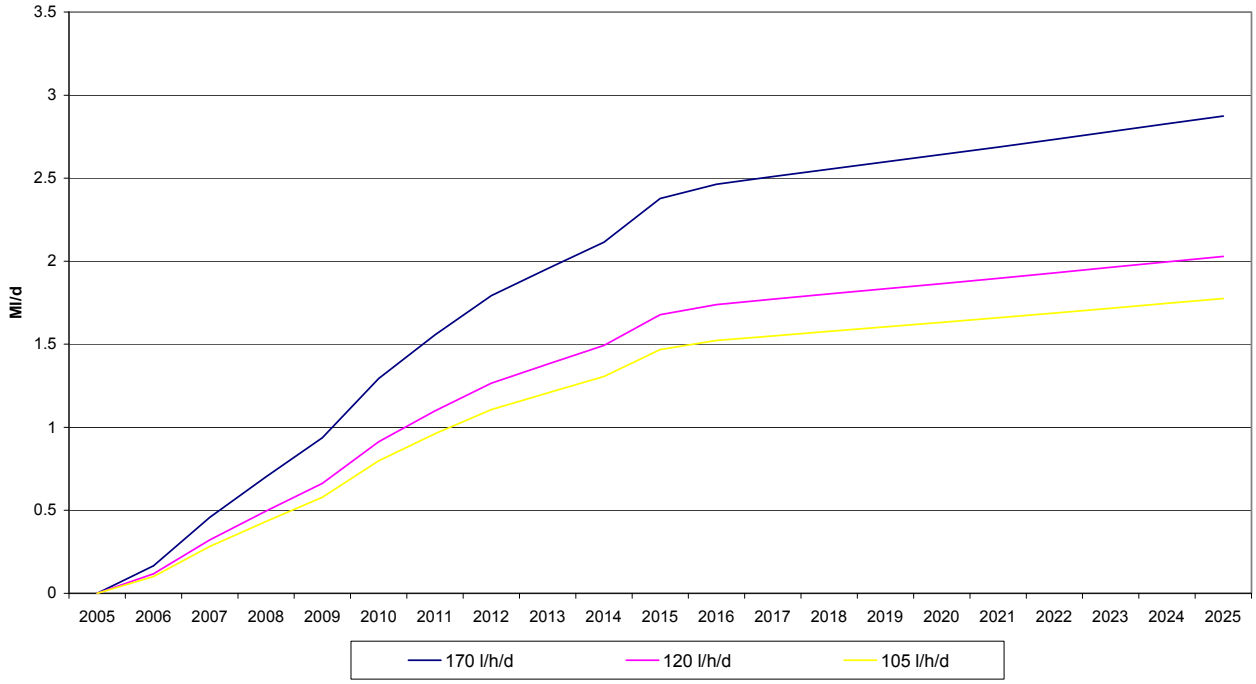


Figure 5.6 Additional capacity required at Gravesend STW



The results of the analysis indicate that the potential effect of the proposed Ebbsfleet Valley developments on additional DWF requirements at sewage treatment works are significant for both water companies, up to 4 Ml/d for Long Reach sewage treatment works and 5Ml/d for Northfleet sewage treatment works based on the highest consumption figure (170/l/h/d) and seen as the difference between the scenario 1 and 2 plots presented above. In scenarios where a sewage treatment works receives none of the Ebbsfleet flows, it can be seen that the increasing trend (in additional DWF) reaches a plateau by 2026 or even begins to drop (see Scenario 1 for Long Reach), as the number of developments and occupancy rates decrease.

Non-household water use will clearly add additional demand on the wastewater infrastructure. It is difficult to determine a robust estimate of this increase without understanding the nature of non-household use associated with the new employment. However, based on a set of conservative assumptions that the majority of these jobs will be in the service sector and office-based, water usage is likely to equate to between 15 and 20 l/h/d. For example, for the proposed 20,000 new jobs in Ebbsfleet this would equate to an additional demand of 0.3 – 0.4 Ml/d. This is less than 10% of the additional demand outlined in the above graphs, which have been reviewed by both water companies and is therefore considered unlikely to pose a risk to in terms of under capacity. However, the absence of any detailed data regarding future / planned headroom data precludes confirmation that this is the case.

5.3.2 Revised / Future Consent limits

Uncertainties surrounding increased demand associated with growth (including the phasing of growth), the potential impacts of climate change and changing environmental quality standards / consent limits complicate long-term wastewater infrastructure planning. Although all the STW serving Kent Thameside Area are compliant, tightening of the environmental quality standards in the receiving water would lead to a reduction in the

environmental capacity and drive further investment to further improve effluent quality. In addition as flows approach or exceed the consented flow (and an STW is identified as being at risk or failing its consent conditions) the water company will be required to renegotiate consent conditions with the Environment Agency. The Environment Agency national permitting centre have stated (*Pers. Comm., June 2008*) that any exceedance in the flow consent is likely to lead to tighter water quality standards to ensure no overall increase in the consented effluent load. This approach is adopted to ensure there is no deterioration in the receiving water quality. However, the tightening of effluent quality standards should not exceed those considered achievable using the Best Available Techniques (BAT). A cost benefit analysis should also be conducted to ensure any change in consent conditions is sustainable in terms of both cost and wider environmental impacts such as increased use of raw materials, energy and carbon.

The Pollution Prevention and Control Regulations 2000 introduced the concept of BAT. Associated with this is the Best Available Technique Not Entailing Excessive Costs (BATNEEC). Unfortunately there is no widely adopted agreement between the water companies and the Environment Agency regarding what constitutes either BAT or BATNEEC. However, they do mark a threshold at which it is important to consider both the cost and wider environmental and sustainability issues of meeting tighter effluent standards.

Under the Thames Tideway study, there are already revised consent limits, including Long Reach WwTW, being proposed by the Environment Agency relating to effluent water quality parameters, as detailed in Table 5.3; these standards are proposed to come into force by the year 2014. Once in force these revised consents should significantly improve the water quality of the Thames upstream of Kent Thameside. However, given the uncertainty surrounding future consent limits together with future designations and the sensitivity of the Thames Estuary this is unlikely to increase further the environmental capacity and thus enable a significant increase in the effluent load.

Table 5.3 Proposed Thames Tideway STW standards – proposed to come into force by 2014

STW	Flow, Ml/d		95 Percentile, mg/l			Upper Tier, mg/l		
	DWF	FFT	Solids	BOD	Ammonia	Solids	BOD	Ammonia
Mogden	559	1064	45	18	2.5 > 15°C 3.5 13°C – 15°C 5 < 13°C	108	54	13 > 15°C 15.5 13°C – 15°C 20 < 13°C
Beckton	1344	2336	45	18	2.5 > 15°C 3.5 13°C – 15°C 5 < 13°C	108	54	13 > 15°C 15.5 13°C – 15°C 20 < 13°C
Crossness	597	1118	45	18	2.5 > 15°C 3.5 13°C – 15°C 5 < 13°C	108	54	13 > 15°C 15.5 13°C – 15°C 20 < 13°C
Riverside	103	206	45	18	2.5 > 15°C 3.5 13°C – 15°C 5 < 13°C	108	54	13 > 15°C 15.5 13°C – 15°C 20 < 13°C
Long Reach	186	338	50	22	4.5 > 15°C 6 13°C – 15°C 9 < 13°C	125	58	18.5 > 15°C 23 13°C – 15°C 33 < 13°C

5.3.3 Location Specific Capacity Issues

Long Reach Sewage Treatment Works

Thames Water's model of the Long Reach works uses a similar approach to the sewer network model, but also takes account of population totals from proposed developments of less than 100 units (as sewage from these would have to be treated at the works). A rate of annual PE growth is estimated and modelled to specify the required capacity adjustments.

A summary of the processes identified with upgrade requirements are as follows:

1. Extension of the existing Activated Sludge Plant;
2. Additional Final Settlement Tanks;
3. Modifications to Return Activated Sludge and Surplus Activated Sludge pumping;
4. Additional blowers and ancillaries.

Thames Water consider that upgrades 1 – 3 constitute permitted development and it is only the upgrades to the blower house that will require planning permission. All upgrades are expected to be completed and operational before 2012.

Northfleet Sewage Treatment Works

Southern Water has been funded in AMP4 to deliver improvements to trunk sewerage and wastewater treatment capacity in the Northfleet catchment to meet the initial demands from new development in Kent Thameside. Southern Water are currently progressing schemes which will provide capacity to accommodate broadly the same number of new households set out in the current development schedule to 2015. It is anticipated that additional funding will need to be secured in the AMP5 period to provide the additional capacity beyond this date, depending on where particular developments (e.g. Ebbsfleet Valley) will drain to Nortfleet or Long Reach. If the growth occurs as forecast a consent review will also be triggered at Northfleet STW which may result in an ammonia removal scheme being required. This scheme has been included in the draft Business Plan for AMP5.

One option that has been raised is to potential to relocate Northfleet STW to release the land for higher value development. This was discussed with Southern Water who at present have no plans to relocate or divert flows elsewhere. Should relocation of Northfleet STW be considered as an option this should be done so through the Minerals and Waste Development Framework and in harmony with the Local Development Framework. Relocation would be likely to require the construction of a terminal pumping station at the existing location to transfer flows to alternative suitable location. Southern Water were unwilling to provide a cost estimate for relocating the STW, since previous ball park estimates, provided other for studies, have later become adopted as actual values, which then become difficult to defend. The broad range provided in the revised report (10's of millions) was a compromise agreed with Southern Water.

A tighter range of cost estimates is provided in the table below for a number of growth and consenting scenarios. These estimates have been derived by our in-house engineers based on their experience in commissioning similar size wastewater treatment works and cost models used by other water companies (i.e. not Southern Water). It is important to note that these estimates have not been approved by Southern Water and therefore should be treated with caution and not reproduced outside of the context of this report. These estimates do not account for location and asset specific issues associated with Northfleet WwTW, for this reason they are presented as a range to infer the level of accuracy of +/- 50%. Further details on the method used in deriving these costs can be found in Appendix H.

Table 5.4 Cost estimates for relocation of Northfleet STW under different growth and consenting scenarios

Scenario	Min (£millions)	Max (£millions)
Baseline: like-for-like replacement – no growth current consent conditions	7,8	23.3
Scenario 1a: 10% growth accommodated with exiting quality consent conditions	8.2	24.6
Scenario 1b: 10% growth and tighter consent conditions to include nitrate removal	9.6	28.7
Scenario 2: 50% growth and tighter consent conditions to include nitrate removal	11.5	34.5

A new site would also be required with a planning consent. The lead time if a suitable site is made available by the Local Authority with planning consent would be less than 5 years. However, if Southern Water has to find a suitable site and potentially face a public enquiry the lead time could increase to up to 10 years. In addition, the costs would not be met by Southern Water or its customers via increased charges in accordance with Ofwat policy, but by the development agency, developer or other third party. Any change to the discharge point or load would also require a discharge consent, the conditions of which would be set by the Environment Agency. The identification of potential sites for relocation of this works could form part of a Phase II Water Cycle Study.

Gravesend Sewage Treatment Works

Southern Water has stated that no major investment is planned in AMP4 in the Gravesend catchment, but have identified that investment is likely to be required in AMP5 to provide capacity for future new development. This will be progressed through the current Periodic Review process.

5.3.4 Sludge Management

The Gravesend Sludge Recycling Centre is on the Gravesend STW site and provides treatment for Gravesend indigenous sludge, as well as liquid imported sludge from surrounding satellite sites, including Northfleet. The Recycling Centre at Gravesend provides mixing and thickening of sludge, followed by mesophilic anaerobic digestion; the treated sludge is then dewatered to a cake by centrifuge and stockpiled before being used as an agricultural soil conditioner.

Southern Water operates thermal drying at a number of key treatment centres, this moves the product from a 'conventional' to an 'enhanced' treated standard, increasing the application opportunities. Southern Water has stated that the sludge facilities at Gravesend have the capability for being extended but are not currently earmarked for expansion since they have yet to determine if additional capacity will be required on this site before 2015. However, quality constraints due to future growth are being considered but have yet to be determined and incorporated as numerical increases in sludge volumes, as this is under consideration by Southern Water's sludge strategy team.

Thames Water stated that sludge treatment facilities are available within the Long Reach STW site. Potential impacts of planned population growth in Kent Thameside on the volume and quality of sewage sludge have not been quantified; however the Long Reach catchment is subject to an on-going Quality and Growth project (with a 2021 growth horizon) that takes a holistic approach and will consider sludge management issues. In addition, advanced sludge treatment methods are being considered in a company-wide approach. Treated sludge from Long Reach STW is currently used for agricultural land applications.

Although the sludge strategy is yet to be adopted, the following high level comments have been provided by Thames Water:

- 10 yr strategy - introduce enhanced digestion followed by recycling to land (whilst assessing feasibility of enhanced digestion followed by thermal destruction)
- 25 yr strategy - consider co-digestion followed with thermal destruction

Once the strategy has been finalised detailed design of the sludge upgrade will commence with the intention to deliver the work during AMP5.

Sewage sludge management may present challenges in the future as a result of increased volumes. In addition the widespread implementation of water efficiency measures may result in more concentrated sewage arriving at the STWs. The volume and concentration of sludge will also increase if additional treatment is required to meet tighter consent standards. It has not been possible to undertake specific calculations on sludge management / future capacity as part of this assessment due to a lack of detailed data and the uncertainty surrounding changing consent conditions and the influence of water efficiency measures.

It is the mass of nitrogen in sewage sludge which determines the quantity that can be applied per unit of land as defined in the Nitrates Directive. The greater the mass/concentration of nitrogen per unit of sewage sludge the more land is required for its disposal. It is considered that the proportional changes in concentration of sewage sludge as a result of water efficiency measures or treatment standards relative to the current conditions are not significant.

Looking forward, the future management of sewage sludge may be affected by a proposed Soil Directive. However, the proposed Soil Directive will look to continue and promote the disposal of sewage sludge to land and therefore is not considered to present any significant barriers to growth in the Kent Thameside area. Should any requirement for nitrate removal be imposed on Thames Tideway sewage treatment works there will be a reduction of nitrogen in sewage sludge as a result because it is lost to the atmosphere via nitrate removal techniques. This will therefore result in less pressure in the area for agricultural land applications.

5.4 Conclusion and Recommendations

The Strategic Direction Statements of both Thames and Southern Water highlight that projected population growth will increase demand for sewerage services, placing increasing pressure on the treatment works and sewerage network. The challenge is to provide infrastructure that can deliver secure water supplies and safe recycling of wastewater to the environment. Both water companies have provided assurances that the proposed growth in Kent Thameside has been considered in their recent draft Business Plan Submissions to OFWAT and that there are no major barriers to development associated with the wastewater infrastructure. These assurances have been supported by detailed descriptions of the methods adopted to assess both capacity pinch points in drainage network, as specific developments locations are connected, and treatment processes that are likely to become issues due to growth either within or adjacent to the existing sewage treatment works catchment.

Existing or planned headroom was deemed to be commercially confidential and as a result it has not been possible to identify the timing when existing / planned capacity will be exceeded and thus highlight potential temporary barriers that may require phasing of the development. In the absence of any detailed analysis of the hydraulic headroom we recommend that the Kent Thameside Regeneration Partnership proactively engage with Thames and Southern Water and OFWAT. This continued dialogue is essential to provide certainty surrounding development outside existing sewer networks and to agree the future capacity requirements, based on the analysis of future capacity required under the different water efficiency (CSH) scenarios. The adoption of water efficiency measures in new build developments offer the potential to return significant savings in terms of the required capacity of the sewer network and may together with the optimisation of treatment processes enable additional properties to be connected within the existing headroom compared to estimates derived using higher consumption rates.

In considering capacity of the receiving water environment, the additional pollutant load derived from the population increase in Kent Thameside to 2026 is expected to be a relatively small contribution to total sewage treatment works loads discharged to the Thames Estuary. Considering the large dilutive capacity of the outer Thames Estuary, the three sewage treatment works are regarded as being well positioned to receive additional loads with respect to the receiving water environment. In addition, the construction of the Tideway Tunnel will also serve to virtually eliminate overflows from the sewer network so improving the dissolved oxygen levels in the estuary.

In summary, the relatively large size of the existing wastewater treatment infrastructure will help to ensure there is sufficient capacity to accommodate the future increase wastewater flows within or adjacent to the existing sewer catchments, largely through upgrades at specific locations in the sewer network and minor upgrades to the treatment processes. These upgrades have all been incorporated in the both Thames and Southern Water's Business Plan submissions to OFWAT.

Both water companies should make clear to Kent County Council as Waste Planning Authority and the Borough Councils their intentions for investment in waste water and sludge treatment, and in particular identify those works that they believe will require planning consent, and possibly the provision of new land through the MWDF and LDF that are currently in preparation. In particular the possible relocation of the Northfleet STW should be discussed with KCC and Gravesham Borough.

Where development is outside the existing drainage network (i.e. Ebbsfleet) due to the close proximity foul drainage could be accommodated at either Northfleet of Long Reach sewage treatment works and both water

companies have made provision for this in their Business Plans. It is also possible that an inset agreement (or arrangement) could be made, without direct involvement of the water companies. An inset agreement could be set up for part (or all) of the Ebbsfleet developments, whereby private sewage treatment facilities are be commissioned by the developers to treat sewage from Ebbsfleet and obtain a consent from the Environment Agency to discharge to the River Thames. Another alternative would be for the developer to be responsible for the foul drainage with a commercial arrangement with either water company to receive wastewater flows to an existing sewage treatment works catchment.

All the existing sewage treatment works currently comply with existing consent conditions. However, as flows increase due to population growth any existing headroom will be eroded increasing the risk on non-compliance against the consented flow. This will trigger the water company to renegotiate consent conditions with the Environment Agency and through their no deterioration policy this is likely to lead to pro-rata tightening of effluent quality limits. Current conditions are not approaching BAT and therefore there is scope to meet tighter conditions. However, a change in the conservation status / sensitivity classification of the Thames Estuary, particularly designation as a Sensitive Area under the UWWTD, would significantly reduce the capacity of the receiving water and lead to a further tightening of consent conditions, including the introduction of a limit for Nitrogen, although further upgrades to meet tighter standards would be subject to a cost benefit analysis and funded through the periodic review process.

6. Flood Risk and Surface Water Management

6.1 Overview

Flooding in Kent Thameside has been studied as part of the Kent Thameside Strategic Flood Risk Assessment (SFRA). The final document is presented in Appendix J along with the Dartford SFRA. .These studies provide a means of assessing the sustainability of the proposed development sites with respect to tidal and fluvial flooding.

This chapter will focus on the impact of surface water management on the proposed development sites and the sustainability of such large scale development in Kent Thameside.

6.1.1 Surface Water

Kent Thameside lies south of the Thames Estuary, all of the surface water bodies in Kent Thameside and the surface water infrastructure drain into the Estuary. The Thames Estuary is tidally dominated; tidal flood defences are situated along the northern boundary of Kent Thameside to protect it from tidal storm surges. The outfalls of the rivers and drainage infrastructure form part of the tidal defences to ensure that a tidal storm surge cannot flow back through the defences.

The River Darent is the largest fresh water body in the two boroughs. It flows south along the western part of Dartford Borough through Dartford Town Centre and into the Thames Estuary through the Dartford Creek Barrier. The Ebbsfleet is a small stream that runs along the boundary between Dartford and Gravesham boroughs. It discharges to the east of the Swanscombe Peninsula.

The Thames and Medway canal is now disused, but parts of it remain “wet”. The canal basin lies in Gravesend and is still used as a marina, with tidal doors opening to the Thames Estuary at high tide and keeping the water in the basin at low tide. The basin is now separated from the rest of the canal which starts at the junction of Norfolk Road and Wharf Road and runs east-southeast through the Shorne Marshes to Lower Higham.

There are a number of marshes in the Kent Thameside area, which can be grouped into: The Dartford Marshes in the west, lying to the east of the Dartford Creek and north of Dartford; The Swanscombe Marshes, which lie between Greenhithe and the Swanscombe Peninsula (these marshes are actually partly on Swanscombe Peninsula); and the Shorne Marshes (part of the wider North Kent Marshes), which lie to the east of Gravesend.

6.1.2 Geology and Hydrogeology

Kent Thameside lies to the north of the North Downs, which are a series of chalk hills, the geology of the area is predominantly chalk. The chalk is part of the South England Chalk Formation, which also includes Salisbury Plain and the South Downs. It is highly porous and designated a major aquifer, providing many groundwater abstractions for public water supply and other uses. The chalk also provides a convenient means of discharging surface water runoff as it has a relatively high infiltration capacity which means that surface water can be managed locally.

However, the groundwater around abstractions is protected from pollutants to ensure that it remains a viable source of drinking water by Source Protection Zones (SPZs). Discharges to the chalk in the area is therefore limited by the SPZs

The chalk is covered by some discreet areas of sand and mudstone and the soil is predominantly free draining loam. Figure 6.1 shows the hydrology and geology of Kent Thameside.

6.2 Thames Estuary and River Darent Flooding

As discussed, the flooding in Kent Thameside has been studied as part of the Kent Thameside Strategic Flood Risk Assessment. This document as well as the Dartford Town Centre SFRA provides a means of assessing the sustainability of the proposed development sites with respect to tidal and fluvial flooding. Existing flood defence structures were modelled when assessing flood risk to development areas.

6.3 Flood Risk in Key Development Areas

This section of the Report addresses the Flood Risk in relation to the Key Development Areas (KDAs) as identified in the Kent Thameside Strategic Flood Risk Assessment. These sites should not be inferred as being 'preferred' development sites nor should they be considered as sites which the Council will necessarily wish to develop. Furthermore, there is no certainty that all sites will be released for development.

The potential sites are derived from datasets supplied to Entec by the Kent Thameside Regeneration Partnership, based on the latest information in GIS format.

6.3.1 Rationale and Methodology

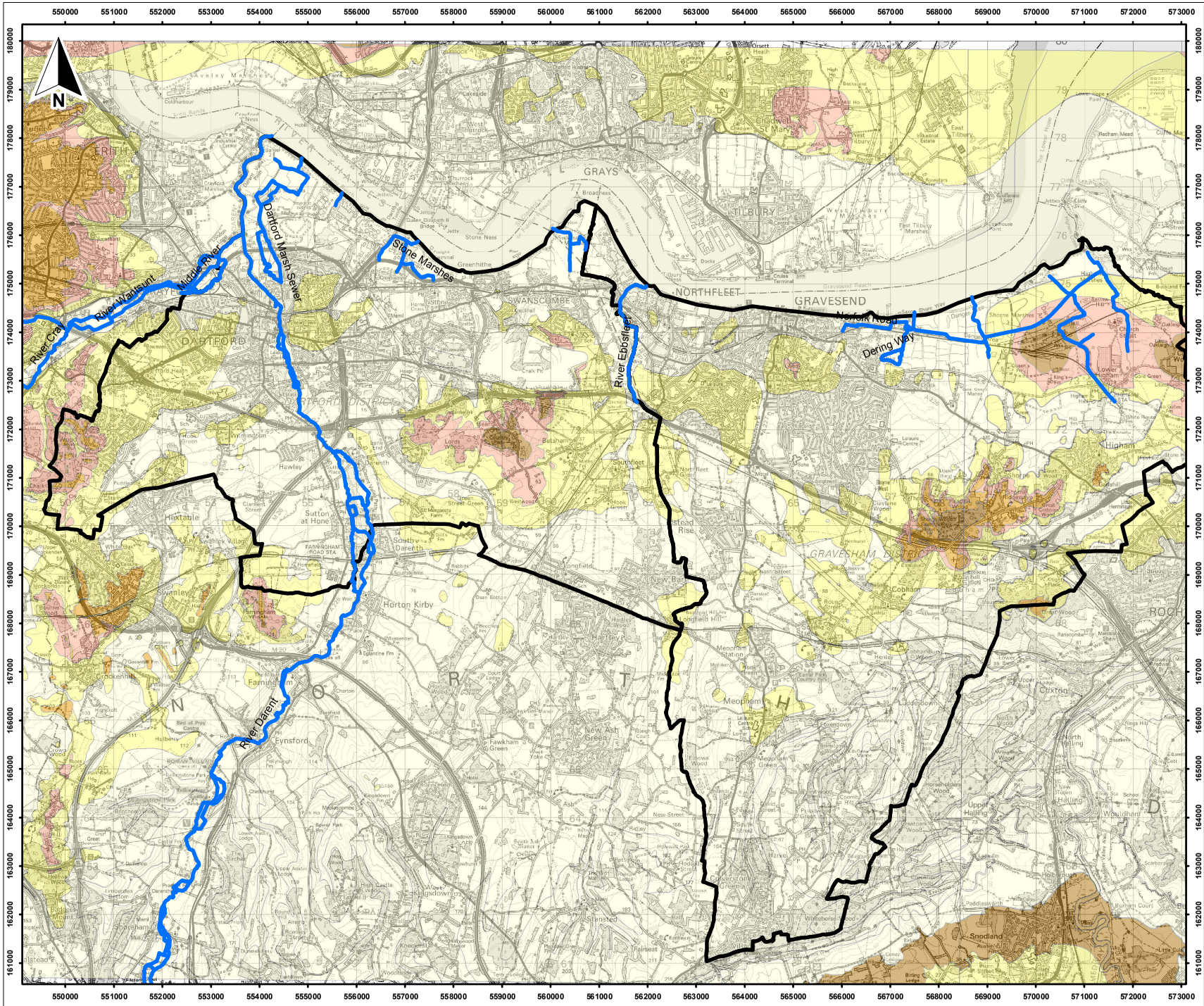
The allocation of flood risk to the sites was based on assessing only the tidal and fluvial flood risks. Sites will subsequently be referred to as being either *at flood risk* or *not at flood risk*. The two classifications are based on whether the site is within / partially within the extents of Flood Zone 2 or 3, or whether the site falls completely within Flood Zone 1. This terminology is adopted for the purposes of best representing the planning policy guidance as outlined in PPS25.

Based on PPS25 guidance, flood risk has been assessed for all sites greater than one hectare in size (whatever flood zone they reside in). Sites of less than one hectare have only been assessed if they reside within flood zones 2 and 3. That is not to say that the sites outside Flood Zones 2 and 3 are not at potential risk of flooding from other localised sources, but from planning and flood risk perspectives, it is only Flood Zones 2, 3a and 3b that determine the allocation of sites for development purposes.

Based on the flood risk zones defined by the Environment Agency, it was possible to assess the spatial distribution of these zones against the distribution of potential sites. The Flood Zone polygons were interrogated within GIS to attribute all sites greater than 1 hectare in size and all sites classed as *at flood risk*. Each potential site was divided up using the extent of the PPS25 flood risk zones (as supplied by the Environment Agency).

6.3.2 Flood Risk Summary

Of the 58 sites assessed in this process, 17 were classified as *not at flood risk*, having a total area of less than 1 hectare and being located within Flood Zone 1. The flood risk for all areas within the study area are shown in Figure 6.2.



Key:

- Main Rivers
- Local Authority Boundaries

Geology

- CHALK
- MUDSTONE
- MUDSTONE AND SANDSTONE
- SAND AND GRAVEL
- SANDSTONE
- SANDSTONE AND MUDSTONE

0 500 1,000 1,500 2,000 2,500 3,000 3,500 4,000 Meters

Scale: 1:77,500 @ A3

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Kent Thameside Water Cycle Strategy

Figure 6.1
Hydrologuy and Geology

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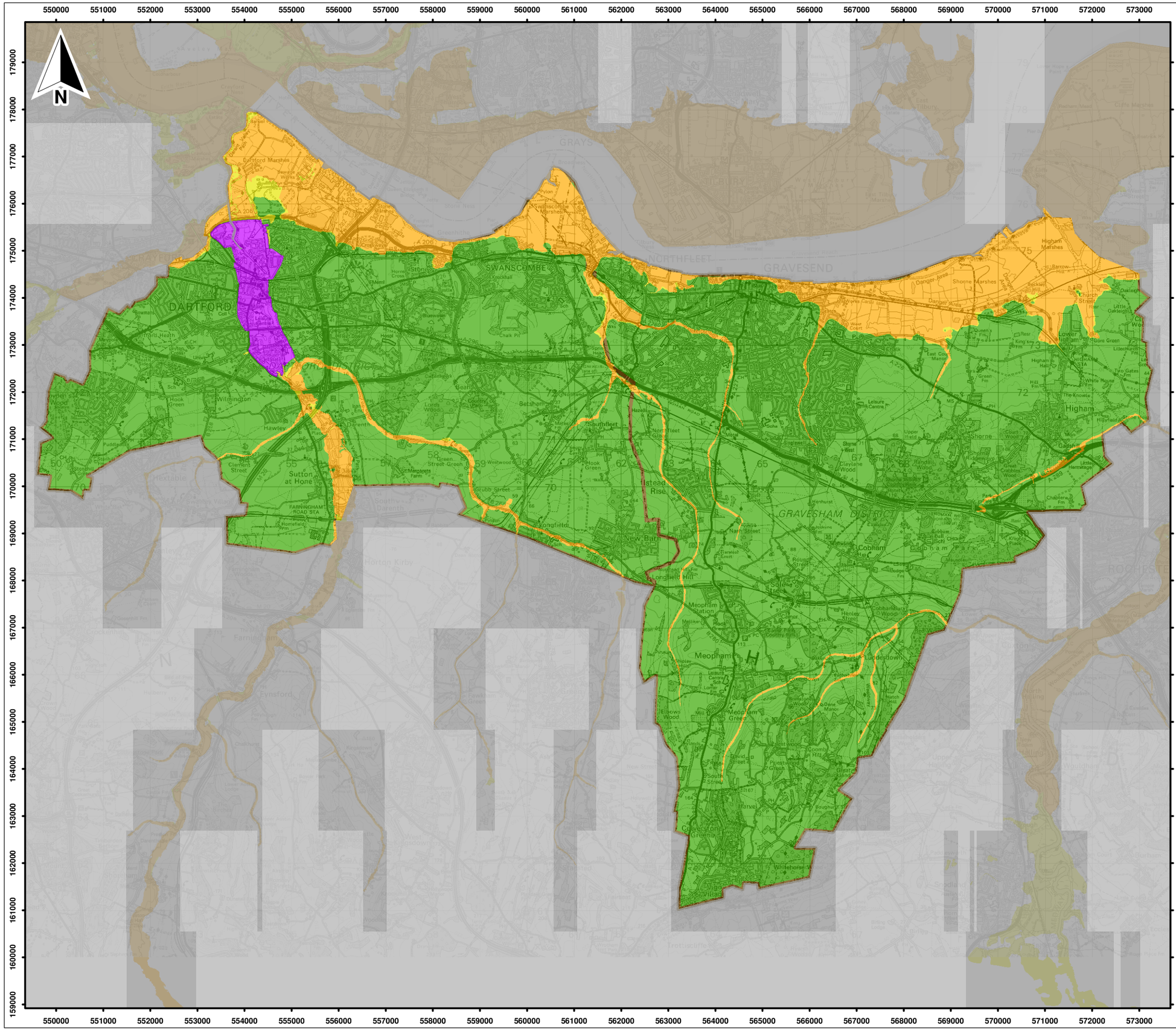

Key:

Council Boundaries

Zone of Flood Risk

- Flood Zone 3a - High Probability
- Flood Zone 2 - Medium Probability
- Flood Zone 1 - Low Probability
- Consult Dartford Town Centre SFRA July 2008

Notes

- Flood Zones issued by the Environment Agency 2008
- Flood Zones illustrated are defined on the basis of an undefended scenario
- No Flood Zone 3b (Functional Floodplain) is held the the Environment Agency for this area
- The Dartford Town Centre SFRA (2008) defined a Flood Zone 3b (Functional Floodplain) in Dartford Town Centre

Scale: 1:78,000 @ A3

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Kent Thameside Water Cycle Strategy

Figure 6.2

Flood Risk Zones in Dartford and Gravesham

March 2009
20656-SC2a rampj

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6.4 Surface Water Management Infrastructure

6.4.1 Current Infrastructure

Surface water in Kent Thameside is managed by a mixture of techniques. Combined drainage systems pipe both the surface water and foul effluent to the treatment works, or out through Combined Sewer Overflows (CSOs) during heavy rainfall, when the network capacity is exceeded. More modern separate systems, take the foul flows to the treatment works and surface water flows to the Thames Estuary. There are some localised schemes that use infiltration as a means of surface water disposal.

The majority of drainage systems are conventional pipe networks, either combined or surface water only. The surface water networks discharge through the tidal defences into the Thames Estuary via flapped valves that prevent water returning up the pipe during high tides. The combined sewers also use flap valves on the CSOs for the same purpose. During high tide the water in the sewer networks is unable to be discharged, consequently a rainstorm event that occurs in conjunction with a high tide has the potential to cause flooding if the volume of runoff exceeds the storage capacity of the sewer network.

The development in Kent Thameside should aim not to increase the load on the drainage infrastructure from surface water runoff. The analysis of the hydraulic capacity of the existing surface water management networks is beyond the scope of this assessment, the level of detailed knowledge of the existing systems and the assessments required are not feasible in the timescale and constraints of this study. As a broad indication of the scale of SuDS features, or other attenuation techniques, that are required to manage the runoff for the proposed site a simple drainage assessment has been undertaken assuming some very general principles about the sites (Section 6.5.3).

6.4.2 Planning Policy 25 – Development and Flood Risk

Planning Policy Statement 25 – *Development and F*lood Risk (PPS25) sets out Government policy on development and flood risk. Its aims are to ensure that flood risk is taken into account at all stages in the planning process to avoid inappropriate development in areas at risk of flooding, and to direct development away from areas of highest risk. It also aims to ensure that new development does not increase the risk of flooding elsewhere.

In respect of surface water management PPS25 manages flood risk by limiting the runoff from new development to the existing rate, to ensure that discharges from new developments do not increase the risk of flooding elsewhere. PPS25 stipulates that all developments greater than 1 hectare must be accompanied by a Flood Risk Assessment that details the surface water management plans that will be employed to ensure there is no increase in the runoff from the proposed development once it has been built.

The Pitt review reiterates comments in PPS25. It makes it clear that developments within flood zone 2 and 3 should not be allowed to proceed unless there is clear proof that they are compatible developments for these zones. This report makes reference to the Kent Thameside and Dartford Town Centre SFRAs which will be used to inform the decision making process when advising on the suitability of developments in line with guidance within the Pitt review. The Pitt Review was comprehensive and considered all stages of flooding - preparedness, response and recovery - as well as the coordination, responsibilities, and legislation necessary to ensure the United Kingdom can

advance in the area of flood risk management. As a result, there are 92 recommendations in the review which have been broadly categorised (by Entec) and provided in Appendix I.

6.4.3 Climate change

PPS25 details allowances to be made to accommodate climate change. These include allowances for rising sea-levels. Rising sea-levels have the potential to increase the risk of tidal storm surges flooding Kent Thameside by overtopping the flood defences or increaing the risk of a breach of the defences. These allowances have been included in the SFRA. Rising sea-levels have the potential to increase the risk of sewer flooding as the sewers are likely to be tide-locked more frequently.

When modelling the proposed runoff from the site a factor of 30% has been applied to account for any increases in rainfall intensity as a result of climate change. This is based on guidance within PPS25, and is applicable to a design horizon of 2115.

6.5 Sustainable Urban Drainage Systems

Within the developments there is the potential to use Sustainable Urban Drainage Systems (SuDS). SuDS are designed to reduce the potential impact of new and existing developments with respect to surface water drainage discharges by using more natural processes to convey surface water away from development. These systems are more sustainable than conventional drainage methods because they:

- Manage runoff flow rates, reducing the impact of urbanisation on flooding
- Protect or enhance water quality
- Are sympathetic to the environmental setting and the needs of the local community
- Provide a habitat for wildlife in urban watercourses
- Encourage natural groundwater recharge (where appropriate).

They do this by:

- Dealing with runoff close to where the rain falls
- Managing potential pollution at its source now and in the future
- Protecting water resources from point pollution (such as accidental spills) and diffuse sources. [24]

SuDS techniques are often described in a “management train”, a series of progressively larger scale practices to manage runoff. The management train is:

[24] CIRIA C69; *The SUDS Manual*; CIRIA 2007

- Prevention - application at individual sites, e.g. use of rainwater harvesting, management to prevent accumulation of pollutants.
- Source Control – control of runoff at or very near to its source e.g. through permeable pavements, green roofs etc.
- Site Control - management of water in a local area or site - e.g. by routing water from building roofs and carparks to large soakaways or infiltration or detention basins.
- Regional Control - management of runoff from a site or number of sites, typically in a balancing pond or wetlands.

6.5.1 Sustainable Urban Drainage Systems limitations

It should be noted that there is an ongoing maintenance requirement of SuDS features, for example to ensure that outlets do not become blocked, or that assets have not been damaged after a severe flooding event.

At an early stage in the development if SuDS are to be promoted clarification should be sought firstly with the water companies as to whether they are willing to adopt the SuDs features[25]. In the event that they are not, then an alternative maintenance arrangement should be sought, this could be by setting up a management company who would maintain the SuDS features. Discussions should also be held with the local council to assess if they would be willing to adopt the SuDS features.

Long term arrangements for adoption and maintenance of SuDS are a key issue, as some SuDS structures and features cannot be adopted by sewerage undertakers under current legislation. Appropriate maintenance of SuDS is essential in ensuring that there are no impacts on the foul drainage system[26]. Infiltration has been proposed as one of the main forms of SuDS for a large number of the sites, note should be taken of table 6.2 and figure 6.3 which detail limitations on where infiltration can be used if sites are located above aquifers, which need to have strong pollution control measures to ensure that they are not polluted, this is covered in more depth in section 6.5.2 below.

6.5.2 SuDS Infiltration Assessment

Many SuDS techniques rely on infiltration of the collected surface water runoff into the ground. Filter strips, soakaways, swales, infiltration basins and wetlands are examples of SuDS techniques at all scales that use infiltration to manage surface water. SuDS are not limited to infiltration, green roofs, rainwater harvesting and detention basins are examples of non-infiltration techniques. As the underlying geology is chalk however infiltration would initially be the preferred SuDS option, due to groundwater recharge, and from a developers perspective there is less land take with SuDS features which can use infiltration. In addition to the details below regarding source protection zones, which will limit the areas suitable for infiltration drainage, checks should be

[25] For example, Thames Water has stated that they currently do not adopt SuDS.

[26] If SuDS are not properly maintained, surface water can get diverted into the foul water system and result in flows above design capacity, leading to e.g. flooding of properties.

made on a site by site basis to confirm local groundwater levels. Usually where the groundwater table is 1 m or higher below ground level then infiltration is not considered to be an appropriate means of surface water disposal due to the potential increase in flood risk. On site infiltration testing should also be undertaken at each site to confirm the local infiltration rates.

As discussed in Section 6.1.2 Kent Thameside lies on top of an important aquifer and the groundwater abstractions have Source Protection Zones (SPZ) around them that limit the discharges to the chalk, and therefore limit the potential for SuDS in Kent Thameside. Figure 6.3 shows the location of the SPZs in relation to the proposed development sites. There are three types of SPZ, defined as follows:

- zone I (inner zone): the area defined by a minimum of 50 m radius, or the distance corresponding to a 50 day travel time from any point below the water table, to the point of abstraction
- zone II (outer zone): similar to the inner zone (I), with a 400 day travel time and or a minimum of 25% of the source recharge area, whichever is the larger.
- zone III (catchment zone): includes the whole catchment area for the source.

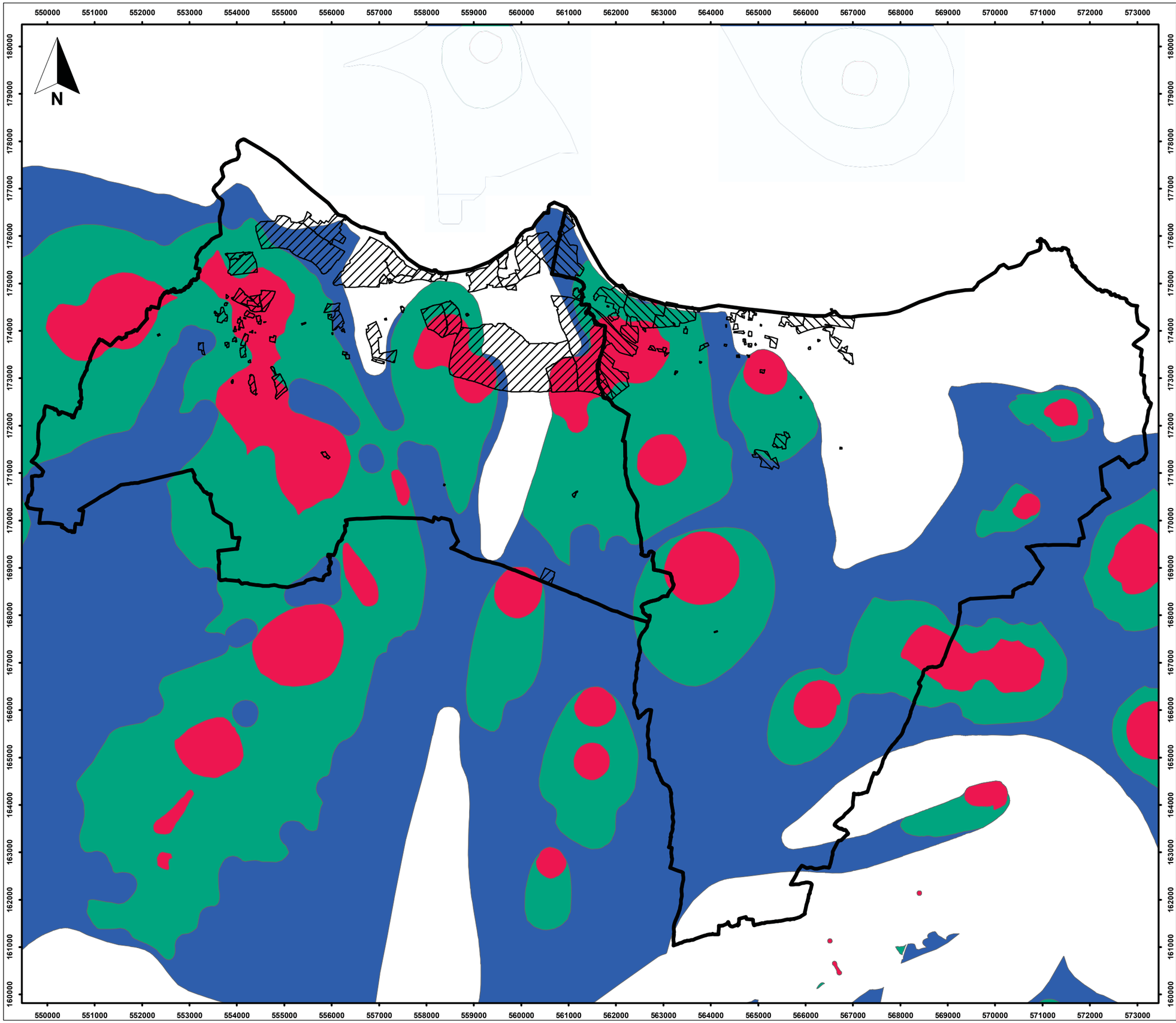
Each of these zones has different requirements for the quality of the water that can be discharged to it and consequently the types of development from which runoff may infiltrate. Table 6.2 shows the development types that are permissible in each zone and the techniques required to control pollution before it is discharged.

Table 6.1 Acceptability for discharges to SPZs

Impermeable Area	Zone I	Zone II	Zone III
Roof Drainage	No objection (provided for sole use of roof drainage)	No objection	No objection
Public/Amenity	Not acceptable	Acceptable	Acceptable
Large Car Parks	Not acceptable	Acceptable (with interceptor)	Acceptable (with interceptor)
Lorry Parks	Not acceptable	Presumption Against	Acceptable (with interceptor)
Garage Forecourts	Not acceptable	Presumption Against	Acceptable (with interceptor)
Major Roads	Not acceptable	Presumption Against. Acceptable only in exceptional circumstances	Acceptable only if investigation favourable and with adequate precautions
Industrial Sites	Not acceptable	Presumption Against	Acceptable only if investigation favourable and with adequate precautions

CIRIA R156 Infiltration Techniques

Outwith the SPZ there are Resource Protection Zones, these list the acceptable discharges dependent on the strata that the soakaways will be discharging to, a summary of these is provided in Table 6.3 below. Both table 6.2 and 6.3, are based on data within CIRIA guide 156, *'Infiltration Drainage - Manual of good practice'*.



Key:

- Dartford Sites
- Gravesham Sites
- Local Authority Boundaries

Source Protection Zones

- Inner
- Outer
- Catchment

0 500 1,000 1,500 2,000 2,500 3,000 3,500 Meters

Scale: 1:77,500 @ A3

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Kent Thameside Water Cycle Strategy

Figure 6.3
Sites and Source Protection Zones

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Entec

Table 6.2 Acceptability for discharges to Protected Resources

Impermeable Area	Major Aquifer	Minor Aquifer	Non-Aquifer
Roof Drainage	No objection	No objection	No objection
Public/Amenity	Acceptable	Acceptable	Acceptable
Large Car Parks	Acceptable (with interceptor)	Acceptable (with interceptor)	Acceptable (with interceptor)
Lorry Parks	Acceptable (with interceptor)	Acceptable (with interceptor)	Acceptable (with interceptor)
Garage Forecourts	Acceptable (with interceptor)	Acceptable (with interceptor)	Acceptable (with interceptor)
Major Roads	Acceptable (subject to investigation and with interceptor)	Acceptable (subject to investigation and with interceptor)	Acceptable (with interceptor)
Industrial Sites	Acceptable only if investigation favourable and with adequate precautions	Acceptable (subject to investigation and with interceptor)	Acceptable (subject to investigation and with interceptor)

CIRIA R156 Infiltration Techniques

These tables show that Public amenity and large car parks would be able to utilize infiltration techniques in all but the inner zone with the use of an oil interceptor and other developments with poorer runoff water quality would be permissible in the outer zone and outside the catchments.

Having established that SuDS infiltration techniques are feasible in principle in Kent Thameside the direct applicability to potential development sites needs to be established. All proposed development sites that are greater than 1 ha are listed in Table 6.4, each site is indicated as to whether it lies entirely within an inner zone and whether any land within its boundary lies outside of a catchment area.

Table 6.3 SuDS potential for sites over 1 ha

Area	Site	Area, m^2	Proposed Completions	Wholly in Inner SPZ	Part of Site out of Catchment
Dartford Town Centre	Co - Op	14,682	165	Yes	
	Lowfield Street	45,758	940		
	Mill Pond	30,541	390.0	Yes	
	North East Gateway	89,396	370.0	Yes	
	North West Gateway	73,605	0.0	Yes	
	Northern Gateway East 2	28,893	130.0	Yes	
	Overy Street	13,251	165.0	Yes	
	Station mound	18,962	200.0	Yes	
Dartford West	Dartford West Campus West (completed/nearing completion)	19,958	91.0		
	West Hill Hospital (completed/ nearing completion)	42,551	194.0		
Swanscombe/Greenhithe	Ingress Park	291,959	78.0		Yes
	Craylands Lane	17,759	n/a		Yes
	Everards, Station Road Greenhithe	14,657	211.0		Yes
	Korsnas Site	34,588	149.0		Yes
	Swancombe Peninsula - Dartford	123,212	600.0		Yes
	Swanscombe Peninsula - Gravesham	460,426	n/a		
	Swanscombe Peninsula East	296,775	n/a		Yes
	Swanscombe Peninsula West	302,737	n/a		Yes
Ebbsfleet Valley	Eastern Quarry	2,555,813	5452.0		Yes
	Ebbsfleet - Northfleet Rise	326,327	464.0		

Area	Site	Area, m^2	Proposed Completions	Wholly in Inner SPZ	Part of Site out of Catchment
Dartford North	Littlebrook Power Station	315,412	n/a		Yes
	Dartford Fresh Marshes	207,254	n/a		
	Dartford Fresh Marshes	42,845	n/a		
	Thames Euro Port	215,606	850.0		Yes
	The Bridge	1,087,391	1500.0		Yes
Dartford South	Darenth Road	90,570	19.0		
	Darenth Mill	12,390	n/a		
	East Hill ATC	12,988	8.0	Yes	
	Powder Mill Lane	42,592	43.0	Yes	
Dartford East	Waterstone Park (completed / nearing completion)	250,712	n/a		
	St Clemants Valley	204,633	n/a		
	Ebbsfleet - Springhead	411,959	388.0		
	Northfleet West Sub Station	390,260	1410		
	Station Quarter South	1,377,643	1504.0		
Northfleet Embankment	Northfleet Embankment Indust.	518,717	n/a		
	Northfleet Embankment West	232,757	1000.0		
	Northfleet Embankment East	303,904	1670.0		
Northfleet South	Campbell Road Pit	13,681	59.0		
	South of Dover Road	11,192	74.0	Yes	
	Vale Road	9,588	40.0	Yes	
Canal Basin/NE Gravesend	Canal Basin Phase 1	102,753	1000.0		Yes
	Canal Basin Phase 2	277,097	870.0		Yes

Area	Site	Area, m^2	Proposed Completions	Wholly in Inner SPZ	Part of Site out of Catchment
Dartford Rural	Axton Chase School	62,940	140.0		
Stone/Crossways	Cross Ways (completed/ nearing completion)	909,686	n/a		Yes
	Cross Ways DBC	25,764	n/a		Yes
	Darenth Valley Hospital	11,898	n/a		
	Fantaseas	44,619	165.0		
	St. James ' Lane Pit	211,417	705.0		Yes
	Stone House Hospital	76,268	310.0		
	NE Gravesend Industrial	59,289	n/a		
	NE Gravesend Phases 2 & 3	54,086	20.0		Yes
Gravesend Town Centre	Community Hosp & M Block	17,358	45		Yes
	Heritage Quarter East	18,213	407.0		Yes
	Heritage Quarter West	15,651	223.0		Yes
	Sikh Temple	34,447	n/a		Yes
Gravesend South	Christianfields	77,215	319.0		
	Southfields School	115,666	133.0		

Of the 57 sites in Kent Thameside greater than 1ha proposed for development 11 are wholly in the Inner SPZ and would be restricted in the use of SuDS, in terms of using infiltration techniques. However, 24 sites greater than 1 ha have some part outside of a groundwater catchment and would have very little restriction on the use of SuDS. The remaining sites greater than 1 ha lie in a groundwater catchment but have some land outside of the inner SPZ and would have some flexibility as to the use of SuDS depending upon the land use type.

6.5.3 SuDS Scale and outline modelling

As a broad indication of the scale of SuDS features, or other attenuation techniques, that are required to manage the runoff for the proposed site a simple drainage assessment has been undertaken assuming some very general principles about the sites. It should be noted that this is not a detailed drainage assessment and that the figures are only indicative. Critical storms have not been selected for individual catchments, a 5 hour storm has been adopted as the base storm for the drainage assessments as it was considered that this will give indicative storage values for an outline assessment on storage volumes.

The sites have been divided into greenfield and brownfield, as an indication of whether they are developed (and can discharge at an un-attenuated rate) or undeveloped (and therefore have greenfield runoff currently). The runoff generated after they have been developed has been calculated for a five hour, 1 in 100 plus climate change storm based on a general impermeable proportion of 50%. Where a site is brownfield it is assumed that 100% of the site will be impermeable (although for some sites in Dartford specific impermeable densities have been provided), again it should be noted that these are broad assumptions, and that modeling has been undertaken to give outline storage volumes. A factor of 20% has been applied for climate change, based on guidance within PPS25, this is applicable to a design horizon of 2085. Modelling has been based on the Wallingford Procedure, modified rational method.

Table 6.4 shows the volume of runoff that would need to be attenuated and the reduction in runoff from the existing sewer network if the brownfield sites were also to be limited to greenfield runoff, this is based upon guidance within the London plan. **It should be made very clear however that the more stringent greenfield rates in the London Plan are not under any circumstances a requirement for Kent Thameside and that the councils are under no obligation to adopt them (they have been mentioned for comparative purposes)**. PPS25 recommends limiting run-off rates at existing or less than existing brownfield rates. However, the rationale behind reducing brownfield sites to greenfield discharges is to reduce flood risk which may be appropriate in areas with restricted sewer capacity and therefore having a conservative value on the storage volumes required to obtain greenfield runoff is useful. Finally it is worth pointing out that water companies will often seek to get any new flows from a site reduced to greenfield rates and the Environment Agency have stated that they will look to developers to reduce the runoff rate for their developments and aspire to the greenfield runoff rate. The last column shows a ‘worst case’ storage volume scenario, this is the storage required in the event that sites are unable to discharge flows due to effects such as tide locking or blocked outfalls.

The following data has been used when calculating the storage volumes; a uniform 1 in 100 year greenfield runoff of 3.8 l/s//ha calculated using IoH 124; a five hour 1 in 100 year plus 30% climate change; rainfall of 75mm; a

runoff co-efficient of 1; the Modified Rational method has been used.

Tide locking does not significantly increase the storage volumes when comparing the brownfield and worst case scenarios. This is due to the Greenfield value of 3.5 l/s/ha acting as a large restriction already, which means that the majority of flows will have to be attenuated based on the conservative assumption that 100% of the site is impermeable, therefore tide locking will not have that significant an additional effect. Storage would increase if outfalls became blocked, although this effect would not occur due to tide locking as these will obviously recede and allow flows to discharge. However, tide-locking may be important at a localized level. For example, the Environment Agency (Nigel Pye, *Pers. Comm*.) have identified a potential issue with a site called "Robin's Creek" in Gravesham. The area consists of a defended creek receiving waters from the River Ebbsfleet and adjoining industrial site with sufficient capacity to allow for 72 hours of flood storage during a major fluvial event. The creek is self-draining at low tide and has a standard flap valve cover to the outlet. The issue is that should an exceptional rainfall event which takes up all available storage capacity coincide with a major spring tide or surge tide event, tide locking could occur. Depending on the frequency and amount of new rainfall, surge tide height and duration, there is then the possibility that the available storage could not be replaced within a sufficiently rapid period so leading to flooding of the Ebbsfleet river basin. Although a relatively low probability, as climate change impacts, the risk is seen to increase. In light of this possibility, the EA state that it is imperative therefore that Robin's Creek is maintained as fluvial storage.

It should be noted that an impermeable area value of 100% was adopted to assess the highest likely storage values unless site specific information was available. Use of greenspaces, trees, and planted areas, will have an obvious visual amenity, but will also help to reduce surface water flows by providing localized infiltration areas, and the reduction of sheet flows associated with large impermeable areas.

Table 6.4 SuDS Scale for Sites over 1 ha

Development Area	Site	Area, m^2	Proposed Completions	Runoff status	Impermeable Density	Storage required for Greenfield/brownfield sites, m^3	Additional Storage required to achieve Greenfield for brownfield sites, m^3	Worst case scenario, no discharge to reflect tide locking, m^3
Dartford Town Centre	Co - Op	14,682	165.0	Brownfield	100%		1,332	1,433
	Lowfield Street	45,758	940.0	Brownfield	100%		4,152	4,465
	Mill Pond	30,541	390.0	Brownfield	80%		2,175	2,384
	North East Gateway	89,396	370.0	Brownfield	70%		5,495	6,106
	North West Gateway	73,605	32.0	Brownfield	100%		6,679	7,182
	Northern Gateway East 2	28,893	130.0	Brownfield	80%		2,058	2,255
	Overy Street	13,251	165.0	Brownfield	80%		944	1,034
	Station mound	18,962	200.0	Brownfield	100%		1,721	1,850
Dartford West	Dartford West Campus West (completed / nearing completion)	19,958	91.0	Brownfield	75%		1,324	1,461
	West Hill Hospital (completed / nearing completion)	42,551	194.0	Greenfield		1,785		2,076
Dartford North	Littlebrook Power Station	315,412	n/a	Brownfield	100%		28,620	30777
	Dartford Fresh Marshes	207,254	n/a	Greenfield		8,694		10,112

Development Area	Site	Area, m^2	Proposed Completions	Runoff status	Impermeable Density	Storage required for Greenfield/brownfield sites, m^3	Additional Storage required to achieve Greenfield for brownfield sites, m^3	Worst case scenario, no discharge to reflect tide locking, m^3
	Dartford Fresh Marshes	42,845	n/a	Greenfield		1,637		2,090
	Thames Euro Port	215,606	799.0	Brownfield	70%		13,252	14,727
	The Bridge	1,087,391	1410.0	Greenfield		45,615		53053
Dartford South	Darenth Road	90,570	19.0	Greenfield		3,799		4419
	Darenth Mill	12,390	n/a	Brownfield	50%		473	604
	East Hill ATC	12,988	8.0	Brownfield	55%		608	697
	Powder Mill Lane	42,592	43.0	Greenfield		1,787		2078
Dartford East	Waterstone Park (completed / nearing completion)	250,712	n/a	Greenfield		10,517		12232
	St Clemants Valley	204,633	n/a	Greenfield		8,584		9984
Dartford Rural	Axton Chase School	62,940	149.0	Brownfield	50%		2,640	3071
Stone/Crossways	Cross Ways	909,686	n/a	Brownfield	50%		38,160	44383
	Cross Ways DBC	25,764	n/a	Brownfield	50%		1,081	1,257
	Darenth Valley Hospital	11,898	n/a			499		580
	Fantaseas	44,619	165.0	Greenfield		1,872		2,177
	St. James ' Lane Pit	211,417	705.0	Greenfield		8,869		10,315

Development Area	Site	Area, m^2	Proposed Completions	Runoff status	Impermeable Density	Storage required for Greenfield/brownfield sites, m^3	Additional Storage required to achieve Greenfield for brownfield sites, m^3	Worst case scenario, no discharge to reflect tide locking, m^3
	Stone House Hospital	76,268	310.0	Greenfield		3,199		3,721
Swanscombe/Greenhithe	Ingress Park (completed/ nearing completion)	291,959	78.0	Brownfield	50%		12,247	14,244
	Craylands Lane	17,759	n/a	Greenfield		745		866
	Everards, Station Road Greenhithe	14,657	198.0	Brownfield	75%		972	1,073
	Korsnas Site (completed/ nearing completion)	34,588	140.0	Brownfield	70%		2,126	2,363
	Swancombe Peninsula - Dartford	123,212	600.0	Greenfield		5,169		6,011
	Swanscombe Peninsula - Gravesham	460,426	n/a	Greenfield		19,314		22464
	Swanscombe Peninsula East	296,775	n/a	Greenfield		12,449		14479
	Swanscombe Peninsula West	302,737	n/a	Greenfield		12,700		14,770
Ebbsfleet Valley	Eastern Quarry	2,555,813	5902.0	Greenfield		107,214		124,696
	Ebbsfleet - Northfleet Rise	326,327	464.0	Greenfield		13,689		15,921
	Ebbsfleet - Springhead	411,959	480.0	Greenfield		17,281		20,099

Development Area	Site	Area, m^2	Proposed Completions	Runoff status	Impermeable Density	Storage required for Greenfield/brownfield sites, m^3	Additional Storage required to achieve Greenfield for brownfield sites, m^3	Worst case scenario, no discharge to reflect tide locking, m^3
	Northfleet West Sub Station	390,260	1410	Greenfield		16,371		19,040
	Station Quarter South	1,377,643	1600.0	Greenfield		57,791		67,214
Northfleet Embankment	Northfleet Embankment Indust.	518,717	n/a	Brownfield	100%		47,067	50,615
	Northfleet Embankment West	232,757	1000.0	Brownfield	100%		21,120	22,712
	Northfleet Embankment East	303,904	1670.0	Brownfield	100%		27,576	29,654
Northfleet South	Campbell Road Pit	13,681	59.0	Greenfield		574		667
	South of Dover Road	11,192	74.0	Greenfield		469		546
	Vale Road	9,588	40.0	Brownfield	100%		870	936
Canal Basin/NE Gravesend	Canal Basin Phase 1	102,753	1000.0	Brownfield	100%		9,324	10,026
	Canal Basin Phase 2	277,097	870.0	Brownfield	100%		25,143	27,039
	NE Gravesend Industrial	59,289	n/a	Greenfield		2,487		2,893

Development Area	Site	Area, m^2	Proposed Completions	Runoff status	Impermeable Density	Storage required for Greenfield/brownfield sites, m^3	Additional Storage required to achieve Greenfield for brownfield sites, m^3	Worst case scenario, no discharge to reflect tide locking, m^3
	NE Gravesend Phases 2 & 3	54,086	20.0	Greenfield		2,269		2,639
Gravesend Town Centre	Community Hosp & M Block	17,358	45.0	Brownfield	50%		728	847
	Heritage Quarter East	18,213	407.0	Brownfield	100%		1,653	1,777
	Heritage Quarter West	15,651	223.0	Brownfield	100%		1,420	1,527
	Sikh Temple	34,447	n/a	Greenfield		1,445		1,681
Gravesend South	Christianfields	77,215	219.0	Brownfield	50%		3,239	3,767
	Southfields School	115,666	133.0	Greenfield		4,852		5,643

Assuming: a uniform 1 in 100 year greenfield runoff of 3.8 l/s//ha calculated using IoH 124; a five hour 1 in 100 year plus climate change rainfall of 75mm; a runoff co-efficient of 1; the Modified Rational method has been used.

Table 6.4 shows the scale of SuDS or other attenuation techniques required to manage surface water. There is potential to exploit the natural infiltration potential of the bedrock in Kent Thameside, which would reduce the storage requirements for the sites. Some sites may not have access to areas suitable for infiltration on site, but an integrated drainage plan could be implemented where several sites share a large scale SuDS scheme. In particular Eastern Quarry has a large area that does not fall within any of the groundwater catchments and there is potential to utilize this for the implementation of a wetland feature that could mange the surface water runoff for all the Ebbsfleet Valley sites.

Table 6.4 also shows the potential for SuDS to ease the load on the sewer network. If greenfield runoff rates are applied to all sites, including brownfield developments the impact of increased foul sewage on the treatment works could be reduced. Likewise if brownfield sites did not discharge as much surface water to the drainage network the incidents of CSOs and sewer overflows during tide locking could be reduced, mitigating some of the impacts of climate change.

To achieve this kind of impact a Surface Water Management Plan would need to be implemented to strategically plan the required infrastructure and ensure that holistic approach is put into practice. All the relevant stakeholders, especially the water companies and developers would need to co-operate to ensure that it could be delivered.

6.6 Potential Surface Water Management Options

6.6.1 Surface Water Management Plan

For larger sites or where there will be several developments in one area it is advised that the SuDS management train is adopted, details of which are repeated below.

SuDS techniques are often described in a “management train”, a series of progressively larger scale practices to manage runoff. The management train is:

- Prevention - application at individual sites, e.g. use of rainwater harvesting, management to prevent accumulation of pollutants.
- Source Control – control of runoff at or very near to its source e.g. through permeable pavements, green roofs etc.
- Site Control - management of water in a local area or site - e.g. by routing water from building roofs and carparks to large soakaways or infiltration or detention basins.
- Regional Control - management of runoff from a site or number of sites, typically in a balancing pond or wetlands.

By adopting the management train approach it will ensure that the natural catchment process is mimicked, it will also mean that there is a more efficient use of land, by for example having a regional control feature which serves

several localized sites. The risk as discussed with SuDS is ensuring that a suitable management procedure is set in place to ensure that the SuDS features are suitably maintained; this is particularly pertinent if it will be a feature serving several sites. Long term maintenance procedures must be supported by legal agreements with the identified SuDS undertakers.

As discussed in section 6.4.1 there should be no increase in surface water runoff rates as a result of the developments as per the guidance within PPS25 and the Pitt report. As a large percentage of the sites are currently brownfield, and it is proposed to reduce flows from these sites down to greenfield rates then it is evident that the developments will in effect be providing 'betterment', by reducing surface water runoff and hence decreasing flood risk.

7. Integrated Solutions

The scale of the development in Kent Thameside together with the development of areas, such as Ebbsfleet, not connected to existing water infrastructure offer a significant opportunity to integrate the different elements of the water cycle and work towards sustainable water management. The opportunities for more holistic management of the water cycle are discussed in this chapter.

The adoption of SuDS features has the potential to significantly reduce the demand on existing water supplies, particularly through the large scale adoption of rainwater harvesting and greywater recycling. This will be essential to meet the target per capita consumption rates of 80 l/d and CSH level 5/6. In addition where it is found that infiltration techniques can be used this will also aid natural recharge of the aquifers from which drinking water is extracted from. SuDS features can also be used attenuate flow to the existing drainage network and thus mitigate the erosion of hydraulic headroom. Further reductions in flows to sewer may also be achieved through returning brownfield to greenfield sites and the use of SuDS within future developments. Reducing or attenuating flows to the sewer will lead to a positive impact on water quality in terms of reducing Combined Sewer Overflow (CSO) spill frequencies.

Improved water efficiency measures within new builds will also have benefits for various elements within the Water Cycle Study. Making new developments more efficient in terms of water use will also lead to a reduction in the per capita wastewater load on the sewage infrastructures. For example through the use of efficient toilet flushing systems, showers etc. Further reduction in water supply demand could be achieved, particularly through the large scale use of rainwater through large-scale rainwater harvesting and the adoption of water butts at the property level. Although the use of rainwater will reduce surface runoff and potentially lead to some improvement in the quality of the receiving water it would not lead to a significant reduction in the foul flows to sewer beyond those achieved through efficient water use in the home. Conversely, grey water recycling offers the potential to further reduce flows and pollutant loads to sewer since water is effectively being used twice, firstly drainage from the sink / shower and secondly, following storage and basic treatment, for toilet flushing. Rainwater and grey water systems are relatively easy to implement on large scale development particularly where there is no existing water infrastructure. As a word of caution regarding the use grey water systems, if they are to be acceptable to the general public then reliable systems that operate on a “fit and forget” basis will be required and it is unclear in this respect whether current designs can be considered a reliable, cost-effective and publicly acceptable solution.

SuDS help to mimic the natural water cycle, which leads to further benefits in terms of groundwater recharge, and providing a good degree of biological filtration of potential contaminants. SuDS schemes can also be used for habitat creation to enhance the biodiversity and green spaces and thus the amenity value of a site. When carefully designed, this can lead to wider socio-economic benefits (i.e. providing a focus for the community and increasing house prices). To achieve the maximum benefit of large scale SuDS initiatives it is essential that they are incorporated early within the development plans of a particular site or sites and that plans and funding are secured to ensure these assets are properly maintained.

The wide scale adoption of water efficiency measures and SuDS schemes has the potential to lead to a reduction in the flows to sewer. However pollutant load derived from excreta remains largely unchanged and as a result of this, due to less dilution, the concentration of effluent during dry-weather flow is increased. This change in sewage composition, and volume, reaching the treatment plant in dry weather, has the potential to influence efficiency of wastewater treatment processes. Although there is little supporting evidence (observed data) to quantify the impact recent studies (EA Pers. Comm) indicate the potential for a marginal improvement, particularly during primary sedimentation. Results also suggest a tendency towards increased primary sludge production and a decrease during secondary treatment, with an overall reduction in sludge production when water reduction is reduced by more than 20%.

Reduced flow also leads to lower velocities during dry weather and increased sedimentation within the sewer networks. This together with the increased pollutant concentrations has the potential to exacerbate acute pollution problems associated with first flushes (erosion) of pollutants within the sewer network, following extended dry periods, and associated spills from combined sewer overflows (CSOs). However, rainwater (roof-runoff) reuse strategies offer significant potential to reduce the total volume and frequency of CSO discharges to the receiving water and thus pollutant loads, whilst also reducing the risk of urban flooding.

The benefits and disadvantages of water efficiency measures, either individually or in combination, will be location specific depending on the characteristic of the catchment served, sewer network and treatment process as well as the population served (existing versus growth). In order to identify sustainable water cycle management strategies it is important to integrate the downstream influence of water efficiency measures on wastewater treatment and receiving water quality. New sewer networks can be designed around a reduced wastewater consumption rate / DWF, however, the hydraulics / gradients of existing sewer networks will have been designed to accommodate higher flows and thus may lead to self cleansing issues when connected to an extensive new development where water efficiency measures have been widely adopted.

8. Summary and Conclusion

The Strategic Direction Statements of both Thames and Southern Water highlight that projected population growth will increase demand for water and sewerage services, placing increasing pressure on the water and sewerage network. The challenge is to provide infrastructure that can deliver secure water supplies and safe recycling of wastewater to the environment.

This phase I / outline water cycle study has identified no ultimate environmental or water infrastructure constraint to the proposed growth within Kent Thameside. However, the findings have been constrained by the available data and concerns regarding commercial confidentiality. Although this information may be considered less sensitive once the final determination has been approved by OFWAT[27]. This study has identified technical and planning issues that will need to be overcome to provide the sustainable and integrated water management solutions although none are considered insurmountable and for many there are a number of potential options. Continued and proactive engagement with key stakeholders, particularly the water companies and the Environment Agency is considered to be essential in order to reduce the uncertainty in key areas, largely due to a lack of data of future implementation of new legislation. This partnership working will also help to facilitate the selection and implementation of integrated water management solutions that will enable growth to be achieved in a sustainable fashion.

[27] Southern Water's view of competition and confidentiality issues in Kent Thameside is that they are likely to remain particularly sensitive even beyond the Business Plans submission.

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Appendix A
Development

Novermber 2007

Site name	2005 2005-06	2006 2006-07	2007 2007-08	2008 2008-09	2009 2009-10	2010 2010-11	2011 2011-12	2012 2012-13	2013 2013-14	2014 2014-15	2015 2015-16	2016 2016-17	2017 2017-18	2018 2018-19	2019 2019-20	2020 2020-21	2021 2021-22	2022 2022-23	2023 2023-24	2024 2024-25	2025 2025-26	Total	Post 2026	Post 2026 Total
Dartford Northern Gateway																								
West & East																								
Millpond Road			0	0	0	0	52	52	52	0	0	0	0	0	0	0	0	0	0	0	0	155		155
East- community			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Northern Gateway East 1			0	0	0	0	42	42	42	0	0	0	0	0	0	0	0	0	0	0	0	127		127
Northern Gateway East2			0	0	0	0	0	0	0	66	66	0	0	0	0	0	0	0	0	0	0	132		132
Dartford North Town centre																								
Station																								0
Riverside																								0
Orchard/Hythe Street																								0
Acacia Hall Quarter																								0
Orchard st/ Kent Rd			0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6		6
52 Spital St			0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11		11
22-26 Spital Street			0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13		13
77-83 Hythe Street			0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11		11
Apex Car Park			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Prospect Place, Dartford			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Prospect Place, Dartford			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Co-op Site			0	0	0	94	71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	165		165
Overy Street			0	0	0	0	42	42	42	0	0	0	0	0	0	0	0	0	0	0	0	127		127
1-7 Suffolk Street			0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10		10
Spring Vale (Co-op)			0	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24		24
Northern Gateway West			0	0	0	0	0	0	32	0	0	0	0	0	0	0	0	0	0	0	0	32		32
Police Station- Instone Road			0	0	0	0	47	0	0	0	0	0	0	0	0	0	0	0	0	0	0	47		47
Iceland Block			0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	11		11
Station Approach			0	0	0	0	24	24	0	0	0	0	0	0	0	0	0	0	0	0	0	47		47
63-69 High Street			7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7		7
Milan Day Centre			0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8		8
Market Street			0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8		8
Lowfield Street, Dartford			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Lowfield Street, Dartford			0	0	0	0	188	188	188	188	188	0	0	0	0	0	0	0	0	0	0	940		940
Lowfield Street, Dartford			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Lowfield Street, Dartford			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Fairfield Pool, Dartford			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
URC, West Hill			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Foyer Scheme, Overy Street			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Glaxo East			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
28 Spital Street			0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6		6
63-69 High Street, Dartford			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
49 Westgate Road, Dartford			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Westgate Road/ Priory Road			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Gateway Club, Westgate Road			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Westgate Road/Hythe Street, Dartford			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
West Hill Hospital			141	53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	194		194
West Hill House			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
St Anslelms RC			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Maypole			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Maypole School			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
125-129 Dartford Road			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
KCC land, Heath Lane			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
NW Kent College, Miskin Road			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Dartford Adult Education Centre			17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17		17
40 Chasttillian Road			0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10		10
Adj 1 Mildred Close			13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13		13
The Coleburt Centre, King Edward			0	0	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24		24
R/o Anne of Cleeves Road			0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11		11
Dartford Technology Campus			0	0	42	43	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	86		86
			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
The Bridge (N. Dartford)			141	188	188	188	188	188	188	141	0	0	0	0	0	0	0	0	0	0	0	1410		1410

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025			
Site name	**2005-06**	**2006-07**	**2007-08**	**2008-09**	**2009-10**	**2010-11**	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**2021-22**	**2022-23**	**2023-24**	**2024-25**	**2025-26**	**Total**	**Post 2026**	**Post 2026 Total**
The Bridge (N. Dartford)			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
The Bridge (N. Dartford)			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Littlebrook Power Station			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
The Bridge (N. Dartford)			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Dartford Park			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Puffing Billy Site			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Newtown Tavern, Fulwich Road			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
St Edmund Ch, St Edmunds Road			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
S. of University Way			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Dartford Fresh Marshes: GSK			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Dartford Fresh Marshes: Residue			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Dartford Fresh Marshes: Residue			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Dartford Fresh Marshes: Residue			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Dartford Fresh Marshes: GSK			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Dartford Fresh Marshes: GSK			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
115 Priory Road, Dartford			0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5		5
Adj 1 Mildred Close			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Temple Farm House, Joyce Green Lane			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
78, 80 West View Rd, Dartford			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Sandpit Road			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Sandpit Road			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Sandpit Road			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Finn Fitness, Burnham Road			0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13		13
			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Darenth Road			0	0	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19		19
Darenth Road			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Darenth Road			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Darenth Road			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Oakfield Lane Campus			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Greenwood, Darenth Road			0	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8		8
Powdermill Lane			0	0	0	0	0	43	0	0	0	0	0	0	0	0	0	0	0	0	0	43		43
Darenth Road			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
East Hill ATC			8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8		8
Princes Park			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
75 Brent Lane			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
33,35 Myrtle Road, Dartford			0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8		8
36-40 Heath Street, Dartford			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Adj Fox and Housnds, Lowfield Street			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Wilmington Hse, Church Hill, Wil.			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
389-397 Princes Road			0	0	19	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32		32
			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Bellegrove Ceramics			0	0	28	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	48		48
94-98 London Road			0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5		5
78-40 Westview Road			0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8		8
			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Orchard Cottage, Longfield Hill			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Axton Chase School, Longfield			0	0	0	0	71	70	0	0	0	0	0	0	0	0	0	0	0	0	0	140		140
Tile Kiln Lane			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Lane End			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Edwin Road, Wilmington			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Sandpit Road in Dartford North			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Holy Trinity			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Pepper Hill Waste Centre			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Hawley Grange			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Fosters Yard, Station Rd, Longfield			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
23 Longfield Avenue			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Fawkham Avenue, New Barn Road			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Clockhouse stables, Green Street Green			10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10		10
Hook Place Farm			0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6		6
r/o 49-59 Tile Kiln Lane			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
8, 10 Main Road, Sutton-at-Hone			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
North of Page Close, Bean			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025			
Site name	**2005-06**	**2006-07**	**2007-08**	**2008-09**	**2009-10**	**2010-11**	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**2021-22**	**2022-23**	**2023-24**	**2024-25**	**2025-26**	**Total**	**Post 2026**	**Post 2026 Total**
E. of Ladywood Rd, Lane End			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Wilmington Hall			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Milk Depot, Watling St			0	0	0	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25		25
			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Crossways			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Crossways			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Crossways			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Crossways			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Crossways			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Crossways			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Crossways			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Crossways			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Thames Europort/Johnsons Wharf			0	0	0	0	0	47	188	188	188	188	0	0	0	0	0	0	0	0	0	799		799
St Mary's Road, adj Crossways			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
St Mary's Road, adj Crossways			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
St Mary's Road, adj Crossways			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Stone House Hospital			0	0	0	94	122	94	0	0	0	0	0	0	0	0	0	0	0	0	0	310		310
Former Fantaseas site			0	0	0	0	47	71	47	0	0	0	0	0	0	0	0	0	0	0	0	165		165
West of Archery House			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
St. Mary's Rd, Crossways			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Plantation Cottage, Hedge Place Road			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Waterstone Park			150	119	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	270		270
St Clements Valley (Stone Castle)			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Kestner (Asda) (finished)			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Watling Street			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Bow Arrow Lane			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Bluewater			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Bluewater			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Darent Valley Hospital (finished)			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Darenth Valley Hospital			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Stone			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
TA Stone Place Road			0	24	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36		36
Church Hill, Stone			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Tylers House, Dartford			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Stone Lodge, Dartford			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Charles Street			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Salisbury Road			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
St James Lane Pit			0	0	0	0	188	188	188	141	0	0	0	0	0	0	0	0	0	0	0	705		705
225 London Road, Stone			0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8		8
Unigate Dairy, Lingfield Rd, Stone			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
125, 129 London Road			0	0	0	0	0	18	0	0	0	0	0	0	0	0	0	0	0	0	0	18		18
			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Ingress Park			78	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	78		78
Ingress Park			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Ingress Park			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Ingress Park			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Ingress Park			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Station Road, Greenhithe			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Greenhithe Village			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Bendigo Wharf, Greenhithe Finished			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Greenhithe Riverside			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Craylands Lane			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
W of Craylands Ln, S London Rd			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Knockhall			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Cobham Terrace, Greenhithe			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
East of Craylands Lane			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Douglas Bros, Craylands Lane			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Swan Valley School Phase 2			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Swanscombe Peninsula West			0	94	94	94	94	94	94	0	0	0	0	0	0	0	0	0	0	0	0	564		564
Swanscombe Peninsula West			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
126 Stanhope Road			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Ingress Vale Church, Knockhall Road			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Knockhall Rd reservoir			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
33 Bean Road			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025			
Site name	**2005-06**	**2006-07**	**2007-08**	**2008-09**	**2009-10**	**2010-11**	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**2021-22**	**2022-23**	**2023-24**	**2024-25**	**2025-26**	**Total**	**Post 2026**	**Post 2026 Total**
34-40 Station Rd, Greenhithe			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
Korsnas, Galley Hill Road			140	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	140		140
Everards			113	86	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	198		198
Mounts Court, Greenhithe			0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13		13
			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Eastern Quarry			0	0	188	329	329	329	329	329	329	329	329	329	329	329	329	329	329	329	329	5452	450	5902
Northfleet West Sub Station			0	0	0	94	188	188	188	188	188	188	188	0	0	0	0	0	0	0	0	1410		1410
Ebbsfleet - SQS & SQS			0	103	56	85	94	94	94	94	160	160	160	160	160	85	0	0	0	0	0	1504		1504
CTRL Domestic																						0		0
CTRL International																						0		0
Springhead									40	52												92		92
Springhead			3	50	75	75	75	75	35													388		388
Northfleet Rise									75	75	75	75	75	89								464		464
Northfleet Rise																						0		0
																						0		0
Ebbsfleet Valley	0	0	3	153	319	583	686	686	761	738	752	752	752	578	489	414	329	329	329	329	329	9310		9310
Ebbsfleet Valley - Dartford	0	0	0	103	244	508	611	611	611	611	677	677	677	489	489	414	329	329	329	329	329	8366		8366
Ebbsfleet Valley - Gravesend	0	0	3	50	75	75	75	75	150	127	75	75	75	89	0	0	0	0	0	0	0	944		944
																						0		0
																						0		0
Northfleet Embankment West						50	50	50	50	50	50	50	50	50	50							500		500
Northfleet Embankment West												50	50	50	50	50	50	50	50	50	50	500		500
Northfleet Industrial																						0		0
Net = 0																						0		0
N'fleet Emb. N of Crete Rd					75	75	75	75	75	75	75	75	75	75	75	75	75	25				1000		1000
N'fleet Emb. S of Crete Rd							75	75	75	75	75	75	50									500		500
Vineyard Pit																						0		0
Church Path Pit																						0		0
Northfleet Embankment	0	0	0	0	75	125	200	200	200	200	200	250	225	175	175	125	125	75	50	50	50	2500		2500
																						0		0
																						0		0
Canal Basin Phase 1a		128	222																			350		350
Canal Basin Rest of Phase 1					100	100	100	100	100	100	50											650		650
Canal Basin Phase 2							50	164	164	164	164	164										870		870
																						0		0
Northeast Gravesend	78																					78		78
North East Gravesend				20		.																20		20
North East Gravesend																						0		0
North East Gravesend																						0		0
Norfolk House, Norfolk Road	8																					8		8
Laffan's Yard, Norfolk/Suffolk Rd				15																		15		15
Canal Basin/NE Gravesend	86	128	222	35	100	100	150	264	264	264	214	164	0	0	0	0	0	0	0	0	0	1991		1991
																						0		0
																						0		0
Heritage Quarter W						100	100	23														223		223
Heritage Quarter E					100	100	100	107														407		407
Transport Quarter Rathmore Road						100	24															124		124
Transport Quarter Island Block/Barrack Row							50															50		50
Lord Street				52	100																	152		152
Lord Street		32																				32		32
Parrock Street											254											254		254
Clifton Slipways																						0		0
Stuart Road	38	32																				70		70
Stuart Road						13																13		13
Homemead Car Park	4																					4		4
Commercial Wharf, West Street	65	0	2																			67		67
Sikh Temple, Saddington St, Gravesend																						0		0
Cygnet House, Windmill Street, Gravesend						30																30		30
Police Station, Windmill Street, Gravesend						40																40		40
131/135 High Street					11																	11		11
12/14 High Street /Bank Street				4																		4		4
12/14 High Street /Bank Street			21																			21		21
17 High Street			5																			5		5

Site name	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	Total	Post 2026	Post 2026 Total
60-61 High Street	11																					11		11
19/21 Queen Street				7																		7		7
Rear 29/21 Queen Street				10																		10		10
27 Harmer Street				6																		6		6
28 Harmer Street			5																			5		5
31 Harmer Street				7																		7		7
38-46 Harmer Street				14																		14		14
5 Overcliffe / St James's Street	20																					20		20
St Johns Hall, Windmill Street						20																20		20
68 & 69 Windmill Street	4																					4		4
60/61 Windmill Street/South Street			5																			5		5
60/61 Windmill Street/South Street			2																			2		2
Milton Hall, 62 Windmill Street		4	3																			7		7
95 Windmill Street (garages at rear)						12																12		12
120-121 Windmill Street	8																					8		8
115-117 Wrotham Road, Gravesend				14																		14		14
119-131 Wrotham Road	24																					24		24
178-182 Parrock Street				12																		12		12
Adj 2 Alanbrooke				5																		5		5
Pier Hotel - 4/5 Town Pier Sq.				7																		7		7
55-58 High Street/ Pirncess Street			20																			20		20
Clifton Slipways, West Street				82																		82		82
15 The Grove			6																			6		6
Gravesend Town Centre	174	68	69	220	211	415	274	130	0	0	254	0	0	0	0	0	0	0	0	0	0	1815		1815
																						0		0
																						0		0
Brookvale																						0		0
8 Lennox Road			8																			8		8
Cliffords, Vale Road, Northfleet						5																5		5
Adj Tudor Close			6																			6		6
Detling Road, Northfleet						14																14		14
Campbell Road Pit				59																		59		59
Vale Road						40																40		40
South of Dover Road				50	24																	74		74
Northfleet Bus Garage						36																36		36
Glebe Road Garage, Gravesend					13																	13		13
1 & 2 London Road			24																			24		24
5 London Road			6																			6		6
Fox & Hounds, 26-27 London Road				7																		7		7
Warwick Place Garage Courts	18																					18		18
Janita Fashiions, Burch Road						47																47		47
Bedford Road depot						10																10		10
All Saints Road						6																6		6
Landsdowne Square		17																				17		17
18 Dashwood Road				7																		7		7
Cooper Road (Community Centre)			15																			15		15
New House Lane/Lawrence Square			20																			20		20
3-4 Pier Road			6																			6		6
Northfleet South	18	17	85	123	37	158	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	438		438
																						0		0
																						0		0
Depot, 29 Rochester Road						8																8		8
Southfields School				23	50	50	10															133		133
Southfields School			50	27																		77		77
Christianfields redevelopment			10	25																		35		35
Christianfields redevelopment				13	26	26	26	26	26	26	15											184		184
426 gross 167 loss																						0		0
74 Darnley Road		12																				12		12
70 Parrock Street			9																			9		9
96 Parrock Street				7																		7		7
Glen View, Leith Park Rd, Parrock Rd			57																			57		57
3 Albion Road			6																			6		6
Five Ash Works, Dover Rd E, Gravesend		12																				12		12
Valley Drive Service Station						10																10		10
98-99 Windmill Street				11																		11		11

Site name	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	Total	Post 2026	Post 2026 Total
16 Whinfield Way			10																			10		10
Denton Retreat						8																8		8
Sun Lane Garage, 121 Sun Lane		6	5																			11		11
Hillside Avenue					5																	5		5
1-2 East Milton Road (Prince of Orange)				17																		17		17
58-60 Wrotham Road				22																		22		22
140-143 Milton Road			24																			24		24
146 Milton Road			5																			5		5
Gravesend Grammar School for Boys					8																	8		8
																						0		0
Gravesend South	0	30	176	145	89	102	36	26	26	26	15	0	0	0	0	0	0	0	0	0	0	671		671
																						0		0
CTRL Maintenance Depot, Marling Cross																						0		0
Jeskyns Farm, Cobham																						0		0
(car park north end of Henhurst Road)																						0		0
Meopham Service Sta, Meopham	11																					11		11
N of Evenden Rd, Meopham	10																					10		10
Rhodanthe & Land Adj, Watling Street, Three Crutches																						0		0
Faincroft,Sole Street			5																			5		5
School Lane, Higham			9																			9		9
Harvel Works, Harvel			6																			6		6
Land East of Conifer Drive				5																		5		5
Ifield Farm, Shorne				5																		5		5
																						0		0
Gravesend Rural	21	0	20	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	51		51

2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	Total	Post 2026	
0	0	818	749	708	1,104	1,836	1,771	1,672	1,335	1,130	865	677	489	489	414	329	329	329	329	329	15700		0
0	0	818	749	708	1,104	1,836	1,771	1,672	1,335	1,130	865	677	489	489	414	329	329	329	329	329	15,700		
0	0	818	749	708	1,104	1,836	1,771	1,672	1,335	1,130	865	677	489	489	414	329	329	329	329	329	15700		
1	243	575	583	587	975	735	695	640	617	758	489	300	264	175	125	125	75	50	50	50	8112		
	62	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	537		
1	305	600	608	612	1,000	760	720	665	642	783	514	325	289	200	150	150	100	75	75	75	8,649		
												73	73	73	73	72	72	72	72	72			
	305	600	608	612	1,000	760	720	665	642	783	514	398	362	273	223	222	172	147	147	147	9300		
0	305	1417.8	1357.2	1319.8	2103.6	2595.8	2491	2337.3	1976.8	1912.9	1378.8	1074.8	851	762	637	551	501	476	476	476	25000		

Table 4.2 Floorspace Development Completion Projection

Gravesham

Site Use	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	Total
A1	2458	-824	328	3296	500	1000	745	19220	1193	745	1193	0	0	0	0	0	0	0	0	0	0	24554
A3	0	0	0	0	0	1205	0	893	0	0	0	0	0	0	0	0	0	0	0	0	0	2098
B1	0	1373	1056	10271	2500	9560	7560	16260	10000	19374	19374	19024	9377	0	0	0	0	0	0	0	0	125829
B1a	0	0	0	0	0	26000	26000	9374	9374	9374	9377	0	0	0	0	0	0	0	0	0	0	87499
B1c	0	0	0	0	0	0	0	0	0	3754	0	0	0	0	0	0	0	0	0	0	0	3754
B2	0	-3129	0	1013	0	2600	0	1666	10000	10000	14598	0	0	0	0	0	0	0	0	0	0	36748
B8	0	294	0	7261	0	0	2900	0	5420	0	0	0	0	0	0	0	0	0	0	0	0	15875
C1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D2	0	521	0	0	500	0	600	2300	867	600	867	0	0	0	0	0	0	0	0	0	0	6255
D1,D2 & D	0	0	0	0	0	2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2000
Sui Generi	0	0	10000	-431	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9569
Support/co	0	0	0	0	2040	0	0	0	8672	0	8672	0	0	0	0	0	0	0	0	0	0	19384
C1 (Beds)	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20
D2 (Beds)																						0
1 FE	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3
2 FE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	2458	-1745	11384	21410	5641	41365	36806	44413	45526	43848	54081	19024	9377	0	0	0	0	0	0	0	0	339565

Dartford

Site Use	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	Total
A1	493	0	929	827	16041	-4499	16300	800	19800	16300	850	300	300	0	0	0	0	0	0	300	0	68741
A3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B1	0	155	0	815	11000	42500	56500	56500	64000	68500	46873	28000	20500	25500	28000	28000	25500	18000	15500	10500	5500	551843
B1a	0	11702	360	21837	1248	0	14958	23211	19838	0	0	0	0	0	0	0	0	0	0	0	0	93154
B1c	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B2	0	231	0	1464	9003	0	7800	500	7800	500	500	500	500	500	500	500	500	500	500	500	500	32798
B8	0	73497	0	6856	42100	32089	500	1250	2500	1250	500	500	500	500	500	500	500	500	500	500	500	165552
C1	0	0	0	0	0	0	5000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5000
D1	0	0	0	0	0	870	52500	0	0	0	0	0	0	25000	0	0	0	0	0	0	12500	90870
D2	0	0	0	0	8250	8250	8750	0	16500	12000	0	0	0	0	0	0	0	0	0	0	0	52750
D1,D2 & D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sui Generi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Support/co	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C1 (Beds)	0	0	0	0	0	0	159	0	0	0	0	0	0	0	0	0	0	0	0	0	0	159
D2 (Beds)	0	0	0	0	0	0	800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	800
1 FE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2 FE	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2
Total	493	85585	1289	31809	87642	79211	163267	82261	129439	98550	48723	29300	21800	51500	29000	29000	26500	19000	16500	11800	19000	1060708

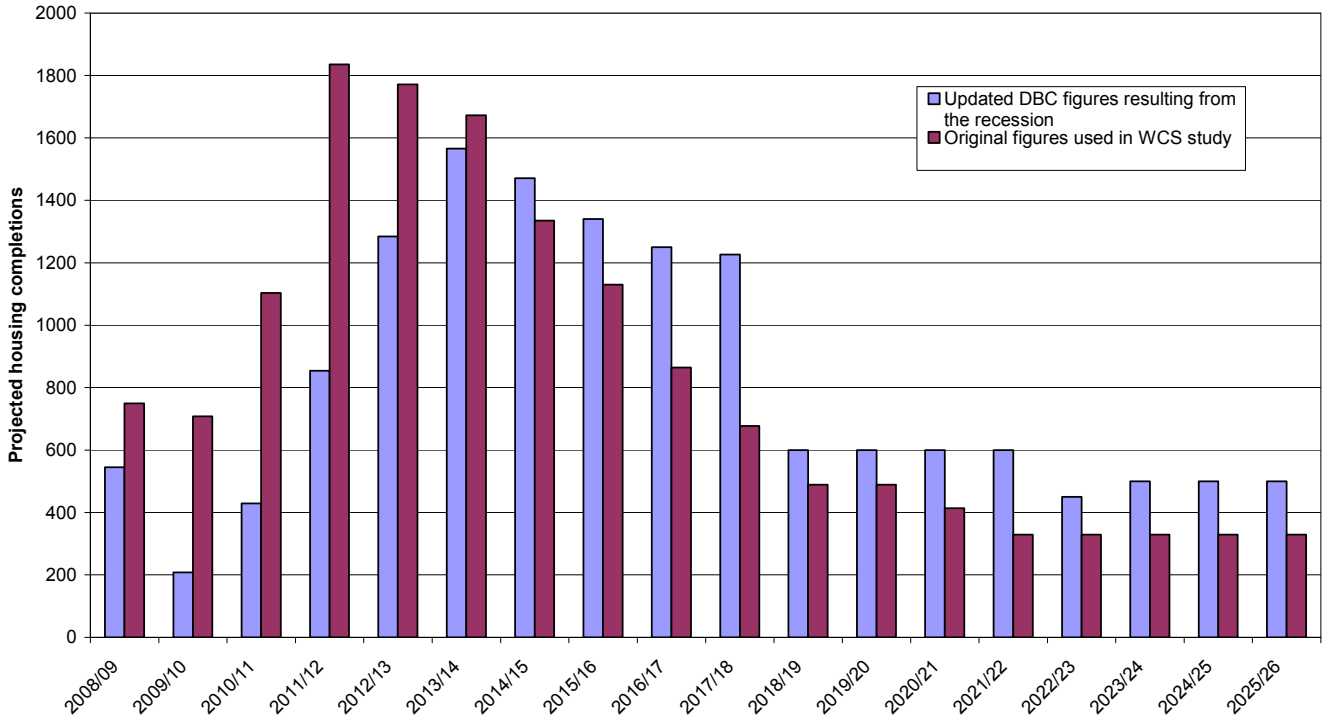
From data received from the Councils in April 2008

Entec

Creating the environment for business

Appendix B
Dartford Borough Revised Housing Trajectory

Implications of the latest trajectory for the draft South East Plan housing figures for the Borough



The above figure provides a comparison of the phasing of the latest housing growth projections for Dartford Borough (Detailed Trajectory 09 08 Vers 3.xls) against the growth figures used in the phase 1 outline Water Cycle Study. Overall the total projected deliverable housing figures remain fairly consistent 15875 versus 15700, respectively. The above figure clearly illustrates that the phasing of the latest growth projections is lower than the figures used in the WCS, in some cases by a significant margin, until the last year of AMP5 (i.e. 2014). Water company investment planning is conducted in the 5 year (AMP) cycles and Thames Water and Southern Water have both provided assurances that they have made adequate provision for growth (based on the original figures) within their draft business plan for the AMP5 period. Unfortunately due to commercial confidentiality, capacity/headroom data and a detailed description of the analysis undertaken as part of the periodic review process was not made available to this study which precludes a detailed quantitative assessment. However, Thames Water have provided assurances that they can accommodate the projected growth based on the higher figures and assumptions used in the study. They have also been provided with the opportunity to comment of the draft outline Water Cycle Study. Therefore the comparison of the phasing of housing completions across Dartford Borough

indicates that the revised trajectory is unlikely to impose any additional restrictions.

This borough level assessment considers the existing or planned treatment/hydraulic capacity of Longreach WwTW and not the capacity of the surface or foul water drainage networks. These more location specific issues require detailed data regarding the capacity of the drainage network, which unfortunately was not made available to this study. However, the attached spreadsheet illustrates that using the site name we have been able to link all but 12 of the 50 Deliverable and Developable Sites to those used in the original analysis. We have also identified the difference in total housing projection and highlighted those (in red) that exceed 100 where locational issues should investigated further in the phase 2 "detailed" water cycle study. Provision of both data sets with a common site reference or as GIS layers would improve the confidence in this linkage and facilitate this assessment by enabling this data to be overlaid on to key asset information (i.e. the location of overflows and pumping stations). However, in the absence of any detailed data on the capacity of key water company infrastructure assets this would still be limited to a qualitative assessment.

Should a decision be made by the LPAs to conduct a Phase II study, it will be important that the most recent housing projection data forms the basis of any further work and that location specific/network issues are considered in detail, particularly associated with the larger developments with high completion rates during the first years of construction. Where a significant increase in network capacity is required, it is unlikely that it will not be possible to connect larger developments to the existing sewer network. Instead wastewaters will have to be conveyed directly to the nearest WwTW. The location of the larger development sites and their proximity to the nearest WwTW, together with the logistical issues associated with laying new sewer mains, particularly across urban areas, will influence phasing restrictions on growth in the Borough, particularly where complex/ambitious engineering solutions or further environmental impact assessments are required.

Extract from attached spreadsheet illustrating increase in housing projections where link determined.

Area	Site Ref	Deliverable and Developable Sites Sites within Priority Areas	TOTAL 2008 to 2026	Increase on figure used in Phase 1 WSC
Major sites north of A2	1	Ebbsfleet	1800	296
Major sites north of A2	2	The Bridge (balance)	1250	-160
Major sites north of A2	3	Ingress Park(balance)	126	48
Major sites north of A2	4	Waterstone Pk (balance)	147	-123
Infill sites in urban area (under 200)	7	Craylands Lane	110	110
Infill sites in urban area (under 200)	12	Myrtle Road	9	1
Infill sites in urban area (under 200)	16	Powder Mill Lane	50	7
Infill sites in urban area (under 200)	20	Knockhall Road	49	49
Town centre	23	77 - 83 Hythe Street	8	-3
Infill sites in urban area (under 200)	26	TA Centre, Stone	37	1
Infill sites in urban area (under 200)	29	The Coleburt Centre, King Edward Ave	53	29
Town centre	31	389-397 Princes Road, Dartford	32	0
Town centre	32	Lowfield Street	926	-14
Town centre	34	NG East (GSK)	320	188
Town centre	35	Millpond	390	235
Town centre	36	Station Approach	200	153
Town centre	37	Overy Street	160	33
Town centre	38	Co-op site	176	11
Major sites north of A2	40	Swanscombe Pen. West Riverfront	350	-214
Major sites north of A2	42	Everards	211	13
Infill sites in urban area (under 200)	43	West Hill Hospital (balance)	52	-142
Infill sites in urban area (under 200)	44	Fantaseas	175	10
Major sites north of A2	45	Eastern Quarry (EQ2)	4000	-1452
Infill sites in urban area (under 200)	46	Stone House Hospital	330	20
Infill sites in urban area (under 200)	47	Dartford Technology College Campus	91	5
Major sites north of A2	48	St James Lane Pit (Stone Pit 2)	1000	295
Infill sites in urban area (under 200)	49	Darenth Mill, Darenth Road	20	0
Dartford Rural	57	Axton Chase	149	9
Town centre	59	1-7 Suffolk Road	11	1
Town centre	60	Spring Vale	26	2
Infill sites in urban area (under 200)	61	FinnFitness, Burnham Road	24	11
Infill sites in urban area (under 200)	65	Mounts Court	14	1
Infill sites in urban area (under 200)	84	Bellgrove Ceramics	51	3
Town centre	85	Police Station - Instone Road	67	20
Major sites north of A2	91	Northfleet West Sub Station Site	1500	90
Infill sites in urban area (under 200)	112	Milk Depot, Watling Street	27	2
Town centre	114	NG East (RBT)	130	3
Infill sites in urban area (under 200)	128	Darenth Road	70	0
Infill sites in urban area (under 200)	297	Adj 116 Priory Road	5	0

In the absence of any common site reference links have been determined base on site name.

A comparison of schedules with a common site reference would facilitate a more robust comparison of housing growth trajectories.

Appendix C
Environmental Quality Standards

Dissolved Oxygen

A series of dissolved oxygen standards have been developed for the estuary to ensure that the river supports sustainable fisheries. The standards are composite, and include a duration and return period for each oxygen concentration:

Table C.1 Environment Agency Dissolved Oxygen Standards for the Tideway

Dissolved Oxygen (mg/l)	Return Period (years)	Duration (tide)
4	1	29
3	3	3
2	5	1
1.5	10	1

Note: The objectives apply to any continuous length of river >=3km. Duration means that the DO must not fall below the limit for more than the stated number of tides. A tide is a single ebb or flood. Compliance will be assessed using the network of automatic quality monitoring stations. (Source Thames Tideway Strategic Study, 2004)

Current levels of dissolved oxygen occasionally do not meet these standards.

Nutrients

The nutrient status of the Thames Estuary is assessed for the purposes of Sensitive Area designation under the (UWWTD). Sewage Treatment Works discharging to waters that are hypernutrified, and where there is evidence of adverse environmental effects as a result of eutrophication, are required to carry out nutrient removal from their effluent. The Thames is hypernutrified but there is little evidence of ecological damage. A recent review of Sensitive Area designation has not resulted in further proposed designations.

Faecal Indicator Organisms

Bathing Waters

The current Bathing Water Directive (cBWD), 76/160/EEC, came into force 30 years ago to help protect public health and the environment from faecal pollution at popular bathing waters. The cBWD has recently been updated and simplified by the revised Bathing Water Directive (rBWD), 2006/7/EC, which came into force on 24 March 2006. The rBWD takes a new approach to assessing water quality, using fewer but more stringent standards than at

present. It sets 4 new standards of water quality ('excellent', 'good', 'sufficient' and 'poor') and all bathing waters are to achieve at least the "sufficient" classification by the end of 2015 (with limited exceptions). Nine Bathing Waters associated with the Thames Estuary have been identified (see Figure 5.1 and Table C.2).

Defra (2007) assessed the anticipated 'at risk bathing waters' which according to the monitored data used in the assessment (2003 – 2006) are at risk of dropping down a class under the rBWD. None of the nine Bathing Waters are considered at risk (>25% chance of failing) of dropping a class under the rBWD.

Table C.2 Bathing Waters present in the Thames Estuary, compliance for 2006 and classifications predicted under the revised Directive (Defra, 2007).

Reference	Bathing Waters Name	Region and Area Name	Bathing Waters Type	Sampling Point Grid Reference	Compliance level for 2006	Classifications predicted under revised Directive (Defra 2007)*
Contents						
11950	Sheerness	Southern	Coastal	TQ92507500	Guideline	Excellent
11904	Leigh Bell Wharf	Thames	Estuarine	TQ84058557	imperative	Good
11902	Southend Chalkwell	Thames	Estuarine	TQ85478544	Guideline	Sufficient
11900	Southend Westcliff Bay	Thames	Estuarine	TQ86458525	Guideline	Good
11850	Southend Three Shells	Thames	Estuarine	TQ88208504	Guideline	Good
11830	Southend Jubilee	Thames	Estuarine	TQ89008450	imperative	Good
11800	Southend Thorpe Bay	Thames	Estuarine	TQ91108470	Guideline	Sufficient
11780	Shoeburyness	Thames	Estuarine	TQ92558410	Guideline	Excellent
11770	Shoebury East	Thames	Estuarine	TQ94578515	Guideline	Excellent

* Using 2003 - 2006 data

Shellfish Waters

The Shellfish Directive (79/923/EEC) aims to protect or improve shellfish waters in order to support shellfish life and growth, therefore contributing to the high quality of shellfish products directly edible by man. It sets physical, chemical and microbiological water quality requirements that designated shellfish waters must either comply with ('mandatory' standards) or endeavour to meet ('guideline' standards) in establishing programmes for improvement of designated waters. Four Shellfish Waters have been identified to be considered as part of this study, these are shown in Figure 5.1 and described in Tables C.3.

Table C.3 Identified Shellfish Waters in the Thames Estuary

Reference	Shellfish Water	Region and Area Name	Sampling Point Grid Reference	Species present
Contents				
11950	Southend	Thames	TQ 88850 81300	Cockles (*Cardium edule*), Mussels (*Mytilus edulis*), Pacific Oysters (*Crassostrea gigas*)
11904	Outer Thames	Thames	TR 05360 81900	Cockles (*Cardium edule*) and Mussels (*Mytilus edulis*).
11902	Sheppey	Thames	TQ 99840 75390	Native Oysters (*Ostrea edulis*), Mussels (*Mytilus edulis*), Cockles (*Cardium edule*).
11900	Foulness	Thames	TR0032084320	Cockles (*Cardium edule)*

The quality of commercially harvested shellfish intended for human consumption must comply with the EU Food Hygiene Regulations (852 / 853 / 854), which took effect on 1 January 2006. The regulations set microbiological standards for the flesh quality of shellfish from designated production areas, which are classified as either A, B or C. These standards are set to ensure that shellfish are placed on the market fit for human consumption. The Shellfish production areas identified for assessment as part of this study, these are shown in Figure 5.1 and described in Table C.4.

Table C.4 Identified shellfish production areas in the Thames Estuary

Production Area	Bed Name	Species	Class	Explanatory Note
Thames Estuary	NE Maplin Sands	*C. edule*	A	4
	Mid Maplin Sands	*C. edule*	B	
	Foulness Sands	*C. edule*	A	1
	Leigh Foreshore	*C. edule*	B	
	Leigh Foreshore	*Mytilus* spp.	B	
	Southend Flats	*Mytilus* spp.	B	
	Southend Flats	*C. edule*	B	
	West of Southend Pier	*C. gigas*	B	
	Phoenix	*C. edule*	B - LT	
	Shoebury Island	*C. edule*	B	4
	Scrapsgate	*C. edule*	B - LT	
	Sheppey	*Mytilus* spp.	B - LT	

* 1 Classification is provisional due to insufficient sample results, either in number or period of time covered.
4 Area classified at higher level, although shows marginal compliance

A programme of Pollution Reduction Plans been drawn up by the Environment Agency in accordance with paragraph 6 of The Surface Waters (Shellfish) Directions 1997, for the purposes of giving effect to Article 5 of the Shellfish Waters Directive 79/923/EEC. Article 5 requires the establishment of 'programmes in order to reduce pollution and to ensure that designated waters conform, within six years following designation. The programme shows the state of the catchment with respect to the Shellfish Waters Directive standards. It examines and explains the causes of any failures to meet those standards. The programme describes what actions are being taken to maintain and improve water quality in this catchment, ensure compliance with the mandatory standards of the Shellfish Waters Directive, and endeavour to observe the guideline standards. The pollution production plans for the identified Shellfish Waters show general compliance over the last 7 years. Many failures relate to inefficiencies in sampling frequencies. Remedial actions raised to prevent future failures of standards relate to sewage treatment works and CSOs local to the shellfish water (on the North bank of the Thames Estuary) and often only those that discharge directly into them.

WFD - Dissolved Oxygen

Standards proposed by UKTAG for dissolved oxygen for the WFD vary with salinity because the solubility of oxygen declines with increasing salinity and are all set as annual 5-percentiles. The proposed standards are based on recent studies, for example an upper limit of 7 mg/l will normally satisfy most requirements and that in transitional and coastal waters a dissolved oxygen level of 2 mg/l stresses the majority of fish species.

Table C.5 Draft UKTAG WFD Dissolved oxygen standards for transitional and coastal waters

	Freshwater	Marine	Description
	5-percentile (mg/l)		
High	7	5.7	Protects all life-stages of salmonid fish
Good	5 – 7	4.0 – 5.7	Resident salmonid fish
Moderate	3 – 5	2.4 – 4.0	Protects most life-stages of Non-salmonid adults
Poor	2 – 3	1.6 – 2.4	Resident non-salmonid fish, poor survival of salmonid fish
Bad	2	1.6	No salmonid fish. Marginal survival of resident species

Table C.5 takes no account of the reducing solubility of oxygen as salinity increases. If standards need to be set for particular areas of transitional waters then they should be read from the graph presented by UKTAG which shows the variation of oxygen standards with salinity.

In addition to the 5-percentile standards, in order to protect against more extreme events and the regulation of intermittent discharges UKTAG propose basing standards on the principles of Fundamental Intermittent Standards. These specify return periods for particular thresholds of dissolved oxygen. Fundamental Intermittent Standards would be tailored to meet individual situations such as the Thames Tideway where it is clear that intermittent discharges are likely to cause the biology to fail to meet objectives under the Water Framework Directive.

WFD - Nitrogen

Under the WFD UKTAG proposes that coastal waters be assessed using the winter mean of dissolved inorganic nitrogen. The proposed thresholds for high and good status are based on the thresholds developed for UK assessments made for the OSPAR Convention (OSPAR). The thresholds have been developed by deriving a salinity gradient from the freshwater end, using the River Leven mean dissolved inorganic nitrogen concentration of 42µM as reference for zero salinity, to the salt-water end of a water body (salinity 30 – 34.5). The UKTAG suggests that this mixing curve applies to estuarine and coastal waters in the UK with salinity of 25 and above. It should not be used for rivers or for the upper end of estuaries.

The UKTAG used the salinity gradient to derive thresholds that are "normalised" to a selected standard salinity - 25 for transitional waters, and 32 for coastal waters. Measurements of the winter mean of dissolved inorganic nitrogen should be transformed to the standard salinity using the salinity gradient. For a particular water body the average salinity would used with the graph to read off the appropriate standard. Following scientific principles and post assessment alteration to align WFD thresholds with OSPAR the proposals for Nitrogen for Coastal and transitional waters were made. Extensions to Poor and Bad classes for the WFD have been proposed, however the UKTAG suggests that these are used for guideline purposes to prioritise action and that they should not be used to classify ecological status. This is for the reasons given above: the secondary biological effects should be considered before the final status is declared. They can also be used to help show in general terms whether waters that are worse than good are improving.

Table C.6 Draft UKTAG WFD proposals for nitrogen thresholds in transitional and coastal waters

Area	Salinity	Class Boundaries Dissolved Inorganic Nitrogen (as micromoles per litre)			
		High	Good	Moderate	Poor
Coastal (at salinity 32)	30 – 34.5	12	18	27	40.5
Transitional (at salinity 25)	<30	20	30	45	67.5

The assessment of thresholds of nutrients in transitional waters requires an understanding of how different types of estuaries respond to nutrients. Plant growth depends on a supply of nutrients and light. The susceptibility of waters to nutrient enrichment is controlled by the attenuation of light within the water body, which in turn is controlled partly by the amount of suspended matter in the water column.

UKTAG established nutrient thresholds for three types of water bodies, based on the level of turbidity. The UKTAG linked the established typologies for transitional waters under the Water Framework Directive to the three turbidity related categories, and calculated the maximum concentrations of nutrient which would produce an annual net primary production exceeding the threshold. This relationship is shown in Table C.6

Table C.7 UKTAG WFD proposals for nitrogen in coastal and transitional waters

Area	Salinity	Dissolved Inorganic Nitrogen (µM) Dissolved Inorganic Nitrogen (as micromoles per litre)	
		Winter mean High - Good	Winter mean Good - Moderate
Offshore	>34.5	10	15
Coastal (at salinity 32)	30 – 34.5	12	18
Transitional (at salinity 25)	<30	20	30
If a transitional water fails the Good boundary , look at the turbidity and type …			
Turbidity and type of transitional water (at salinity 25)		Winter mean Good - Moderate	99-percentile
Very turbid, TW1,TW3	<30	30	270
Medium turbidity, TW2, TW4		30	180
Intermediate/Clear, TW5, TW6		30	70

Typologies for the Water Framework Directive: TW1: Partly mixed or stratified, meso or polyhaline, macrotidal, intertidal or shallow subtidal, predominantly sand and mud. TW2: Partly mixed or stratified, meso or polyhaline, mesotidal, intertidal or shallow subtidal, predominantly sand and mud. TW3: Fully mixed, polyhaline, macrotidal, sand or mud substratum, extensive intertidal areas. TW4: Fully mixed, polyhaline, mesotidal, sand or mud substratum, extensive intertidal areas. TW5: Transitional Sea Lochs. TW6: Transitional Lagoons

The thresholds based on winter mean nutrients would be assessed first. These are in the top half of Table C.7. If these are met the status of the water body is at least good. If the threshold for good status is exceeded for a transitional water, then the turbidity related value is brought in and the water body downgraded to moderate only if this too is failed.

Appendix D
Planning Context

The Planning and Compulsory Purchase Act 2004 came into force from September 2004. This Act amended the Town and Country Planning Act 1990 and, in part, introduced new legislation including a new statutory policy framework for planning. Under Section 38 of The 2004 Act, the determination of planning applications must now be in accordance with the approved development plan unless material considerations indicate otherwise. Other changes to the 1990 Act included the replacement of Regional Planning Guidance with new statutory Regional Spatial Strategies (RSS), the abolition of Structure Plans and the replacement of Local Plans with spatially orientated Local Development Frameworks (LDF). Whilst the Development Plan Documents which make up the LDFs are being prepared interim arrangements exist whereby certain Structure and Local Plan policies will continue to apply provided that upon Direction of the Secretary of State they were saved before 27th September 2007[28]. New statements of government planning policy (PPS) have, and are, being prepared to replace Planning Policy Guidance notes (PPG) and to provide an up to date national planning policy framework.

Current and emerging planning policies relevant to water management, infrastructure and flood risk are outlined for this provides the framework under which the Local Authorities are obliged to deliver growth.

National Policy

PPS 1 – Delivering Sustainable Development

Planning Policy Statement 1 (PPS1) was published in January 2005 and sets out the Government's overarching planning policies on the delivery of sustainable development through the planning system. The policies set out in the PPS need to be taken into account by regional planning bodies in the preparation of regional spatial strategies and by local planning authorities in the preparation of local development documents. The Government considers Sustainable development is the core principle underpinning planning and in its objectives for the planning system reiterates the four aims set out in its 1999 strategy[29]. These are:

- *social progress which recognises the needs of everyone;*
- *effective protection of the environment;*
- *the prudent use of natural resources; and,*

[28] Paragraph 1(3) of Schedule 8 to the Planning and Compulsory Purchase Act 2004

[29] A Better Quality of Life - A Strategy for Sustainable Development for the UK 1999

- *the maintenance of high and stable levels of economic growth and employment.*

National policies and regional and local development plans are seen as providing the framework for planning for sustainable development and ensuring development is effectively managed. The PPS advises that amongst the key principles to ensure development plans and decisions taken on planning applications contribute to the delivery of sustainable development is the adoption of an integrated approach. Regional planning bodies and local planning authorities should ensure that development plans promote outcomes in which environmental, economic and social objectives are achieved together over time and contribute to global sustainability by addressing the causes and potential impacts of climate[30].

It advises that in protecting and enhancing the environment planning authorities should seek to enhance the environment as part of development proposals; avoid significant adverse impacts and pursue alternative options. Where adverse impacts are unavoidable, planning authorities and developers should consider possible mitigation measures and where these are not possible, compensatory measures may be appropriate[31].

Development plan policies should take account of environmental issues *such as the protection of groundwater from contamination and the potential impact of the environment on proposed developments by avoiding new development in areas at risk of flooding and sea-level rise, and as far as possible, by accommodating natural hazards and the impacts of climate change*[32]. The policies should also minimise the consumption of new resources by making more efficient use or reuse of existing resources. The PPS advises that Regional planning authorities and local authorities should promote amongst other things the sustainable use of water resources and the use of sustainable drainage systems in the management of run-off[33].

In delivering sustainable economic development the Government advises that Planning authorities should r*ecognise the wider benefits of economic development and consider these alongside adverse local impacts, ensure that suitable locations are available for developments, actively promote and facilitate good quality development, which is sustainable and consistent with their plans, ensure the provision of sufficient, good quality, new homes in suitable location, ensure that infrastructure and services are provided to support new and existing economic development and housing and ensure that development plans take account of the regional economic strategies of Regional Development Agencies, regional housing strategies, local authority community strategies and local economic strategies*[34]. Sufficient land of a suitable quality in appropriate locations needs to be brought forward to meet the expected needs taking into account issues such as *the need to avoid flood risk and other natural hazard* and *to address the management of pollution and natural hazards, the safeguarding of natural resources, and the minimisation of impacts from the management and use of resource*[35]*s*.

[30] Paragraph 13 of PPS 1
[31] Paragraph 19 of PPS 1
[32] Paragraph 20 of PPS 1
[33] Paragraph 22 of PPS 1
[34] Paragraph 23 of PPS 1
[35] Paragraph 27 of PPS 1

The supplement to PPS1: *Planning and Climate Change* published in December 2007 seeks to set out how planning should contribute to reducing carbon emissions and stabilising climate change.

PPS 25 – Development and Flood Risk

Planning Policy Statement 25 (PPS 25) was published in December 2006. Its aims are to ensure that flood risk is taken into account in the planning process to avoid inappropriate development in areas at risk of flooding and to direct development away from areas at highest risk. Where, in exceptional circumstances, new development is necessary in such areas then the aim is to make it safe without increasing flood risk elsewhere and, where possible, to reduce flood risk overall[36].

Regional planning bodies (RPBs) and local planning authorities (LPAs) are advised that they should prepare and implement planning strategies that assist in delivering sustainable development by appraising the risk, managing the risk and reducing the risk. In so doing they should specifically:

- *identify land at risk and the degree of risk of flooding from river, sea and other*
- *sources in their areas;*
- *prepare Regional Flood Risk Appraisals (RFRAs) or Strategic Flood Risk Assessments (SFRAs) as appropriate, as freestanding assessments that contribute to the Sustainability Appraisal3 of their plans;*
- *frame policies for the location of development which avoid flood risk to people and*
- *property where possible, and manage any residual risk, taking account of the impacts of climate change;*
- *only permit development in areas of flood risk when there are no reasonably*
- *available sites in areas of lower flood risk and benefits of the development outweigh the risks from flooding;*
- *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*

[36] Paragraph 5 of PPS 25

for flood storage, conveyance and SUDS; re-creating functional floodplain; and setting back defences[37].

RPBs and LPAs are further advised that they should work with the Environment Agency and other stakeholders to make the best use of their expertise and information.

In preparing planning strategies RPBs and LPAs are advised to adopt the following principles:

- *Regional Spatial Strategies (RSSs) include a broad consideration of flood risk from all sources and set out a strategy for managing it. This should be consistent with RFRAs and SFRAs, the policies in this PPS and Shoreline Management Plans, Catchment Flood Management Plans and River Basin Management Plans prepared by the Environment Agency under the Water Framework Directive;*

- *Local Development Documents (LDDs) set out policies for the allocation of sites and the control of development which avoid flood risk to people and property where possible and manage it elsewhere, reflecting the approach to managing flood risk in this PPS and in the RSS for their region;*

- *where climate change is expected to increase flood risk so that some existing development may not be sustainable in the long-term, LPAs should consider whether there are opportunities in the preparation of LDDs to facilitate the relocation of development, including housing4 to more sustainable locations at less risk from flooding;*

- *flood risk should be considered alongside other spatial planning issues such as transport, housing, economic growth, natural resources, regeneration, biodiversity, the historic environment and the management of other hazards. Policies should recognize the positive contribution that avoidance and management of flood risk can make to the development of sustainable communities, including improved local amenities and better overall quality of life. They should be integrated effectively with other strategies of material significance such as Regional Economic Strategies; and*

- *the sustainability appraisal of RSSs and LDDs should incorporate or reflect the RPB's RFRA and the planning authority's SFRA, so as to ensure that the planning strategies for the area support the Government's objectives for development and flood risk set out in this PPS*[38].

In addition, LPAs should in determining planning applications:

- *have regard to the policies in this PPS and, as relevant, in the RSS for their region, as material considerations which may supersede the policies in their existing development plan, when considering planning applications for developments in flood risk areas before that plan can be reviewed to reflect this PPS;*

- *ensure that planning applications are supported by site-specific flood risk assessments (FRAs) as appropriate;*

- *apply the sequential approach at a site level to minimise risk by directing the most vulnerable development to areas of lowest flood risk, matching vulnerability of land use to flood risk;*

[37] Paragraph 6 of PPS 25

[38] Paragraph 7 of PPS 25

- *give priority to the use of SUDS; and*
- *ensure that all new development in flood risk areas is appropriately flood resilient and resistant, including safe access and escape routes where required, and that any residual risk can be safely managed*[39].

The PPS advises that a risk-based approach should be adopted at all levels of planning to avoid adding to the causes or "sources" of flood risk, managing flood "pathways" and reducing the adverse consequences of flooding. It advises that Flood Risk Assessment should be carried out, having regard to climate change, and to inform the application of the sequential approach which is central to the policy statement[40].

Regional Planning Bodies (RPBs) are advised that when developing Regional Spatial Strategies they should apply the sequential approach when establishing locational criteria for regionally significant land uses, including the identification of broad locations. Local planning authorities should apply the sequential approach as part of the identification of land for development in areas at risk of flooding[41]. Similarly the PPS advises LPAs that in allocating land in LDDs for development they should apply the Sequential Test[42] to demonstrate that there are no reasonably available sites in areas with lower probability of flooding that would be appropriate to the type of development or land use proposed[43]. Where there is the risk of flooding then development should be located in Flood Zone1 and, if there is no reasonably available site in Flood Zone 1, Flood Zone 2 and then Flood Zone 3. Within each Flood Zone new development should be directed to sites at the lowest probability of flooding from all sources as indicated by the SFRA[44]. If, following application of the Sequential Test, it is not possible for the development to be located in zones of lower probability of flooding then in appropriate circumstances, the Exception Test[45] can be applied which provides a method of managing flood risk while still allowing necessary development to occur[46].

The PPS advises that the RPB should take flood risk into account *in determining strategic planning considerations in the RSS for its region, including the criteria to be used for selecting and determining broad strategic locations for housing provision and transport infrastructure. Its RFRA should identify the risk to its regionally strategic locations. The RPB should consult the Environment Agency and other operating authorities on flood risk issues when preparing its RSS*[47].
Similarly LPAs should consult the Environment Agency and other relevant bodies *(including adjacent LPAs), when preparing policies in their LDDs on flood risk management and in relation to areas potentially identified as at risk*

[39] Paragraph 8 of PPS 25
[40] Paragraph 9 of PPS 25
[41] Paragraph 15 of PPS 25
[42] Annex D and Table D.1 of PPS 25
[43] Paragraph 16 of PPS 25
[44] Paragraph 17 of PPS 25
[45] Paragraphs D9–D14 of PPS 25
[46] Paragraph 18 of PPS 25
[47] Paragraph 24 of PPS 25

of flooding. Their sustainability appraisals, land allocations and development control policies should all be informed by a SFRA carried out in liaison with the Environment Agency[48].

Regional Spatial Strategy

Regional Planning Guidance for the South East (RPG9) is currently being replaced by the South East Regional Spatial Strategy (The South East Plan) which has been subject to an Examination in Public heard by a Panel of Experts. It will establish the broad development strategy for the region and provide a regional framework within which Local Planning Authorities can prepare their Local Development Frameworks (LDF) for the period to 2026.The Panel has submitted its recommendations to the Government which is expected to issue its proposed alterations and modifications and consult on these changes in the Autumn 2008. It should be noted that since this report was commissioned the Draft South East Plan has been updated (in July 2008) and a number of policies have changed their number and title based on The Secretary of State's Proposed Changes to the South East Plans (these changes are highlighted in the text below).

As well as providing the strategic planning guidance for the Region, the Kent Thames Gateway Sub-Region and the Boroughs of Dartford and Gravesham, the South East Plan will place specific targets on the Boroughs for the delivery of housing and employment growth for the period up to 2026. Policy KTG1 of the draft South East Plan recommended that the housing provision target for the Sub Region is 48,000 dwellings, the vast majority of which will be located in Kent Thameside area. In response the Panel considers that the housing provision target for the Sub Region be increased to 49,000 but that the individual targets for the Boroughs of Dartford and Gravesham remain unchanged at, respectively, 15,700 and 9,300. It also recommends that the employment target for the Sub-Region remains unchanged at 58000 jobs. The South East Plan provides the strategic context within which Dartford and Gravesham Councils' will need to produce their Local Development Frameworks and deliver this required growth within Kent Thameside. The Secretary of State has proposed changes to the South East Plan (July 2008) which includes an increase in the number of houses in the Borough of Dartford to 17,340. It should be recognised that this will further increase the demand for water supply and waste water treatment capacity over and above the original housing levels used in the calculations in this study.

Policy KTG9 is specific to the Kent Thames Gateway Sub-Region and relates to flood risk (in the Secretary of State's proposed changes to the South East Plan KTG9 is now KTG6 and the title remains Flood Risk). It states that *in order to accommodate the growth levels proposed in this strategy it will be necessary to implement co-ordinated measures for flood protection and surface water drainage in the Thames, Medway and Swale. Strategic Flood Risk Assessments will be undertaken for each urban area and its major development sites, and reviewed in the light of the Environment Agency's long term plans for flood risk management. Development will be planned to avoid the risk of flooding and will not be permitted if it would:*

i Be subject to an unacceptable risk of flooding or increase the risk elsewhere

ii Prejudice the capacity or integrity of flood plains or flood protection measures.

[48] Paragraph 25 of PPS 25

Local Development Documents will include policies to:

i Adopt a risk based approach to guiding categories of development away from flood risk areas

ii Ensure that development proposals are accompanied by flood risk assessments.

Policy KTG10 refers to green initiatives (in the Secretary of State's proposed changes to the South East Plan KTG10 is now KTG7 and the title remains Green Initiatives) and states that amongst the measures necessary to take forward "Greening the Gateway" in North Kent through the concepts of 'functional green and blue space 'is the co-ordination by the responsible organisations of the development, management and use of the countryside, urban green spaces and areas requiring flood management.

In addition the draft Plan recognises the general importance of addressing all issues relating to water. More specifically sustainable water resources, groundwater and river water quality management in policy NRM1, strategic water resources development and water management in policy NRM2 and sustainable flood risk management in policy NRM3. In the Secretary of State's proposed changes to the South East Plan Policy NRM1 is now restricted to sustainable water resources and groundwater and a new policy NRM2 entitled Water Quality is proposed.

Policy NRM1 relates to sustainable water resources and groundwater. It states *water supply and ground water will be maintained and enhanced through avoiding adverse effects of development on the water environment. A twin-track approach of demand management and water resource development will be pursued. In preparing Local Development Documents, and determining planning applications, local authorities should:*

i Ensure compatibility with River Basin Management Plans and take account of other plans and strategies including water and sewerage company asset management plans, the Environment Agency's Regional Water Resources Strategy, Catchment Abstraction Management Strategies, groundwater vulnerability maps and groundwater source protection zone maps

ii identify any circumstances under which new development will need to be supported by water efficiency standards exceeding extant Buildings Regulations standards

iii Set out the circumstances under which sustainable drainage solutions should be incorporated into new development

iv Encourage winter water storage reservoirs and other sustainable farming practices which reduce summer abstraction, diffuse pollution and runoff, increase flood storage capacity and benefit wildlife and recreation

v Direct new development to areas where adequate water supply can be guaranteed from existing and potential water supply infrastructure. Where this is not possible, development should be phased so that sustainable new capacity can be provided ahead of new development

Policy NRM2 refers to water quality. *It States that water quality will be maintained and enhanced through avoiding adverse effects of development on the water environment. In preparing Local Developments, and determining planning applications, local authorities should:*

i Take account of water cycle studies, groundwater vulnerability maps and groundwater source protection zone maps prepared by the Environment Agency, and water and water sewerage company asset management plans

ii Ensure that the rate and location of development does not lead to an unacceptable deterioration of water quality, and

iii Not permit development that presents a risk of pollution or where satisfactory pollution prevention measures are not provided in areas of high groundwater vulnerability (in consultation with the Environment Agency and Natural England).

Local authorities will work with water and sewerage companies and the Environment Agency to:

i Identify infrastructure needs, allocate areas and safeguard these for infrastructure development

ii Ensure that adequate wastewater and sewerage capacity is provided to meet planned demand, and

iii Take full account of the cumulative impacts of wastewater discharges on groundwater, inland and marine receiving waters

Local authorities should promote land management initiatives to reduce diffuse agricultural pollution.

Policy NRM3 (formerly NRM2) refers to strategic water resources development; *it states there is a demonstrable need for new water resource schemes and increased demand management over the period of the Plan to cater for water supply needs of current and future development and the protection of the environment. Strategic new water resource options that may be required to be operational over the Plan period include:*

i Upper Thames reservoir by 2019/20

ii Enlargement of Bewl reservoir by 2014/15

iii Broad Oak reservoir by 2019/20

iv Clay Hill reservoir by 2014/15

v Havant Thicket reservoir by 2020/21

Local authorities should work with the water companies and Environment Agency in assisting in the timely delivery of schemes. Local Development Documents should allocate and safeguard sites identified for reservoir

development from other uses. Additional resource schemes, including enlargement of Darwell reservoir, a strategic option in north-west Sussex, together with bulk water transfers, effluent re-use and desalination may also be required. In considering applications for new water resource schemes, consideration should be given to:

i Need at local, sub-regional, regional, and inter-regional scales

ii Presence of alternative options and environmental impact including water efficiency in new and existing properties

iii Potential to deliver social and environmental benefits.

Policy NRM4 (formerly NRM3) relates to sustainable flood risk management. It states *the sequential approach to development in flood risk areas set out in PPG25 (to be superseded by PPS25) will be followed.*
Inappropriate development should not be allocated or permitted in zones 2 and 3 of the floodplain (Map NRM2) or areas with a history of groundwater flooding, or where it would increase flood risk elsewhere, unless there is over-riding need and absence of suitable alternatives. Where development is proposed for parts of zones 2 and 3, local authorities (in the case of plan allocations) and developers (in the case of specific proposals) with advice from the Environment Agency should undertake a Strategic Flood Risk Assessment (SFRA) to provide a comprehensive understanding of the flood risk and options for managing that risk in a cost effective manner. This should have regard to climate change and identify appropriate types of development and suitable mitigation and adaptation measures in scheme design and layout.

Existing flood defences will be protected from development. Where development is permitted in appropriately defended floodplains it must be designed to be resilient to flooding (to minimise potential damage) and to allow for the future maintenance, realignment or management of the defences to be undertaken. In the preparation of Local Development Documents and considering planning application local authorities, in conjunction with the Environment Agency, should also:

i Take account of River Basin Management Plans, Catchment Flood Management Plans and Shoreline Management Plans in developing Local Development Documents and other strategies. Where locationally specific flood risk and land management options such as flood storage, managed realignment and set back from coastal defences are identified, land should be safeguarded for these purposes and appropriate land management practices should be encouraged

ii Require incorporation and management of Sustainable Drainage Systems (SuDS), other water retention and flood storage measures to minimise direct surface run–off, unless there are practical or environmental reasons for not doing so

iii Take account of increased sewage effluent flows on fluvial flood risk.

Policy NRM5 (formerly NRM4) refers to conservation and improvement of biodiversity. It states in the development and implementation of plans and strategies, local authorities and other bodies shall avoid a net loss of biodiversity, and actively pursue opportunities to achieve a net gain across the region by, amongst other thing:

> *v Influencing and applying agri-environment schemes, forestry, flood defence, restoration of mineral extraction sites and other land management practices to deliver biodiversity targets*

Policy NRM8 (formerly NRM6) relates to coastal management: It states *an integrated approach to coastal zone planning and management should be pursued, where the dynamic nature and character of the coast is managed through enhanced collaboration between organisations and across administrative boundaries. In the development and implementation of the Local Development Documents and other strategies, local authorities and other agencies should, amongst other things:*

> *i Take account of climate change and forecast effects on the costal zone*
>
> *ii Promote and establish cross-border and cross-sectoral arrangements to facilitate an integrated approach to implementation of Shoreline Management Plans, Estuary Management Plans and Coastal Habitat Management Plans (ChaMPs)*
>
> *iii Ensure that development does not prejudice options for managed realignment, significantly affect sediment inputs and transport, lead to an increase in flood risk or preclude the delivery of sustainable flood risk management solutions in the future*
>
> *vi Realise opportunities for sustainable coastal defences which enhance the region's wildlife, and fisheries, especially where this will contribute to the achievement of regional and national biodiversity targets.*

Local Development Framework

Until such time as the South East Plan is finalised and the Development Plan Documents (DPD) have been adopted the Kent and Medway Structure Plan 2006 and the Dartford and Gravesham Local Plans will, as far as their saved policies, continue to be the Development Plan for Kent Thameside.

Both Dartford and Gravesham are in the process of preparing their Core Strategy DPDs and these emerging documents are obliged to conform to the Regional Spatial Strategy. As such they are the means by which strategic policy will be transposed to the local level and, when adopted, then they will provide local policy and replace the relevant parts of the Structure and Local Plans. The Core Strategy DPD is the key development plan document which will provide the overarching strategy for policy and development within the Boroughs for the Plan period. Other Local Development Documents will build on this strategy and deliver the detail although within this framework there is a degree of flexibility on how this is done.

Gravesham Core Strategy DPD

The Borough of Gravesham published its Key Issues and Options in a consultation document dated October 2007[49]. It identifies what it considers to be the key issues under the headings of location of new development and managing flood risk (section 12) and, water supply and water quality (section 13). Section 14 relates specifically to key planning issues relevant to Thames Riverside. In addition background information and rationale are provided to support its approach.

The identified key issues relating to the development of LDF policy on the topic of location of new development and managing flood risk are:

- *Achieving the most appropriate balance between the need to prioritise the use of previously developed land to accommodate new development whilst avoiding flood risk and managing it elsewhere.*
- *Ensuring tidal flood defences are maintained to an appropriate level to withstand future flooding and that space is left for flood storage and to both upgrade and maintain defences;*
- *Ensuring that surface water run-off is managed (including fluvial flows in the Ebbsfleet Valley) through sustainable drainage design;*
- *Ensuring that the LDF Core Strategy delivers outputs which are consistent with the objective of managing residual flood risk.*

In terms of the location of new development, the key options are identified as being to:

a. Adopt the PPS25 sequential approach to the release of development land, with brownfield land developed in advance of greenfield sites. This would take into account the need to create a pattern of development that will accommodate and encourage public transport accessibility. The Kent Thameside Strategic Flood Risk Assessment would be used as an important tool, and sites would only be allocated where the level of flood risk is acceptable in relation to the type of development proposed and residual risk can be adequately managed. Ebbsfleet would be developed as a major mixed-use employment/transport hub and brownfield sites on the Thames riverside regenerated to residential/employment/service uses.

b. Prioritise the use of sites demonstrated to be at least risk from flooding in identifying areas for development, irrespective of their previously developed/greenfield status.

c. Seek to produce a new pattern of development, avoiding areas at potential risk of flooding and valued greenfield sites within the urban area, by review of Green Belt boundaries on the urban fringe and around village settlements. All proposals on sites at risk of flooding would be expected to be accompanied by a site-specific Flood Risk Assessment (FRA) at the Development Control stage, detailing compliance with the PPS25 sequential/exception tests and addressing localised flood risk issues/mitigation measures. In terms of flood risk management, it would

[49] Gravesham Borough Council Consultation on Core Strategy Key Issues and Options October 2007

still be necessary to ensure that flood defences are maintained to a high standard, risk of surface water flooding mitigated, and residual flood risk pro-actively managed. Options in relation to maintaining standards of tidal flood protection are constrained by the need to consider design solutions on a catchment wide basis, with design parameters dictated by climate change impact. The approach followed within the LDF Core Strategy will therefore be dictated to a large extent by 'best science', derived from the work of the Intergovernmental Panel on Climate Change (IPCC) and the UK Climate Impacts Programme (UKCIP), as fed through the Thames Estuary 2100 (TE2100) project.

The identified key issues relating to the development of LDF policy on the topic of water supply and water quality are:

- *Additional resources coming on stream in a timely manner;*
- *Whether there are local constraints or impediments to implementation, below the WRZ level;*
- *Whether there is a need to require water savings greater than can be met through changes to Building Regulations/the introduction of the Code for Sustainable Homes to manage demand; and*
- *Whether a case can be made to further manage demand/conserve water resources as a matter of principle, particularly as climate change is likely to have adverse impacts on the wider natural environment.*

The key options are identified as *Do nothing/Minimum Required Under Legislation* and *Pro-active approach with Borough Council as lead player.* In the latter case *policy would seek to achieve a high standard of water efficiency in new development, commensurate with the need to also deliver on other sustainability objectives in relation to the economy, housing and the environment.*

Key issues identified for Thames Riverside relate to the need to accommodate competing demands for riverside land, whilst addressing the constraints imposed by its location. In particular, there is a need to:-

- *Accommodate traditional heavy industrial/commercial uses which are river related;*
- *Release sites to accommodate new mixed-use development;*
- *Take into account the implications of flood risk and the need to maintain/enhance the flood defence;*
- *Improve both the use of the river and public access to the riverside, possibly in connection with the promotion of parts of the Gravesham waterfront as a key boating centre on the Thames;*
- *Improve connectivity along the river front to link development sites; and*
- *Maintain and enhance landscape/townscape/nature conservation/heritage interest.*

In addition the background to this section recognises that land will need to be provided for flood prevention, including hard and soft flood defences, and that, amongst other things, flood risk, including the need to retain/upgrade/repair flood defences, and drainage, including restricted discharge of surface water at certain states of the tide, will act as constraints. These problems may be exacerbated as a result of climate change.

A range of key planning options are separately set out as they relate to a list of character zones that comprise the riverfront and whilst indirectly relevant, these essentially relate to the planning aspects.

Borough of Dartford Preferred Policy Approaches

The Borough of Dartford published its Preferred Policies approach in a document dated July 2006[50]. The section on infrastructure requirements recognises that water supply is a concern; and PPA3 states *the choice of sites for development will be made with reference to the availability of infrastructure capacity to serve them* and PPA74 recognises national planning policy on flood risk.

The Preferred Options were published for consultation in January 2008[51] as a series of approaches and those that are relevant include:

Preferred Approach 1: Selection of Development Sites

The Council's preferred approach is to give preference to development on large strategic previously-developed 3 sites north of the A2 over infill sites and rural sites. This allows new communities to be sustainably planned with the necessary supporting infrastructure. It also provides opportunities to deliver jobs and training, transport infrastructure, community facilities and green spaces from which the existing as well as new communities can benefit.

Preferred Approach 2: Spatial Pattern of Development

The Council's preferred approach is to promote a pattern of development focusing on three key areas:

- Dartford Town Centre - revitalisation of its role as a shopping, entertainment and service centre for the surrounding communities,
- The east-west corridor from Ebbsfleet through to Stone - bringing back into productive use former chalk quarries and integrating existing communities with the new facilities these developments can provide
- The Thames waterfront – bringing life and activity to the riverside through the replacement of underutilised and degraded sites with attractive mixed use development that provides public access to the river.

[50] Dartford's Core Strategy – Preferred Policy Approaches Document July 2006

[51] Dartford's Core Strategy – Preferred Options January 2008

Preferred Option 3: Network of Key Centres

The Council's preferred approach is to encourage the complementary roles of the three key centres, Dartford, Bluewater and Ebbsfleet

Preferred Approach 6: Employment Land

The Council's preferred approach is to use the Draft South East Plan figure as a guide in allocating land for business uses. The main focus of new employment development will be at Ebbsfleet, The Bridge, sites within or close to Dartford Town Centre, as well as part of large mixed use schemes, including Eastern Quarry and Waterstone Park.

Preferred Approach 8: Employment Growth

The Council's preferred approach is to aim for sufficient new jobs to at least match the number of new economically active residents over the Plan period, as well as some allowance to reduce current commuting levels out of the Borough and for jobs that may be taken up by those outside the borough. Two jobs for every home, or approximately 32,000 jobs, is considered to be an appropriate target. With the land supply and mix of jobs identified above, at least this figure is achievable.

Preferred Approach 10: Balanced Housing Development

The Council's preferred approach to the delivery of housing is to take the Draft South East Plan housing target of 15,700 homes as a starting point and test whether this allows for a satisfactory relationship between infrastructure requirements, phasing and delivery. The homes should be

delivered in such a way that provides for balanced growth and leads to patterns of development that are sustainable in the long term. The issues that are critical in these respects are:

- The capacity of the transport network to cope with the growth
- Phasing of water supply and waste water treatment
- Delivery of jobs in tandem with the housing growth

These have been tested against the Draft South East Plan target and demonstrate that it is possible to achieve the target of 15,700 homes by 2026. Beyond this target number, capacity and phasing constraints may result in unbalanced growth, resulting in a negative impact on residents, businesses in the area and the environment.

Preferred Approach 12: Priority Sites for Housing

In allocating housing sites, in accordance with its vision for the area, the Council's preferred approach is to give

priority to:

- Dartford town centre sites – it is critical to the success of the town centre that new housing development moves forward apace with new retail and leisure developments, so that an expanded customer base is bedded in from the outset and helps support the expanded shopping offer in the town centre.

- Major sites north of the A2 –housing on these sites will allow for provision of new facilities of all kinds for the adjoining communities.

- Thames waterfront sites – recreational use and a complementing mix of development including housing, of the riverfront, will bring activity and destination uses to the river. (See also Preferred Approach 2 and paragraphs 2.12 -2.13)

- On the basis of these priorities and the sites with existing planning consent, the strategic sites and combination of sites for housing development (500 units or more) to 2026 are:

  - Ebbsfleet 1,600 units
  - The Bridge 1,500 units
  - Eastern Quarry 5,800 units (further capacity post 2026)
  - Dartford town centre sites 2,000 units
  - Cotton Lane (Fantaseas and Stone House Hospital) 500 units
  - St James lane Pit 750 units
  - Northfleet West Sub-station 1,500 units
  - Swanscombe Peninsula (part) 600 units
  - Thames Europort/Johnsons Wharf 850 units

Preferred Approach 16: Water Supply and Treatment Capacity

The Council will work with the water supply and treatment providers to ensure that new development and water services are co-ordinated. Housing and commercial development will be monitored to ensure that the pace of development does not outstrip the water supply and treatment capacity at any time. A site for a new water reservoir on land to the west of Bean will be allocated in the Plan. The Council will work with Thames Water to ensure that a suitable design for the scheme is agreed and implemented.

Preferred Approach 27: Flood Risk

In identifying land for development, the Council will aim to ensure that the risk from flooding is acceptable in relation to the type of development proposed and that residual risk can be adequately managed. This will be

achieved through Flood Risk Assessments (FRA) of individual sites. The Council recognises that the key actions in keeping flood risk at an acceptable level will come through the implementation of the findings of the Thames Estuary 2100 Project (TE 2100). The Council will engage in the further stages of the study and seek not to foreclose any options through proposals in this Plan. In particular, the Council will safeguard the Dartford Marshes and the Black Duck Marshes from development, in the event that these areas are required to act as water storage areas in extreme flooding events; and ensure that new development does not constrain potential improvements to flood defences which may be recommended by TE 2100. Development itself, can increase the risk of flooding as a result of the loss of permeable surfaces and resulting surface water run off. Sustainable development of the Borough requires that new development does not add further to the risk of flooding. Sustainable Urban Drainage Systems (SUDS) will be a requirement in new developments. The Council requires a generous provision of green space and water in new development (see Preferred Approach 24) in part to ensure that the provision of permeable surfaces and water storage areas can mitigate against the risk of flooding.

Preferred Approach 28: Water Efficiency

The Council's preferred approach is to seek a higher standard for water efficiency than required under the proposed amendments to Building Regulations, where the costs of efficiency measures are proportionate to the benefits achieved. Major sites will be expected to act as exemplars, with highest possible standards of water efficiency achieved. High standards of water efficiency in commercial developments will also be sought. To assist in moving towards 'water neutrality' in the Thames Gateway38, the Council will seek opportunities and funding to offset new demand through fitting existing homes and other buildings with more efficient devices and appliances. The second phase of a Water Cycle Study for the Kent Thameside area will identify water conservation measures which also provide positive benefits for flood mitigation, such as rainwater harvesting. The Council will draw on the results of this study in preparing its final policies.

Timescales

The dates shown in Table 3.2 have been taken from the most recent Local Development Schemes and relate to the Core Strategy DPDs; they are relevant to the production of the WCS which in its interim state will feed into the process.

Table D.1 LDF key Dates

	Issues and Options - consultation	Preferred Options - consultation	Submission to SoS - consultation
Dartford	July 2006	January 2008	September 2008
Gravesham	November/December 2007	February/March 2008	June 2008

Policy Requirements placed on the Local Development Framework

The core strategy is required to set out the long term spatial vision for a Local Authority's area and the strategic policies required to deliver that vision[52]. They are therefore the key documents in the Dartford and Gravesham Local Development Frameworks for both providing the planning policy framework for the Boroughs and, specifically, delivering development in Kent Thameside. The Core Strategies are required to implement policies of the Regional Spatial Strategy and other strategies and it is suggested that there is an obligation for them to address the issue of water management, infrastructure and flood risk, specifically within the context of delivering housing growth.

Both Gravesham and Dartford are in the early stages in the preparation of their LDFs; and their Core Strategies and other Local Development Documents will essentially continue to evolve as part of the information gathering and adoption processes. However they will need to include policies to address the issues of water management, infrastructure and flood risk in these documents and the following table identifies the topics that need to be included and the relationship with national and emerging regional planning policy. It should, however, be noted that there are options as to how this is best achieved.

Table D.2 Local policy relating to water management, infrastructure and flood risk (updated to reflect the Secretary of State's Proposed Changes to the South East Plan, July 2008)

PPS25	RSS	LDF
Identify land at risk and the degree of risk of flooding Prepare Regional Flood Risk Appraisals (RFRAs) or Strategic Flood Risk Assessments (SFRAs)	Local Development Documents will include policies to ensure that development proposals are accompanied by flood risk assessments in KTG (KTG6)	Requirement that development proposals are accompanied by flood risk assessments in line with PPS 25
Policies for the location of development which avoid flood risk where possible, and manage any residual risk, taking account of the impacts of climate change Only permit development in areas of flood risk when there are no reasonably available sites in areas of lower flood risk and benefits of the development outweigh the risks from flooding	Adopt a risk based approach to guiding categories of development away from flood risk areas in KTG (KTG6) Local authorities (in the case of plan allocations) with advice from the Environment Agency should undertake a SFRA to provide a comprehensive understanding of the flood risk and options for managing that risk in a cost effective manner. This should have regard to climate change and identify appropriate types of development and suitable mitigation and adaptation measures in scheme design and layout. Existing flood defences will be protected from development (NRM4).	Avoidance of flood risk and requiring the Sequential Approach to development
Safeguard land from development that is required for current and future flood management	Take account of River Basin Management Plans, Catchment Flood Management Plans and Shoreline Management Plans in developing Local Development Documents and other strategies (NRM4). Ensure compatibility with River Basin Management Plans and take account of other plans and strategies including water company asset	Safeguarding land for flood management and regard given to other Plans and Strategies

[52] Paragraph 2.10 Planning Policy Statement 12: Local Development Frameworks

PPS25	RSS	LDF
	management plans, the Environment Agency's Regional Water Resources Strategy and Catchment Abstraction Management Strategies, groundwater vulnerability maps and groundwater source protection zone maps (NRM1)	
	Facilitate an integrated approach to implementation of Shoreline Management Plans, Estuary Management Plans and Coastal Habitat Management Plans (NRM8)	-
	Ensure that development does not prejudice options for managed realignment (coast)lead to an increase in flood risk or preclude the delivery of sustainable flood risk management solutions in the future (NRM8)	Specific policy on coast including reference to development not prejudicing options for managed realignment leading to increase in flood risk or precluding delivery of sustainable flood risk management solutions in the future (recognising that Dartford Borough does not have a coast)
Reduce flood risk to and from new development through location, layout and design, incorporating sustainable drainage systems (SUDS)	Require incorporation and management of Sustainable Drainage Systems (SuDS), other water retention and flood storage measures to minimise direct surface run–off, unless there are practical or environmental reasons for not doing so (NRM4).	SuDS and other water retention and flood storage measures to minimise direct surface run–off
Use opportunities offered by new development to reduce the causes and impacts of flooding	identify opportunities for flood storage areas to contribute to green infrastructure networks(KTG6)	Flood storage area and associated measures to contribute to green infrastructure networks
Policies for the allocation of sites and the control of development which avoid flood risk to people and property where possible and manage it elsewhere, reflecting the approach to managing flood risk in this PPS and in the RSS for their region	Influencing and applying flood defence and other land management practices to deliver biodiversity targets (NRM5)	-
Where climate change is expected to increase flood risk, LPAs should consider whether there are opportunities in the preparation of LDDs to facilitate the relocation of development, including housing to more sustainable locations at less risk from flooding	Take account of climate change and forecast effects on the costal zone (NRM8)	Re-location of development having regard to effects of climate change
Flood risk should be considered alongside other spatial planning issues.	Co-ordination by the responsible organisations of the development, management and use of areas requiring flood management in KTG (KTG7)	-
The sustainability appraisal of RSSs and LDDs should incorporate or reflect the RPB's RFRA and the planning authority's SFRA, so as to ensure that the planning strategies for the area support the Government's objectives for development and flood risk	-	-
Consult the Environment Agency and other relevant bodies (including adjacent LPAs), when preparing policies in their LDDs on flood risk management and in relation to areas potentially identified as at risk of flooding	-	-

PPS25	RSS	LDF
-	Work with water and sewerage companies and the Environment Agency to identify infrastructure needs, allocate areas and safeguard these for infrastructure development (NRM2)	Infrastructure needs, allocation of areas and safeguarding these for infrastructure development
-	Commitment to working with Government, EA, Ofwat and regional stakeholders to ensure the delivery of water efficiency savings (NRM1 amended)	Working with stakeholders to ensure the delivery of water efficiency savings
-	Ensure that the rate and location of development is in step with current and planned provision of adequate water supply, sewerage and waste water treatment infrastructure capacity (NRM1 amended)	Planned provision of adequate water supply, sewerage and waste water treatment infrastructure capacity.
-	Require development that would use significant quantities of water to incorporate measures to achieve high levels of water efficiency, and reflect current best practice and, where appropriate, sustainable drainage solutions where these are consistent with protection of groundwater quality (NRM1)	Measures to achieve high levels of water efficiency and sustainable drainage solutions where these are consistent with protection of groundwater quality
-	Encourage winter water storage reservoirs and other sustainable farming practices which reduce summer abstraction, diffuse pollution and runoff, increase flood storage capacity and benefit wildlife and recreation(NRM2)	Winter water storage reservoirs and other sustainable farming practices which reduce summer abstraction, diffuse pollution and runoff, increase flood storage capacity and benefit wildlife and recreation
-	Not permit development that presents a risk of pollution or where satisfactory pollution prevention measures are not provided in areas of high groundwater vulnerability (NRM2)	Prevention of water pollution
-	Local Development Documents should allocate and safeguard sites identified for reservoir development from other uses (NRM3)	Safeguarding sites identified for reservoir development, if applicable.
-	Facilitate the delivery of strategic infrastructure (NRM3).	Delivery of strategic infrastructure
-	Take account of increased sewage effluent flows on fluvial flood risk. (NRM4)	Sewage effluent flows and effect on fluvial flood risk.
-	Management of water quality (NRM2)	Water quality

Infrastructure Contributions

The provision of water infrastructure will involve significant costs and there will be an expectation from the Local authorities and stakeholders that developers will contribute towards these costs. Currently Section 106 obligations provide opportunities to secure water infrastructure, or contributions towards such infrastructure on the back of the grant of planning permissions, provided they fulfil the legal tests[53] but, most importantly, are necessary in planning terms. There are options to introduce a tariff arrangement similar to that operated by Milton Keynes Partnership[54] or to operate a tailored approach to individual applications. The Planning Bill currently before Parliament would

[53] Circular 05/2005: Planning Obligations

[54] The Milton Keynes Tariff: English Partnerships and Milton Keynes Partnership

introduce the option for Community Infrastructure Levies (CIL); fixed contributions set by the Local Authorities and based on adopted Infrastructure Plans[55].

However, whatever the approach that is to be adopted, it is necessary that there is an up to date policy base which provides for securing such benefits[56]. It is therefore suggested that policies need to be included within the Core Strategies which allow specifically for the delivery of such benefits with regard to water infrastructure. It is also likely to be appropriate to provide detail within other LDDs both to specify/justify the requirements and to provide guidance in which case a Supplementary Planning Document would appear to be most appropriate.

[55] The Community Infrastructure Levy: Department for Communities and Local Government January 2008

[56] B25 Annex B Circular 05/2005: Planning Obligations

Appendix E
Water Resources

Water Resource availability in Kent Thameside

The Environment Agency has published assessments of water availability within individual catchments in the CAMS documents. The CAMS documents classify water resource availability for surface water and groundwater into the following categories:

- Water available. There is water available within the catchment for abstraction licensing;
- No water available. The water that is present is already fully allocated;
- Over licensed. This means that if abstractors used their full allocation they would have the potential to cause unacceptable environmental impact at low flows. Additional water may be available at high flows with appropriate restrictions; or
- Over abstracted. This means that existing abstraction is causing unacceptable environmental impact at low flows. Additional water may be available at high flows with appropriate restrictions.

There are two CAMS documents that cover the Kent Thameside area. The eastern part of Kent Thameside lies within the Medway CAMS, whilst the western part falls within the Darent and Cray CAMS. In summary, both documents identify that there are little or no further water resources available in these catchments. If development within Kent Thameside requires additional resources to be developed, further storage (reservoirs) or transfers from outside the catchments will be required.

Medway CAMS

The Medway catchment covers an area of 1800 km^2 and is the largest river catchment in Kent. The Medway rises near East Grinstead in West Sussex and flows eastwards through the towns of Tonbridge, Maidstone and into the Medway estuary at Rochester (Environment Agency, 2007b). Kent Thameside lies in the northwest corner of the catchment.

Of water abstracted from the catchment, 60% is taken from surface water whilst the remainder is taken from groundwater sources. Licensed abstraction in the Medway catchment is dominated by public water supply, with 93% of abstraction within the CAMS area being for this purpose. The remainder is abstracted for agriculture (5%), industry (1%) and other uses (1%) (Environment Agency, 2007b).

The catchment is strategically important for public water supply. Two public water supply reservoirs (Bough Beech and Darwell) are located in the upper parts of the catchment, whilst water is transferred out of the catchment to the wider Kent area and into East Sussex. The Medway Scheme is a pumped storage scheme which operates in the catchment. Water is abstracted from the lower reaches of the River Medway at times of higher flows and

pumped to Bewl Reservoir where it is stored. At times of reduced flows in the river, water is released from Bewl to supports abstraction downstream for public water supply purposes. The scheme is operated in a manner that ensures that sufficient flows occur in the river to maintain water and environmental quality. This flow is known as the Minimum Residual Flow or MRF.

Potential for further resource development within the Medway CAMS

The nature of the Medway catchment is such that groundwater and surface water resources have little connectivity, and thus the Environment Agency has assessed the availability of resources for the rivers and groundwater units separately. The assessments for each element are provided in Table E.1 and E.2, but in summary the Medway catchment is at least classified as "no water available", and is in places identified as over licensed and over abstracted.

Table E.1 Medway CAMS surfacewater resource availability status

Surfacewater Assessment Point	Name	Classification
Chafford upper	River Medway	No water available at low flows
Penshurst	River Eden	Over licensed at low flows
Hadlow	River Bourne	Over licensed at low flows
Stonebridge upper	River Teise	Over licensed at low flows
Stilebridge	River Beult	No water available at low flows
Teston	River Medway	Over licensed at low flows
Lenside	River Len	No water available at low flows
Allington	River Medway	Over licensed at low flows

Based on the information presented in Table 2.6a (Environment Agency, 2007b)

Table E.2 Medway CAMS groundwater resource availability status

Groundwater Management Unit	Status
Western Chalk	Over licensed at low flows
Eastern Chalk	Over Licensed at low flows
Western Lower Greensand	Over abstracted at low flows
Eastern Lower Greensand	Over Licensed at low flows
Hastings Beds	No water available at low flows

The licensing strategy of the Environment Agency as set out in the CAMS document is that it will seek to secure downward variations to abstraction licences under its existing powers when abstraction licences are renewed.

The Habitats Directive and the Water Framework Directive and the Environment Agency's Restoration of

Sustainable Abstraction (RSAP) programmes have the potential to impact on water abstractions across the country. Where it can be demonstrated that abstractions are having a detrimental impact upon the environment then the Environment Agency will seek to reduce abstractions at those sites.

Discussions with the Environment Agency have revealed that there are no licences currently at risk in the Medway CAMS area. An investigation was recently undertaken by the Environment Agency to determine whether the abstractions on the River Medway were having a detrimental impact on the European-designated Medway Marshes Special Area of Conservation, Special Protection Area and Ramsar Site. The study concluded that there was no impact of the abstraction on the site, and therefore no reductions in abstraction were identified. However, the CAMS document has identified that the Minimum Residual Flow on the River Medway may need to be reviewed in the future. This could reduce the amount of water available from the River Medway for public water supply purposes.

The assessment within the CAMS document and the Environment Agency strategy to secure a reduction in abstraction in the catchment where possible shows that the scope for further resource development within the Kent Medway catchment is therefore limited. The CAMS document identifies that to meet future demand it is likely that additional water storage (for example increasing the capacity of storage reservoirs such as Bewl Water) or the provision of additional water transfers will be required.

Darent and Cray CAMS

The Darent catchment, including its largest tributary the River Cray, covers an area of 423 km^2 (Environment Agency, 2007c). The River Darent rises in the Surrey Hills at Westerham and flows eastwards to Sevenoaks. From Sevenoaks the Darent flows north through Otford, Eynsfors and enters the tidal River Thames at Dartford. The main tributary of the River Darent is the River Cray, which rises in the west of the Darent and Cray CAMS area within Orpington. The Cray flows north to Bexleyheath and Crayford and merges with the Darent at a point downstream of the tidal limit. The Darent and Cray is split into four water resources management units of which, the Kent Thameside lies within the New Ash Green and Dartford WRMU.

Water abstraction within the Darent and Cray CAMS is dominated by groundwater abstraction. There are nine surface water abstraction licences within the Darent and Cray CAMS licensed for a total of 2.2 Ml/d. None of these licenses are located within the within the Kent Thameside. The majority of the abstraction is groundwater abstraction, with a total licensed abstraction volume of 304 Ml/d. Over one third of the groundwater licences are located within the New Ash Green WRMU, where 130 Ml/d is licensed for abstraction. Of this, 83% is licensed for public water supply purposes with the remaining 17% licensed for industrial purposes.

Table E.3 Groundwater abstractions by volume (rounded to the nearest Ml/d)

Water Resources Management Unit	Number of licences	Licensed volume	Abstracted volume	Abstraction as a % of licensed volume
Upper Darent	11	51	33	65%
Middle Darent	9	44	23	52%
Rivers Cray and Shuttle	15	79	57	72%
New Ash Green and Dartford	20	130	17	13%
Total	55	304	130	

Based on data provided in Environment Agency (2007d), Table 1.5.1

The public water supply licences were granted as 'Licences of Right' to abstract water under the 1963 Water Act. No consideration was given to the environmental impact of these abstractions at the time the licences were issued, and they are often licensed at abstraction rates that exceed the capacity of abstraction equipment or the capability of the aquifer to provide the licensed yield. Consequently, there are areas within the catchment that have been assessed as over abstracted.

The over-abstraction has caused low flows in the River Darent. The impact of this has been particularly acute during very dry periods (e.g. during 1990). A programme of restoration has been implemented to reduce abstraction from groundwater sources. Although the reaches that suffered from low flows are outside the Kent Thameside area, the programme has impacted on some of Thames Water's public water supply sources which supply Kent Thameside, further details of which are provided below.

Potential for further resource development within Darent and Cray CAMS

There is no additional water available within the catchment. The Environment Agency has assessed the water resource availability for three of the units as "over abstracted", whilst in the remaining unit, the New Ash Green and Dartford WRMU as over-licensed.

Table E.4 Water Resource Availability Status

Water Resources Management Unit	Status
Upper Darent	Over abstracted
Middle Darent	Over abstracted
Rivers Cray and Shuttle	Over abstracted
New Ash Green and Dartford	Over licensed

For all four water resources management units in the CAMS area, the Environment Agency states that:

"any applications for consumptive abstraction from this unit either from ground or surface waters are unlikely to be successful" (Environment Agency 2007c, p 24)

However, there are may be some exceptions to this. In the New Ash Green and Dartford WRMU the CAMS document indicates that abstraction licence applications for water of marginal quality may be considered. If the Environment Agency were to consider licensing new licences the applicant would need to demonstrate that:

- Environmental sustainability is not in question;
- There justification for the need of the licence; and
- Water is used efficiently.

The document identifies the potential for the development of a new water resource within Kent Thameside. The Eastern Quarry is a source of Chalk used in cement manufacture, but has been identified for development and earmarked for housing provision. The site is currently dewatered with the water being discharged to the tidal River Thames. The CAMS document acknowledges that new development will require additional water resources above the sources already developed and identifies this source as having the potential to be used for public water supply purposes when chalk extraction ceases in 2008. However, subsequent discussions with Environment Agency staff has shown that work is being undertaken within the area to determine the extent to which the new abstractions that Thames Water are developing are intercepting groundwater flows to the quarry. This means that there may be less water (or no water) available from this source in the future.

Public Water Supply

Thames Water and Southern Water are the public water supply undertakers for Kent Thameside. The companies set out their plans for water resource provision at the sub-company level, in zones called water resource zones (WRZs). A WRZ is defined as *"the largest possible zone in which all resources, including external transfers, can be shared and hence the zone in which all customers experience the same risk of supply failure from a resource shortfall"* (Environment Agency, 2007e, p24-3). Kent Thameside is within Southern Water's Kent Medway WRZ and Thames Water's London WRZ. A small area at the south of the District of Dartford is supplied by South East Water.

The integrated nature of water resources zones means that water used for public supply purposes within Kent Thameside could be sourced elsewhere within the WRZ. To understand the availability of water resources to supply Kent Thameside within the public water supply system, it is necessary to review water company plans within the two WRZs and to understand the growth allowances that have been included. The plans for Southern Water and Thames Water are reviewed in the following sections.

Southern Water

Medway Water WRZ and supply to Kent Thameside

The Kent Medway WRZ extends along the Kent Coast from Gravesend in the west to Sittingbourne in the east, and extends inland as far as the North Downs. Within the zone are the towns of Chatham, Rochester, Strood, Gillingham and the Isle of Grain.

The zone is largely supplied by groundwater sources, with the approximately three quarters of water supply from these sources and the remainder from a surfacewater abstraction on the River Medway. This zone is strategically important in terms of water supply to the wider Kent and Sussex area. This is because of the key surface water storage provided by Bewl reservoir and transfers to two other Southern Water zones (the Kent Thanet and Sussex Hastings WRZs) that this supports. There are also three inter-company transfers from the Medway zone to South East Water.

Development within Kent Thameside should be considered in respect of the growth within the wider area. For example, growth elsewhere within the WRZ and in the wider South East will all increase demand on these resources. The wider aspects have been considered by the Water Resources in the South East group study and are not considered further within this study.

The River Medway Scheme is the principal surface water source in the area contributing almost 25% of the supply capability in Kent Medway WRZ. This river regulation scheme centres on Bewl Water, a reservoir located in the headwaters of the Medway catchment. Bewl Water is a pump-storage reservoir, meaning that storage in the reservoir is largely dependent on water abstracted from two river intakes, one on the River Teise and a second on the River Medway. Water is released from the reservoir to support abstraction downstream near Maidstone, from which water taken for treatment at Burham water treatment works. The Medway Scheme is a shared resource, with South East Water being entitled to 25% of the yield of the scheme. There is also a raw water transfer between Bewl Water and Darwell reservoir. This transfer assists in enhancing the yield of Darwell to support Southern Water's Sussex Hastings WRZ.

A group of eleven groundwater sources are located in the north and west of the Kent Medway WRZ (which includes the Kent Thameside area) constitute around 20% of the supply capability in the Kent Medway WRZ. In response to the recent drought period and as a result of low pressure problems in the parts of the WRZ, Southern Water recommissioned two of the groundwater sources in this group.

Thames Water

London Water Resource Zone and supply to Kent Thameside

The western part of Kent Thameside is supplied by Thames Water and falls within the London WRZ. London WRZ covers much of the urban area of greater London, from Hounslow in the west to Dartford in the east and from Cheshunt in the north to Biggin Hill in the South. Approximately 6.5 million people are supplied with water in the London WRZ (Ofwat, 2007).

Surface water is taken from the River Thames, stored in the large bunded reservoirs in west London and treated at four large advanced water treatment works in the west of the city. There is a further large surface water abstraction on the River Lee in the North East of the city, which is treated at a separate advanced water treatment works. The movement of water within the London WRZ is facilitated by the Thames Water Ring Main (TWRM), a large diameter tunnel that takes water from the four treatment works to the west of the city and transfers it eastwards. Water is pumped out of at various locations around the ring main and put into the local distribution networks.

In addition to the surface water abstractions, there are a large number of groundwater abstractions (wells and boreholes) within London WRZ, the majority of which are located in the South and East of the zone.

London WRZ currently has a dry year supply-demand deficit. This means that demand for water could exceed the supply capability under the prolonged dry period conditions that water companies are required to plan for. In turn, this could result in the imposition of water supply restrictions (such as hosepipe bans) on a more frequent basis than the company sets out in its Levels of Service.

In the 2004 WRP Thames Water planned significant investment is order to improve the supply demand balance for London WRZ in order to restore the balance between supply and demand for water. In AMP4 period, this included a substantial reduction in leakage, the delivery of small-scale groundwater schemes and the construction of a desalination plant in Beckton. In the medium to longer term, security of supply would be maintained by continuing reductions in leakage, further groundwater development and the construction of the Upper Thames Major Resource Development by 2026 (Thames Water, 2006).[57]

The leakage reduction programme involves reducing leakage by the targeted replacement of the worst performing mains within London to reduce leakage, and also through increasing the finding and fixing of leaks on other areas of the water supply network. The company has been progressing with the development of these schemes since 2004. The construction and delivery of the desalination plant at Beckton has been the subject of an ongoing planning appeal between Thames Water and the Greater London Authority. This has been recently resolved and the construction of the desalination plant should now be completed by the end of AMP4.

The Draft WRMP 2008 shows that the supply demand deficit in London WRZ should be closed in 2011/12

[57] The preferred option for the Upper Thames Major Resource Development (UTMRD) is a new storage reservoir in Oxfordshire.

primarily due to the delivery of the desalination plant and ongoing reduction in leakage. Until this time water customers supplied by Thames Water run the risk of more frequent supply restrictions (such as hosepipe bans) than set out in the company's Levels of Service.

Thames Water customers in the Kent Thameside area currently receive their water supply from nine local groundwater sources. Due to the integrated nature of the water supply network these sources also supply other demand areas in the South and East of the London WRZ.

The review of the CAMS documents above shows that the Darent and Cray catchment has been assessed as "over abstracted" by the Environment Agency. Low flows have occurred historically on the middle sections of the River Darent, where the river has dried up completely during droughts in the 1990s[58]. The Darent Area Action plan was developed in the early 1990s, which sought to reduce abstraction in the catchment and restore flows within the river. As part of this project, Thames Water has agreed with the Environment Agency to reduce abstraction from two groundwater sources.

These sources are locally important for public water supply and Thames Water and the Environment Agency have been involved in finding and developing alternative groundwater sources to enable these reductions to take place. A series of boreholes have been developed to the further east of the River Darent. These are yet to be fully commissioned, but this process should be completed by the end of 2008. Subject to approval by the Environment Agency, the Bean boreholes will be brought on line and enable the final reductions at Horton Kirby and Eynsford to be completed. The principle behind the agreement is that there will be no overall increase in the volume abstracted.

South East Water - Water Resource Zone 6

The areas of Longfield and New Barn are supplied by South East Water and are located within the company's Water Resource Zone number 6 (WRZ 6). The main town in the WRZ is Maidstone, located to the east. The remainder of the zone is largely rural, suppling the towns and villages between Tonbridge and Sevenoaks to the South and West and Chatham/Rochester to the North and East.

The area was previously supplied by Mid Kent Water however, from 1 January 2008 Mid Kent Water became part of South East Water. South East Water's Resource Zone 6 is comprised of Mid Kent Water's Stansted, Burham and Maidstone WRZ's. In the area formerly supplied by Mid Kent Water, 85% of water is sourced from groundwater sources, 12% from the River Medway scheme and the remainder from Southern Water as bulk supply agreements. In what now constitutes South East Water's WRZ 6, groundwater is abstracted from the chalk and greensand aquifers which underlie much of central, North and East Kent.

In the draft WRMP South East Water forecasts a supply demand deficit in WRZ 6 from 2016, which will be resolved by revisions to an existing abstraction licence and the development of a new groundwater source. In the longer term South East Water plans to develop the Broad Oak storage reservoir, to be operational from 2025 in

[58] Environment Agency (2007) The Darent and Cray Catchment Abstraction Management Strategy Technical Document.

another of the company's WRZs (WRZ 8). This will enable the company to lay a strategic transfer main from WRZ 8 to WRZ 6 to meet demand during peak periods in WRZ 6.

Impact of improvements in water efficiency in new households

The forecasts presented above are based on the allowances for new household demand that the water companies made in their 2004 Water Resources Plans. Since that time the Government has launched the Code for Sustainable Homes (CSH), which introduces whole-building performance standards against which new homes can be rated. For water, performance against the CSH is measured in terms of pcc, expressed in litres per head per day (l/h/d). There are three standards for water efficiency in the CSH as follows:

- CSH Level 1/2 120 l/h/d
- CSH Level 3/4 105 l/h/d
- CSH Level 5/6 80 l/h/d

It should be noted that the pcc figures quoted above exclude an allowance for water use outside the home (for example, for car washing or garden water use). CLG estimate that the outdoor element of water use is approximately 4% of indoor use. The CSH is currently voluntary, although from April 2007 and all housing built on English Partnerships' land and from April 2008 all social housing funded through the Housing Corporation has to be built to CSH Level 3.

Following the publication of the CSH, the Government has committed to the introduction of a minimum regulatory standard for water consumption in new homes. This has been set at 125 l/h/d (including external water use) and will be introduced through amendments to the Building Regulations in 2008 (CLG,2007). The regulatory minimum is approximately equal to the CSH Level 1/2 standard, when an allowance for external use is included.

The assessments presented in section 4.5.3 show how changing the assumptions over the efficiency levels of new homes have the potential to reduce demand from development within Kent Thameside when compared to the allowance made by the water companies in the WRP 2004.

It should be noted that these scenarios are for illustrative purposes, as constructing all new homes to the more challenging levels of efficiency from the outset may not be achievable in practical terms. The house-building industry would need time to implement improvements in design to enable these standards to be achieved, especially in the private sector where there will be no requirement to deliver housing to a standard more efficient than 125 l/h/d. No allowance has been made in this assessment for the construction of publicly funded housing to CSH Level 3 standard (all new social housing will be constructed to this standard from April 2008). No information was available to this assessment of the number of publicly funded houses to be built on the site.

It should be noted that the demand assessment presented in this study is an estimate based on published information. The uncertainties associated with this assessment are discussed further in Appendix G.

The assessment shows that constructing all new homes to the standard allowed by the water companies would

result in an additional demand for water from households in the Kent Thameside or around 9.1 Ml/d. If all new households were constructed to CSH Level 5/6 standard the increase in demand would be almost halved, at around 4.8 Ml/d. The construction of new homes to the CSH Level 1/2 standard would result in an increase in demand of around 7.3 Ml/d by 2026. The greatest rate of increase in demand would occur over the period between 2010 and 2015 in line with the greatest rate of house building.

Appendix F
Costs of the consumption standards in the Code for Sustainable Homes

The following tables present indicative costs for the fixtures and fittings required to construct a new home to the water performance standards of the CSH. These costs have been calculated based on work published by the Environment Agency (Environment Agency, 2007g). The Environment Agency study used the Water Use Calculator provided in the CSH Technical Guidance (updated in CLG, 2008b) to estimate the costs of the fixtures and fittings that would be required to achieve the water performance standards in the CSH.

The CSH Water Use Calculator contains assumptions about the frequency of use and duration of use of fixtures and fittings per person per day. For example, the CSH Water Use Calculator states that, on average, a person showers for 0.6 times per day, for a duration of 5 minutes. Based on the Water Use Calculator, a per capita consumption of 125 l/h/d can be achieved using a shower with a flow rate of 8 litres per minute (with the other fixtures and fittings of the flow rate and capacities shown in Table F1). The cost of a shower of this flow rate is £209 (based on an internet search at the time of the study). The cost of achieving the CSH standards can be estimated by totalling the costs for each fixture or fitting. The costs presented below should be considered as indicative costs as retail and wholesale costs may vary.

The key point to note is that based on this assessment, there is little difference in the costs required to achieve CSH Level 3/4 compared to CSH Level 1/2. The inclusion of water recycling technology to achieve CSH Level 5/6 increases the cost considerably.

Table F.1 Cost of fixtures and fittings required to deliver new home to the 125 l/h/d pcc standard (equivalent to CSH Level 1/2)

Micro-component of demand	Flow rate or capacity	Cost per item	Number per property	Cost per property
WC	6/3 litre dual flush	£119	2	£238
Basin taps	3 litres/min	£20	2	£40
Shower	8 litres/min	£209	1	£209
Bath	160 litres capacity	£198	1	£198
Kitchen sink taps	3 litres/min	£60	1	£60
Washing machine	45 litres/cycle	£280	1	£280
Dishwasher	12 litres/cycle	£350	1	£350
Outdoor Tap		£10	1	£10
TOTAL				£1385

Table F.2 Cost of fixtures and fittings required to deliver new home to the 105 l/h/d pcc standard (CSH Level 3/4)

Micro-component of demand	Flow rate or capacity	Cost per item	Number per property	Cost per property
WC	4.5/3 litre dual flush	£120	2	£240
Basin taps	1.7 litres/min	£60	2	£120
Shower	6 litres/min	£209	1	£209
Bath	160 litres capacity	£198	1	£198
Kitchen sink taps	3 litres/min	£60	1	£60
Washing machine	45 litres/cycle	£280	1	£280
Dishwasher	12 litres/cycle	£350	1	£350
Outdoor Tap		£10	1	£10
TOTAL				£1,467

Table F.3 Cost of fixtures and fittings required to deliver new home to the 80 l/h/d pcc standard (equivalent to CSH Level 5/6)

Micro-component of demand	Flow rate or capacity	Cost per item	Number per property	Cost per property
WC	4.5/3 litre dual flush	£120	2	£240
Basin taps	1.7 litres/min	£60	2	£120
Shower	6 litres/min	£209	1	£209
Bath	140 litres capacity	£455	1	£455
Kitchen sink taps	1.7 litres/min	£60	1	£60
Washing machine	45 litres/cycle	£280	1	£280
Dishwasher	12 litres/cycle	£350	1	£350
Rainwater harvesting	-	£3,200	1	£3,200
Outdoor Tap		£10	-	-
TOTAL				**£4,024**

Appendix G
Water Demand Calculation – Methodology

Introduction

The water demand forecast for Dartford and Gravesham has been calculated using data supplied by Thames Water and Southern Water as part of their Draft Water Resource Management Plans (WRMP) 2008. A Microsoft Excel spreadsheet model was created that calculated the total demand based on individual demand components reported by the water companies.

Data for forecast household numbers and non –household floor space values have been provided by the relevant Local Authorities. Table G.1 below details the individual elements of demand that have been recalculated for the Dartford and Gravesham and the information sources used.

Table G.1 Household Demand Components and Sources of Information

Demand Component	Number of households	Household occupancy Rate	Per Capita Consumption
Existing Household	Local Authority	Local Authority	Draft WRMP
Forecast Household (new households)	Local Authority	Local Authority	Draft WRMP and Code for Sustainable Homes

Table G.2 Non-Household and other Demand Components and Sources of Information

Demand Component	Floor space	Consumption
Existing Non-Household		Draft WRMP (proportioned)
Forecast Non-Household	Local Authority	Microcomponent based
Indicative Leakage/DSOU*		Draft WRMP (proportioned)

DSOU is Distribution System Operational Use. This is an allowance that water companies make in their forecasts for legitimate mains network operational requirements (e.g. mains flushing)

WRZ description/proportioning

In order to derive the forecast water demand value specific to the Dartford and Gravesham Districts it has been necessary to extract certain data from the WRMP 2008 tables and apportion it. This is necessary as the water companies produce their data based on Water Resources Zones. The geographical areas of these WRZ's do not

match the Local Authority boundaries. For existing and forecast households and forecast non-households this apportioning was done using actual property numbers as opposed to the Draft WRMP property numbers but for other items such as Non-Household demand another method had to be used as the information regarding actual properties was not available. ArcGis was used to calculate the areas of the Local Authority boundaries and the individual WRZ's from which an apportioning factor could be derived. These factors are shown in Table G.3. These apportioning factors could then be applied to the Draft WRMP data to derive Existing Non-Household Demand and base year Leakage and DSOU values.

Due to the similarity of the boundary locations for Dartford District/London WRZ and Gravesham District /Kent Medway WRZ, Local Authority housing numbers and non-household floor space areas were assigned directly to each corresponding WRZ. i.e. Existing and forecast household numbers for Dartford were assigned to the calculations for London WRZ.

Table G.3 Water Resource Zone Apportioning Factors

Polygon Name	Area (m^2)	WRZ Areal Apportioning Factor
Dartford Local Authority region (1)	73,134,824.47	
Gravesham Local Authority Region (1)	99,115,041	
London Water Resource Zone	1,414,670,821	**5.17 %**
Kent Medway Water Resource Zone	418,387,876	**23.69 %**

1) Census based Local Authority boundaries were used

Existing Households

The water demand from the existing households was calculated using the standard methodology shown below:

$$D = H \times O \times C$$

where :

D = Water Demand
H = Households (provided by Local Authorities)
O = occupancy rate (persons per property, provided by Local Authorities)
C = per capita consumption (WRMP l/h/d)

This calculation was conducted for two different building types, existing measured households and existing unmeasured households as per standard WRMP methodology. The water companies include an allowance for leakage from "Void" households (i.e. unoccupied properties connected to the water supply system). The same allowance has been included in this assessment.

Existing household numbers were supplied by Dartford and Gravesham Districts along with household occupancy rates (see Table G.4 and Table G.5). These figures were factored against the WRMP data to ensure that the same measured and unmeasured population proportions were used as those used by the relevant water companies. This was necessary as measured and unmeasured properties have different per capita consumption (pcc) values attributed to them. The WRMP pcc values used are shown in Table G.6.

Table G.4 Existing Housing Stock in Local Authority Areas

Local Authority Area	Existing household numbers
Dartford LA	37,600
Gravesham LA	40,000

1) Data supplied by relevant local authorities

Table G.5 Local Authority Household Occupancy Rates

Occupancy Rate (p/hh)	2006	2011	2016	2021
Dartford LA	2.36	2.31	2.26	2.22
Gravesham LA	2.41	2.35	2.27	2.24

Data from South East Plan data as provided by Kent County Council. Data for intervening years was interpolated using a flat profile.

Table G.6 Draft WRMP Existing Household per Capita Consumption (litres/head/day)

l/h/d	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
London Unmeasured	168.5	168.3	168.3	168.4	168.8	169.2	169.5	169.8	170.3	171.0	171.7	172.4	173.4	174.6	174.4	174.0	174.8	175.7	176.4	177.1
London Measured	160.9	159.9	159.2	158.9	156.9	155.0	154.1	153.7	153.8	146.6	146.8	147.2	147.6	148.0	148.8	150.0	151.2	152.4	153.5	154.7
Kent Medway Unmeasured	182.4	182.4	182.5	182.5	182.6	182.6	182.6	182.6	182.8	182.6	182.7	182.7	182.7	182.8	183.0	183.0	183.0	183.1	183.1	183.1
Kent Medway Measured	186.1	182.3	179.8	178.1	173.1	170.9	169.5	168.8	168.2	168.3	168.4	168.5	168.6	168.8	168.9	169.1	169.3	169.4	169.6	169.9

Forecast Household Demand

The forecast household demand was calculated using the same formula as shown for existing households. Actual forecast household numbers as supplied by the relevant Local Authority were used along with Local Authority Occupancy rates. Several different pcc values were then applied to give results that related to different house type scenarios. These values are shown in Table G.7.

Table G.7 Forecast Household PCC Values

Description	Per Capita Consumption Allowance (l/h/d)
London WRZ (1)	137-161 l/h/d
Kent Medway WRZ (2)	164 l/h/d
Regulatory Minimum	125 l/h/d
CSH 1/2	120 l/h/d (+ 4.8 l/hh/d outdoor use)
CSH 3/4	105 l/h/d (+ 4.2 l/hh/d outdoor use)
CSH 5/6	80 l/h/d (+ 3.2 l/hh/d outdoor use)

1) Data extracted from Thames Water Draft WRMP tables. New household PCC is predicted to increase over time hence start and end values.

2) Data extracted form Southern Water Draft WRMP tables. New household PCC is predicted to remain static over time.

Existing Non-Household

Existing Non-Household demand data was taken from the relevant Draft WRMP tables and apportioned using the areal factors shown in Table G.3. This was done for the base year to derive the existing non-household consumption value. This value was then carried forward throughout the planning period. Both Billed Measured and Billed Unmeasured values were apportioned to give one overall existing non-household demand figure.

Table G.8 Existing Non-Household Demand for WRZ and Local Authority.

	Water Resource Level Consumption (Ml/d)	Dartford and Gravesham apportioned consumption (Ml/d)
London WRZ		
Billed unmeasured Non-Household Consumption	17.92	0.93
Billed Measured Non-Household Consumption	408.12	21.10
Kent Medway WRZ		
Billed unmeasured Non-HH Consumption	1.25	0.30
Billed Measured Non-HH Consumption	23.95	5.67
Total (Dartford and Gravesham) Non-Household Consumption		**30.0**

Forecast Non-Household

The demand from forecast non-household developments was calculated using a bottom-up approach. This was done using forecast annual non-household floor space areas supplied by the relevant Local Authority. The data supplied was subdivided by standard planning use classification codes. A demand figure was then applied. These demand values were derived from several published sources. This is a necessary departure from the water company planning approach. The water companies forecast demand from non-households using forecasts of economic growth for industrial and commercial sectors and apply these trends at the Water Resource Zone Level. Unlike the approach to forecasting household demand, the water companies do not make allowances for consumption for different property types at the water resource zone level.

Table G.9 details values used and the source of each value. A figure for average water use per employee per day was used alongside employment density figures to derive a water demand/ m^2 value where appropriate. Water consumption values on a l/bed/year value were used for building types where this data was provided by the Local Authority.

Table G.9 Water Demand per m^2 and Data Sources

Use Class	Water Demand per unit	Units	Density Factor (1)	LA data supplied Format	Water consumption allowance data Source (2)
A1	9300	(l/p/yr)	20 (m^2/p)	m^2	Entec Unpublished Estimate
A3	3200	(l/building/day)	Average building size 200 m^2	m^2	Water Mark (OGCb 2003)
B1	600	(l/m^2/yr)	N/A	m^2	Water Mark (OGCb 2003)
B1a	600	(l/m^2/yr)	N/A	m^2	Water Mark (OGCb 2003)
B1c	600	(l/m^2/yr)	N/A	m^2	Water Mark (OGCb 2003)
B2	9300	(l/p/yr)	34 (m^2/p)	m^2	Entec Unpublished Estimate
B8	9300	(l/p/yr)	50 (m^2/p)	m^2	Entec Unpublished Estimate
C1	40000	(l/Bed/yr)	20% of floor space unused, and 30m2 per bedroom.	m^2	Water Mark (OGCb 2003)
D1	332	(l/m^2/yr)	N/A	m^2	Water Mark (OGCb 2003)
D2	3200	(l/building/day)	Average building size 15000 m^2	m^2	Water Mark (OGCb 2003)
D1,D2 & D3 Mixed	332	(l/m^2/yr)	N/A	m^2	Entec Unpublished Estimate
Sui Generis	600	(l/m^2/yr)	N/A	m^2	Water Mark (OGCb 2003)
Support/core	600	(l/m^2/yr)	N/A	m^2	Water Mark (OGCb 2003)
C1 (Beds)	40000	(l/Bed/yr)	N/A	Beds	Water Mark (OGCb 2003)
C2 (Beds)	60000	(l/Bed/yr)	N/A	Beds	Water Mark (OGCb 2003)
1 FE	3850	(l/Pupil/yr)	210 pupils/school	Number of buildings	Water Mark (OGCb 2003)
2 FE	3850	(l/Pupil/yr)	420 pupils/school	Number of buildings	Water Mark (OGCb 2003)

(1) English Partnerships (2001) Employment Densities: A Full Guide. London. English Partnerships.

(2) Where no data is available, Entec has derived water use estimates based on water use estimates per device and frequency of use information drawn from published data.

The calculated forecast non-household demand is presented in Table F.10 below.

Table G.10 Forecast Non-Household Demand (2025-26)

Area	Ml/d
Dartford LA	1.52
Gravesham LA	0.52
Total	2.04

Leakage and Distribution System Operational Use

The Draft WRMP values for Total Leakage and Distribution System Operational Use were apportioned using the previously discussed factors (see Table G.3). This was done for the base year only to give an indicative value for these two demand elements. Table G.11 displays these results. These values are not included in the total demand values presented elsewhere in the report.

Table G.11 Base Year (2006-07) Indicative Leakage and DSOU

Ml/d	WRMP	Kent Thameside
London WRZ		
Leakage	677.55	35.03
DSOU	5.91	0.31
Kent Medway		
Leakage	18.16	4.30
DSOU	0.22	0.05
Kent Thameside Total		
Leakage		39.33
DSOU		0.36

Appendix H
Cost estimates for relocation of Northfleet STW under different growth and consenting scenarios

Northfleet WwTW relocation:

Consent:	**Current**	**BOD**	100	mg/l
		Ammonia	50	mg/l
Population equivalen	**Current**		48,000	
	.+10%		52,800	
	.+50%		72,000	
DWF	**Current**		9,300	m3/day

Notes:

Costs below exclude any cost associated with providing addditional sewerage capacity to Northfleet catchment beyond transfer of flows from existing site to new site
Costs below exclude any land purchase costs
Costs below are @ Sep-08 price base date
Assumptions for trunk main length: 2 km
Assumption is for standard ground conditions (no piling)

Baseline: like-for-for like replacement - current PE, no nitrificatio — **Total All-In Cost @ Sep-08** **15,555,176**

Transfer pumping station:
48,000 PE

Unit Type	*Size*	*UoM*
ST I/S Pumps		kW

Project Cost Breakdown @ PBD — *Percentage On Cost*

Feasibility
Design
Support
Land
Construction
Supervision
Overhead
Other Construction Costs (services etc.)
Total On -Cost 33.1%

Total All-In Cost @ Sep-08 **411,864**

Trunk main:
length: 2 km

Total All-In Cost @ Sep-08 **2,000,000**

Replacement works:
48,000 PE consent: 25 / 45 BOD / SS

Unit Type	*Size*	*UoM*
Dorr Detritor GRP		m2
Screenings Dewatering		m3/day
Fine Screen (1 - 9mm)		m3/day
Prim Sed Tank, Auto-dsldge(ST)		m2
AS Anoxic Tank		m3
AS Final Tank		m2
AS Tank		m3
ASP Diffused Air Plant		Kw
ASP Mixer		kW
RAS Pumps		kW
Belt Thickener		m3/day
Sludge Holding Tank,		m3
Sludge Pump		Kw
Storm Water Tank		m3
ST I/S Pumps		kW

Project Cost Breakdown @ PBD — *Percentage On Cost*

Feasibility
Design
Support
Land
Construction
Supervision
Overhead
Other Construction Costs (services etc.)
Total On -Cost 30.0%

Total All-In Cost @ Sep-08 **13,143,312**

Scenario 1a: PE+10%, no nitrificatior — **Total All-In Cost @ Sep-08** **16,373,565**

Transfer pumping station:
52,800 PE

Unit Type	*Size*	*UoM*
ST I/S Pumps		kW

Project Cost Breakdown @ PBD — *Percentage On Cost*

Feasibility
Design
Support
Land
Construction
Supervision
Overhead
Other Construction Costs (services etc.)
Total On -Cost 32.9%

Total All-In Cost @ Sep-08 **428,350**

Trunk main:
length: 2 km

Total All-In Cost @ Sep-08 **2,000,000**

Replacement works:
52,800 PE consent: 25 / 45 BOD / SS

Unit Type	*Size*	*UoM*
Dorr Detritor GRP		m2
Screenings Dewatering		m3/day
Fine Screen (1 - 9mm)		m3/day
Prim Sed Tank, Auto-dsldge(ST)		m2
AS Anoxic Tank		m3
AS Final Tank		m2
AS Tank		m3
ASP Diffused Air Plant		Kw
ASP Mixer		kW
RAS Pumps		kW
Belt Thickener		m3/day
Sludge Holding Tank,		m3
Sludge Pump		Kw
Storm Water Tank		m3
ST I/S Pumps		kW

Project Cost Breakdown @ PBD — *Percentage On Cost*

Feasibility
Design
Support
Land
Construction
Supervision
Overhead
Other Construction Costs (services etc.)
Total On -Cost 30.0%

Total All-In Cost @ Sep-08 **13,945,215**

Scenario 1b: PE+10%, new consent: 10 / 45 / 3 — **Total All-In Cost @ Sep-08** **19,141,437**

Transfer pumping station:
52,800 PE

Unit Type	*Size*	*UoM*
ST I/S Pumps		kW

Project Cost Breakdown @ PBD — *Percentage On Cost*

Feasibility
Design
Support
Land
Construction
Supervision
Overhead
Other Construction Costs (services etc.)
Total On -Cost 32.9%

Total All-In Cost @ Sep-08 **428,350**

Trunk main:
length: 2 km

Replacement works:
52,800 PE consent: 10 / 45 / 3 BOD / SS / Ammonia

Unit Type	*Size*	*UoM*
Dorr Detritor GRP		m2
Screenings Dewatering		m3/day
Fine Screen (1 - 9mm)		m3/day
Prim Sed Tank, Auto-dsldge(ST)		m2
AS Anoxic Tank		m3
AS Final Tank		m2
AS Tank		m3
ASP Diffused Air Plant		Kw
ASP Mixer		kW
RAS Pumps		kW
Belt Thickener		m3/day
Sludge Holding Tank,		m3
Sludge Pump		Kw
Storm Water Tank		m3
ST I/S Pumps		kW

Total All-In Cost @ Sep-08 **2,000,000**

Project Cost Breakdown @ PBD	*Percentage On Cost*
Feasibility	
Design	
Support	
Land	
Construction	
Supervision	
Overhead	
Other Construction Costs (services etc.)	
Total On -Cost	30.0%
Total All-In Cost @ Sep-08	**16,713,087**

Scenario 2: PE+50%, new consent: 10 / 45 / 3
Transfer pumping station:
72,000 PE

Unit Type	*Size*	*UoM*
ST I/S Pumps		kW

Total All-In Cost @ Sep-08 **22,987,831**

Project Cost Breakdown @ PBD	*Percentage On Cost*
Feasibility	
Design	
Support	
Land	
Construction	
Supervision	
Overhead	
Other Construction Costs (services etc.)	
Total On -Cost	32.2%
Total All-In Cost @ Sep-08	**487,507**

Trunk main:
length: 2 km

Replacement works:
72,000 PE consent: 10 / 45 / 3 BOD / SS / Ammonia

Unit Type	*Size*	*UoM*
Dorr Detritor GRP		m2
Screenings Dewatering		m3/day
Fine Screen (1 - 9mm)		m3/day
Prim Sed Tank, Auto-dsldge(ST)		m2
AS Anoxic Tank		m3
AS Final Tank		m2
AS Tank		m3
ASP Diffused Air Plant		Kw
ASP Mixer		kW
RAS Pumps		kW
Belt Thickener		m3/day
Sludge Holding Tank,		m3
Sludge Pump		Kw
Storm Water Tank		m3
ST I/S Pumps		kW

Total All-In Cost @ Sep-08 **2,000,000**

Project Cost Breakdown @ PBD	*Percentage On Cost*
Feasibility	
Design	
Support	
Land	
Construction	
Supervision	
Overhead	
Other Construction Costs (services etc.)	
Total On -Cost	30.0%
Total All-In Cost @ Sep-08	**20,500,324**

Appendix I
Summary Pitt Review Recommendations

In 2007 the Secretaries of State asked Sir Michael Pitt to undertake a comprehensive review of the lessons to be learned from the summer floods of 2007. The Government asked that the process both thorough and independent; a fair assessment of what happened and what might be done differently. Copies of the full report and summaries are available on the Cabinet Office web pages (http://www.cabinetoffice.gov.uk/thepittreview/final_report.aspx).

> *"The floods of last year caused the country's largest peacetime emergency since World War II. The impact of climate change means that the probability of events on a similar scale happening in the future is increasing. So the Review calls for urgent and fundamental changes in the way the country is adapting to the likelihood of more frequent and intense periods of heavy rainfall."*

The Pitt Review was comprehensive and considered all stages of flooding - preparedness, response and recovery - as well as the coordination, responsibilities, and legislation necessary to ensure the United Kingdom can advance in the area of flood risk management. As a result, there are 92 recommendations in the review which have been broadly categorised and provided below:

Flood Preparedness

Improved Understanding and Forecasting

1) The Met Office should continue to improve its forecasting and predicting methods to a level which meets the needs of emergency responders.
2) The Environment Agency should further develop its tools and techniques for predicting and modelling river flooding, taking account of extreme and multiple events and depths and velocity of water.
3) The Environment Agency and the Met Office should work together, through a joint centre, to improve their technical capability to forecast, model and warn against all sources of flooding.
4) The Environment Agency should work with partners to urgently take forward work to develop tools and techniques to model surface water flooding.
5) Defra should work with Ofwat and the water industry to explore how appropriate risk-based standards for public sewerage systems can be achieved.
6) Defra, the Environment Agency and Natural England should work with partners to establish a programme through Catchment Flood Management Plans and Shoreline Management Plans to achieve greater working with natural processes.
7) The Government should provide Local Resilience Forums with the inundation maps for both large and small reservoirs to enable them to assess risks and plan for contingency, warning and evacuation, and the

outline maps be made available to the public online as part of wider flood risk information.

Funding

8) The Government should give priority to both adaptation and mitigation in its programmes to help society cope with climate change.

9) The Government should commit to a strategic long-term approach to its investment in flood risk management, planning up to 25 years ahead.

10) The Government should develop a scheme which allows and encourages local communities to invest in flood risk management measures.

Raising Community Awareness

11) The Risk and Regulation Advisory Council should explore how the public can improve their understanding of community risks, including those associated with flooding, and that the Government should then implement the findings as appropriate.

12) The Government should implement a public information campaign which draws on a single definitive set of flood prevention and mitigation advice for householders and businesses, and which can be used by media and the authorities locally and nationally.

13) The Environment Agency should work with local responders to raise awareness in flood risk areas and identify a range of mechanisms to warn the public, particularly the vulnerable, in response to flooding.

Development Planning and Building (Design/Rights/X)

14) There should be a presumption against building in high flood risk areas, in accordance with PPS25, including giving consideration to all sources of flood risk, and ensuring that developers make a full contribution to the costs both of building and maintaining any necessary defences.

15) Householders should no longer be able to lay impermeable surfaces as a right on front gardens and the Government should consult on extending this to back gardens and business premises.

16) The automatic right to connect to surface water drainage of new developments to sewerage systems should be removed.

17) Building Regulations should be revised to ensure that all new or refurbished buildings in high flood-risk areas are flood resistant or resilient.

18) Local authorities, in discharging their responsibilities under the Civil Contingencies Act 2004 to promote business continuity, should encourage the take-up of property flood resistance and resilience by businesses.

19) The operation and effectiveness of PPS25 and the Environment Agency's powers to challenge development should be kept under review and strengthened if and when necessary.

20) All local authorities should extend eligibility for home improvement grants and loans to include flood resistance and resilience products for properties in high flood-risk areas,

Understanding Local Drainage

21) Local authorities should collate and map the main flood risk management and drainage assets (over and underground), including a record of their ownership and condition.

22) Local authorities should lead on the management of local flood risk, with the support of relevant organisations.

23) Local authorities should positively tackle local problems of flooding by working will all relevant parties, establishing ownership and legal responsibility

24) Local Surface Water Management Plans, as set out under PPS25 and coordinated by local authorities, should provide the basis for managing all local flood risk.

25) Local authorities should assess and, if appropriate, enhance their technical capabilities to deliver a wide range of responsibilities in relation to local flood risk management.

26) As part of the forthcoming and subsequent water industry pricing reviews, Ofwat should give appropriate priority to proposals for investment in the existing sewerage network to deal with increasing flood risk.

Flood Defence

27) The Environment Agency should maintain its existing risk-based approach to levels of maintenance ad this should be supported by published schedules of work for each local authority area.

28) The Government should develop a single set of guidance for local authorities and the public on the use and usefulness of sandbags and other alternatives, rather than leaving the matter wholly to local discretion.

Defining Agency Roles and Consolidating Legislation

29) The forthcoming flooding legislation should be a single unifying Act that addresses all sources of flooding, clarifies responsibilities and facilitates flood risk management

30) The Environment Agency should be a national overview of all flood risk, including surface water and groundwater, with immediate effect

31) All relevant organisations should have a duty to share information and cooperate with local authorities and the Environment Agency to facilitate the management of flood risk.

32) The Government should resolve the issue of which organisations should be responsible for the ownership and maintenance of sustainable drainage systems.

33) The Government should implement the legislative changes proposed in the Environment Agency biennial report on dam and reservoir safety through the forthcoming flooding legislation.

34) All upper tier local authorities should establish Oversight and Scrutiny Committees to review work by public sector bodies and essential service providers in order to manage flood risk, underpinned by a legal requirement to cooperate and share information.

Flood Insurance

35) The Government and the insurance industry should wok together to deliver a public education programme setting out the benefits of insurance in the context of flooding.

36) The Government should review and update the guidance *Insurance for all: a good practice guide* for providers of social housing and disseminate it effectively to support the creation of insurance with rent schemes for low income households.

37) In flood risk areas, insurance notices should include information on flood risk and the simple steps that can be taken to mitigate the effects.

38) The insurance industry should develop and implement industry guidance on flooding events, covering reasonable expectations of the performance of insurers and reasonable actions by customers

Flood Response

Improved Flood Warnings

39) The Environment Agency should provide a specialised site-specific flood warning service for infrastructure operators, offering longer lead times and greater levels of detail about the velocity and depth of flooding.

40) The Met Office and the Environment Agency should issue warnings against a lower threshold of probability to increase preparedness lead times for emergency responders.

41) The Met Office and Environment Agency should issue joint warnings and impact information on severe weather and flooding emergencies to responder organisations and the public.

42) The Environment Agency should make relevant flood visualisation data, held in electronic map format, available online to Gold and Silver Commands.

43) The Met Office and Environment Agency should urgently complete the production of a sliding scale of options for greater personalisation of public warning information, including costs, benefits and feasibility.

44) Local Resilience Forums should continue to develop plans for door-knocking, coordinated by local authorities, to enhance flood warnings before flooding and to provide information and assess welfare needs once flooding has receded.

45) The Environment Agency should work urgently with telecommunications companies to facilitate the roll-out of opt-out telephone flood warning schemes to all homes and businesses liable to flooding, including those with ex-directory numbers.

46) Local authority contact centres should take the lead in dealing with general enquiries from the public during and after major flooding, redirecting calls to other organisations when appropriate.

Coordinated Emergency Response

47) Upper tier local authorities should be the lead responders in relation to multi-agency planning for severe weather emergencies at the local level and for triggering multi-agency arrangements in response to severe weather warnings and local impact assessments.

48) The Environment Agency should work with its partners to progressively develop and bring into use flood visualisation tools that are designed to meet the needs of flood-risk managers, emergency planners and responders.

49) Local authorities should establish mutual aid agreements in accordance with the guidance currently being prepared by the Local Government Association and the Cabinet Office.

50) The Government should urgently put in place a fully funded national capability for flood rescue with Fire and Rescue Authorities playing a leading role, underpinned as necessary by a statutory duty.

51) Defra should amend emergency regulations to increase the minimum amount of water to be provided in an emergency, in order to reflect reasonable needs during a longer-term loss of mains supply.

52) Where a Gold Command is established for severe weather events, the police, unless agreed otherwise locally, should convene and lead the multi-agency response.

53) Gold Commands should be established at an early stage on a precautionary basis where there is a risk of serious flooding.

54) The Ministry of Defence should identify a small number of trained Armed Forces personnel who can be deployed to advise Gold Commands on logistics during wide-area civil emergencies and, working with Cabinet Office, identify a suitable mechanism for deployment.

55) Central government crisis machinery should always be activated if significant wide-area and high-impact flooding is expected or occurs

56) A national flooding exercise should take place at the earliest opportunity in order to test the new arrangements which central government departments are putting into place to deal with flooding and infrastructure emergencies.

57) Category 1 and 2 responders should assess the effectiveness of their emergency response facilities, including flexible accommodation, IT and communications systems, and undertake any necessary improvement works.

58) The Government should issue clear guidance on expected levels of Category 2 responders' engagement in planning, exercising and response, and consider the case for strengthening enforcement arrangements.

59) The Cabinet Office should provide advice to ensure that all Local Resilience Forums have effective and linked websites providing public information before, during and after an emergency.

60) Council leaders and chief executives should play a prominent role in public reassurance and advice through the local media during a flooding emergency, as part of a coordinated effort overseen by Fold Commanders.

Secured Critical Infrastructure

61) The Government should urgently begin the systematic programme to reduce the disruption of essential services resulting from natural hazards by publishing a national framework and policy statement setting out the process, timescales and expectations,.

62) Relevant government departments and the Environment Agency should work with infrastructure operators to identify the vulnerability and risk of assts to flooding and a summary of the analysis should be published

in Sector Resilience Plans.

63) In the short-term, the Government and infrastructure operators should work together to build a level of resilience into critical infrastructure assets that ensures continuity during a worst-case flood event.

64) A specific duty should be placed on economic regulators to build resilience in the critical infrastructure

65) The Government should extend the duty to undertake business continuity planning to infrastructure operating Category 2 responders to a standard equivalent to BS25999, and that accountability is ensured through an annual benchmarking exercise within each sector.

66) The Government should strengthen and enforce the duty on Category 2 responders to share information on the risks to their infrastructure assets, enabling more effective emergency planning within Local Resilience Forums.

67) The Highways Agency, working through Local Resilience Forums, should further consider the vulnerability of motorways and trunk roads to flooding, the potential for better warnings, strategic road clearance to avoid people becoming stranded and plans to support people who become stranded.

68) The rail industry, working through Local Resilience Forums, should develop plans to provide emergency welfare support to passengers stranded on the rail network.

Individual Responsibilities

69) The public should make up a flood kit – including personal documents, insurance policy, emergency contact numbers (including local council, emergency services and Floodline), torch, battery or wind-up radio, mobile phone, rubber gloves, wet wipes or antibacterial hand gel, first aid kit and blankets.

70) The Government should establish a programme to support and encourage individuals and communities to be better prepared and more self-reliant during emergencies, allowing the authorities to focus on those areas and people in greatest needs

71) Flood risk should be made part of the mandatory search requirements when people buy property, and should form part of Home Information Packs.

Flood Recovery

72) The Government, the Association of British Insurers and other relevant organisations should work together to explore any technological or process improvements that can be made to speed up the drying out and stabilising process of building recovery after a flood.

73) Aims and objectives for the recovery phase should be agreed at the outset by Recovery Coordinating Groups to provide focus and enable orderly transition into mainstream programmes when multi-agency coordination of recovery is no longer required.

74) Government Offices, in conjunction with the Local Government Association, should develop arrangements to provide advice and support from experienced organisations to areas dealing with recovery from severe flooding emergencies.

Health & Wellbeing

75) The monitoring of the impact of flooding on the health and wellbeing of people, and actions to mitigate and manage the effects, should form a systematic part of the work of Recovery Coordinating Groups.

76) Local response and recovery coordinating groups should ensure that health and wellbeing support is readily available to those affected by flooding based on the advice developed by the Department of Health or other relevant bodies should develop a single set of flood-related health advice for householders and businesses which should be used by all organisations nationally and locally and made available through a wide range of sources.

Roles & Responsibilities

77) The Government should establish a National Resilience Forum to facilitate national level multi-agency planning for flooding and other emergencies.

78) For emergencies spanning more than a single local authority area, Government Offices should ensure coherence and coordination, if necessary, between recovery operations.

79) Local authorities should coordinate a systematic programme of community engagement in their area during the recovery phases.

80) All central government guidance should be updated to reflect the new arrangements for recovery and Local Resilience Forums should plan, train and exercise on this basis.

81) Local Recovery Coordination Groups should make early recommendations to elected local authority members about longer-term regeneration and economic development opportunities.

Reporting

82) There should be an agreed framework, including definitions and timescales, for local-central recovery reporting.

83) Following major flooding events, the Government should publish monthly summaries of progress of the recovery phase, including the number of households still displaced from all or parts of their homes.

84) Local Resilience Forums should evaluate and share lessons from the response and recover phases to inform their planning for future emergencies.

Funding & Regeneration

85) Local authorities should continue to make arrangements to bear the cost of recovery for all but the most exceptional emergencies, and should revisit their reserves and insurance in light of last summer's floods.

86) Central government should have pre-planned rather than ad-hoc arrangements to contribute towards the financial burden of recovery from the most exceptional emergencies, on a formula basis.

87) National and local Recovery Co-ordinating Groups should be established from the outset of major emergencies and in due course there should be formal handover from the crisis machinery.

88) Local Recovery Coordination Groups should make early recommendations to elected local authority

members about longer-term regeneration and economic development opportunities.

Adopting the Review

89) The Government should publish an action plan to implement the recommendations of this Review, with a Director in Defra overseeing the programme of delivery and issuing regular progress updates.

90) The Government should establish a Cabinet Committee with a remit to improve the country's ability to deal with flooding and implement the recommendation of this Review.

91) The EFRA Selection Committee should review the country's readiness for dealing with flooding emergencies and produce an assessment of progress in implementation of the Review's recommendations after 12 months.

92) Each Oversight and Scrutiny Committee should prepare an annual summary of actions taken locally to manage flood risk and implement this Review, and these reports should be public and reviewed by Government Offices and the Environment Agency.

Entec

Creating the environment for business

Appendix J
Dartford and Kent Thameside SFRAs

Kent Thameside Delivery Board

Updating the SFRA

Final Report

March 2009

Entec UK Limited

Report for

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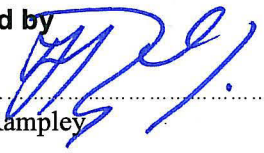
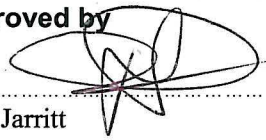


John Rampley

Approved by



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Kent Thameside Delivery Board

Updating the SFRA

Final Report

March 2009

Entec UK Limited

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No.	Details	Date
1	Draft SFRA Update Report	
2	Revised Draft SFRA Update Report	19/09/08
3	Revised Draft SFRA Update Report	16/01/09
4	Final SFRA Update Report	13/03/09

Contents

1. Introduction

1.1 Background

Entec was commissioned by Kent Thameside Delivery Board to undertake a Strategic Flood Risk Assessment (SFRA) for Kent Thameside in 2005. The original SFRA was undertaken in line with the requirements of Planning Policy Guidance 25 (PPG25), the overriding guidance on development in flood risk areas. In December 2006 PPG25 was replaced by Planning Policy Statement 25 – Development and Flood Risk (PPS25), the Update Report reflects the policy changes.

PPS25 has updated guidelines on the production of SFRAs and has new guidance on assessing the potential impact of climate change. The revised guidance defines new impacts from climate change on flooding, for example increased rainfall or river flows. The PPS25 Practice Guide (June 2008) requires climate change to be considered up to the 100 year horizon.

Kent Thameside has been identified as being at a high risk from tidal flooding, owing to the northern portion of the area being in the Thames Estuary floodplain. The changes in sea-level rise along the South East coast, as a result of climate change, from PPS25 compared to PPG25 have a potentially significant impact on flood risk.

This Updated SFRA and the original Kent Thameside SFRA should be read alongside the Dartford Town Centre SFRA which was completed for Dartford Council in 2008. The town centre SFRA involved the re-modelling of the River Darrent and a detailed analysis of flood risks which were interpreted to inform site specific guidance. The recommendations in the Dartford Town Centre SFRA are specific to Dartford's unique flood risks and development pressures. The overall principals of flood risk management through avoidance and safe PPS25 compliant developments are themes common to both SFRAs.

1.2 Objectives

Kent Thameside Delivery Board have requested the SFRA to be updated in the following areas:

- Update the tidal breach modelling for six of the original tidal breaches with the latest sea-level rise data;
- Review the existing SFRA and confirm that it conforms to the requirements of PPS25;
- Propose a scope and timeframe for further updating the SFRA.

1.3 Structure of the Report

This Update Report broadly replaces Section 3 and 5 of the Original SFRA Stage 2 Report by, updating the data and information on tidal breach modelling. The report contains the following sections:

- Section 1 introduces the report and provides the objectives;
- Section 2 provides a summary of the design condition used to model the new tidal breach levels, broadly a revision of Section 3 of the Stage 2 report for the original SFRA;
- Section3 describes how the breach assessment was undertaken and gives the depth maps from the breach analysis, and is a revision of Section 5 of the original Stage 2 SFRA report;
- Section 4 provides the hazard maps from the breach analysis, and is a revision of the original Section 7;
- Section 5 provides a review of the update process and recommendations for the future of the SFRA.

2. Design Condition of New Breach Models

2.1 Climate Change

PPS25 sets out new sea-level rise contingencies for the period up to 2115. These are shown in Table 2.1.

Table 2.1 Climate Change Sea Level Rise Figures stated in PPS25

Administrative Region	Net Sea Level Rise (mm/yr) Relative to 1990			
	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
East of England, East Midlands, London, SE England	4.0	8.5	12.0	15.0
South West	3.5	8	11.5	14.5
NW England, NE England	2.5	7.0	10.0	13.0

Source = PPS25 Table B.1 (page 15)

Based on these data it is calculated that the sea-level rise in the Thames Estuary from 1990 to 2115 is approximately 1.2m. These sea level rise figures have been incorporated into the TuFLOW modelling. For reference and comparison purposes, the Thames still water levels calculated by the ISIS OM8 in-bank model - August 2005 to February 2006 developed by Halcrow have been presented in Table A.1 in Appendix A. The levels for 2015, 2065 and 2115 have been calculated by applying the incremental sea level rise figure advocated by PPS25 to the 2002 Halcrow levels. Figure A.1 in Appendix A illustrates the location of the ISIS model nodes, as supplied by the Environment Agency (Neil Gunn 18/07/07). The Defra climate change figures only allow for calculation of levels up to the year 2115. Despite the absence of available climate change data, beyond 2115, the impact of climate change is predicted to continue beyond this horizon. The Thames Estuary 2100 (TE2100) Flood Risk Management Plan should be consulted (upon completion in 2010) to address the flood risk and climate change impacts up to 2115.

2.2 Storm Surge Profile

JBA Consulting have recently undertaken a review of the extreme storm surge in the Thames Estuary and the establishment of a new extreme tidal storm surge profile. This revision has resulted in a shift in the shape of the tidal surge. The '*shape of the tidal surge*' can be described as the change in the shape of the normal tidal cycles (tide level against time), as a consequence of meteorological driving factors. JBA's revision of the Thames tidal surge has resulted in a shift from a surge that increased the maximum tide level of several tidal cycle peaks to a surge

which has a more pronounced influence on just one tidal cycle. The impacts of this revision are increased peak water level, to those used in the earlier Kent Thameside SFRA.

The impact of the Thames tidal surge analysis and the climate change sea level rise figures presented in PPS25 have necessitated the re-modelling of breaches in the Dartford and Gravesham tidal flood defences.

3. Breach Modelling Assessment

3.1 Introduction

The original SFRA report identified that a breach in the tidal flood defences during an extreme tidal event would result in a significant flood risk in Kent Thameside. The 2-dimensional hydrodynamic flood modelling software TuFLOW was used in the SFRA Update to simulate the impact of a breach in six locations in Dartford and Gravesham. The original SFRA analysed twelve breach locations, the SFRA Update is reviewing only six of these. TuFLOW records, water surface levels, depth, velocity and a flood hazard value. These detailed outputs enable detailed mapping of the flood risk posed by a failure in the defences to be produced.

This section of the SFRA update outlines the methodology used to update the Thames defence breach modelling. This is required as the methodology used in the SFRA Update, differs slightly from that used in the original study. The primary differences are related to the modelling software used and the extreme Thames tide level data.

Failure of Flood Defences

The SFRA is a tool which presents and interprets spatially variable flood risk information to inform the planning process, its purpose is to provide an evidence base for the formulation of the LDF. As such the SFRA has assessed the consequence of flood defence failure. The likelihood of the extreme tide events occurring is low (0.1% annual probability of occurrence), but as the original SFRA demonstrates, the consequences are very significant. The likelihood of defence failure is also low and when combined with the probability of the occurrence of the extreme tidal event, the likelihood of flooding is very low. Nonetheless, the consequence of a breach remains very high. The SFRA is therefore geared towards facilitating the management of the hazard rather than prescribing the probability of it occurring and the most likely location of such failures.

The TE2100 process has involved a review of the Thames tidal defences and this information is due for release in the spring of 2009.

3.2 Approach and Model Input Data

The tidal Thames floodplain is divided into discrete topographic areas, the term ‘embayments’ is used to describe these areas of floodplain. The East London SFRA provided a name for all the embayments in East London and in the interest of continuity the same naming convention has been retained in the Kent Thameside SFRA and Kent Thameside SFRA update. The embayments are illustrated in Figure 3.1 and are known as the Dartford, Swanscombe and Gravesham embayments.

3.2.1 Software

The modelling software applied in the Kent Thameside SFRA Update differs to that used in the original SFRA in that the fully 2-dimensional hydrodynamic flood modelling software TuFLOW is being utilised in preference to JBA Consulting’s raster based flood routing model JFLOW. There are several advantages of this approach which include the model’s more

sophisticated hydrology equations and TuFLOW's ability to write out velocity and flood hazard values. TuFLOW also allows a Stage Hydrograph[1] to be used to represent the rising and falling tide levels in the Thames. The rising and falling limbs of the predicted tidal Stage Hydrograph could therefore be modelled with greater accuracy, as during the falling limb of the tide, water can return to the Thames channel. This function of TuFLOW removes the requirement, which JFLOW had, of first having to calculate the breach inflows (m^3/sec) in the 1-dimensional ISIS modelling software package.

3.2.2 Topography

One of the key data inputs into a TuFLOW model is the topography of the modelled area. LiDAR (Light Detecting and Ranging) data is typically used in a TuFLOW model to represent the ground elevation. The LiDAR data is comprised of a fine resolution grid of cells each with individual elevation values. This *elevation surface* is referred to as a 'DTM' (Digital Terrain Model). The same LiDAR data (supplied by the Environment Agency), used in the original Kent Thameside SFRA, was used in this SFRA Update. In the original SFRA there was a portion of the Dartford embayment which did not have full LiDAR coverage. To rectify this data gap, SAR (Synthetic Aperture Radar) data was requested from the Environment Agency. SAR data is similar to LiDAR in that it is a grided surface elevation model. SAR data is recognised as being less accurate than LiDAR, this is primarily a function of the data capture and post collection processing techniques used. Nonetheless, in the absence of a higher quality data alternative, SAR data represents the only practical solution.

Small edits[2] were made to the DTM to prepare the data for modelling in the original study; these edits have been retained in the updated modelling. There have been some changes to landform in Kent Thameside since the LiDAR data used in this study was captured. The most notable example being around the area of the Ebbsfleet International Rail Station. Major changes to the topography were incorporated in to the DTM. Due to the inherent complexities in DTM editing, small alterations have not been incorporated. The SFRA therefore represents an indicative extent of flood risk. Site specific Flood Risk Assessments (FRAs) should be undertaken in identified risk areas to confirm the degree of flood risk and inform appropriate flood risk management options.

3.2.3 Modelling Parameters

The topographic data (LiDAR and SAR) was re-sized into a 10m resolution elevation grid. A 10m resolution elevation grid is defined as a regular grid of 10m by 10m cells each with a single elevation value. This resolution improves the TuFLOW model stability and is considered an acceptable resolution by the Environment Agency for SFRA breach modelling.

The tidal defences were digitised into the model; these were fixed with a crest level of 10m AOD. This was because the SFRA was only required to model the residual risk associated with a structural failure in the flood defences. To model breach scenarios without including the significant additional complexities associated with over topping modelling, which may be associated with the 1 in 1000 year event in 2115, the defence heights were fixed at 10m.

[1] Stage Hydrograph = a record of water level over time.

[2] Edits were undertaken to represent know flow routes and to improve model stability.

When modelling a given breach in TuFLOW, a small stretch of the River Thames in the vicinity of the breach location is modelled. Applied to this part of the model is the Thames Stage Hydrograph which controls the tidal water levels.

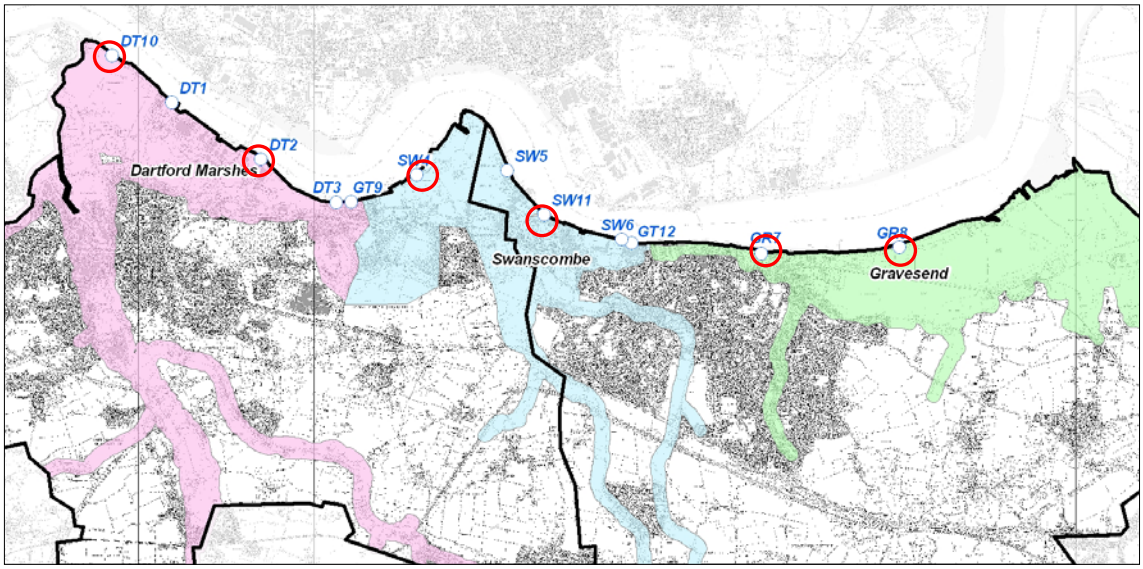
TuFLOW is a sophisticated modelling package with significant capability. It cannot however, simulate a '*dam failure*' scenario. This limitation in the modelling software means that it is not possible to start the breach simulation when the tide level in the Thames is at its peak. The breach simulation therefore has to commence at the low point in the tidal cycle. Following Environment Agency standing advice on breach modelling[3] the simulations were run for two Tidal cycles. This allowed for the influence of two tidal level peaks and two tide level troughs, which resulted in water flowing into the embayments during rising tide levels and caused water to leave the embayment on the receding limb of the tide. The Kent Thameside Delivery Board note that some detailed modelling work undertaken in North East Gravesend indicated that there is a good match between the resultant maximum flood extents between running a breach simulation from around high tide, and running a simulation from low tide. The rates of inundation are not necessarily comparable.

3.3 Location and Configuration of Breaches

Locations for breach models were chosen as part of the original study. Twelve locations were chosen in total, these included breaches in soft defences (earth embankments, which may be formed around a clay core) with low lying invert level, hard defences (re-enforced concrete or steel sheet pile walls) close to urban centres and failure of gates in the flood defences. Figure 3.1 shows the location of the breaches modelled in the original study. The six breaches that had the most significant flood risk impact have been remodelled to assess the impacts of the revised Thames tide levels; these are shown in Figure 3.1.

[3] Personal Communication with Environment Agency Thames Barrier Flood Mapping and Data Management Team

Figure 3.1 Breach Location Map



All Kent Thameside SFRA breaches are identified, Update breaches are circled in red.

Environment Agency policy for defence breaches is to use a 50m wide breach in soft defences and a 20m wide breach for hard defences. This policy was adopted for Kent Thameside except in the case of the failure of flood defence gates (Breach GR7), where the width of the gate was used in the modelling. Table 3.1 shows a list of the breaches modelled in the SFRA Update.

Table 3.1 Comparison of Breach Data for Original and Revised Study

Embayment	Breach ID	Width	Breach Invert Level	Original ISIS Model Thames Design Level 1:1000 year level	Revised ISIS Model Thames Design Level 1:1000 year level for the year 2115
		m	mAOD	mAOD	mAOD
Dartford	DT_2	50.0	3.0	5.83	7.139
Dartford	DT_10	50	1.0	5.84	7.161
Swanscombe	SW_4	50.0	1.4	5.79	7.057
Swanscombe	SW_11	20	0.3	5.78	7.011
Gravesend	GR_7	7.3	-1.8	5.76	6.895
Gravesend	GR_8	50.0	1.1	5.72	6.814

The six breaches that have been remodelled in this Update SFRA are those identified in the original study as those potentially representing the worst case scenarios for flooding in Kent Thameside. This being due to either the large volume of flood waters that pass through the breaches and thus cause the most extensive and deepest flooding or because of their proximity to urban centres. The Update breaches are evenly distributed between Dartford and Gravesham, with a mix of hard and soft defence failure scenarios being modelled in each council area. A

breach in the Northfleet Embankment has not been modelled as the area behind the defences is an existing industrial area. Future development in this area will have to be supported by robust site specific FRAs which demonstrate that the development proposals meet the requirements of PPS25. It is important to note that this area remains as a zone of residual flood risk as it is in defended Flood Zone 3, despite it not being remodelled in the SFRA Update.

4. Mapping

4.1 Flood Depth

The resultant flood data from the Breach Analysis is presented in Figures B1 to B7 in Appendix B.

4.2 Flood Hazard

The flood hazard for the residual risk associated with breaches in the Thames defences has been mapped according to the methodology set out in the original report. Flood hazard provides an indication of the risk flood waters may pose to life. It is given, as a product of the velocity and depth of the flood waters, by the following equation[4]:

$$\text{flood hazard} = \text{depth} \times (\text{velocity} + 0.5)^{5}$$

The flood hazard is categorised according to Table 4.1 to describe the flood risk posed by the flood waters. Flood hazard mapping is presented in Figures B8 to B14 in Appendix B

Table 4.1 Criteria for mapping flood hazard

Degree of Flood Hazard	Classification of Flood Hazard		Description
	From	To	
Low		< 0.75	Caution "*Flood Zones with shallow flowing water or deep still standing water*"
Moderate	0.75	1.25	Dangerous for some (i.e. children) "*Danger: Flood zone with deep or fast flowing water*"
Significant	1.25	2.5	Dangerous for most people "*Danger: Flood zone with deep fast flowing water*"
Extreme	>2.5		Dangerous for all "*Extreme Danger: Flood zone with deep fast flowing water*"

Taken from the Flood Risk to People Report – Phase 2 (March 2006)

The hazard mapping for each breach model can be found in Appendix B, the classifications are based on Table 4.1.

[4] Steven Wade, Mohammed Hassan & Valerie Bain, *Flood risks to people in defended areas*, (HR Wallingford Ltd) presented at the London CIWEM conference, January 2005.

[5] Taken from the Flood Risk to People Report – Phase 2 (March 2006)

The breaches modelled in this SFRA Update Report provide a detailed appreciation of the likely extent of flooding and the potential hazard, which is likely to result from a defence failure during an extreme tidal event in the year 2115. As described in Section 3, the six breach locations were selected because they were deemed to present the greatest risk to the majority of the embayments. There will however be sites where breaches in different locations to those modelled in the SFRA will potentially present the greatest potential flood risk to a given site. The most hazardous breach location for any given site needs to be reviewed with the Environment Agency for any development proposal.

4.3 Sequential Test Supporting Material

4.3.1 Principal of the Sequential Test and PPS25

PPS25 exists to reduce the flood risks, faced by future developments, through the planning process. It advocates a risk avoidance approach to spatial planning. This is in contrast to a risk management approach which has historically been the case through the construction of flood walls and flood defence infrastructure.

4.3.2 Planning Process

The SFRA Update has identified which potential development sites are outside the Flood Zones 2 and 3 and what land uses are considered appropriate for each site based on the guidance specified in PPS25 (using Table 4.2 and Figures C1 and C2 in Appendix C, which delineate the Environment Agency Flood Zones).

Figures C1a and C1b display the identified risk across each site put forward for review in the assessment. The flood risk zones are defined by the Environment Agency Flood Zones, which does not include Functional Floodplain (Zone 3b). In the Dartford Town Centre a functional floodplain was defined and was used to provide a functional floodplain classification for sites in Dartford on Figure C1a. The reader is asked to consult the Dartford Town Centre SFRA for details of this delineation and location specific planning guidance. Figures C2a and C2b are borough wide maps and use only the Environment Agency Flood Zones (Zone 1, Zone 2 and Zone 3a).

The sequential approach directs planned development towards Flood Zone 1. There will however be occasions where planning permissions will be sought in higher flood risk zones, particularly with respect to the redevelopment of brownfield sites in the urban centres, to remain inline with wider sustainability objectives. If a development with a vulnerability classification (see table D.2 in PPS25), is sought in a flood risk zone with a higher probability of flooding than stated as acceptable in Table D.1 (in PPS25), then the Exception Test must be passed as part of the site specific FRA. Flood mitigation measures should be considered as early as possible in the design development process to reduce and manage the flood risks associated with development.

4.3.3 Vulnerability and Risk

There are several key points that the Councils should consider when applying the Sequential Test to inform the site allocation process, these are outlined below.

- Increasing the vulnerability of a site by proposing an alternative use of a higher vulnerability (even if consistent with the risk) is considered an increase in flood risk and is not inline with the principals of PPS25.

- The most vulnerable landuses should be allocated first, in the areas of least risk.
- Placing less vulnerable uses in low risk areas and thus reducing the amount of available space for more vulnerable uses in the lower risk zones is not appropriate. Such a situation can only be considered if it can be demonstrated that the only suitable site, for the low vulnerability landuse, is in the area of low risk. Reasons for this may include space constraints and required transport access.
- If land in zone 3a has to be utilised, development should be steered towards the areas of lowest hazard within that zone.

4.3.4 Site Specific Level of Flood Risk Assessment

The SFRA does not replace the need for site specific flood risk assessments to be undertaken for proposed developments. Figures C1a (Dartford) and C1b (Gravesham) in Appendix C present the distribution of flood zones for each of the potential development sites made available for assessment in the SFRA. The detailed modelling undertaken in the Dartford Town Centre SFRA has been utlilised in the assessment of sites in Dartford. Please note that the same site boundaried and classifications used in the Dartford Town Centre SFRA have been used in this Kent Thameside SFRA Update. Figures C2a (Dartford) and C2b (Gravesham) classify the zones of flood risk across in accordance with the classifications presented in Table 4.2. Figure C2a and C2b can be used to guide the decision making process when presented with windfall sites.

Table 4.2 Flood Risk Classification and Guidance

PPS25 Flood Zone	Probability	PPS25 Landuse Guidance
Flood Zone 3b	Highly likely	Only the water compatible uses and the essential infrastructure listed in Table D.2 (Appendix D) should be permitted in this zone. Development should be designed and constructed in such a way to: remain operational and safe for users in times of flood; result in no net loss of floodplain storage; not impede water flows; and not increase flood risk elsewhere Essential Infrastructure in this zone should pass the Exception Test
Flood Zone 3a	Likely	The water compatible and less vulnerable uses of land in Table D.2 are appropriate in this zone. The highly vulnerable uses should not be permitted in this zone. The more vulnerable and essential infrastructure uses in Table D.2 should only be permitted in this zone if the Exception Test is passed. All developments in this zone should be accompanied by a FRA.
Flood Zone 2	Unlikely	The water compatible, less vulnerable and more vulnerable uses of land and essential infrastructure in Table D.2 are appropriate in this zone. Subject to the Sequential Test being applied, the highly vulnerable uses in table D.2 are only appropriate in this zone if the Exception Test is passed. All development proposals in this zone should be accompanied by a FRA
Flood Zone 1	Highly Unlikely	All uses of land are appropriate in this zone

Guidance taken from Table D.1 in PPS25

5. Review and Recommendations

5.1 Review

PPS25 and *Development and Flood Risk: A Practice Guide Companion to PPS25* sets out a framework for the delivery of a SFRA. The purpose of a Stage 1 SFRA is to facilitate the completion of the Sequential Test and identify whether the Exception test is required. The recommended outputs of a Stage 1 SFRA are:

- plans showing the LPA area, Main Rivers, ordinary watercourses and flood zones, including the functional floodplain where appropriate, across the local authority area as defined in Table D1 of PPS25, as well as all allocated development sites;
- an assessment of the implications of climate change for flood risk at allocated development sites over an appropriate time period, if this has not been factored into the plans above;
- areas at risk of flooding from sources other than rivers and the sea;
- the location of any flood risk management measures, including both infrastructure and the coverage of flood warning systems;
- locations where additional development may significantly increase flood risk elsewhere. That being Flood Zones 2 and 3 as development in these zones has the potential to influence flow routes and flood water levels;

With the addition of the mapping provided in this Update Report, the Kent Thameside SFRA now provides all the information set out above.

The requirements of a Stage 2 SFRA are intended inform the application of the Exception Test, i.e. probability of flooding, rate of onset, depth and velocity. The data required for this is now available, individual site assessments have not been undertaken in the Kent Thameside SFRA. The information presented in the Kent Thameside SFRA and the Update Report robust evidence base to support the LDF site allocation process.

5.2 Recommendations and Conclusions

Residual Flood Risk

The revised advice on the assessment of the impact of climate change has had a significant impact on the flood risk to Kent Thameside, in that flood extents are generally larger and deeper. This will have an impact on the single site FRAs and the interpretation of the Exception Test. Individual FRAs will need to be undertaken for any sites within the Environment Agency Flood Risk Zones. FRAs should consult the SFRA to inform the level of residual risk.

The predicted increase in peak tide level by the year 2115 is substantial. The predicted peak tide level of the 1 in 1000 year event exceeds the current flood defence crest levels. Therefore in the event of the 1 in 1000 year tide occurring, in the year 2115, it is predicted that there will be overtopping of the defences. This prediction is based on the assumption that the current flood defences are not re-engineered. Overtopping of flood defences represents as different type of

flooding to that associated with defence failure. Nonetheless, overtopping and breaching are both classified as residual flood risks. They are risks that exist despite there being formal flood defences. This SFRA update has not quantified or mapped the flooding associated with overtopping and as such the resultant extent of this risk is not defined. This uncertainty implies that a site specific FRA for new development proposals, for which the application of the Exception Test is required, should assess the potential implications of flooding resulting from defence overtopping.

TE2100 and Production of the LDF

A review of the flood defence assessment management procedure is recommended and a robust programme for maintaining and improving the defences should be prepared. This should include a regular review of the latest climate change predictions and the impact of the peak flood level. The strategy for flood management in the Thames Estuary will be determined by the final outcomes of the TE2100 review process. The emerging four potential flood management policies have significantly different implications on how the level of risk facing Kent Thameside will be addressed over the next one hundred years. These four policies represent a refinement of the four high level policies that the Environment Agency consulted on in December 2007, but details could not be released by the Environment Agency. Upon the completion of the TE2100 project it would be pertinent to undertake a review of the SFRA to assess the implications of the adopted TE2100 policies. It is understood that that there is no intention to reduce the current design standard of the flood defences in the developed areas of Kent Thameside.

At the time of this report's production the TE2100 project is appraising detailed options, the outcomes will be available in the spring of 2009. It is likely that there will be policies involving the sustained provision of the existing standard of protection and the potential for providing areas for flood water storage. The TE2100 output in 2009 should be reviewed to identify any locations identified as potential flood storage areas. It is recommended that through the spatial planning process designated locations are safeguarded for use as flood storage areas by resisting new development. It is also recommended that development immediately behind the flood defences to be designed in such a way as to easily facilitate the raising and re-engineering of the tidal flood defences. For all development applications immediately behind flood defences, consultation with the Environment Agency should be sought.

5.3 Maintaining an up to date Flood Risk Evidence Base

The following questions are ones which the Councils are advised to ask in order to ensure that the most recent flood risk information and flood risk policies are used to inform planning decisions.

- Has the appraisal of detailed TE2100 options been released? (timetabled for 2009)
- Has the final options report of TE2100 been released? (timetabled for 2010)
- Has there been any revision to national planning policy? (check biannually)
- Has the Environment Agency issued revised/updated guidance on development in floodplains? (check biannually)
- Has revised tide level / climate change data been released or have the flood zones been modified (check biannually)

The Environment Agency are due to release revised fluvial floodplain extents for the whole of the River Darent and downstream of the A2 on the River Cray. This modelling will utilise the latest 2-dimensional floodplain modelling techniques and provide hazard classification for the entire fluvial floodplain of the Darent. When the modelling is completed it will be used to update the Environment Agency Flood Zones. When available, the updated Flood Zones should be utilised into spatial planning decision making process.

Appendix A
Thames Still Water Levels Climate Change Allowances

Figure A.1 Location of ISIS Thames Model Nodes

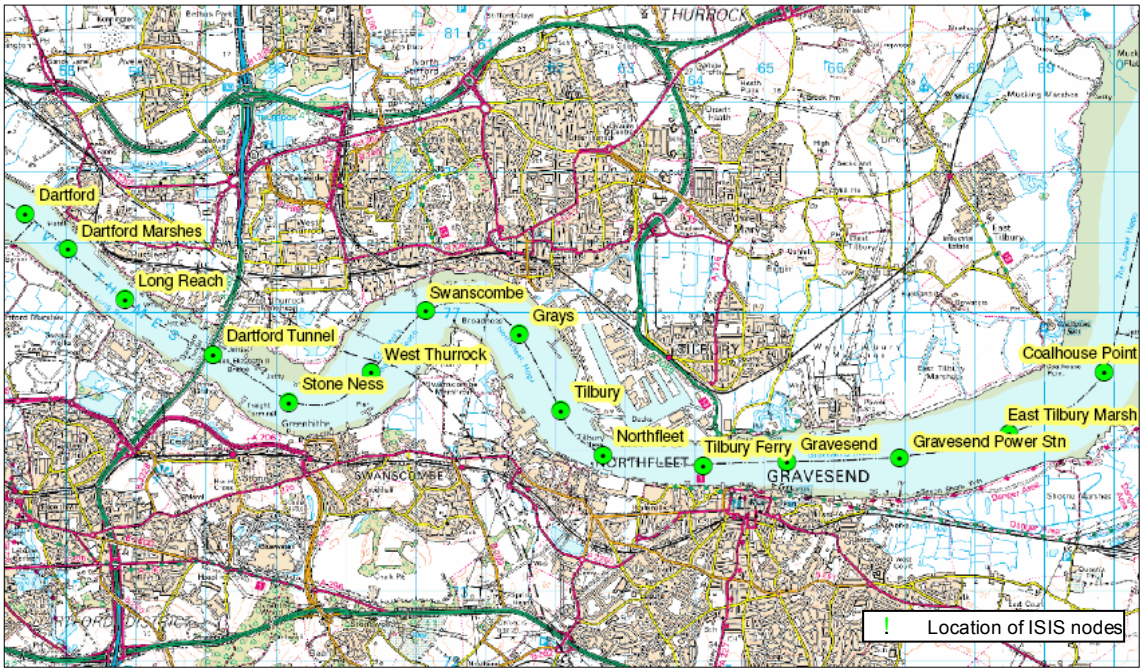
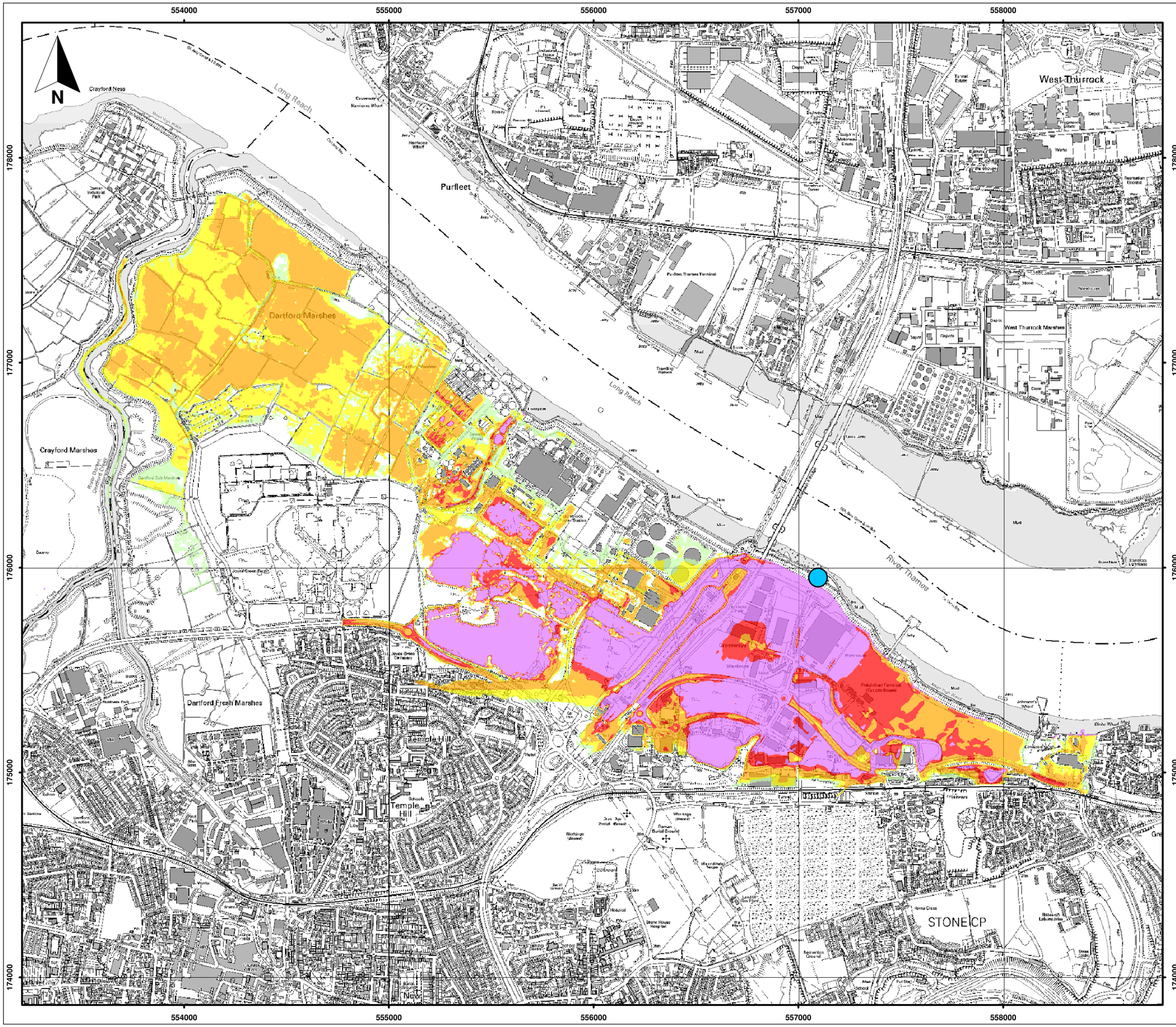


Table A.1 Design Flood Levels for different Annual Exceedence Probability Flood Events (AEP) for a Range of Time Horizons

Node Name	Design Year	2% AEP	1% AEP	0.5% AEP	0.05% AEP	0.01% AEP
Coalhouse Point	2002	4.97	5.12	5.27	5.47	5.62
	2015	5.022	5.172	5.322	5.522	5.672
	2065	5.437	5.587	5.737	5.937	6.087
	2115	6.127	6.277	6.427	6.627	6.777
Dartford	2002	5.31	5.44	5.57	5.75	5.88
	2015	5.362	5.492	5.622	5.802	5.932
	2065	5.777	5.907	6.037	6.217	6.347
	2115	6.467	6.597	6.727	6.907	7.037
Dartford Marshes	2002	5.3	5.43	5.56	5.74	5.87
	2015	5.352	5.482	5.612	5.792	5.922
	2065	5.767	5.897	6.027	6.207	6.337
	2115	6.457	6.587	6.717	6.897	7.027
Dartford Tunnel	2002	5.28	5.42	5.55	5.72	5.85
	2015	5.332	5.472	5.602	5.772	5.902
	2065	5.747	5.887	6.017	6.187	6.317
	2115	6.437	6.577	6.707	6.877	7.007
East Tilbury Marsh	2002	5	5.15	5.3	5.5	5.65
	2015	5.052	5.202	5.352	5.552	5.702
	2065	5.467	5.617	5.767	5.967	6.117
	2115	6.157	6.307	6.457	6.657	6.807
Gravesend	2002	5.04	5.19	5.33	5.53	5.68
	2015	5.092	5.242	5.382	5.582	5.732
	2065	5.507	5.657	5.797	5.997	6.147
	2115	6.197	6.347	6.487	6.687	6.837
Gravesend Power Stn	2002	5.03	5.17	5.32	5.52	5.67
	2015	5.082	5.222	5.372	5.572	5.722
	2065	5.497	5.637	5.787	5.987	6.137
	2115	6.187	6.327	6.477	6.677	6.827
Grays	2002	5.23	5.37	5.51	5.68	5.81
	2015	5.282	5.422	5.562	5.732	5.862
	2065	5.697	5.837	5.977	6.147	6.277
	2115	6.387	6.527	6.667	6.837	6.967
Long Reach	2002	5.29	5.43	5.56	5.73	5.87
	2015	5.342	5.482	5.612	5.782	5.922
	2065	5.757	5.897	6.027	6.197	6.337
	2115	6.447	6.587	6.717	6.887	7.027

Node Name	Design Year	2% AEP	1% AEP	0.5% AEP	0.05% AEP	0.01% AEP
Northfleet	2002	5.15	5.29	5.43	5.6	5.74
	2015	5.202	5.342	5.482	5.652	5.792
	2065	5.617	5.757	5.897	6.067	6.207
	2115	6.307	6.447	6.587	6.757	6.897
Stone Ness	2002	5.29	5.42	5.56	5.73	5.86
	2015	5.342	5.472	5.612	5.782	5.912
	2065	5.757	5.887	6.027	6.197	6.327
	2115	6.447	6.577	6.717	6.887	7.017
Swanscombe	2002	5.27	5.41	5.54	5.71	5.84
	2015	5.322	5.462	5.592	5.762	5.892
	2065	5.737	5.877	6.007	6.177	6.307
	2115	6.427	6.567	6.697	6.867	6.997
Tilbury	2002	5.19	5.33	5.47	5.64	5.77
	2015	5.242	5.382	5.522	5.692	5.822
	2065	5.657	5.797	5.937	6.107	6.237
	2115	6.347	6.487	6.627	6.797	6.927
Tilbury Ferry	2002	5.09	5.23	5.37	5.56	5.7
	2015	5.142	5.282	5.422	5.612	5.752
	2065	5.557	5.697	5.837	6.027	6.167
	2115	6.247	6.387	6.527	6.717	6.857
West Thurrock	2002	5.28	5.41	5.55	5.72	5.85
	2015	5.332	5.462	5.602	5.772	5.902
	2065	5.747	5.877	6.017	6.187	6.317
	2115	6.437	6.567	6.707	6.877	7.007

Appendix B
Mapping Output



Key:

Breach Location

Breach Model - Maxium Depth (m)
1 in 1000 year event in 2115

- < 0.5 m
- 0.5 - 1.0 m
- 1.0 - 2.0 m
- 2.0 - 2.5 m
- > 2.5 m

0 200 400 600 800 Meters

Scale: 1:18,000 @ A3

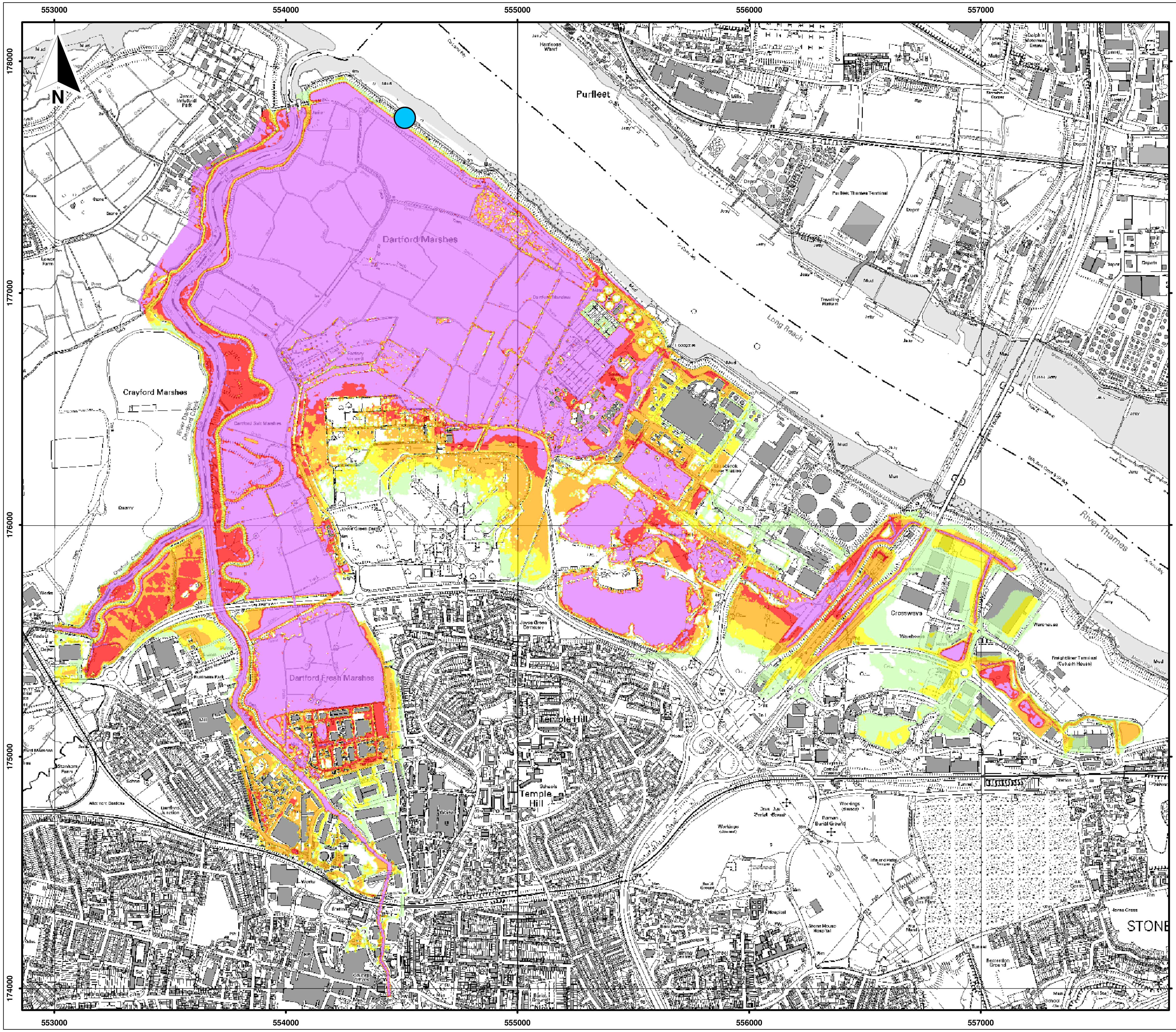
H:\Projects\HM-255\20000-Projects\20656 KTDB SFRA Extension\Mapping Results\Mapping Results

Kent Thameside SFRA Extension

Figure B1
DT2 Breach Model
1 in 1000 year event in 2115
Depth data (m)

September 2008
20656-S00 bollm

Entec



Key:

Breach Location

Breach Model - Maxium Depth (m)
1 in 1000 year event in 2115

- < 0.5 m
- 0.5 - 1.0 m
- 1.0 - 2.0 m
- 2.0 - 2.5 m
- > 2.5 m

0 200 400 600 800 Meters

Scale: 1:16,000 @ A3

H:\Projects\HM-255\20000-Projects\20656 KTDB SFRA Extension\Mapping Results\Mapping Results

Kent Thameside SFRA Extension

Figure B2
DT10 Breach Model
1 in 1000 year level in 2115
Depth results (m)

September 2008
20656-S00 bollm

Entec

565000 566000 567000 568000 569000

175000 174000 173000

Tilbury Power Station

Sewage Works

River Thames

Gravesend Reach

Royal Terrace Pier

Denton Wharf

Canal Basin

Denton

Westcourt

Great Clane Lane Marshes

Filborough Marshes

Eastcourt Marshes

Chalk

Key:

Breach Location

Breach Model - Maxium Depth (m)
1 in 1000 year event in 2115

- < 0.5 m
- 0.5 - 1.0 m
- 1.0 - 2.0 m
- 2.0 - 2.5 m
- > 2.5 m

0 200 400 600 Meters

Scale: 1:14,000 @ A3

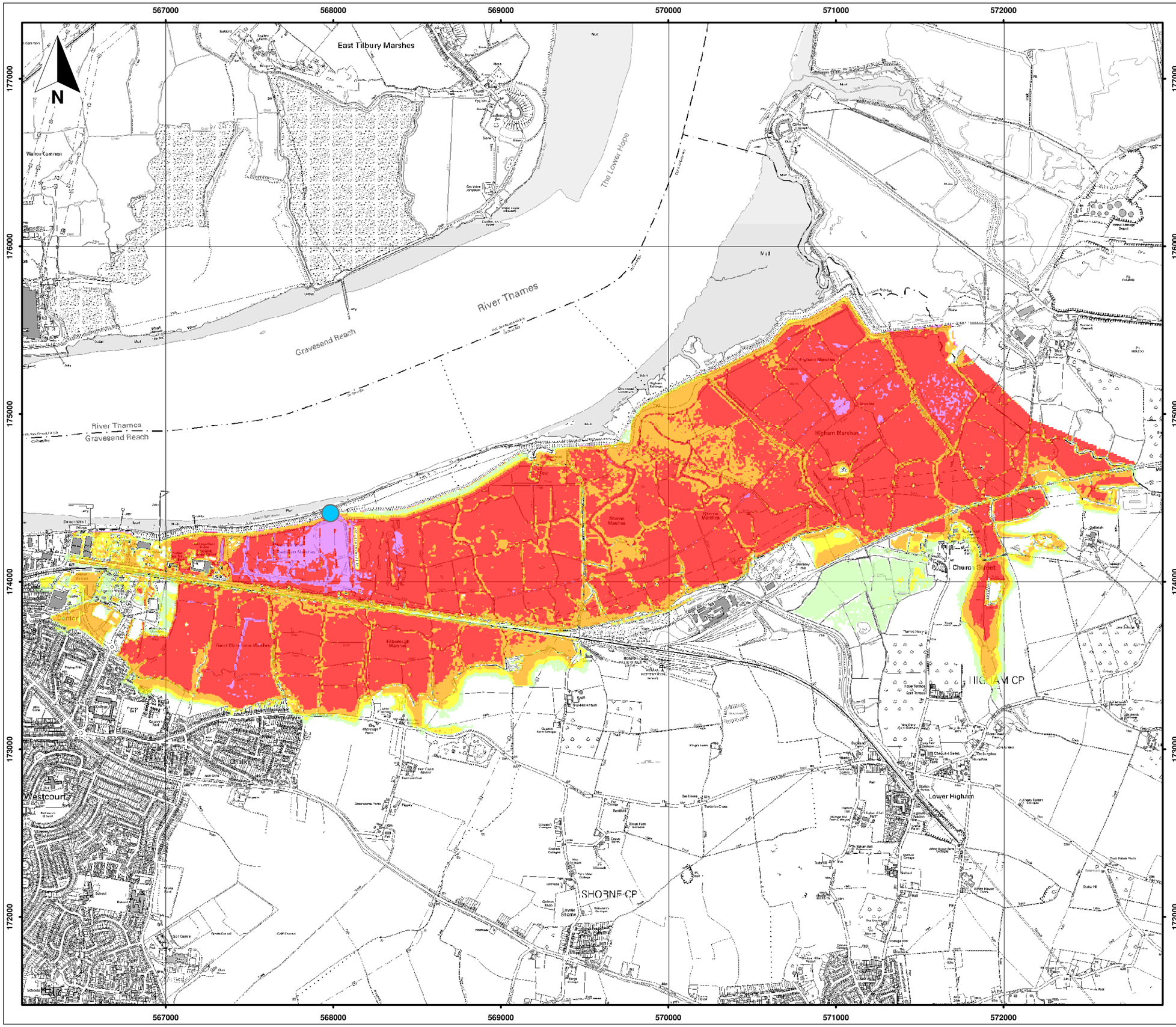
H:\Projects\HM-255\20000-Projects\20656 KTDB SFRA Extension\Mapping Results\Mapping Results

Kent Thameside SFRA Extension

Figure B3
GR7 Breach Model
1 in 1000 year event in 2115
Depth results (m)

September 2008
20656-S00 bollm

Entec



Key:

Breach Location

Breach Model - Maxium Depth (m)
1 in 1000 year event in 2115

- < 0.5 m
- 0.5 - 1.0 m
- 1.0 - 2.0 m
- 2.0 - 2.5 m
- > 2.5 m

0 200 400 600 800 Meters

Scale: 1:22,000 @ A3

\Project pathname

Kent Thameside SFRA Extension

Figure B4
GR8 Breach Model
1 in 1000 year event in 2115
Depth results (m)

October 2007
20656-S00 bollm

Entec

559000 560000 561000 562000

176000 175000 174000

N

SWANSCOMBE

SWANSCOMBE AND GREENHITHE CP

Greenhithe

Knockhall

Swanscombe Marshes

Botany Marshes

Northfleet Industrial Estate

Kent Kraft Industrial Estate

Bell Wharf

Paper Mills Wharf

Tide Gauge

Sewage Works

Allotment Gardens

Northfleet West Grid Sub Station

Springhead Enterprise Park

Chalk Pit

Workings (disused)

Key:

Breach Location

Breach Model - Maxium Depth (m)
1 in 1000 year event in 2115

- < 0.5 m
- 0.5 - 1.0 m
- 1.0 - 2.0 m
- 2.0 - 2.5 m
- > 2.5 m

There have been landform changes in this area and the flood extents are therefore indicative

0 200 400 Meters

Scale: 1:12,000 @ A3

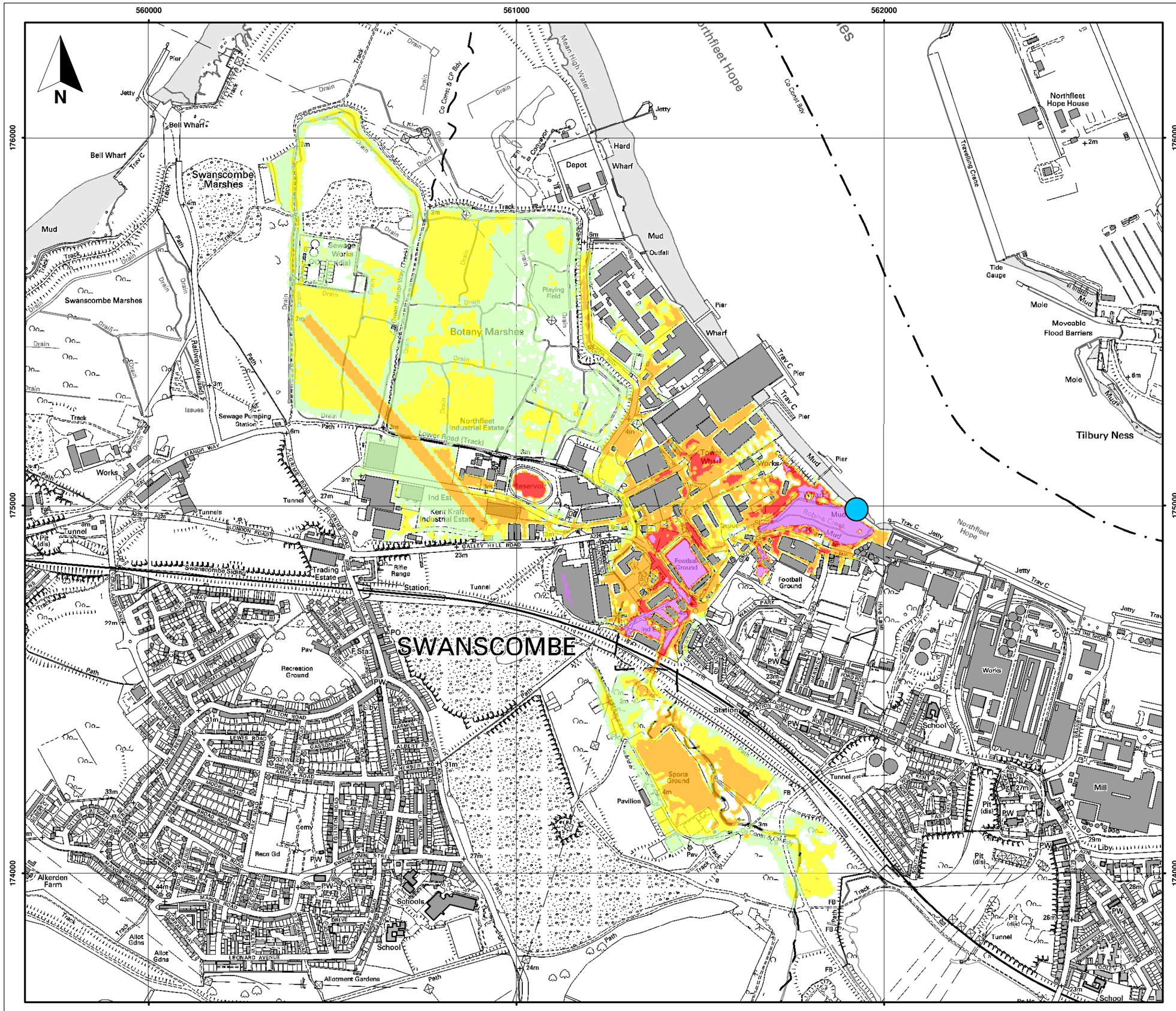
H:\Projects\HM-255\20000-Projects\20656 KTDB SFRA Extension\.Mapping Results\Mapping Results

Kent Thameside SFRA Extension

Figure B5
SW4 Breach Model
1 in 1000 year event in 2115
Depth results (m)

September 2008
20656-S00 bollm

Entec



Key:

Breach Location

Breach Model - Maxium Depth (m)
1in 1000 year event in 2115

- < 0.5 m
- 0.5 - 1.0 m
- 1.0 - 2.0 m
- 2.0 - 2.5 m
- > 2.5 m

There have been landform changes in this area and the flood extents are therefore indicative

0 200 Meters

Scale: 1:10,000 @ A3

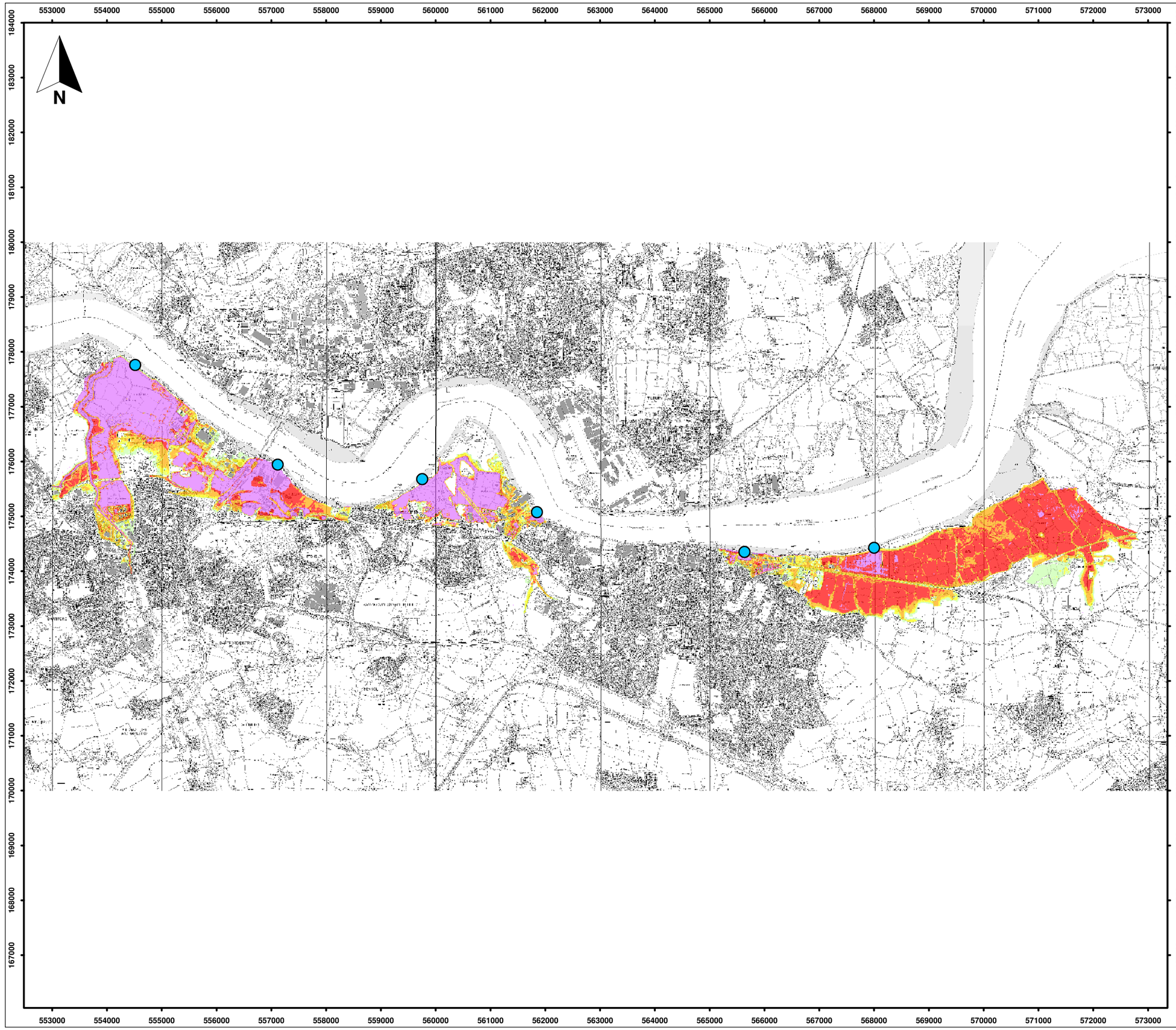
H:\Projects\HM-255\20000-Projects\20656 KTDB SFRA Extension\Mapping Results\Mapping Results

Kent Thameside SFRA Extension

Figure B6
SW11 Breach Model
1in 1000 year event in 2115
Depth results (m)

September 2008
20656-S00 bollm

Entec



Key:

Breach Locations

All Breach Models
Combined Maxium Depth (m)
1 in 1000 year event in 2115

- < 0.5 m
- 0.5 - 1.0 m
- 1.0 - 2.0 m
- 2.0 - 2.5 m
- > 2.5 m

0 1,000 2,000 3,000 4,000 5,000 Me

Scale: 1:18,000 @ A3

H:\Projects\HM-255\20000-Projects\20656 KTDB SFRA Extension\Mapping Results\Mapping Results

Kent Thameside SFRA Extension

Figure B7
Kent Thameside
1 in 1000 year event in 2115
Combined Maximum Depth results (m)

September 2008
20656-S00 bollm

Entec

554000 555000 556000 557000 558000

178000 177000 176000 175000 174000

N

Crayford Ness

Long Reach

Purfleet

West Thurrock

Dartford Marshes

West Thurrock Marshes

Crayford Marshes

River Thames

Crossways

Dartford Fresh Marshes

Temple Hill

Temple Hill

STONE CP

Key:

Breach Location

Rapid Inundation Zones (Hazard)
1 in 1000 year event in 2115

- No Danger (< 0.75)
- Danger for Some (0.75 - 1.25)
- Danger for Most (1.25 - 2.5)
- Danger for All (> 2.5)

0 200 400 Meters

Scale: 1:18,000 @ A3

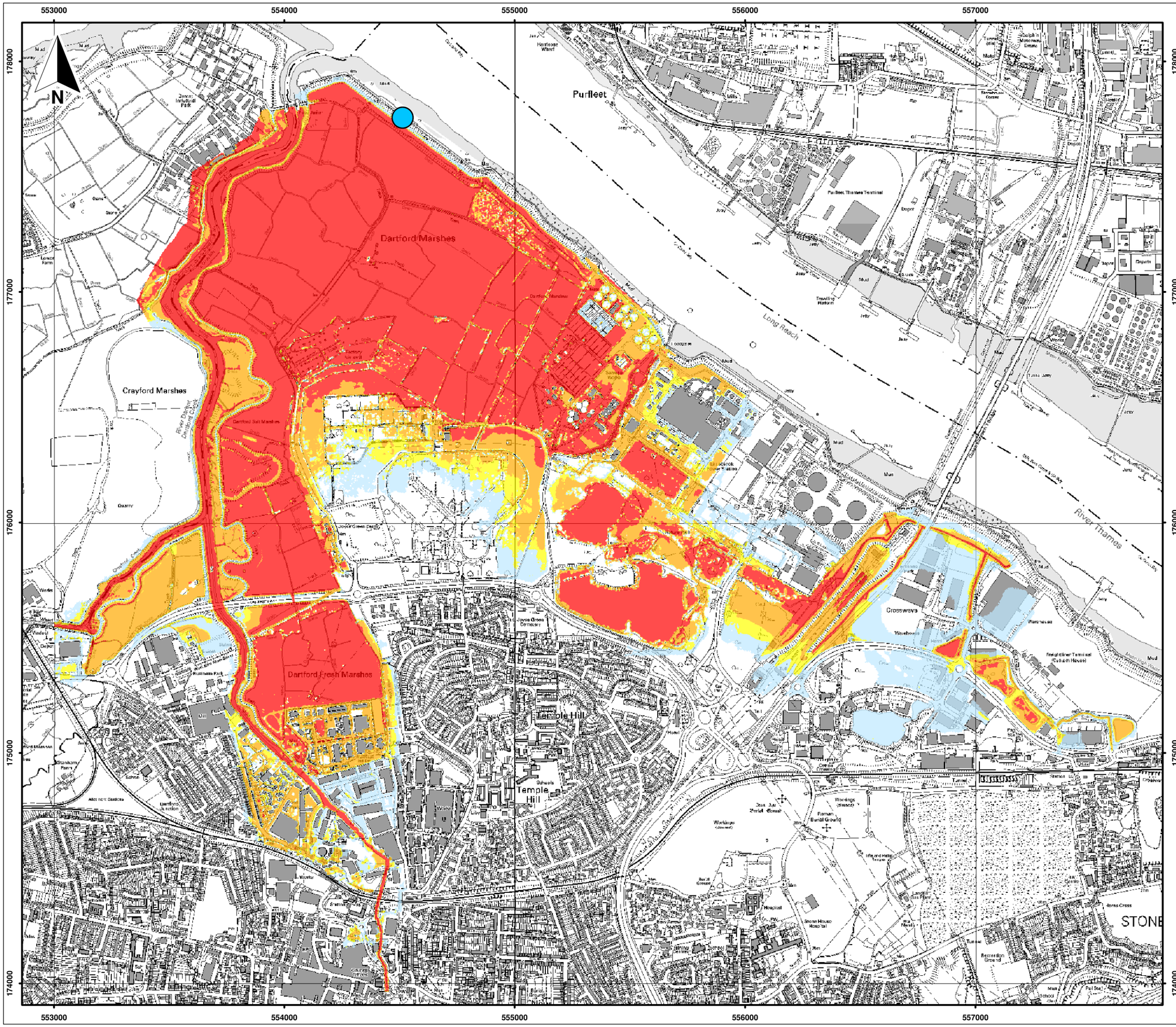
\Project pathname

Kent Thameside SFRA Extension

Figure B8
DT2 Breach Model
1 in 1000 year event in 2115
Hazard

September 2008
20656-S00 bollm

Entec



Key:

Breach Location

Rapid Inundation Zones
1 in 1000 year event in 2115

- No Danger (< 0.75)
- Danger for Some (0.75 - 1.25)
- Danger for Most (1.25 - 2.5)
- Danger for All (> 2.5)

0 200 400 600 800 Meters

Scale: 1:16,000 @ A3

H:\Projects\HM-255\20000-Projects\20656 KTDB SFRA Extension\Mapping Results\Mapping Results

Kent Thameside SFRA Extension

Figure B9
DT10 Breach Model
1 in 1000 year event in 2115
Hazard

October 2007
20656-S00 bollm

Entec

565000 566000 567000 568000 569000

175000 174000 173000

Tilbury Power Station
Sewage Works
Outfall
Jetty
Wharf
Mud
River Thames
Gravesend Reach
Co Const Rdy
H.E.R. Boro Const & UA Bdy
Royal Terrace Pier
Pier
Denton Wharf
Offices
Mean High Water
Metropolitan Police Specialist Training Centre
National Sea Training College
Eastcourt Marshes
Million Rifle Range
Denton
Gravesend
Westcourt
Great Crane Lane Marshes
Filborough Marshes
Chalk
Filborough Farm
Eastcourt Cottages
East Court Manor
Greenacres Farm
Piggery
Polperro
Caravan Park
Sports Ground
Playing Field
School
Recreation Ground
Allot Gdns
Path
Drain

Key:

Breach Location

Rapid Inundation Zones (Hazard)
1 in 1000 year event in 2115

- No Danger (< 0.75)
- Danger for Some (0.75 - 1.25)
- Danger for Most (1.25 - 2.5)
- Danger for All (> 2.5)

0 200 400 600 Meters

Scale: 1:14,000 @ A3

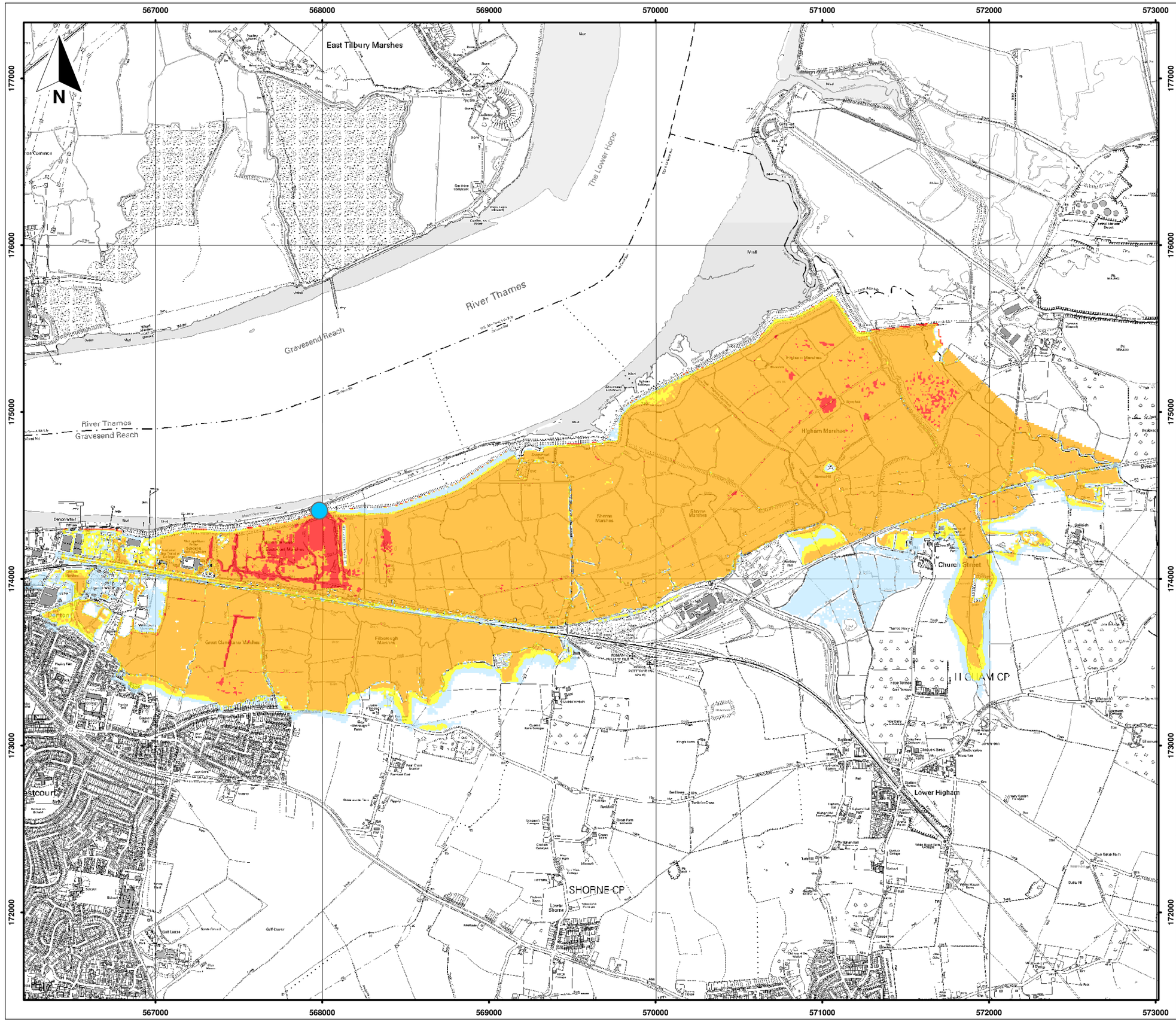
H:\Projects\HM-255\20000-Projects\20656 KTDB SFRA Extension\Mapping Results\Mapping Results

Kent Thameside SFRA Extension

Figure B10
GR7 Breach Model
1 in 1000 year event in 2115
Hazard

October 2007
20656-S00 bollm

Entec



Key:

Breach Location

Rapid Inundation Zones (Hazard)
1 in 1000 year event in 2115

- No Danger (< 0.75)
- Danger for Some (0.75 - 1.25)
- Danger for Most (1.25 - 2.5)
- Danger for All (> 2.5)

0 200 400 600 800 1,000 Meters

Scale: 1:22,000 @ A3

H:\Projects\HM-255\20000-Projects\20656 KTDB SFRA Extension\Mapping Results\Mapping Results

Kent Thameside SFRA Extension

Figure B11
GR8 Breach Model
1 in 1000 year event in 2115
Hazard

September 2008
20656-S00 bollm

Entec

559000 560000 561000 562000

176000 175000 174000

N

SWANSCOMBE

SWANSCOMBE

WANSCOMBE AND GREENHITHE CP

Swanscombe Marshes

Botany Marshes

Northfleet Industrial Estate

Kent Kraft Industrial Estate

Greenhithe

Knockhall

Bell Wharf

Paper Mills Wharf

Tower Wharf

Northfleet Hope

Co Coast Bdy

Co Coast & CP Rly

Jetty

Wharf

Pier

Mud

Sand

Causeway

Cromes

Outfall

Tide Gauge

Hard

Depot

Sewage Works (dis)

Sewage Pumping Station

Playing Field

Lower Road (Track)

Ind Est

Reservoir

Works

Tunnel

Railway (disused)

Trading Estate

Rifle Range

Station

Swanscombe Siding

Football Ground

Robins Creek

Sports Ground

Pavilion

School

Schools

Recreation Ground

Allot Gdns

Allotment Gardens

Cemy

Ingress Gardens

Sports Field

Workings (disused)

Chalk Pit

Alkerden Farm

Western Cross Farm

Conveyors

Conveyor

Northfleet West Grid Sub Station

Sewage Works

Springhead Enterprise Park

Dam

Lodge

Track

Path

Drain

Trav C

Pw

Pav

FB

Rec Gd

Cemy

Sub Sta

Ind Est

Recreation Ground

Allotment Gardens

Sewage Works

Springhead Enterprise Park

Northfleet West Grid Sub Station

Workings (disused)

Chalk Pit

Alkerden Farm

Western Cross Farm

Ingress Gardens

Sports Field

Allot Gdns

Sports Ground

Pavilion

Tide Gauge

Travelling Crane

Co Coast Bdy

Co Coast & CP Rly

Mean High Water

Northfleet Hope

Jetty

Wharf

Pier

Mud

Sand

Causeway

Cromes

Outfall

Hard

Depot

Sewage Works (dis)

Sewage Pumping Station

Playing Field

Lower Road (Track)

Ind Est

Reservoir

Works

Tunnel

Railway (disused)

Trading Estate

Rifle Range

Station

Swanscombe Siding

Football Ground

Robins Creek

Sports Ground

Pavilion

School

Schools

Recreation Ground

Allot Gdns

Allotment Gardens

Cemy

Ingress Gardens

Sports Field

Workings (disused)

Chalk Pit

Alkerden Farm

Western Cross Farm

Conveyors

Conveyor

Northfleet West Grid Sub Station

Sewage Works

Springhead Enterprise Park

Dam

Lodge

Track

Path

Drain

Trav C

Pw

Pav

FB

Rec Gd

Cemy

Sub Sta

Ind Est

Recreation Ground

Allotment Gardens

Sewage Works

Springhead Enterprise Park

Northfleet West Grid Sub Station

Workings (disused)

Chalk Pit

Alkerden Farm

Western Cross Farm

Ingress Gardens

Sports Field

Allot Gdns

Sports Ground

Pavilion

Tide Gauge

Travelling Crane

Co Coast Bdy

Co Coast & CP Rly

Mean High Water

Northfleet Hope

Key:

Breach Location

Rapid Inundation Zones (Hazard)
1 in 1000 year event in 2115

- No Danger (< 0.75)
- Danger for Some (0.75 - 1.25)
- Danger for Most (1.25 - 2.5)
- Danger for All (> 2.5)

There have been landform changes in this area and the flood extents are therefore indicative

0 200 400 Meters

Scale: 1:12,000 @ A3

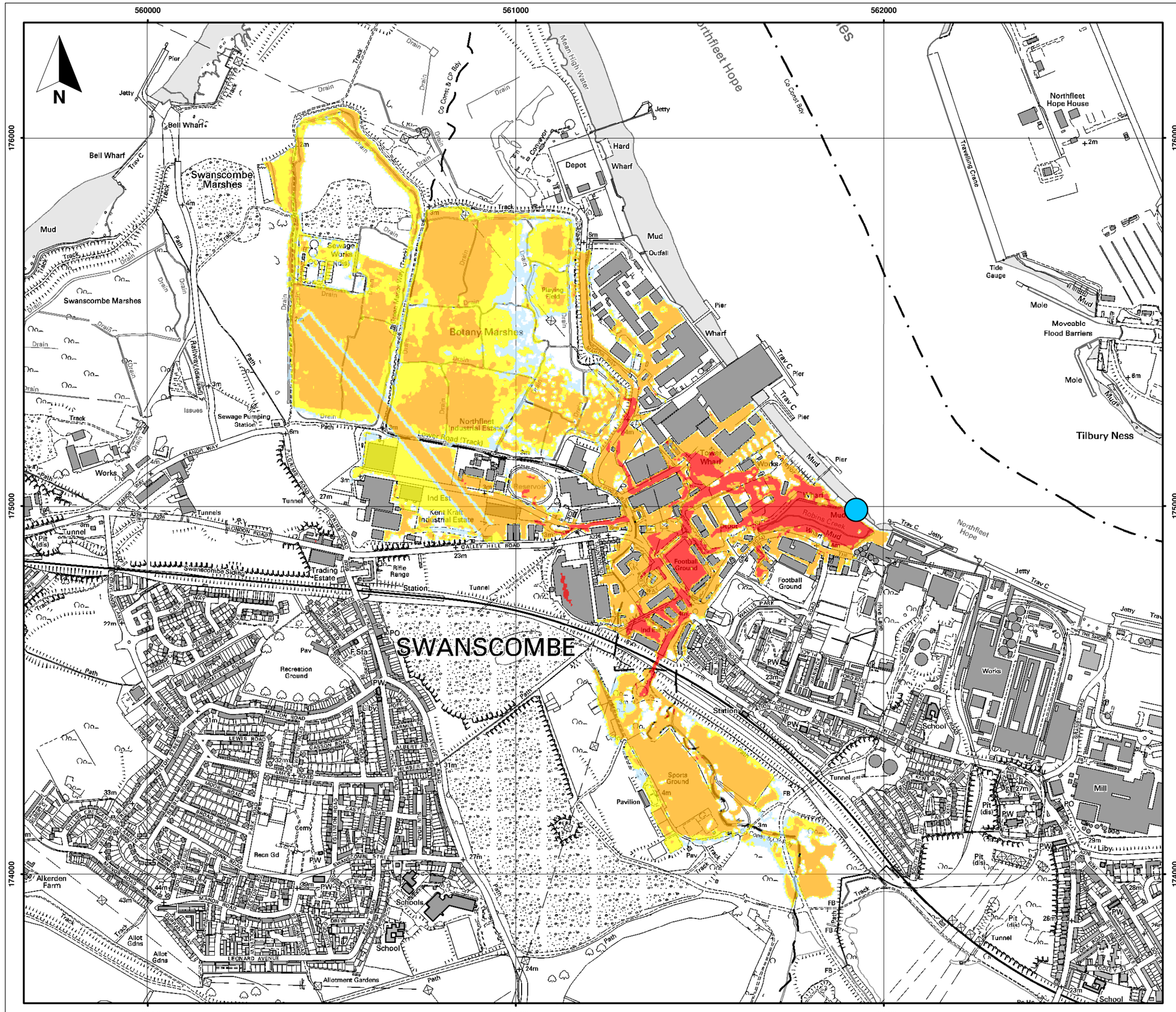
H:\Projects\HM-255\20000-Projects\20656 KTDB SFRA Extension\Mapping Results\Mapping Results

Kent Thameside SFRA Extension

Figure B12
SW4 Breach Model
1 in 1000 year event in 2115
Hazard

September 2008
20656-S00 bollm

Entec



Key:

Breach Location

Rapid Inundation Zones (Hazard)
1 in 1000 year event in 2115

- No Danger (< 0.75)
- Danger for Some (0.75 - 1.25)
- Danger for Most (1.25 - 2.5)
- Danger for All (> 2.5)

There have been landform changes in this area and the flood extents are therefore indicative

0 200 400 Meters

Scale: 1:10,000 @ A3

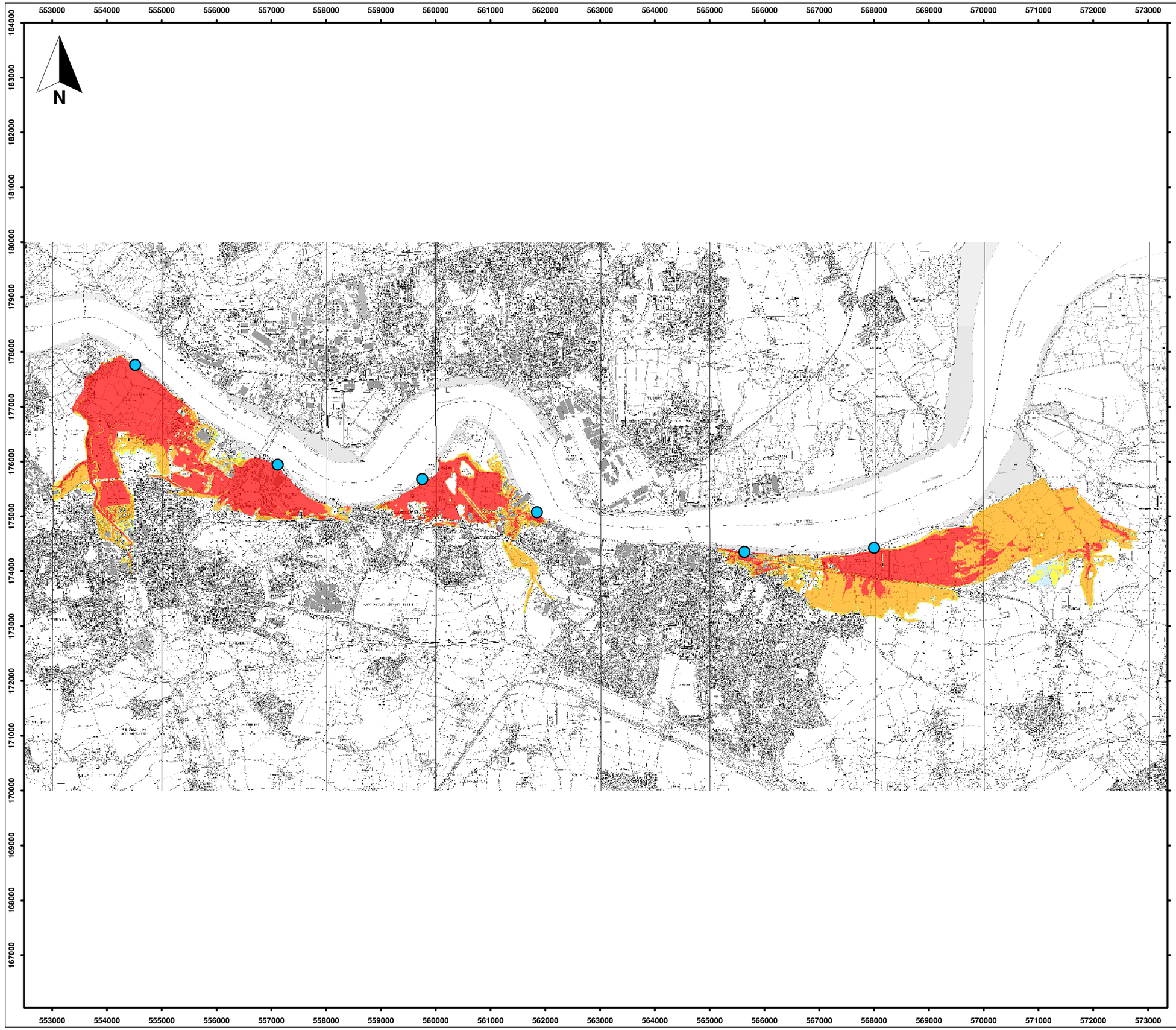
H:\Projects\HM-255\20000-Projects\20656 KTDB SFRA Extension\Mapping Results\Mapping Results

Kent Thameside SFRA Extension

Figure 4B13
SW11 Breach Model
1 in 1000 year event in 2115
Hazard

September 2008
20656-S00 bollm

Entec



Key:

Breach Locations

All Breach Models
Combined Maximum
Rapid Inundation Zones (Hazard)

- No Danger (< 0.75)
- Danger for Some (0.75 - 1.25)
- Danger for Most (1.25 - 2.5)
- Danger for All (> 2.5)

0 1,000 2,000 Meters

Scale: 1:18,000 @ A3

H:\Projects\HM-255\20000-Projects\20656 KTDB SFRA Extension\Mapping Results\Mapping Results

Kent Thameside SFRA Extension

Figure B14
Kent Thameside
1 in 1000 year event in 2115
Combined Maximum Hazard

September 2008
20656-S00 bollm

Entec

Appendix C
Mapping to Support Sequential Test

Key:

Council Boundaries

Zone of Flood Risk

- Flood Zone 3b Functional Floodplain
- Flood Zone 3a High Probability
- Flood Zone 2 Medium Probability
- Flood Zone 1 Low Probability

Notes

Flood Zones issued by the Environment Agency 2008

Zone 3b derived from Dartford Town Centre SFRA (2008)

Scale: 1:43,000 @ A3

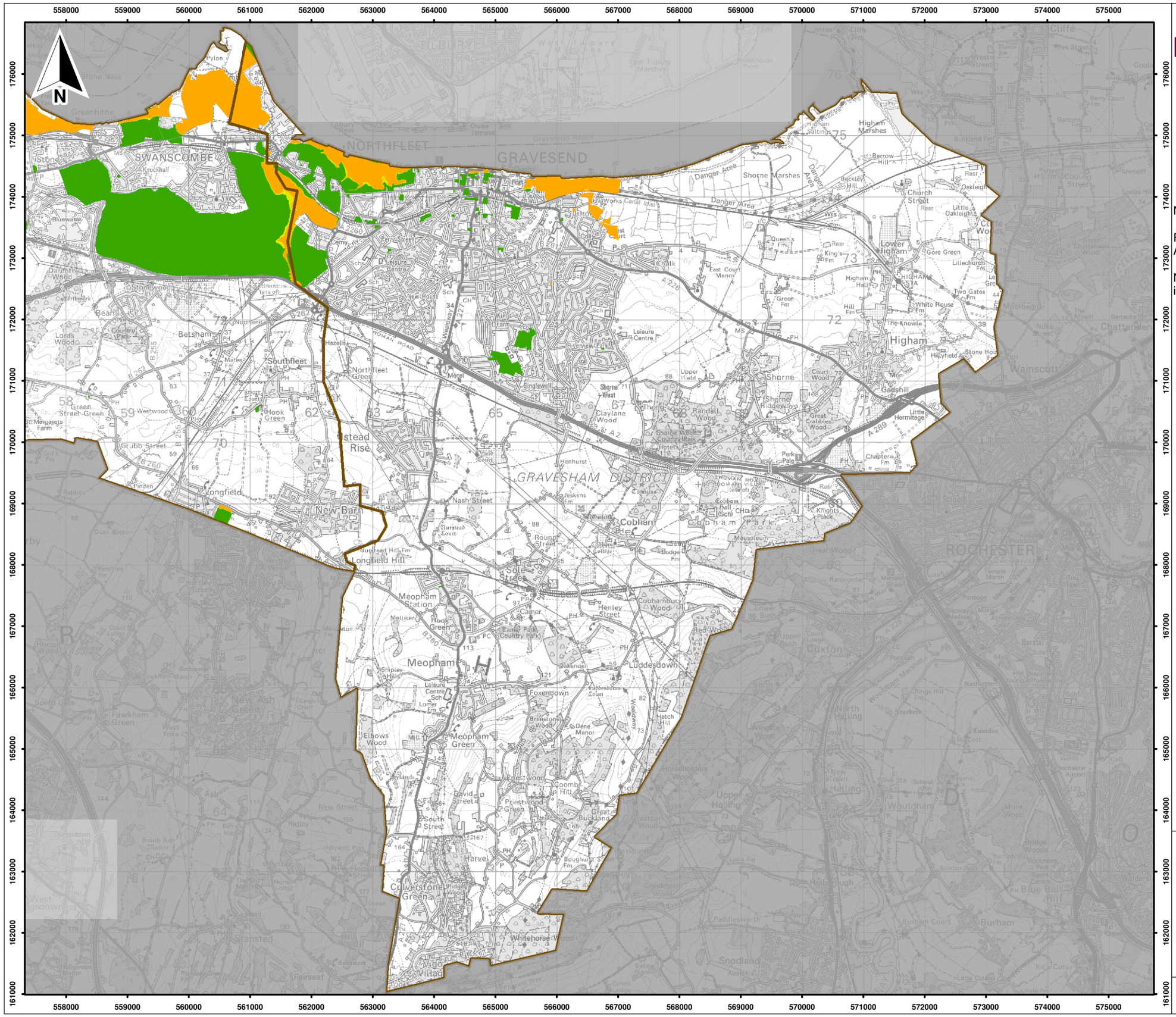
H:\Projects\HM-255\20000-Projects\20656 KTDB SFRA Extension\GIS\Development Sites Flood Risk 19Sept08 RAMPJ

Kent Thameside SFRA (Update)

Figure C1a
Classification of Flood Risk for Potential Development Sites in Dartford

March 2009
20656-SC1 rampj

Entec



Key:

Council Boundaries

Zone of Flood Risk

- Flood Zone 3a High Probability
- Flood Zone 2 Medium Probability
- Flood Zone 1 Low Probability

Notes

Flood Zones issues by the Environment Agency 2008

No Flood Zone 3b (Functional Floodplain) is held by the Environment Agency in Gravesham

Scale: 1:43,000 @ A3

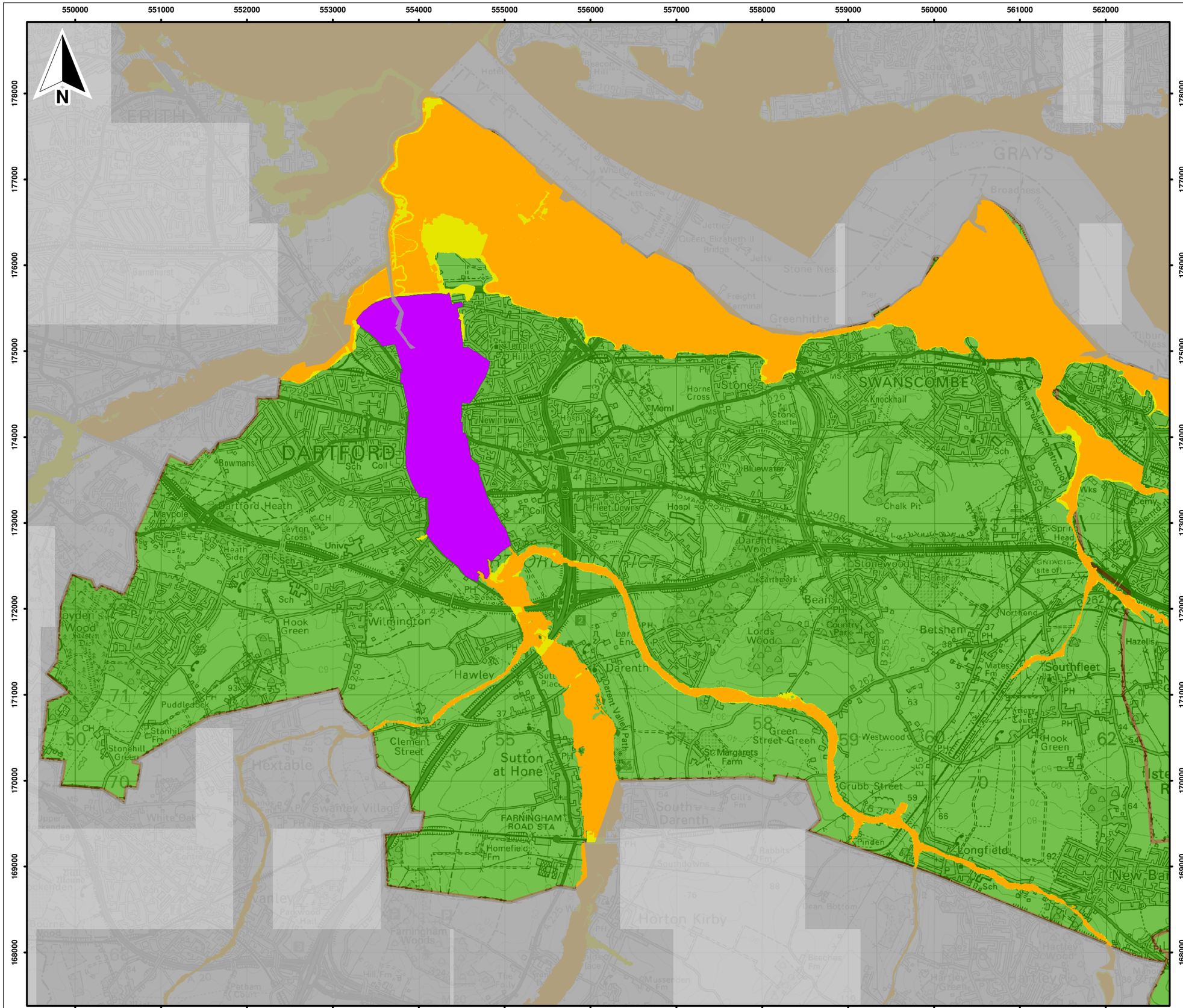
H:\Projects\HM-255\20000-Projects\20656 KTDB SFRA Extension\GIS\Development Sites Flood Risk 19Sept08 RAMPJ

Kent Thameside SFRA (Update)

Figure C1b
Classification of Flood Risk for Potential Development Sites in Gravesham

March 2009
20656-SC1b rampj

Entec



Key:

Council Boundaries

Zone of Flood Risk

- Flood Zone 3a - High Probability
- Flood Zone 2 - Medium Probability
- Flood Zone 1 - Low Probability
- Consult Dartford Town Centre SFRA July 2008

Notes

- Flood Zones issued by the Environment Agency 2008
- Flood Zones illustrated are defined on the basis of an undefended scenario
- No Flood Zone 3b (Functional Floodplain) is held the the Environment Agency for this area
- The Dartford Town Centre SFRA (2008) defined a Flood Zone 3b (Functional Floodplain) in Dartford Town Centre

Scale: 1:46,000 @ A3

H:\Projects\HM-255\20000-Projects\20656 KTDB SFRA Extension\GIS\Development Sites Flood Risk 19Sept08 RAMPJ

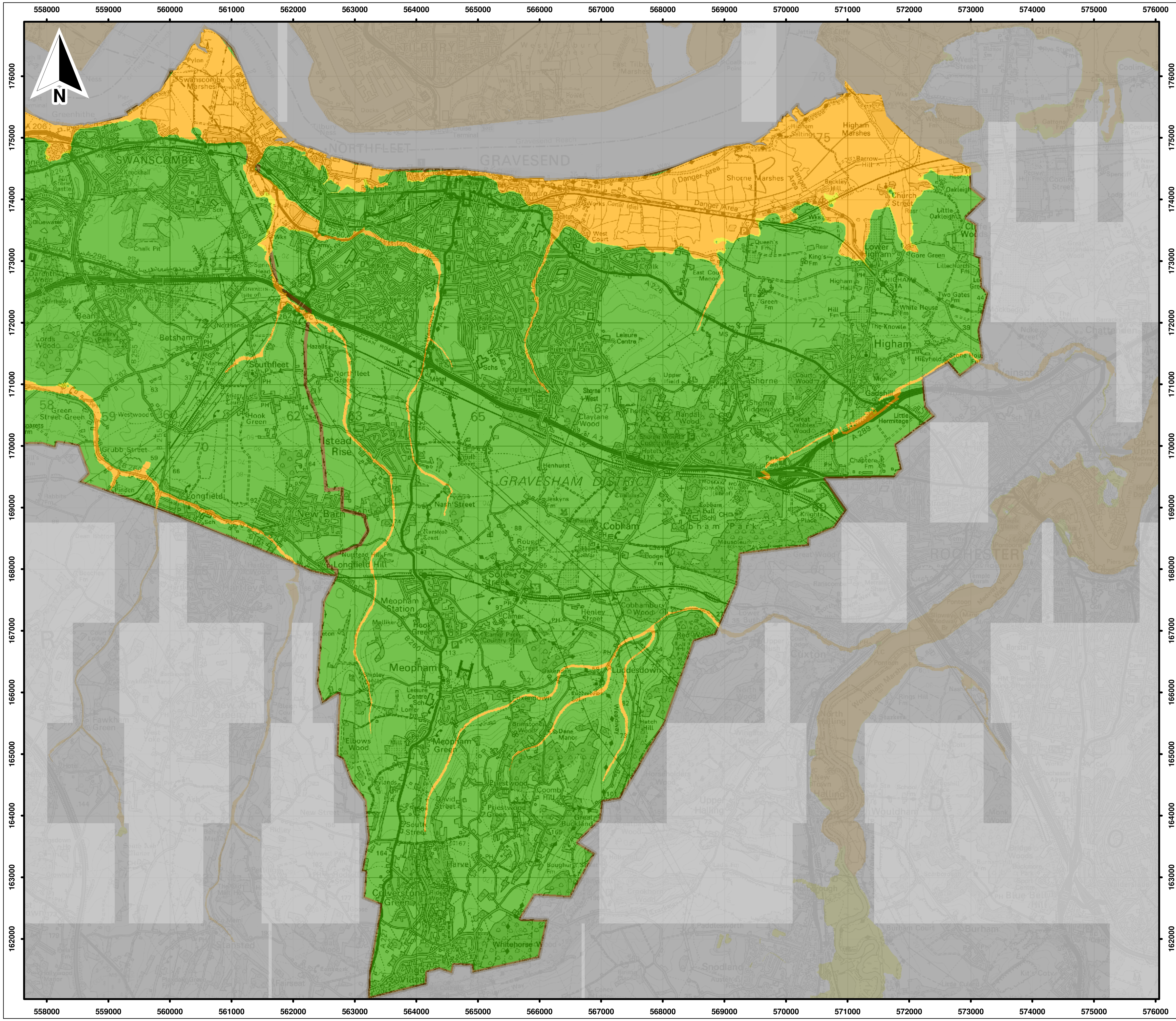
Kent Thameside SFRA (Update)

Figure C2a

Flood Risk Zones in Dartford

March 2009
20656-SC2a rampj

Entec



Key:

Council Boundaries

Zone of Flood Risk

Flood Zone 3a - High Probability

Flood Zone 2 - Medium Probability

Flood Zone 1 - Low Probability

Notes

- Flood Zones issued by the Environment Agency 2008
- Flood Zones illustrated are defined on the basis of an undefended scenario
- No Flood Zone 3b (Functional Floodplain) is held the the Environment Agency for this area

Scale: 1:59,500 @ A3

H:\Projects\HM-255\20000-Projects\20656 KTDB SFRA Extension\GIS\Development Sites Flood Risk 19Sept08 RAMPJ

Kent Thameside SFRA (Update)

Figure C2b

Flood Risk Zones in Gravesham

March 2009
20656-SC2b rampj

Entec

Appendix K
Water Company comments on Draft Report

Table K.1 Comments from Southern Water

<table>
<tr><th>Comment</th><th>Entec Response</th></tr>
<tr><td>Page 23 - SWS fully supports the Code for Sustainable Homes but as you explain in section 4 the code is voluntary and standards higher than level 1/2 are not supported by the proposed changes to building regulations. We suggest it is important to restate this constraint in the Conclusions and Recommendations in section 4.2.8 as implementation of levels higher than level 1/2 will have no statutory backing and it should not be implied that there is any guarantee that they can be achieved.</td><td>Addressed in context with other comments on this issue.</td></tr>
<tr><td>Page 36 - The water demand forecasts on page 36 appear to be based on demand in an average year. The water industry forecasts demand in a dry year i.e. at pcc levels +30 l/h/d above average. Are your demand forecasts too conservative in this respect?</td><td>I have double checked the allowances that we have made and can reconfirm that we have used dry year annual average data from the Draft WRMP. Data for both companies is presented below.

I am not sure why Southern Water think that demand maybe too low. It is possible that they were expecting to see dry year critical period figures being used, which would be higher than this. We have emphasised in the report that they are dry year annual average (peak demands rather than annual average).

<table>
<tr><th>Company</th><th>Component</th><th>2006-07</th><th>2025-26</th></tr>
<tr><td>Southern Water</td><td>New houses</td><td>164 (2007-08)</td><td>164</td></tr>
<tr><td></td><td>Existing Unmeasured Houses</td><td>182</td><td>183</td></tr>
<tr><td></td><td>Existing Measured Houses</td><td>186</td><td>170</td></tr>
<tr><td>Thames Water</td><td>New houses</td><td>137 (2007-08)</td><td>161</td></tr>
<tr><td></td><td>Existing Unmeasured Houses</td><td>169</td><td>177</td></tr>
<tr><td></td><td>Existing Measured Houses</td><td>161</td><td>155</td></tr>
</table></td></tr>
<tr><td>Page 39 - We agree with the EA view that grey water recycling systems must be "fit and forget" - in our experience the technology is not yet robust enough to rely on them providing sustainable savings. If they don't work customers abandon them. We fully support rainwater harvesting however.</td><td></td></tr>
</table>

Table K.2 Comments from Thames Water

Comment	Entec Response
Para 4.2 says water deficit until 2013/14 page 21 comment on map says 2011/12 which is correct	Comments addressed within the body of this report
Page 22 has this been signed off by the E/A yet and if not can you please make clear	Comments addressed within the body of this report
Page 24 please see comment for page 22 and standardise	Comments addressed within the body of this report
Page 68 we currently do not adopt suds	Comments addressed within the body of this report
8.3.1 para 7 again talks about supply demand deficit 13/14 see comment on para 4.2	Comments addressed within the body of this report