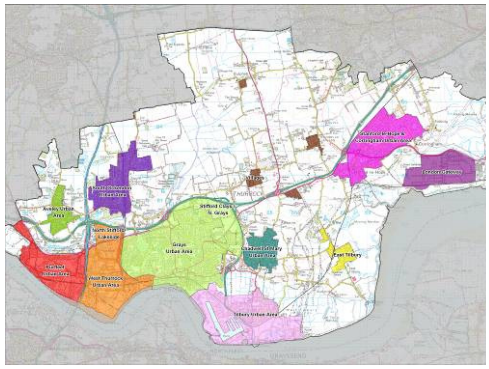
Thurrock Water Cycle Study
Outline Study

Final Report
March 2010



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THURROCK COUNCIL

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Thurrock Water Cycle Study: Outline Study Report
March 2010

Rev	Date	Details	Prepared by	Reviewed by	Approved by
01	August 2009	D122361 - Draft Outline Study Report	**Sarah Kelly** Water Specialist	**Carl Pelling** Principal Hydrologist	**Jon Robinson** Associate Director
02	March 2010	D122361 - Outline Study Report	**Sarah Kelly** Water Specialist	**Carl Pelling** Principal Hydrologist	**Jon Robinson** Associate Director

Scott Wilson
Scott House
Alençon Link
Basingstoke
Hampshire
RG21 7PP

Tel: 01256 310200
Fax: 01256 310201

www.scottwilson.com

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Executive Summary

Study Purpose

The Thurrock Scoping Study was completed by Scott Wilson in February 2009 and undertook a high level assessment of the water cycle related issues and defined whether there are significant constraints that required further assessment within Thurrock. The Outline Study has built on the findings of the Scoping Study and has assessed the impact of the proposed growth targets for Thurrock on the water cycle infrastructure and water environment in the Thurrock Study Area. This is based on the growth identified in the Regional Spatial Strategy (up to 2021) and additional growth up to 2025 (to assess a 15-year housing supply), totalling 17,348 dwellings and an indicative 26,000 jobs between 2009 and 2025. This assessment has been used to determine where additional investment is required to supply new infrastructure or to protect the water environment. This assessment has been undertaken for eleven identified Broad Areas for Regeneration within Thurrock to provide an indication of the spatial constraints to development within the Borough.

Water Resources and Supply

There is little or no water available from existing sources within Thurrock and therefore future development will be served by water supplied from the increase in storage at Abberton Reservoir which is due to be completed in 2014. Until this scheme comes online, ESW will be running at a 'supply demand deficit' in their water resource planning for the area meaning that during a very dry year there is considered to be insufficient resources to meet peak demand, and as such ESW are at risk of not meeting their 'levels of service' to customers. However, ESW have a statutory duty to supply water to Thurrock and even during a very dry year it is not expected that water supply to Thurrock for both existing and new properties will be affected so to cause a constraint to development in the Borough. Therefore, there are not considered to be any water resource constraints to development within Thurrock up to 2025.

ESW have indicated that development up to 2025 is unlikely to require strategic level investment in the water supply network and it should be able to connect to all proposed development areas via the existing strategic mains, though site specific connections will still be required.

Flood Risk Management, Sustainable Drainage Systems and Surface Water Management

The main flood risks to Thurrock are from the River Mardyke and Thames Estaury (tidal). East Tilbury, Grays, London Gateway, Tilbury and West Thurrock all lie with Flood Zone 3a of the Thames Estuary and though these areas are defended from tidal flooding up to the 1 in 1000 year event there is a residual risk to these areas if there is a breach in the flood defences. There is considered to be a constraint to development in Tilbury and London Gateway, where the entire development area lies within Flood Zone 3a and has a hazard rating of 'extreme'.

Surface water management is a key issue within Thurrock and a Surface Water Management Plan should be undertaken for the Borough. The areas of West Thurrock, Grays and East Tilbury may be constrained in the terms of Sustainable Drainage Systems (SuDS) that can be used to limit runoff rates from new development, as they overlie the Source Protection Zones for the Stifford and Linford Public Water Supplies and therefore surface water runoff reduction in the area may be heavily reliant on surface based attenuation. Site-specific SuDS will be dependent on the characteristics of the site, such as pollution potential, presence of contamination, local geology etc. and will require further assessment as part of a site-specific Flood Risk Assessment and/or Drainage Strategy.

Wastewater Treatment and Collection

The method of assessment of Dry Weather Flow (DWF) has recently changed to a statistical method based on measured flows. As part of this change, the DWF consent for Tilbury will need to be increased; however, there is currently some uncertainty around the accuracy of the measurements of DWF at Tilbury WwTW. At the time of completing this Outline WCS, AWS were in the process of determining whether the measured flow is accurate but were unable to conclude whether capacity is available within the higher DWF consent being applied for in order to accommodate growth.

If the measured flow proves to be accurate, the revised consent would not include capacity for growth and a revised consent application will be required to take account of growth. Further investigation of this issue is required at Detailed WCS stage once AWS have concluded their investigation of DWF at Tilbury WwTW.

The existing wastewater network serving the west of Thurrock is almost at capacity and development in the Purfleet, Aveley and West Thurrock area will require an upgrading of the network to increase capacity. Anglian Water Services (AWS) have planned to address this as part of their next AMP5 Capital Scheme (up 2015), planning to build a 1800mm sewer to increase the capacity to service and transport the waste in the west of the Thurrock. However, development will have to be phased to ensure that the required capacity is available with the proposed housing/employment growth.

Water Quality

It is considered that there is sufficient water quality capacity within the Thames Estuary for additional wastewater discharge from development in Thurrock up to 2025. The flow consent at Tilbury WwTW will not be exceeded by growth within the Borough and as such, under existing legislation, there is no statutory requirement to tighten the quality consents from the WwTW. Additionally, tidal rivers often have less rigid or no water quality objectives due in part to the difficulty associated with assigning water quality objectives and monitoring water quality in these stretches of water which are typically affected by flow levels, tides and temperature. However, under the WFD there may be requirements to reduce the consents at Tilbury WwTW to meet the proposed Dissolved Oxygen and Dissolved Inorganic Nitrogen standards; this will require further investigation and discussion with the Environment Agency as part of the Detailed WCS.

Water quality within the lower stretches of the River Mardyke which flows through Thurrock urban area is currently of moderate to poor quality and fails to meet ‘good ecological status’ under the WFD. Poorly managed surface water runoff from development areas bordering this watercourse and the Thames Estuary has the potential to impact on water quality within these watercourses and should therefore be mitigated to ensure there is no deterioration in the existing water quality.

Ecology and Biodiversity

The Habitats Regulation assessment has not identified any hydraulically linked European designated sites or local Sites of Special Scientific Interest (SSSI) as being adversely affected by the proposed development in Thurrock due to the increase in public water supply to serve new development within Thurrock.

However, there may be a requirement for further investigation to consider the impacts of water quality and sediment regime on European Sites dependent on the findings of the AWS investigation into the capacity at Tilbury WwTW. The requirement for further investigation will need to be reviewed as part of the Detailed WCS when confirmation of capacity at Tilbury WwTW is known.

Broad Areas for Regeneration

An assessment has been undertaken for each of the eleven Broad Areas for Regeneration based on the findings of the water resources, flood risk, wastewater treatment and collection, water quality and ecology assessments. This identified the potential constraints to development in each of the areas and included an indication of constraints over five-year phasing periods up to 2025. The areas of Purfleet, Lakeside, Grays, Tilbury, East Tilbury and London Gateway are considered to face the largest constraints to development, particularly with regards to flood risk and wastewater collection.

Key Recommendations for Detailed WCS

The key recommendations for the next stage of the WCS (Detailed Study) are:

- to produce a water efficiency plan to determine measures required to move Thurrock towards 'water neutrality' and to minimise the impact of the dry year shortfall in supply until Abberton Reservoir is operational in 2014;
- undertake a detailed assessment of potential discharge consent changes required at Tilbury WwTW in order to meet future WFD requirements;
- undertake a detailed assessment of individual housing/employment development sites and growth figures within key constrained Broad Areas for Regeneration i.e. Purfleet, Lakeside, Grays, Tilbury, East Tilbury and London Gateway;
- produce infrastructure timelines to determine when new infrastructure is needed against expected completion rates for new development;
- produce a developer checklist to give guidance for developers on what they need to address and cover in their proposals and planning applications to meet with the strategy, and hence ensure minimisation of Environment Agency, Natural England and other stakeholder objections to developer proposals;
- provide recommendations for LDF and AAP (or other DPD/SPD) policies based on technical water assessments (i.e. target water efficiency standards); and,
- make recommendations for developer contributions to strategic water infrastructure.

Acronyms and Abbreviations

Abbreviation	Description
AMP	Asset Management Plan
AWS	Anglian Water Services
BAT	Best Available Technology
BATNEEC	Best Available Technology Not Entailing Excessive Cost
BAR	Broad Areas for Regeneration
BC	Borough Council
BGS	British Geological Society
BOD	Biochemical Oxygen Demand
CAMS	Catchment Abstraction Management Strategy
CBA	Cost Benefit Analysis
CFMP	Catchment Flood Management Plan
CLG	Communities and Local Government
CSO	Combined Sewer Overflow
Defra	Department for Environment, Food and Rural Affairs
DO	Dissolved Oxygen
DWF	Dry Weather Flow
DWI	Drinking Water Inspectorate
FEH	Flood Estimation Handbook
FtFT	Flow to Full Treatment
GQA	General Quality Assessment
GWMU	Groundwater Management Unit
HA	Highways Agency
IDB	Internal Drainage Board
KCDC	Key Centre for Development and Change
l/h/d	Litres/head/day (water consumption measurement)
LDDs	Local Development Documents
LDF	Local Development Framework
LPA	Local Planning Authority
Ml	Mega Litre (a million litres)
NGP	New Growth Point
NE	Natural England
NRA	National Rivers Authority
NWA	No Water Available (in relation to CAMS)
OFWAT	The Office of Water Services
O-A	Over Abstracted (in relation to CAMS)

Abbreviation	Description
O-L	Over Licensed (in relation to CAMS)
P	Phosphorous
PE	Population Equivalent
PPS	Planning Policy Statement
PR	Periodic Review
RBMP	River Basin Management Plan
RSS	Regional Spatial Strategy (East of England Plan)
RQO	River Quality Objective
SAC	Special Area for Conservation
SFRA	Strategic Flood Risk Assessment
SPA	Special Protection Area
SPD	Supplementary Planning Document
SoR	Statement of Response
SPS	Sewage Pumping Station
SPZ	Source Protection Zone
SS	Suspended Solids
SSSI	Site of Special Scientific Interest
SuDS	Sustainable Drainage Systems
TGSE	Thames Gateway South Essex
TTGDC	Thurrock Thames gateway Development Corporation
UKTAG	United Kingdom Technical Advisory Group (to the WFD)
UWWTD	Urban Wastewater Treatment Directive
WCS	Water Cycle Study
WFD	Water Framework Directive
WRMP	Water Resource Management Plan
WRMU	Water Resource Management Unit
WRZ	Water Resource Zone
WwTW	Waste Water Treatment Works

1 Introduction

1.1 Growth in Thurrock

The Regional Spatial Strategy (RSS) for the East of England ('The East of England Plan', Reference 1) was published in May 2008 and set targets to guide the scale and location of growth in Thurrock up to 2021. Thurrock lies within the Thames Gateway, which is the Government's top priority for regeneration in the UK, and high rates of development are planned for the area over the forthcoming two decades. The Thames Gateway was designated as a growth area by the Sustainable Communities Plan in 2003 (Reference 2).

The RSS identifies Thurrock Urban Area (from Purfleet in the west to Tilbury/Chadwell St Mary in the east) as a Key Centre for Development and Change. As such, the Borough of Thurrock is targeted with providing 18,500 new homes and an indicative 26,000 new jobs between 2001 and 2021.

Due to the scale of development proposed for Thurrock, it is considered that a Water Cycle Study (WCS) is required to ensure that the proposed growth targets can be met in the area without adversely impacting on the water environment and that required infrastructure can be planned for and brought online alongside new development, as stated in the Regional Spatial Strategy.

The Thurrock WCS Outline Study was commissioned by Thurrock Borough Council, following the completion of a Scoping Report in February 2009. The Outline Study, providing a holistic, evidence-based approach to feed into the Local Development Framework (LDF), will support the planned growth in the Borough and prepare for the new challenges of climate change and Government policies and European legislation including the Water Framework Directive and European Habitats Directive.

1.2 Aims and Objectives

Building on the findings of the Scoping Study, the key aim of the Thurrock Outline WCS is to provide Thurrock Borough Council, as the Local Planning Authority (LPA), with the evidence base which ensures that water issues have been taken into account when deciding the location and intensity of development within the Borough as part of the development of the Core Strategy and aid in setting core policies related to water as part of the Development Control Policies Supplementary Planning Document (SPD). It will achieve this by:

- assessing of the water resource availability up to 2026 within Thurrock;
- assessing the flood risk to the proposed development sites and mitigation options;
- assessing the likely surface water storage requirements and potential Sustainable Drainage Systems for proposed development in the Borough;
- assessing the capacity of the existing wastewater and clean water network, both current and proposed, to identify the key constraints and required phasing of development to ensure that development does not outstrip capacity;
- assessing the environmental impact of the proposed development within the Borough upon watercourses and ecologically important sites; and,
- determining the key constraints for the proposed development (including potential impacts on phasing) with reference to the above assessments.

If the Outline study concludes that new infrastructure is required, or an impact on the water environment cannot be ruled out as significant, a Detailed WCS will need to be undertaken for site specific allocations, or for the Borough as a whole.

1.3 WCS Steering Group

A Steering Group was formed following the Scoping Stage with the aim of reviewing and guiding the Outline and potentially the detailed stages of the Thurrock WCS. The Steering Group members/WCS stakeholders are:

- Thurrock Borough Council (TBC) as the planning authority and delivery vehicle for growth in the Thurrock Borough;
- The Environment Agency as the statutory planning and flood risk consultee as well as regulator for water quality;
- Anglian Water Services (AWS) as the provider of wastewater infrastructure;
- Essex and Suffolk Water (ESW) as the provider of water supply infrastructure;
- Natural England (NE); and
- Thurrock Thames Gateway Development Corporation (TTGDC) as the organisation charged to deliver the proposed strategic growth within Thurrock and regenerate the existing communities.

By involving key stakeholders at an early stage of the WCS, any recommendations with regards to planning timeframes and infrastructure requirements such as funding, can be discussed and identified early in the planning process.

The Steering Group should advise and agree on the findings of both the Outline Study, and the requirements for the Detailed WCS.

2 Thurrock Water Cycle Study

2.1 Stages of the Thurrock Water Cycle Study

Current draft guidance on Water Cycle Studies (Reference 3) suggests that they should generally be undertaken in three stages, dependent on the status of the various Local Development Documents (LDDs), as part of the wider Local Development Framework (LDF), being prepared by Local Planning Authorities (LPAs) for submission. To coincide with Thurrock's timescales for responses and submissions the WCS is being undertaken in three distinct stages: Scoping, Outline and Detailed (if required).

2.1.1 Scoping Water Cycle Study

The Thurrock Scoping Study (Reference 4) was completed by Scott Wilson in February 2009 and concluded what issues required further investigation within the Outline WCS. It determined the Study Area (Figure 1) and the key 'water-cycle' areas where development is likely to either impact on the water environment, or is likely to require significant investment in water infrastructure (i.e. pipes, or treatment) to service new development. Undertaking a high level assessment, it looked at area-wide issues and defined whether there are significant constraints that would need further assessment to determine whether they affect either the locations of allocation options, or the amount of development that can be provided within an allocation site.

2.1.2 Outline Water Cycle Study

The key aim of the Outline Study is to provide Thurrock Borough Council (BC), as the LPA, with the evidence base which ensures that water issues have been taken into account when deciding the location and intensity of development within Thurrock as part of the development of their Core Strategy. In doing this, the Outline Study builds on the Scoping Study findings and considers all of the ways in which new development will impact on the water environment or water infrastructure specific to where growth is most likely to be targeted. The Scoping Study recommended that the Outline Study should include:

- assessment of the water resource availability up to 2025 within Thurrock;
- assessment of the flood risk to the proposed development sites and mitigation options; this should be undertaken in conjunction with the update to the Thurrock SFRA;
- assessment of the capacity of the existing wastewater and clean water network, both current and proposed, to identify the key constraints and required phasing of development to ensure that development does not outstrip capacity;
- assessment of the likely surface water storage requirements and potential Sustainable Drainage Systems (SuDS) for proposed development in the Borough;
- environmental assessment of the impact of the proposed development within the Borough upon watercourses and ecologically important sites, including the impacts on and requirements for increased discharges at Tilbury Wastewater Treatment Works into the Thames Estuary;
- phasing of proposed development sites and key constraints for each of the major sites, with reference to the above assessments; and
- the setting up of a Project Steering Group at the early stages of the Outline WCS to guide, advise and agree on the findings of the Outline Study, and the requirements for the Detailed WCS.

2.1.3 Detailed Water Cycle Study

The detailed study can vary significantly in its scope and remit; however, if new infrastructure is required, or an impact on the water environment cannot be ruled out as significant, a detailed water cycle study will need to be undertaken for site specific allocations, or for the authority as a whole.

A further key purpose of the detailed study is to define what specific infrastructure and mitigation is required to facilitate development, once the decisions have been made on the location of allocations and the likely intensity and type of development within them. The requirements of a detailed study for Thurrock are determined at the end of this outline assessment.

2.2 Integration with the Planning System

The Scoping WCS described the interaction of the WCS with the LDF and the role of the WCS as an evidence based study which specifically addresses the impact of proposed growth on the 'water cycle'. A summary of the relevant policies and drivers for growth within Thurrock is provided within the Scoping Study Report alongside a description of the Thurrock LDF process (Reference 4).

Since the publication of the Thurrock WCS Scoping Report, Essex and Suffolk Water (ESW) and Anglian Water Services (AWS) Final Business Plans have been published and these set out the required asset investment over the next 5 year period (AMP5, 2010 – 2015), the justification for it and the price increases required to fund it. Ofwat determined the final price limits from this process in November 2009.

Water Companies are able to seek interim determination within the 5 year AMP cycles to fund unforeseen investment requirements. However, the process is lengthy and therefore if significant water cycle infrastructure improvements are required in addition to those included in the current price review it is unlikely that these can be funded before the AMP6 period (2015-2020).

In addition to the publication of the Final Business Plan, ESW have produced a Statement of Consultation in response to comments received during the consultation period for their Draft Water Resources Management Plan (WRMP). The final WRMP is due for publication later in 2009 and until this is published there is still some uncertainty as to what options will be taken forward.

2.3 Approach to Water Cycle Study

The Outline WCS should consider the ways in which new development will impact on the water environment or water infrastructure specific to where growth is most likely to be targeted. In the case of Thurrock, Thurrock Borough Council have identified thirteen Broad Areas for Regeneration (BARs) which cover the areas of proposed growth within the Borough. These will be used to assess the water cycle baseline and potential constraints for proposed development within Thurrock up to 2025. The BARs are:

- Purfleet
- Aveley Urban Area
- South Ockendon Urban Area
- West Thurrock Urban Area
- North Stifford/Lakeside
- Grays Urban Area
- Tilbury
- Chadwell St Mary Urban Area
- East Tilbury
- Villages
- Stanford-le-Hope and Corringham Urban Area
- Shell Haven & Environs (London Gateway)
- Stifford Clays/North East Grays

A detailed description of the BARs is provided in Section 3.2.1. The location of the BARs is shown in Figure 2.

2.4 Identification of Constraints

The Outline WCS has indentified constraints in terms of proposed growth within Thurrock in relation to the five key 'water cycle' areas. A description of the aims of these assessments is provided in Table 2.1.

2.4.1 Traffic Light Coding

The most relevant and important constraints have been identified for each BAR to aid in the assessment of development within Thurrock. For the purpose of the constraints matrices these were amalgamated and put into generic categories as outlined in Table 2.2. It is important to note that a colour coding of red does not mean that the proposed development cannot take place within the BAR, merely that if development where to take place here greater, more significant, constraints would have to be overcome which would likely involve a higher level of infrastructure investment or greater strategic planning.

2.4.2 Constraints Matrix

The resultant outcome was the formulation of a constraints matrix for each of the BARs. The matrix has been designed so that the amount of subjective interpretation of the data is minimised, and hence the traffic lights allocated are based on factual and quantitative data where possible.

The matrix is intended to provide a visual comparison of the appropriateness of development within each of the BARs, with respect to the proposed housing numbers and phasing. For each of the areas a traffic light is applied, and the total number of "green" traffic lights can be directly compared to the total number of "red" traffic lights. Areas with a majority of "green" boxes would be preferred, especially when these are located in the early phasing of the development.

It is important to note that the matrix is a broad brush summary, and that a detailed assessment should be used to provide further analysis during the Detailed study.

2.5 Data Availability

Undertaking of a Water Cycle Study requires a large amount of data collection, much of which is reliant on the willingness of third parties to supply in order to allow the study to be progressed. In some cases, the availability of data with respect to water cycle infrastructure and future planning is not available within the time required to undertake the assessment and various assumptions have to be used to enable the study to continue. This study has built on data collated as part of the Scoping Study and requested further detailed information where required. A catalogue of the data collected, identifying the data provider in each case, and further data required to complete the Detailed WCS has been compiled. The catalogue is provided in Appendix B.

Table 2.1 Identification of Constraints

Assessment	Description	Section
Water Resources and Water Supply	• Determines the existing baseline with respect to available water resources and identifies where the raw water to supply the new development will be sourced. • Identifies potential capacity issues in terms of raw water supply availability and/or water infrastructure. • Considers the requirement for transmission infrastructure for treated water in order to service and supply the new development areas.	Section 4
Flood Risk Management, SuDS and Surface Water Management	• Reviews and summarises the findings of Thurrock's Strategic Flood Risk Assessment (SFRA) Level 1 and Level 2 (Reference 5 & Reference 6) to identify potential sources of flood risk to and from the development in Thurrock and where these pose a constraint to development in these areas. • Considers the suitability of a range of Sustainable Drainage Systems (SuDS) based upon the geology, soils and/or groundwater vulnerability in Thurrock. • Considers management of surface water in Thurrock which has the potential to increase the rate and amount of water that enters watercourses causing an increase in flood risk. • Identifies strategic level flood risk constraints and mitigation measures to development in Thurrock.	Section 5
Wastewater Treatment and Collection	• Assesses how much 'spare' capacity is available in existing wastewater treatment facilities. • Assesses existing wastewater network capacity and requirement for upgrades to serve new development. • Assesses the impact of the discharge of additional treated wastewater from new development on: the water quality of receiving waters; the hydrological/hydraulic regime of receiving waters and associated habitats; and, flood risk downstream of the discharge.	Section 6
Water Quality	• Assesses the current quality of the water related environment against current Environment Agency water quality requirements and future WFD standards. • Assesses the capacity of the water environment to absorb further discharges (from WwTW and/or surface water). • Considers the mitigation requirements to ensure that there is no unacceptable deterioration in the quality of the water related environment as a result of the proposed development.	Section 7
Ecology and Biodiversity	• Identifies any water dependent sites within and hydraulically linked to Thurrock that could be affected by discharges of wastewater and further abstraction of raw water. • Assesses whether any of the proposed development within Thurrock is likely to impact upon any of the identified sites building on the findings of the Habitats Regulations Assessment carried out for Thurrock (Reference 8).	Section 7.4

Table 2.2 Generalised Constraint Traffic Lights

Flood Risk Management & SuDS Potential	Water Resources	Wastewater	Water Quality	Environment[1]
There is little or no perceived risk of flooding to the development area. The site is Groundwater Source Protection Zone 3 (therefore more suitable for infiltration SuDS)	There is an existing raw water source nearby with spare licence capacity. There is water available based on CAMS Methodology Classification.	The development can be accommodated within existing available headroom at WwTW and in wastewater network.	Existing River Quality classification is Good – A/B/C under GQA or High/Good under Water Framework Directive.	No environmental constraints were identified or development levels are considered sufficiently small that they are unlikely to materially increase impacts on European sites.
There is a perceived medium risk of flooding to the development area. The site is in Groundwater Source Protection Zone 2.	There is an existing raw water source nearby but with no spare capacity. There is no water available based on CAMS Methodology Classification.	WwTW has capacity to accommodate the proposed development but the wastewater network is unlikely to have the capacity and therefore may need upgrading. Preliminary assessment suggests that minor upgrade of existing WwTW will suffice to accommodate housing option.	Existing River Quality classification is Moderate under GQA or Moderate under Water Framework Directive.	Medium risk of significant adverse effects as a result of development. Site is downstream of or in close proximity to European sites and may impact upon site if not mitigated.
There is a perceived high risk of flooding to the development area. The site is in Groundwater Source Protection Zone 1.	There is no existing raw water source nearby. Water sources are over abstracted/over licensed based on CAMS Methodology Classification.	Major/significant upgrade of WwTW and/or wastewater network is required to accommodate the proposed development. Pumping of wastewater is required to transfer it to a WwTW with spare capacity.	Existing River Quality is Bad under GQA or Poor/Bad under Water Framework Directive.	High risk of significant adverse effects as a result of development. Site is downstream of or in close proximity to European sites and is likely to impact upon site if not mitigated.

[1] It is not possible at this stage to accurately determine the level of housing that would lead to significant adverse effects on European sites. This would require further investigation in the Detailed Study into (for example) the likely degrees of increase in phosphate associated with levels of development.

3 Development in Thurrock

3.1 Planned Growth within Thurrock

The Thurrock WCS Study Area, as defined in the Scoping Study, is provided in Figure 1. This covers the entire Borough of Thurrock and the bordering Thames Estuary.

The East of England RSS (Reference 1) sets a total of 18,500 new dwellings and an indicative figure of 26,000 new jobs for Thurrock in the period 2001-2021, as part of the wider growth in the Thames Gateway South Essex (TGSE) area. Of this total, 4,952 new dwellings have already been built in the period 2001 - 2009, leaving a residual of 13,548 to be built in the period 2009 - 2021.

However, Planning Policy Statement 3 (PPS3, Reference 9) states that the Borough must plan for at least 15 years worth of housing delivery from the date at which the LDF is adopted. Therefore, because Thurrock BC's LDF will not be adopted until 2010, the WCS has been extended to look ahead to 2025. The RSS states that growth beyond 2021 should take place at the average annual build rate which for Thurrock is 950 dwellings per year. An additional 3,800 homes would therefore be required up to 2025, providing a new target of 17,348 new homes for the period 2009-25.

The majority of the development is planned to be infill development on existing urban/brownfield sites with a minimal amount on greenfield or within the existing Green Belt[2].

3.2 Housing and Employment Development Areas

3.2.1 Broad Areas for Regeneration

The Thurrock Thames Gateway Development Corporation (TTGDC) are charged to deliver the proposed strategic growth within Thurrock and have formulated an overall strategy for the regeneration of Thurrock, called the Regeneration Framework. The Spatial Plan (Reference 11) subsequently outlines the broad locations for proposed development in the Borough. These are in accordance with the Borough Council's Core Strategy and Site Specific Allocation DPD. Thurrock has been divided into thirteen Broad Areas for Regeneration (BARs) (Reference 10), the majority of which are proposed to house residential dwellings:

1. Purfleet
2. Aveley Urban Area
3. South Ockendon Urban Area
4. West Thurrock Urban Area

4b. North Stifford/Lakeside

5. Grays Urban Area
6. Tilbury
7. Chadwell St Mary Urban Area
8. East Tilbury
9. Villages
10. Stanford-le-Hope and Corringham Urban Area

10b. Shell Haven & Environs (London Gateway)

11. Stifford Clays/North East Grays

For the purposes of the Outline WCS some of the BARS have been combined as it is considered that the potential constraints in terms of the water environment and/or infrastructure are unlikely to vary between these sites:

- West Thurrock Urban Area (Area 4) and North Stifford/Lakeside (Area 4b) have been combined into West Thurrock and Lakeside (Area 4); and,

[2] The Site Specific Allocations DPD (Reference 10) states that except for the limited specific planned land releases there will be no Strategic Scale release of Green Belt land in general conformity with the Regional Spatial Strategy East of England Plan.

- Grays Urban Area (Area 5) and Stifford Clays/North East Grays (Area 11) have been combined into Grays (Area 5).

Eleven BARs have therefore been assessed in this Outline WCS. Figure 2 illustrates the Broad Areas for Regeneration within Thurrock.

3.2.2 Housing Development

Thurrock BC are currently planning development in the Borough for the next 15 years (up to 2025) based on the adoption of their Core Strategy in 2010. 4,952 houses have been built in the Borough in the period 2001 – 2009 and Thurrock BC have identified in 5-year phasing periods the number and location of new developments within the Borough up to 2025 through their Strategic Housing Land Allocation Assessment (SHLAA). In the plan period (2009 - 2025) they are planning to build 17,624 dwellings which is slightly above the required 17,348 up to 2025 (as identified in the RSS). It should be noted that the only further development planned at present beyond 2025 is for an additional 1,482 dwellings in the Grays area.

The main locations for development within Thurrock, as identified in the Core Strategy and Site Specific Allocations DPD (Reference 10), are in the Thurrock Urban Area containing Purfleet, West Thurrock & Lakeside, Grays, and Tilbury which together account for around 80% of the planned growth. In order to meet TTGDC's goal of broadening the choice and quality of housing for all in Thurrock, the Spatial Plan has also identified a need to provide dwellings in the outlying communities of Aveley, South Ockendon, Chadwell St Mary, East Tilbury, Stanford-le-Hope and Corringham.

Table 3.1 details the phased development of the 11 BARs and other (windfall) sites over the next 15 years as provided by Thurrock BC. The Outline WCS has assessed the 'water cycle' issues for the proposed growth in the area between 2009 and 2025 i.e. 17,624 dwellings.

Table 3.1 Housing Phasing in Thurrock 2001 - 2025

Broad Area for Regeneration		Built 2001-2009	Proposed Housing (2009 – 2025)			
			2009 - 2014	2014 - 2019	2019 - 2025	Total
1	Purfleet	490	1,225	1,894	105	3,224
2	Aveley	69	147	72	-	219
3	South Ockendon	88	163	1,388	55	1,606
4	West Thurrock & Lakeside	1,865	428	1,128	1,379	2,935
5	Grays	1,435	1,840	2,815	2,274	6,929
6	Tilbury	243	247	103	689	1,039
7	Chadwell St Mary	12	45	344	11	400
8	East Tilbury	165	11	211	21	243
9	Villages	245	20	-	-	20
10a	Stanford-le-Hope & Corringham	266	163	564	190	917
10b	London Gateway	15	-	-	-	-
Other	Windfall	60	81	11		92
Total Dwellings		**4,952**	**4,370**	**8,530**	**4,724**	**17,624**
Cumulative Total		**-**	**4,370**	**12,900**	**17,624**	**-**

LDF Rejected Sites

As part of the SHLAA and LDF process, a number of sites identified within the SHLAA have been rejected at present for inclusion within Thurrock's LDF. As the LDF is currently in development it may be that these sites will be included within the LDF at a later stage. At this stage it is not possible to assess these sites individually but the constraints in terms of development will be the same as those identified for the Broad Area for Regeneration. The locations of the Rejected Sites have been provided in the Section 9 - Broad Area for Regeneration Assessment and if required, these could be further investigated at a site specific level as part of the Detailed WCS.

3.2.3 Employment Development

Employment growth within Thurrock is focused at five principal growth 'hubs' which will act as a catalyst for the rejuvenation of the Borough as a whole:

- Shell Haven / London Gateway – 12,000 - 13,000 jobs will be created at the port and associated employment land for projects including a logistics academy and a proposed new deep water port;
- Lakeside / West Thurrock – 7,000 - 8,000 jobs delivered by new office and leisure development. This will include an Environmental Park, including environmental industry and waste facilities;
- Grays – 4,000 jobs provided by enhancing the area's role as a Civic, cultural, heath and education centre, including a new Thurrock Learning Campus and a new Sports Village;
- Tilbury – 500 - 1,000 jobs at the port and from port related development including, riverside development, a new Marina and a mixed-use development at the Bata Factory Estate (located in East Tilbury); and,
- Purfleet – a proposed 1,000 jobs from high quality mixed use development and employment, including the development of The Royal Opera House.

Whilst it is recognised that there may be other employment sites through out the Borough, it is unlikely that these will have a significant impact on water cycle components and therefore for the purposes of the Outline WCS only those areas targeted for significant employment growth (as identified above) will be assessed at this stage. Table 3.2 details the phased employment in the identified employment growth hubs over the next 15 years. For the purposes of the Outline WCS, employment growth has been assumed to be evenly phased through the development period.

Table 3.2 Indicative Employment Phasing in Thurrock 2009 - 2025

Broad Area for Regeneration		Phasing Year			Total	Type
		2009 - 2014	2014 - 2019	2019 - 2025		
1	Purfleet	350	350	300	1,000	Commercial/ Service
4	West Thurrock & Lakeside	2,500	2,500	2,500	7,500	Commercial/ Service
5	Grays	1,350	1,350	1,300	4,000	Commercial/ Service
6	Tilbury	350	350	300	1,000	Industrial
10b	London Gateway	4,200	4,200	4,100	12,500	Industrial
Total Employment		**8,750**	**8,750**	**8,500**	**26,000**	
Cumulative Total		**-**	**17,500**	**26,000**	**-**	

4 Water Resources and Water Supply

4.1 Introduction

The water resources and water supply assessment determines the existing baseline with respect to available water resources and identifies where the raw water to supply the new development will be sourced. It also considers the requirement for transmission infrastructure for treated water in order to service and supply the new development areas. Any potential capacity issues in terms of raw water supply availability and/or water infrastructure have been identified.

4.2 Water Resources

4.2.1 The South Essex area - Water Resource Baseline Assessment

According to the Environment Agency, Thurrock lies within an area of serious water stress. The Environment Agency manages water resources at the local level through the use of Catchment Abstraction Management Plans (CAMS). Thurrock lies within the Combined Essex CAMS (Reference 12).

Within the CAMS, the Environment Agency's assessment of the availability of water resources is based on a classification system that allocates a resource availability status indicating:

- the relative balance between the environmental requirements for water and how much is licensed for abstraction;
- whether water is available for further abstraction; and
- areas where abstraction needs to be reduced.

The categories of resource availability status are shown in Table 4.1. The classification is based on an assessment of a river system's ecological sensitivity to abstraction-related flow reduction. This classification can then be used to assess the potential for additional water resource abstractions.

Table 4.1: CAMS Resource Availability Status Categories

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

The classification for each of the catchments within the South Essex area is shown in Table 4.2. This shows that there is currently water available for further abstraction within Water Resource Management Unit (WRMU) 4 – River Mardyke but by 2012/13 there is predicted to be no water available within this unit for further abstraction at low flows. The CAMS document reports that there is around 0.9 Ml/d water

available for abstraction (unconstrained). This is a fairly small volume of water and would not be sufficient to supply water to new development within Thurrock. There is no water available for further abstractions at low flows within the Thameside Chalk/Thanet Sand unit (WRMU5). Therefore, taking into account the limitations in water availability during the plan period (2009 – 2025) other sources will need to be identified to supply water to new development within the Borough.

Table 4.2: CAMS Resources within certain South Essex Catchment Areas

WRMU Name	Associated Main River	Resource Availability Status		
		Individual WRMU Status	Integrated WRMU Status	Target Status in 2012/13
WRMU4 – River Mardyke [1]	Thames	Water Available	Water Available	No Water Available
WRMU5 - Thameside Chalk/Thanet Sand	Thames	No Water Available	No Water Available	No Water Available

Key: Integrated WRMU status in table refers to the availability status after downstream conditions have been taken into account and/or, in the case of groundwater, the status of an overlying river.

4.3 Potable Water Supplies

Essex and Suffolk Water (ESW) are the company responsible for supplying water to Thurrock. From the Scoping Study, it has been shown that the Thurrock BC area is underlain by a Major aquifer, the Chalk and also a Minor aquifer, the Thanet Sand, which are in hydraulic continuity with each another. Both of these aquifers are unconfined in the southern part of Thurrock area. To the north of a line running from Ockendon to Corringham, the aquifers are confined by London Clay. The Chalk and Thanet Sand dip down to the north beneath the younger deposits of London Clay. Recharge of these aquifers is quite complex, occurring both locally and also further afield to the south of the Thames Estuary. The Superficial Deposits, consisting of Alluvium and Gravel Deposits, which occur along the line of the Thames Estuary are also defined as a minor aquifer. This shallow aquifer plays an important part in supporting river flows to the River Mardyke and various other smaller watercourses. In general, there is no connection between these rivers and the deeper aquifers. Figures 3a and 3b show the solid and superficial deposits across Thurrock.

There are number of issues affecting the deeper aquifers including:

- salinity problems (i.e. poor water quality) at certain sites near to the Thames Estuary and also in the confined sections of aquifer in the northern part of the area;
- rising groundwater levels as a result of shut downs of heavy industries which previously abstracted a lot of water but which is no longer required, could potentially cause flooding to basements; and,
- agricultural pollution from farms in the northern part of the Thurrock area is affecting water quality in rivers and streams locally.

The lack of ample local water resources and the quality issues associated with these sources, means that the Thurrock area is heavily reliant for its water supply on sources outside the area. Only around 3% of its supplies come from two groundwater sources which abstract from the Chalk aquifer. The main sources of supply are from rivers and reservoirs systems, including the Hanningfield and Abberton pumped storage reservoir systems operated by ESW. Treated water is transferred into the Thurrock area through a network of pumping mains. In addition, a bulk transfer of treated water from Thames Water is also fed into the ESW network. In general, ESW are satisfied with the existing strategic network within the Thurrock area.

4.4 Future Water Demand Assessment

4.4.1 Forecast Growth in Demand

In general, ESW have assumed the growth contained within the RSS ('The East of England Plan'), as the basis for forecasting the growth in their areas, which corresponds with the planned growth by Thurrock BC. A water demand assessment for both future residential and non-residential demands has been undertaken for the proposed development in the Thurrock area. The findings from this assessment are provided below and more detailed information is provided in Appendix C.

4.4.1.1 Residential Demands

The average occupancy rate within metered households in Thurrock is two, with an average metered water consumption of 143 litres/head/day ($lh^{-1}d^{-1}$) for the ESW water supply area (Reference 16). These figures have been used to calculate the expected demand from the additional housing up to 2025 and has been defined as a 'water company forecast' scenario. However, although the ESW forecasts already factor in the change to Part G in the Building Regulations (125 l/h/d for new development post-2010), it is acknowledged that with the requirements of new policy such as the Code for Sustainable Homes (CSH), new houses are likely to become more water efficient and hence demand forecasts could be much lower up to 2025. The forecasts for future demand could vary depending on the targets assumed for water efficiency; hence three further demand scenarios have been calculated based on different targets under the CSH:

- Scenario 1 – Water Company forecast – 143 $lh^{-1}d^{-1}$;
- Scenario 2 – Code for Sustainable Homes[3] Rating 1 & 2 – 120 $lh^{-1}d^{-1}$;
- Scenario 3 – Code for Sustainable Homes Rating 3 & 4 – 105 $lh^{-1}d^{-1}$; and
- Scenario 4 – Code for Sustainable Homes Rating 5 & 6 – 80 $lh^{-1}d^{-1}$.

The results from the assessment show that under the water company forecast (Scenario 1), the total residential water demand for Thurrock up to 2025 would be 5 Mld^{-1}. Broken down into the individual areas, the demands are highest in Grays (2 Mld^{-1}), followed by Purfleet (0.9 Mld^{-1}) and then West Thurrock and Lakeside (0.8 Mld^{-1}).

Using the CSH estimates of lower water consumption, the total residential l water demands would vary from 2.8 Mld^{-1} (Scenario 4) to 4.2 Mld^{-1} (Scenario 2) by 2025.

4.4.1.2 Non-Residential Demands

In addition to the increased residential demand, Thurrock BC also envisages significant growth in employment, with 26,000 new jobs being created by 2021. Limited information is available on the location and type of employment to be created and therefore any estimates of non-residential demand should be considered provisional at this stage.

An estimate of the non-residential demands has been undertaken based on the relationship which exists between non-residential and residential water demands as reported by Ofwat in their 2007-2008 security of supply report (Reference 16); in the case of ESW, the non-residential metered demand is around 52% of the residential metered demand.

[3] Code for Sustainable Homes (CSH) provides a system of credits for all new buildings depending on their level of water efficiency of 120, 105 and 80 $lh^{-1}d^{-1}$

Based on these assumptions, it is estimated that the non-residential demand will be 2.6 Mld^{-1}. Apportionment of this amount into the individual areas would indicate that the largest growth in the non-residential demand would come from London Gateway (1.6 Mld^{-1}), with the next highest non-residential demand coming from the Purfleet and West Thurrock & Lakeside area (which for this employment assessment is combined) at 0.6 Mld^{-1}.

4.4.1.3 Total Water Demands

Table 4.3 shows the combined residential and non-residential demand figures for the Thurrock area. Based on the Water Company forecast consumption figures (Scenario 1), the maximum total demand figure up to 2025 is 7.9 Mld^{-1}. In the case of the minimum demand (Scenario 4), the total water demand figure is 5 Mld^{-1}.

It should be noted that none of these estimates include any allowance for headroom. If an allowance for an additional 10% is added to the demand figures given above for headroom, then this would raise the total water demand figures up to 2025 for the maximum (Scenario 1) and minimum (Scenario 4) estimates of 8.7 Mld^{-1} and 5.5 Mld^{-1} respectively.

Table 4.3 Total Water Demand in Thurrock

	Broad Area for Regeneration	Total Supply (Residential & Non-residential)	Total Supply (Minimum Demand)	Headroom Allowance (10%)	
		Scenario 1	Scenario 4	Scenario 1	Scenario 4
		(Mld^{-1}) *1	(Mld^{-1}) *2	(Mld^{-1}) *3	(Mld^{-1}) *3
1	Purfleet	1.55	1.00	1.70	1.10
2	Aveley	0.06	0.04	0.07	0.04
3	South Ockendon	0.46	0.26	0.51	0.28
4	West Thurrock & Lakeside	0.84	0.47	0.92	0.52
5	Grays	2.23	1.31	2.46	1.44
6	Tilbury	0.59	0.39	0.65	0.43
7	Chadwell St Mary	0.11	0.06	0.13	0.07
8	East Tilbury	0.09	0.05	0.10	0.06
9	Villages	0.01	0.00	0.01	0.00
10	Stanford-le-hope & Corringham	0.26	0.15	0.29	0.16
11	London Gateway	1.63	1.26	1.79	1.39
12	Other (Windfall)	0.03	0.01	0.03	0.02
	Thurrock Total	**7.86**	**5.01**	**8.65**	**5.51**

4.5 Demand Management & Water Efficiency

The South East is considered to be water scarce, where there is little or no water available for new developments or other increases in demand. New water efficient developments can be accommodated in areas where existing houses have improved their efficiency so that the water made available by the existing development, can be taken up by the new development. This would mean that there is no

additional stress on resources as supply is made up from existing sources and this process is referred to as achieving 'water neutrality' for new development.

Thurrock is part of the Thames Gateway Growth Area and as such, is working towards water neutrality (see Appendix C). This means that there would be no increase in water demand as a result of new development. The demand for water in the new development should be met by building efficient development and meeting the demand by introducing water savings in existing homes. Appendix C provides information on measures that can be implemented to improve water efficiency in both existing and new homes within Thurrock.

4.5.1 Water Efficiency in Thurrock

The first step of any water efficiency plan in Thurrock should be to look at water efficient measures being undertaken by ESW. A comparison with average water use by different groups of ESW and an Industry Average (for Water and Sewerage Companies) customer is shown in Table 4.4. Compared with an industry average for Water and Sewerage Companies of 145 lh-1d-1, ESW customers use more water than the industry average at around 156 lh-1d-1 (Reference 16). This pattern is repeated for both metered and un-metered customer groups.

Table 4.4 Summary of Water Usage by ESW & Average Customers

Customer Type	ESW Customers ($lh^{-1}d^{-1}$)	Average Customer ($lh^{-1}d^{-1}$)
Metered	143	131
Un-metered	163	151
Overall	156	145

Source: Ofwat Report 2007-2008 (Reference 16)

4.5.1.1 ESW Future Water Efficiency Plans (WEP)

A summary of ESW's water efficiency measures included in their draft WRMP[4] (2008) are as follows;

- Water Metering – the aim is to achieve as near to universal metering in ESW's Essex Water Resource Zone (WRZ) by 2020 as possible; the current meter penetration is 40% - this level of metering compares well with other Water and Sewerage Companies which typically have around 25% of their customers metered (Reference 16). The level of universal metering considered practical is 85% of homes in ESW's Essex WRZ;
- Tariffs – ESW is proposing within the AMP5 period (2010-15) to investigate the advantages of intelligent meters (an advanced meter (usually electrical) that identifies consumption in more detail than a conventional meter) and the use of tariffs to encourage customers to save water. Results from these investigations will be used to formulate future strategy.
- Water Efficiency – ESW already actively promote reductions in water use and wastage. It is planned to continue with campaigns such as the issuing of five minute timers for showering and expansion of their 'H2eco' scheme which aims to mix customer education with fitting water efficiency devices (15,000 retrofits per annum), including the installation of shower heads and EcoBETA dual flush retro-fit device.
- Leakage – ESW is proposing to maintain leakage at a long term sustainable economic level of leakage[5] (ELL). The current levels of leakage as reported to Ofwat is 15% in the case of ESW, as a

[4] At the time of undertaking the assessments for the Outline WCS, the final AWS WRMP was not available. Details from the final plan, released in mid February 2010, will be included in the Detailed WCS report.

proportion of their distribution input[6] (based on 2007/08). This compares well with an industry average for Water and Sewerage Companies of 27% (Reference 16).

ESW's Statement of Response (SoR, 2009) has incorporated the most recent evidence and confirms the target of 85% of properties to be metered by 2020. The SoR also includes a plan to increase leakage control activities to keep leakage down to the ELL.

In addition to this further water saving measures should be investigated for existing properties, including low flush toilets, low flow showerheads and water butts for gardens, once the final WRMP is available.

4.5.1.2 Water Efficiency Consumption Analysis

The existing homes in Thurrock use on average, 156 litres per head per day (l/h/d). ESW are planning to reduce this to 135 l/h/d by 2034/35 through the retrofitting of water efficiency fixtures and fittings in existing houses and the building of new houses to a higher water efficiency level i.e. reduced water consumption. All new homes post 2010 are to be built to a design standard of 125 l/h/d. This is 5l greater than level 1and 2 of the CSH. Using the CSH standards, greater efficiencies can be achieved in new homes through the installation of efficient fixtures and fittings and through the use of community wide water recycling and harvesting techniques.

The Code for Sustainable Homes targets have been used to determine the overall reduction in wastewater generation and water demand that would ensue if these theoretical targets could be guaranteed for new builds. It is noted at this stage that such targets, whilst aspirational and worth pursuing, are theoretical and there is no guarantee that these water use figures will materialise in the future. ESW have a legal duty to supply domestic properties in their licensed supply area with clean water and are required by the industry regulator Ofwat to maintain 'security of supply' during worst case drought years. As a result, ESW have planned for a target supply volume in their WRMP which they consider will be required in order to obligate their legal and regulatory requirement.

Nevertheless, it is important that water efficiency is considered in future planning and that ESW and Thurrock Borough Council are aware of the savings that could be achieved through attainment of theoretical water consumption reduction in new homes. Table 4.5 provides estimates of the theoretical savings in the water demand in Thurrock and therefore volume of wastewater to be treated at Tilbury WwTW if the water efficiency targets could be reached. It should be noted that the calculations have been undertaken by applying the efficiency to the new houses built only (including the infill development, but not those already completed) i.e. assuming that 156 l/h/d is the baseline for the existing population.

The sensitivity analysis results (see Table 4.5), shows that:

- the current home use from existing population is 24 Ml/d;
- by not considering new homes, demand from existing homes will reduce to 19.6 Ml/d in 2034/5 as a result of retrofitting water efficient devices (a saving of 4.5 Ml/d);
- for the new housing, there would be an increase in demand of 4.8 Ml/day if all new development is built to the design standard of 125l/h/d.
- for development to be 'water neutral' (i.e. no net increase in water demand) new development would have to be built to a specification of 105l/h/d or further water efficiency measures for existing properties would have to be considered to reduce the existing demand by a further 0.3 Ml/d, to 19.3 Ml/d;

[5] Economic Level of Leakage - The level of *leakage* for which the cost of achieving and then maintaining that level is exactly offset by savings in capital and operating costs.
[6] Distribution input – The amount of water put into supply, including water not actually delivered i.e. leakage and water taken illegally.

- not all BARs within Thurrock can be water neutral; the calculation only works across the whole Borough.
- there will be an increase in demand until the existing homes reach the water efficiency target.

It is recommended that in the Detailed WCS, the issue of water efficiency, with regards to required policy by Thurrock Borough Council for new development, be further investigated to determine if water neutrality can be achieved and to help phase the water demand measures in existing homes to ensure that any increase in water demand is minimised. The drafting of a water efficiency plan should involve consideration of water efficiency targets within the Thames Gateway, including the recently published Thames Gateway Environmental Standards Guide (November 2009), and studies by other research bodies, such as the Energy Savings Trust, Waterwise and the Institute for Sustainability Retrofit. In addition, the water efficiency plan will need to consider ways of funding water neutrality aspirations. At present, Ofwat are unlikely to fund ESW to provide large scale retrofitting schemes for existing homes and hence, if the water efficiency plan considers water neutrality to be a key aim for growth, means of funding this (potentially through developer contributions) will need to be considered.

Table 4.5 Water Efficiency Analysis

Development Areas	Existing Housing Demand			New Homes 2009-2025					Overall Saving				
	Current Water Use 156l/h/d (Ml/d)	Future Water Use 141l/h/d 2034/35 (Ml/d)	Water Saving (Ml/d)	Housing Requirements 2009-2025	New homes Water Demand 125l/h/d	CSH 1&2 120l/h/d	CSH 3&4 105l/h/d	CSH 5&6 80l/h/d	Maximum Total Demand New & Existing Homes	125l/h/d (Ml/d)	120l/h/d (Ml/d)	105l/h/d (Ml/d)	80l/h/d (Ml/d)
	a	b	c		i	ii	iii	iv	a + i	c - i	c - ii	c - iii	c - iv
1 Purfleet	0.81	0.66	0.15	3,224	0.87	0.84	0.73	0.56	1.68	-0.72	-0.68	-0.58	-0.41
2 Aveley	1.40	1.14	0.26	219	0.06	0.06	0.05	0.04	1.46	0.20	0.20	0.21	0.22
3 South Ockendon	2.91	2.37	0.54	1,606	0.43	0.42	0.36	0.28	3.35	0.11	0.13	0.18	0.27
4 West Thurrock & Lakeside	1.79	1.46	0.33	2,935	0.79	0.76	0.67	0.51	2.58	-0.46	-0.43	-0.33	-0.17
5 Grays	6.34	5.16	1.18	6,929	1.87	1.80	1.57	1.20	8.21	-0.69	-0.61	-0.39	-0.01
6 Tilbury	1.89	1.54	0.35	1,039	0.28	0.27	0.24	0.18	2.17	0.07	0.08	0.12	0.17
7 Chadwell St Mary	1.50	1.22	0.28	400	0.11	0.10	0.09	0.07	1.60	0.17	0.18	0.19	0.21
8 East Tilbury	0.96	0.78	0.18	243	0.07	0.06	0.06	0.04	1.03	0.11	0.12	0.12	0.14
9 Villages	0.92	0.75	0.17	20	0.01	0.01	0.00	0.00	0.92	0.17	0.17	0.17	0.17
10 Stanford-le-hope & Corringham	3.72	3.03	0.69	917	0.25	0.24	0.21	0.16	3.97	0.45	0.46	0.49	0.54
11 London Gateway	0.87	0.71	0.16	0	0.00	0.00	0.00	0.00	0.87	0.16	0.16	0.16	0.16
Other (Windfall)	0.99	0.81	0.18	92	0.02	0.02	0.02	0.02	1.02	0.16	0.16	0.16	0.17
Total (Ml/d)	**24.10**	**19.61**	**4.50**	**17,624**	**4.76**	**4.57**	**4.00**	**3.05**	**28.86**	**-0.26**	**-0.07**	**0.50**	**1.45**

4.6 Water Resources Strategy

As part of a water company's business planning process (AMP), each water company is required to prepare a plan showing how the growth in demand over the next 25 years will be met. ESW prepared a draft WRMP in April 2008 (Reference 13) which was subsequently consulted upon. An update to this plan was subsequently produced in a Statement of Response (SoR) (Reference 14) to the consultation and a further supplementary report to the Statement of Response was published in September 2009 (Reference 15).

At the time of undertaking the assessments for the Outline WCS, the final AWS WRMP was not available. Details from the final plan, released in late January 2010, will be included in the Detailed WCS report.

4.6.1 Essex & Suffolk Water's Water Resource Management Plan (WRMP)

As described in the Scoping Study, ESW's draft WRMP indicates a shortfall in the amount of available water for supply when compared to the expected demand during dry years within the Thurrock area over the entire planning period through to 2035.

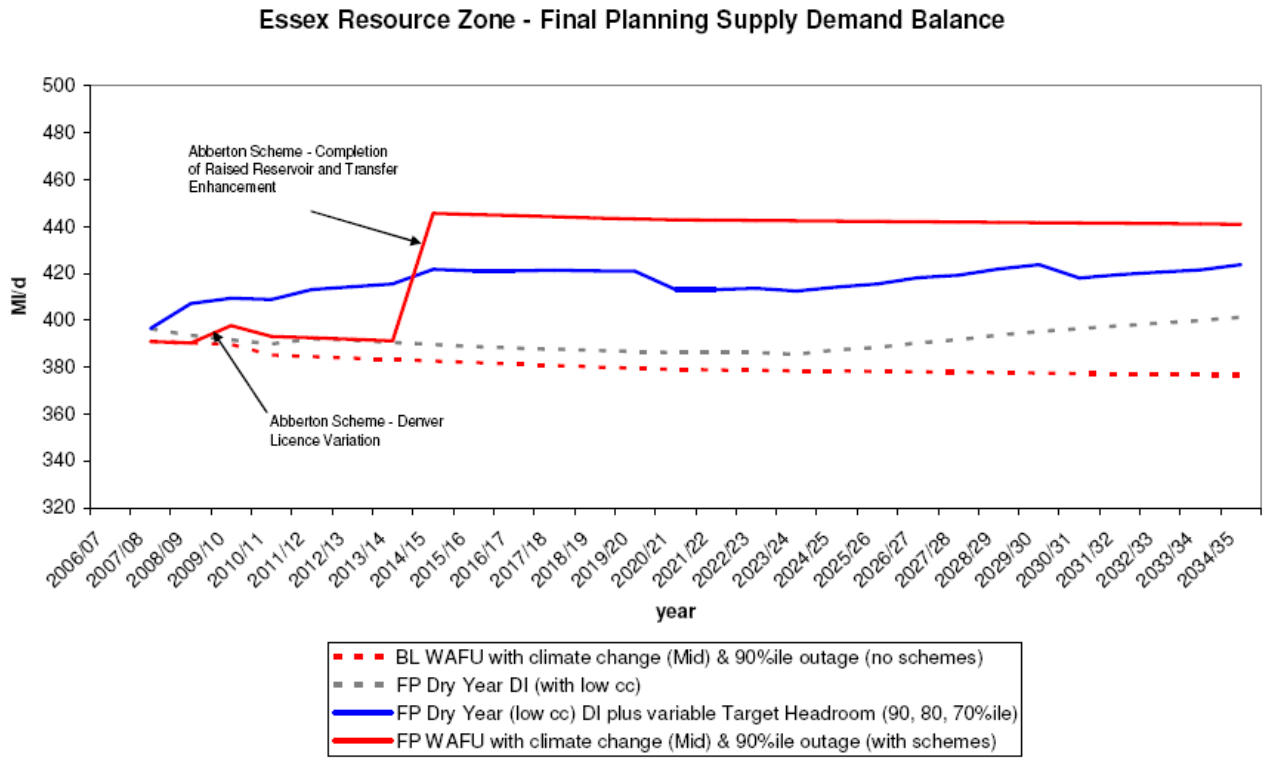
In order to address this shortfall, the strategy proposed in the draft WRMP and re-affirmed in the SoR, is a mixture of demand management measures (to reduce customer demand in the short to medium term) and a major water resource scheme, (namely the Abberton Reservoir dam raising scheme) in 2014/15 (at the end of AMP5).

The demand management measures include universal metering (i.e. all meterable properties to be installed with a meter (85% of total properties)) throughout ESW'S Essex WRZ by 2020 and infrastructure improvements, such as mains renewals. Since producing the scoping study, the raising of Abberton reservoir has been granted planning permission by Colchester BC (letter from ESW to Thurrock Council, dated 30th April 2009). Prior to the anticipated date at which the scheme will become operational, ESW will continue to operate with a supply level that is less than the predicted demand (including allowance for headroom[7]) during dry years. Once the Abberton Reservoir Scheme is completed it is forecast that the Essex WRZ will have a surplus.

Graph 4.1 shows a summary of supply/demand balance within ESW's Essex WRZ over the next 25 years (2010-2035).

[7] Headroom is the minimum buffer that a prudent water company should add to demand to cater for specified uncertainties, such as the under-estimating certain parameters, as well as taking account of the uncertainties from climate change.

Graph 4.1 ESW's Essex WRZ – Final Planning Supply Demand Balance (Reference 13)



Note: BL (Red Line) = Baseline Supply-Demand i.e. without planned measures, FP (Blue Line) = Final Planning Supply -Demand i.e. with planned measures, WAFU = Water Available For Use, DI = Distribution Input

ESW's draft WRMP shows a continued reliance on a Thames Water (TW) feed into ESW's Essex WRZ (to Chigwell) throughout the 25 year planning period. This currently supplies an average of 91 Ml/d to the Essex WRZ and accounts for 20% of the water supplied in the Essex WRZ. Although the amount of resource required does not change over the period, it does state in ESW's draft WRMP that this operating agreement, which has been in place since 1963 and was reconfirmed in 2007 in relation to transfer of water during drought conditions, has two key components that could affect the amount of water supplied to Chigwell, and therefore the Essex WRZ, during drought conditions:

- Should TW enforce a hosepipe ban but ESW does not, the quantity of water supplied to ESW is reduced by 25% (this last occurred in 2006); and
- Should both water companies have a hose pipe ban in place and TW enforces a non-essential use ban, a fair apportionment of supply would take place. This apportionment would be decided on a drought-by-drought basis.

Historically there has not been non-essential ban use in the Thames Water area that has affected the transfer of water to ESW's Essex WRZ, but the potential for such a ban means that there is some uncertainty as to whether the 91 Ml/d could continue to be supplied in the future, particularly in the event of an unusual (non-essential use ban) drought affecting the Thames Water area.

4.7 Water Supply Strategy

Limited information has been provided by ESW on the water supply network within Thurrock for the Outline stage of this WCS. The information presented in this section comes mainly from the draft WRMP (ESW 2008), which until the final WRMP is published remains the best available source of information. A schematic of the ESW water supply system is included in Box 4.2.

Box 4.2 ESW's Simplified Schematic of their Water Supply System (Reference 13)

The current preferred mode of operation for ESW's Essex WRZ treatment works during the summer is for Langham, Langford, Layer and Chigwell (all of which lie outside the Thurrock area) to provide a reasonably constant base load, with output from Hanningfield varying to make up the excess.

In general the groundwater fed Water Treatment Works (WTW), Linford and Stifford which lie within Thurrock, have fairly uniform outputs through the year. Improvements works to mitigate water quality issues with the operation of this WTW has limited the rate at which groundwater can be pumped and as such there is a slight reduction in the amount of water available for supply from this source which has to be made up by extra water supplies fed into network from outside the Thurrock area.

4.8 Potential Risks to Water Supplies

Potential risks to ESW water supplies which may affect the Thurrock area, include:

- Groundwater quality within its aquifers – two main risks affect the aquifers within Thurrock, salinity and nitrate. Predictions of nitrate concentrations in many UK groundwater sources indicates that within a relatively short period many of these sources will no longer be suitable for water supplies. The main source of nitrate is from agricultural inputs in the northern part of the Thurrock area (which may or may not change in the future). Excessive pumping from groundwater may also increase salinity as a result of drawing poorer quality water up from depth. The close monitoring by ESW of the salinity in its borehole source will be required if any increase in pumping is proposed by ESW;
- Climate change – this principally affects surface water systems, such as the Hanningfield and Abberton Reservoirs as climate change is expected to lead to drier, hotter summers which will likely lead to lower summer river flows in rivers. Although the effects of climate change on available water for supply are likely to be relatively small and have been estimated to represent a loss in the order of 6 Ml/d by 2035, based on the UKCIP02 mid climate change scenario (Reference 13)..Nonetheless the situation will need to be monitored closely in the coming years ahead; and
- Water supply resilience – all new (and existing) water supplies should be resilient, whereby if the standard means of water provision is interrupted (be that from physical or chemical mechanisms), then there are alternative means by which supplies of potable water can be maintained. In general, the Thurrock water supply system is well connected, allowing the re-distribution of potable water. This is something which must be incorporated into the design of any new development areas which are being proposed within the Thurrock area.

4.9 Infrastructure Requirements

At this stage it is not possible to assess the infrastructure requirements required to supply water to the proposed dwellings in Thurrock. ESW have indicated through discussions that local connections to the existing mains water supply network would not be a constraint to growth and no additional main water supply infrastructure is required as the majority of development is being built in brownfield/existing housing/employment land.

4.9.1 Water Resources Constraints Assessment

Water resources and supply are an issue that affect the entire Borough of Thurrock rather than a particular BAR. Water from all areas is supplied from the same sources and the entire Borough experiences the same supply/demand balance as it is in one single water resource zone. The only potential difference between BARS is local supply pipeline connections to the mains network, for which ESW have indicated that there are no significant issues. Therefore the constraint assessment (based on the criteria in Table 4.6) has been undertaken for Thurrock as a whole and is based on the phasing options as provided by Thurrock BC.

Table 4.6 Water Resource Constraint Assessment Criteria

Water Resource Assessment	Water Resource Constraint
There is an existing raw water source nearby with spare licence capacity. There is water available based on CAMS Methodology Classification.	Water is available to supply new development. No constraint to development.
There is an existing raw water source nearby but with no spare capacity. There is no water available based on CAMS Methodology Classification.	There is a restriction on water availability during dry years but water resource schemes are planned to address the water supply for new development.
There is no existing raw water source nearby. Water sources are over abstracted/over licensed based on CAMS Methodology Classification.	A major water resource scheme is required to serve new development and is not currently planned for in ESW water resource management plan.

During normal years, ESW have sufficient water resources to supply all demand from existing houses and non-domestic uses in ESW's Essex WRZ and therefore Thurrock. However, for dry years (drought conditions) ESW are currently running at a 'supply demand deficit' in their water resources planning for this zone. This means that during a very dry year there is considered to be insufficient resources to meet peak demand, and as such ESW are at risk of not meeting their 'levels of service' to customers[8]. A water company must be able to demonstrate that it can supply sufficient water in all conditions which ensures that measures such as restrictions on use, and hosepipe bans are only implemented according to a given frequency as agreed to Ofwat. Whilst this does not mean that water resources are not available for new development in 'normal years' it does mean that new and existing development cannot be guaranteed to receive the company's planned 'level of service' for water supply in a dry year. This will continue to be the case until supply and demand is bought back into balance which is forecast to occur in 2015 following completion of the Abberton scheme.

Table 4.7 shows the water resource constraint assessment for development in Thurrock up to 2025. Whilst ESW will be running at a supply demand deficit up until 2014, when the Abberton Scheme is planned to come online, this is not considered to be a constraint to development as ESW have a statutory duty to supply water to the new development, and Thurrock as whole, and will continue to do so even during dry periods.

Table 4.7 Water Resource Constraint Assessment

Water Resource Assessment	Water Resource Constraint
2009 (Baseline)	
2009 - 2014	
2014 - 2019	
2019 – 2025	

[8] 'Levels of service' refer to a water company's targets in ensuring water supplies in dry years.

5 Flood Risk Management, SuDS and Surface Water Management

5.1 Introduction

A review of flood risk in the WCS is essential to ensure that:

- the risk of flooding to and from the potential development areas is quantified and the development is steered away from high risk areas (Flood Zones 2 and 3);
- any flood mitigation measures are planned in a strategic manner; and,
- there is no deterioration to existing communities' standard of protection.

Thurrock's Strategic Flood Risk Assessment (SFRA) has recently been updated in accordance to Planning Policy Statement 25: Development and Flood Risk (PPS25, Reference 17) and its guidance document (Reference 18), incorporating new climate change allowances, new water levels, and updated breach modelling. The findings from the Level 1 and Level 2 SFRA for Thurrock (Reference 5 and Reference 6), have been included in this study to identify potential sources of flood risk to and from the BARs and where these pose a constraint to development in these areas.

The constraints assessment has also considered the suitability of a range of Sustainable Drainage Systems (SuDS) based upon the geology, soils and/or groundwater vulnerability in the BARs, and the management of surface water in the Borough which has the potential to increase the rate and amount of water that enters watercourses causing an increase in flood risk. Strategic level constraints and mitigation measures have been identified where appropriate.

5.2 Catchment Description (including Geological Environment)

5.2.1 Fluvial and Tidal Systems

Thurrock contains the two major watercourses of the Thames Estuary (tidal) and the River Mardyke as well as several smaller watercourses Stanford Brook, Vange Creek / Holehaven Creek, and Arterial Drainage Networks (see Figure 1).

The arterial drainage networks are a collection of drainage channels draining large areas of Thurrock including West Thurrock and Tilbury, as well as the northern parts of the study area in the River Mardyke catchment. Urban areas along the edge of the Thames Estuary generally have a combination of gravity outfalls and pumps and low lying areas around Tilbury have numerous pumping stations to drain the marsh areas. The grazing marshes have extensive channel networks to provide storage when the gravity outfalls are tide locked and the control of water levels has an important influence on their habitat and landscape value.

5.2.2 Geology

The Solid and Drift deposit geologies of the area have been established from British Geological Survey mapping. This information has been reproduced as Figures 3a and 3b respectively.

Adjacent to the Thames Estuary, the Solid geology is Chalk and Red Chalk; to the north there is a band comprising Oldhaven, Blackheath, Lambeth Group and Thanet Beds; and roughly to the north of the A13, these layers are overlain (and hence confined) by London Clay.

The Chalk is the principal underlying aquifer in the area. Rainfall percolates into the aquifer and recharges it. The London Clay prevents infiltration of rainfall (and hence recharge) over the northern part of the study area and therefore results in water travelling over the surface as surface water flow; the River Mardyke therefore responds rapidly to heavy rainfall. The Lambeth Group (formerly know as the Woolich and Reading Formation) consisting of clays, sands, silts and some shelly beds, and Thanet Beds (sands) lie in a band running across mid Thurrock. These exhibit variable permeability across this band.

The Drift deposit geology consists of Alluvium in the south of the study area, adjacent to the Thames Estuary. Alluvium is also present within the floodplain of River Mardyke in the northern part of the study area. Alluvium consists of clays, silts, sands and gravels and the permeability can be highly variable depending on the exact composition of the material. Since this material has been deposited in riverbeds, it tends to be relatively impermeable. In between these two areas of Alluvium, there runs a band of undifferentiated river terrace deposits which generally have a higher permeability.

5.2.3 Flood Defences

Flood defences are typically engineered structures designed to limit the impact of flooding. The Thurrock Level 1 SFRA (Reference 5) details the coastal defences within Thurrock as provided by the National Flood and Coastal Defence Database (NFCDD), compiled by the Environment Agency.

There are a range of tidal and fluvial flood defences within the Thurrock study area and these include:

- Tidal flood defences along the Thames Estuary and tributaries downstream of the tidal limit, these are mainly raised reinforced concrete walls, steel walls, or earth embankments which are recorded as providing protection against a 1 in 1000 year tidal flood event. The section of the Thames within the Thurrock study area has a continuous form of flood defence (predominantly 'hard defences) from the River Mardyke in the west to Fobbing Horse Barrier in the east. Tidal barriers have also been constructed at the mouth of Tilbury Docks to protect this area, much of which is at or below mean high tide level;
- Fluvial flood defences along the River Mardyke; there are approximately 10km of maintained channels, including the channels in close proximity to the Mardyke sluice and Stifford gauging station. These provide protection up to the 1 in 20 year fluvial flood event. This includes channel widening and raised banks to protect it from flooding except in extreme events. Wooden floodgates exist on the River Mardyke, where it joins the Thames Estuary at Purfleet. These gates are self-activating, closing under pressure from rising water levels in the tidal Thames, thereby protecting the River Mardyke from excessive tidal movements.; and,
- Fluvial flood defences along a number of other small watercourse channels. These include natural earth and vegetated channels associated with Manor Way Creek, Vange Creek, Fobbing Creek, and Stanford Brook from Mucking Creek to Stanford-le-Hope.

The Environment Agency is responsible for maintaining almost all of the defences within Thurrock.

Outfalls and Pumping Stations

Whilst the lower reaches of the River Mardyke and Stanford Brook are protected from direct tidal inundation, tides can still affect the fluvial flood levels in these areas. In these locations outfalls are flapped or pumped to prevent tidal inflow according to fluvial and tidal action. During high tide the flaps are closed

(tide locked) and river water from upstream is backed up and stored within the channel. At low tide the flaps are open enabling the river water to drain. Therefore, during larger tides there is a longer period of tide locking and when this occurs with high river flow it is possible for channel capacity to be exceeded causing flooding.

The SFRA reports that unless further channel storage is provided, anticipated increase in sea levels will result in more tide locking and therefore an increased occurrence of flooding in these areas.

5.3 Flood Risk Identification Methodology

The aim of identifying the potential sources of flood risk to the potential development areas is to assess the risks of all forms of flooding to and from a development in order to identify any potential development constraints with respect to flood risk. PPS25 emphasises the need for a risk-based approach to be adopted by planning authorities through the application of the Source-Pathway-Receptor model. This model has been used in the SFRAs produced for Thurrock and hence the findings of these SFRAs have been used in this WCS assessment.

5.3.1 Thurrock Level 1 and Level 2 Strategic Flood Risk Assessment

The Thurrock Level 1 SFRA (Reference 5) has undertaken a strategic level assessment of the sources of flood risk in Thurrock Borough Council's administrative area and considered the implications of flood risk arising from new development. This allows Thurrock Borough Council to undertake the Sequential Test on potential development areas, as required in PPS25 (Reference 17). The Sequential Test is a method by which development areas are considered and selected on the basis of taking forward the areas with lowest flood risk. Where it is has been proven that there are no reasonably available development sites within lesser areas of flood risk, and there are overriding sustainability reasons for considering higher risk options, then the PPS25 Exception Test (Part A) is undertaken dependent on the development type. The Thurrock Level 2 SFRA (Reference 6) has built on the findings of the Level 1 SFRA and Sequential Test and provided detailed information regarding flood hazard in order inform the suitability for development of potential sites with known flooding issues, as identified and outlined in the Level 1 SFRA and the PPS25 Sequential Test.

5.4 Current Flood Risk to Development

The Thurrock Level 1 SFRA (Reference 5) has considered the main flood risks to the area from fluvial sources, tidal sources, groundwater, surface water, sewer flooding and flooding from artificial sources.

5.4.1 Tidal Flood Sources

Tidal flood sources include the sea and estuaries. The Thames Estuary is the only tidal flood source in the Thurrock area. PPS25 requires definition of the following tidal Flood Zones as provided in Table 5.1.

Table 5.1: Tidal Flood Zone Definitions (as defined in PPS25, Table D.1)

Flood Zone	Definition	Probability of Flooding
Flood Zone 1	Land at risk from flood event less than the 1 in 1000 year event (less than 0.1% annual probability of flooding each year)	Low Probability
Flood Zone 2	Land at risk from flood event between the 1 in 200 and 1 in 1000 year event (between 0.5% and 0.1% annual probability of flooding each year)	Medium Probability

Flood Zone	Definition	Probability of Flooding
Flood Zone 3a	Land at risk from flood event equal to, or greater than, the 1 in 200 year event (greater than 0.5% annual probability of flooding each year)	High Probability
Flood Zone 3b	Land where water has to flow or be stored in times of flood, or land purposely designed to be flooded in an extreme flood event (0.1% annual probability). The 1 in 20 year annual probability floodplain is the starting point for consideration but local circumstances should be considered and an alternative probability can be agreed between the Local Planning Authority and the Environment Agency	Functional Floodplain

Climate Change

PPS25 requires developments in floodplains to consider the potential impacts on flood risk for the lifetime of the proposed development.

It is generally assumed that commercial developments should be considered to have a 75 year design life, and residential developments should be considered to have a design life of 100 years in accordance with guidance in the PPS25 Practice Guide (Reference 18). In accordance with Annex B of PPS25, allowances for climate change, based on the UKCIP02 scenarios, should be made on tidal flood sources for a 75 and 100 year design horizon. This requires an assessment of the impact of 10% sensitivity allowance on offshore wind speeds and wave heights for the period 2055-2115 when modelling flood events (Table B.2 of PPS25).

It should be noted that the SFRA has only mapped 100 years of climate change and does not include outputs for 75 years.

Historical Flood Events

The SFRA reports that there is only one record of major tidal flooding in Thurrock in January/February 1953 when an intense low-pressure system developed in the North Sea sending a storm surge south along the east coast and creating a tide level of 5.03m AOD, the highest ever recorded. Existing flood defences were overtopped and a significant proportion of Tilbury, Purfleet and land to the east of Corringham was flooded.

Tidal Flooding in Thurrock

Figure 4a shows the Flood Zones for Thurrock with allowances made for climate change (2109). These were provided by the Environment Agency, produced by projecting the extreme tidal levels for the Thames Estuary onto a Digital Terrain Model (DTM) to determine the extent of flooding. The mapping does not take into account the presence of existing flood defence structures.

Parts of Thurrock are considered to be protected from up to a 1 in 1000 year tidal flood event from the Thames Estuary under normal circumstances. However, there is always a risk that the defences may be overtopped and/or breached; the presence of defences can only reduce, and not remove the risk of flooding.

Flood Hazard Rating (2109)

Hydrodynamic breach modelling has been carried out at 21 locations along the Thurrock frontage as part of the Thurrock Level 1 and Level 2 SFRA to assess the residual risk behind the tidal defences.

As part of the Level 1 and Level 2 SFRA, these breach models have been run for the following return period events during the present day (2009) conditions and with allowances made for climate change (2109):

- 1 in 200 year tidal breach event for the current day 2009 and 2109;
- 1 in 1000 year tidal breach event for the current day 2009 and 2109.

The results from this modelling have been used to map Flood Hazard. Figure 4b shows the flood hazard for the 1 in 1000 year tidal breach event with allowances for climate change (2109) in Thurrock. Flood hazard is a function of the flood depth and flow velocity at a particular point in the floodplain. The hazard rating (HR) has been calculated for the flood risk associated with fluvial systems and the flood risk resulting from breaches in tidal defences. Flood risk is divided into four hazard categories, Extreme, Significant, Moderate and Low, based upon the depth and velocity of flood water (Table 5.2).

The derivation of these categories is based on Flood Risks to People FD2320 (Reference 7), using the following equation:

*Flood Hazard Rating = ((v+0.5)*D) + DF* Where *v = velocity (m/s)*
D = depth (m)
DF = debris factor

Table 5.2: Hazard Categories (Based on FD2320, DEFRA & Environment Agency 2005)

Flood Hazard			Description
	HR < 0.75	**Low**	**Caution** – Flood zone with shallow flowing water or deep standing water
	0.75 ≥ HR ≤ 1.25	**Moderate**	**Dangerous for some** (i.e. children) – Danger: flood zone with deep or fast flowing water
	1.25 > HR ≤ 2.0	**Significant**	**Dangerous for most people** – Danger: flood zone with deep fast flowing water
	HR > 2.0	**Extreme**	**Dangerous for all** – Extreme danger: flood zone with deep fast flowing water

5.4.2 Fluvial Flood Sources

Fluvial flood sources include sections of the river not affected by the sea. The main source of fluvial flooding with Thurrock is the River Mardyke.

PPS25 (Reference 17) defines three 'flood risk zones' with respect to fluvial flooding. The flood zones are classified in terms of flood risk from rivers based on probability of a flood event occurring. The fluvial flood zones are defined in Table 5.3.

Table 5.3: Fluvial Flood Zone Definitions (as defined in PPS25, Table D.1)

Flood Zone	Definition	Probability of Flooding
Flood Zone 1	Land at risk from flood event less than the 1 in 1000 year event (less than 0.1% annual probability of flooding each year)	Low Probability
Flood Zone 2	Land at risk from flood event between the 1 in 100 and 1 in 1000 year event (between 1.0% and 0.1% annual probability of flooding each year)	Medium Probability
Flood Zone 3a	Land at risk from flood event equal to, or greater than, the 1 in 100 year event (greater than 1.0% annual probability of flooding each year)	High Probability

Flood Zone	Definition	Probability of Flooding
Flood Zone 3b	Land where water has to flow or be stored in times of flood, or land purposely designed to be flooded in an extreme flood event (0.1% annual probability). The 1 in 20 year annual probability floodplain is the starting point for consideration but local circumstances should be considered and an alternative probability can be agreed between the Local Planning Authority and the Environment Agency	Functional Floodplain

Flood Zone mapping for the Thames Estuary has been produced based on extreme tidal levels since this presents a more conservative scenario than the fluvial level, hence fluvial flooding from the Thames is not considered as a risk.

The Flood Zones for the River Mardyke and Stanford Brook for the present day (2009) have been created from outputs from the Catchment Flood Management Plan (CFMP) hydraulic models provided by the Environment Agency. The 1 in 1000 year event, 1 in 100 year event and 1 in 20 year event were used to map Flood Zones 2, 3a and 3b respectively.

The maximum water level at each node within the hydraulic model has been extracted and used to create a water surface which can then be compared with the DTM of the study area to determine the extent of the flood outline.

Figure 4a shows the extent of fluvial flooding in Thurrock with allowance for climate change (2109).

Climate Change

The Flood Zones should be defined considering the effects of climate change for the design life of development. It is generally assumed that commercial developments should be considered to have a 75 year design life, and residential developments should be considered to have a design life of 100 years in accordance with guidance in the PPS25 Practice Guide (Reference 18). For fluvial systems, PPS25 requires an increase of 20% in peak river flows and 30% in peak rainfall intensities to be used when modelling fluvial flood events for development up to 2115 (Table B.2 of PPS25).

It should be noted that the SFRA has only mapped 100 years of climate change and does not include outputs for 75 years.

Historical Fluvial Flood Events

The SFRA reports two fluvial flood events in Thurrock:

- Stanford Brook – September 1985 - 76mm rainfall fell in 2 hours and 500 houses flooded above floorboard level in Stanford-le-Hope.
- River Mardyke – September 1968 - Fenchurch Street line affected. 2,400 acres of farmland.

Flood Hazard Rating (2109)

Flood hazard has been calculated for the River Mardyke and Stanford Brook flood outlines using the same formula applied for the breach assessments described above. For these fluvial systems, the 1 in 100 year event which is considered comparable with the 1 in 200 year tidal event, and the 1 in 1000 year fluvial event have been mapped. The flood hazard for Thurrock with an allowance for climate change, as produced for the SFRA, is provided in Figure 4b. This is a composite map of fluvial and tidal flood hazard as described in the Thurrock Level 2 SFRA (Reference 6).

5.4.3 Surface Water Flooding / Overland Flow

Surface water flooding and overland flow typically arises from intense rainfall, often of short duration, that fails to infiltrate the surface or enter drainage systems and as a result travels over the ground surface and can result in local flooding. Local topography and built form can have a strong influence on the direction and depth of flow.

The Level 1 SFRA provides a summary of existing and available data on surface water flooding and does not include probabilistic modelling of surface water flooding. There are several sources of information which are provided in Table 5.4. Recorded surface water flooding events are provided in Figure 4a. The main areas that have been affected by surface water flooding are Tilbury and Bulphan.

Table 5.4 Surface Water Flooding and Overland Flow Sources of Information and Identified Risks (based on findings of the Thurrock Level 1 SFRA)

Source of Information	Description/Analysis	Identified Risk Areas
Topographic Data & Slope Analysis	The SFRA has undertaken a review of topographic data and a GIS slope analysis to determine the location of steep sloping ground, which could potentially generate significant volumes of run-off during extreme events, and in combination with the topographic data, used to determine local low points where ponding of surface water could potentially occur.	Analysis only provides an indication of the overall terrain, and there will be significant variation in risk due to the absence or presence of flow barriers on the ground. Therefore, it was not considered appropriate to attempt to classify these areas further into high, medium and low risk.
Regional Flood Risk Assessment, 2009	The Regional Flood Risk Assessment states that surface water flooding in South Essex is primarily the result of under-capacity culverts, inadequate highway drainage, blocked pipes and overgrown watercourses.	One area that is particularly affected in Thurrock is the urban area of Grays.
National Environment Agency Mapping: Areas Susceptible to Surface Water Flooding	The Environment Agency has undertaken broad scale, national mapping of areas susceptible to surface water flooding. Due to the high level nature of this mapping, it is not considered suitable as a basis for strategic planning within Thurrock however, it provides a useful overview to identify those areas that will require further investigation in relation to surface water flooding sources and pathways. Further information on the Environment Agency's mapping of Areas Susceptible to Surface Water Flooding and relevance to Thurrock is provided in Section 5.2.9 of the Thurrock Level 1 SFRA and illustrated in Figure 9 in Appendix A of the SFRA.	The following areas have been highlighted as being 'more susceptible' to surface water flooding: • Land to the north west and east of Tilbury, due to the low lying nature of the land. • Land in Grays and West Thurrock, likely to be the effect of ponding of surface water runoff being the railway embankments. • A large part of Standford-le-Hope. It is recommended that surface water flooding issues in this area are investigated further.
Catchment Flood Management Plan, 2008	The South Essex Catchment Flood Management Plan has identified those areas that are likely to experience surface water flooding because of urbanisation and the associated high proportion of impermeable surfaces in these areas.	Areas at risk include the urban area around Purfleet, Thurrock, Grays, Tilbury and Standford-le-Hope.

5.4.4 Sewer Flooding

Sewer flooding arises when the capacity of a sewer system is exceeded either as a result of a rainfall event which generates more water than can be accommodated in the sewer or there is a blockage in the sewer which prevents water from flowing. Both situations result in a sewer overflowing or 'surcharging'

Modern sewer systems are typically designed to accommodate rainfall events with a 1 in 30 year return period. Older sewer systems were often constructed without consideration of a design standard therefore some areas may be served by sewers with an effective design standard of less than 1 in 30 years. Consequently, rainfall events with a return period greater than 1 in 30 years would be expected to result in flooding of some parts of the sewer system.

In addition, as towns and villages expand to accommodate growth, the original sewer systems are rarely upgraded and may become overloaded. This problem is compounded by climate change, which is forecast to result in milder wetter winters and increased rainfall intensity in summer months. The combination of these factors will increase the pressure on existing sewer systems, effectively reducing their design standard and increasing the frequency of flooding.

Recorded sewer flooding events are provided in Figure 4a. The main areas that have been affected by sewer flooding are Stanford-le-Hope, Grays, Tilbury and Bulphan.

5.4.5 Groundwater

Groundwater flooding occurs when water levels in the ground rise above surface elevations. Groundwater flooding may take weeks or months to dissipate, as groundwater flow is much slower than surface water flow therefore water levels take much longer to recede.

The SFRA Level 1 (Reference 5) reports that rising groundwater levels have been observed in some parts of the Thurrock area linked to where the chalk geology is not confined (south of the area), in particular around Tilbury Power Station. Other incidences seem to be related to the impact of commercial Chalk quarrying. During the operation of these quarries dewatering took place but extraction came to and end and pumping was halted, then there has been rise in groundwater of approximately 60 mm per annum. Continued increases in groundwater levels could lead to local flooding, especially developments which include basements.

5.4.6 Artificial Sources

PPS25 requires that artificial water sources with a potential to cause flooding within the study area are identified as part of a SFRA. These include canals, reservoirs, ponds, and any feature where water is held above natural ground level. The most well known lake in Thurrock is Alexandra Lake, a 6 hectare lake adjacent to the Lakeside Shopping Centre which provides facilities for water sports and activities.

There are no known records or flooding from artificial sources within Thurrock.

5.5 Potential Flood Risk from Development

Of the minor watercourses in the Borough, Gobions Sewer, Stone House Sewer, East Tilbury Dock Sewer and West Thurrock Sewer, have been identified by the Environment Agency as low-flow channels with no additional capacity to accept surface water runoff. Any future development within the locality of these watercourses will therefore require attenuation (or storage) prior to discharging to greenfield runoff rates (Reference 19).

To ensure that potential flood risk from development within Thurrock is minimised, surface water runoff from the new development will need to be managed to ensure that there is no increase in runoff rates to watercourses or surrounding areas. The Detailed WCS will assess the surface water management options and recommendations for the proposed major development areas.

5.6 Flood Risk Assessment

An assessment has been undertaken as part of the SFRA on the BARs in Thurrock (Table 5.6). Five of the BARs are located within Flood Zone 1; Aveley, Chadwell St Mary, South Ockendon, Stifford Clays / North Grays and the Villages in the north of Thurrock. In addition a large proportion of Stanford-le-Hope and Corringham is located within Flood Zone 1. Within these areas, fluvial flood risk and residual tidal flood risk resulting from a breach in the flood defences, are low and are not expected to impact upon the type and design of development that is appropriate. Where development is proposed within these areas, steps should be taken to ensure that the development does not increase flood risk elsewhere, and greenfield runoff rates should be sought from all new developments through the implementation of sustainable drainage systems (SuDS). Further details with respect to the use of appropriate SuDS are provided in Section 5.7.

The remaining BARs are located predominantly within Flood Zone 3a associated with the Tidal River Thames. These include East Tilbury, Grays, London Gateway, Tilbury and West Thurrock. Though these areas are defended from tidal flooding up to the 1 in 1000 year event, it is necessary to assess the residual risk to these areas by undertaking breach modelling for the area and mapping Flood Hazard. This mapping has been used to apply the Sequential Test to individual development sites within these areas to determine whether there are reasonably alternative sites available for the development in areas of lower flood risk.

The Sequential Test undertaken for Thurrock demonstrates the need for development within these areas and therefore it is likely that development will be proposed where there is residual risk of tidal flooding and may require application of the Exception Test. The SFRA states that in order to apply the Exception Test, more detailed information is required regarding the nature of flooding in these areas such as flood depths, velocities and time to inundation by floodwaters. A Level 2 SFRA has been prepared to present this information and provide guidance for those sites that will require the Exception Test.

For the purposes of the Outline WCS, the constraint matrix as provided in Table 5.5 has been applied to the flood risk constraint assessment.

Table 5.5 Flood Risk Constraint Assessment

Flood Risk Assessment	Flood Risk Constraint
Site is not within Flood Zone 2 or 3a/b. There is no hazard rating during 1 in 1000yr event. There are no records of surface, groundwater or sewer flooding.	There is little or no perceived risk of flooding to the development area. Development can be situated anywhere within the BAR due to its location in Flood Zone 1. The Sequential Test is passed.
Site is located within Flood Zone 2 or 3a/b. There is a hazard rating of significant or extreme during 1 in 1000yr event but not all of the BAR is located in the extreme hazard zone so the site wide sequential test can be applied. There are some records or either surface, groundwater or sewer flooding in the area.	There is a perceived medium risk of flooding to the development area. Development should be steered to lower flood risk areas where possible as Flood Zones 2 and 3 are present. Flood hazard classifications should be used to ensure more vulnerable developments are located in lower flood hazard areas. A Sequential Approach is needed within the BAR.
Site is located within Flood Zone 3a/b. There is a hazard rating of extreme during 1 in 1000yr event for the whole BAR area. There are recorded flooding events in the area from two of the three sources - surface, groundwater and sewer.	There is a perceived high risk of flooding to the development area. If development cannot be steered to other BARs flood hazard classifications should be used to steer more vulnerable developments to lower flood hazard areas in Flood Zone 3. Emergency planning measures should be in place to ensure response to a flood emergency is planned. This will support part c) of Exception Test. The Exception Test is necessary.

Table 5.6 Flood Risk Assessment for Broad Areas for Regeneration in Thurrock

	BAR	Flood Zone 2	Flood Zone 3a/b	Maximum Hazard Rating during 1 in 1000yr	Recorded Surface Water Issues	Groundwater	Recorded Sewer Flooding	Artificial Water Features	Flood Risk Constraint
1	Purfleet	✓	✓	Extreme	✓	-	-	×	Sequential Approach Needed
2	Aveley	×	×	×	-	-	-	×	Sequential Test Passed
3	S. Ockendon	×	×	×	-	-	-	×	Sequential Test Passed
4	West Thurrock	✓	✓	Extreme	-	-	-	✓	Sequential Approach Needed
5	Grays Urban Area	✓	✓	Extreme	-	-	✓	✓	Sequential Approach Needed
5a	Stifford Clays / N. Grays	×	×	×	-	-	-	×	Sequential Test Passed
6	Tilbury	✓	✓	Extreme	-	-	✓	✓	Exception Test Needed
7	Chadwell St Mary	×	×	×	-	-	-	×	Sequential Test Passed
8	East Tilbury	✓	✓	Significant	-	-	-	×	Sequential Approach Needed
9	Villages	×	×	×	✓	-	✓	×	Sequential Test Passed
10a	Stanford-le-Hope & Corringham	✓	✓	Extreme	✓	-	✓	×	Sequential Approach Needed
10b	London Gateway	✓	✓	Extreme	-	-	-	✓	Exception Test Needed

Note: Where Sequential Test has been identified as being needed this needs to take place within the BAR
Where Exception Test has been identified as being needed this is because no alternative sites are available

5.7 Sustainable Drainage Systems (SuDS)

Flood risk generated as a result of any development is an important consideration with respect to the assessment of development area potential and current national planning policy with regards to flood risk management.

In areas where development runoff is likely to be discharged to a river system, it is important that new development does not increase the risk of flooding downstream by increasing runoff rates to greater than that of the runoff generated by existing land use. In addition, it is important that new development does not increase the risk of overland flow to adjoining development areas by increasing the amount of impermeable area.

PPS25 requires that all new development should ensure that runoff rates and runoff volumes from new development are not increased above that of the existing land use. Much of the development in Thurrock will be on previously developed (brownfield) land; hence the requirement to reduce runoff rates, as a result of rainfall, will be less onerous for these developments, compared to those on greenfield sites. For any development on currently undeveloped land, there will be a requirement to ensure that runoff rates and volumes are no greater than the greenfield rates for the design event with return period of 1 in 100 years (with an allowance for climate change) and smaller rainfall events up to this level.

It is important to note that whilst the majority of the proposed development sites are on existing brownfield sites, the latest Environment Agency guidance states that runoff should be limited to that of greenfield rates, thereby requiring less runoff to watercourses and/or adjacent development areas than that currently experienced.

5.7.1 Flood Risk from Development: SuDS Utilisation

In order to reduce runoff rates from developed sites to that of existing (and where possible to achieve 'betterment'), PPS25 and its companion guidance (Reference 18) recommend that Sustainable (urban) Drainage Systems (or techniques) are used, known collectively as SuDS. Development within the new development areas will need to include for the SuDS both at a site specific level but also a strategic scale level. In general, there are advantages to be gained to developing drainage strategies for site wide developments such that strategic scale options such as balancing ponds can be developed at lower overall cost, but also to:

- strategically manage flood risk and surface water;
- maximise green infrastructure linkage;
- maximise ecological enhancement;
- maximise water quality benefits from retention and filter type SuDS; and
- contribute towards the point system for Code for Sustainable Homes grading.

Consideration of the potential SuDS options is a key objective for this strategic WCS. The following Sections outline some of the key outline or strategic considerations for SuDS for the development areas, and it is recommended that further detailed requirements are developed for the BARs either as part of a Surface Water Management Plan (SWMP) or a Detailed WCS.

5.7.2 SuDS Options

The Environment Agency and Defra currently suggest that the SuDS management train is adopted when considering SuDS techniques to be adopted for new development. This lists the order in which different SuDS techniques should be considered for a site in terms of their requirement to mitigate against surface water and flood risk (Reference 20). This states that prevention methods should first be considered, followed by infiltration, attenuation with discharge to watercourse, or attenuation with discharge to sewer. Appendix D provides further information on the SuDS management train and a description of the type of potential SuDS that could be considered for the Thurrock development areas.

Infiltration is a key factor in reducing runoff rates and volumes, as it reduces reliance on surface or engineered storage systems such as balancing ponds or storage tanks. Green areas and open space should be maximised for large development areas where the soil and geology is sufficiently permeable to make it a feasible option. Infiltration can also be encouraged via managed SuDS techniques such as soakaways, swales or infiltration trenches. Given that some of the study area is underlain by permeable geology such as Chalk or Sands and Gravels, infiltration is a key consideration for new development in Thurrock, particularly to the south of the Borough. Despite this, the Chalk underlying Thurrock is considered a Major Aquifer used for public supply (at Linford and Stifford) therefore due regard needs to be paid to protection of groundwater from pollution pathways that can be created by poorly managed or badly located infiltration SuDS, and as such, there are restrictions on the types of infiltration SuDS systems permitted within developments.

Determination of infiltration sensitive areas is considered by reviewing soil type and geology via groundwater vulnerability maps, and catchment areas which feed public water supply sources via source protection zone mapping.

Groundwater Quality - Vulnerability

Groundwater can be vulnerable to contamination from both direct sources (e.g. into groundwater) or indirect sources (e.g. infiltration of discharges onto land). Groundwater vulnerability within the study area has been determined by the Environment Agency, based on a review of aquifer characteristics, local geology and the leaching potential of soils. The vulnerability of the groundwater is important when advising on the suitability of SuDS.

Thurrock is covered by the Environment Agency's Groundwater vulnerability map, Sheet No. 40 (Reference 21). The South of Thurrock is classified as a Major Aquifer due to the presence of Chalk across the southern area. The middle band of Thurrock is classified as a Minor Aquifer due to the presence of Lambeth Group and Thanet Beds and River Terrace Deposits. The North of the Borough is classified as a Non-Aquifer due to the London Clay Formation.

The London Clay plays an important part in determining the distribution of vulnerability classifications across the Thurrock area. The Chalk is largely unconfined to the south of the Borough and the vulnerability classification is high (either HU or H1), whilst the northern part of Thurrock is Intermediate where the River Terrace Deposits and Alluvium overlie the London Clay and Lambeth Group.

For each of the BARs, the groundwater vulnerability has been assessed beneath the area.

Source Protection Zones

The Environment Agency defines groundwater Source Protection Zones around all major groundwater abstraction points. Source Protection Zones (SPZ) are defined to protect areas of groundwater that are

used for potable supply, including public/private potable supply, (including mineral and bottled water) or for use in the production of commercial food and drinks.

SPZs are defined based on the time it takes for pollutants to reach an abstraction point from any point at the water table. It does not include the time taken for water to infiltrate from the surface down to the water table. This transmission time enables the Environment Agency to define three zones around a groundwater abstraction point.

- Zone 1 (Inner Protection Zone) – This is defined as 'any pollution that can travel to the borehole within 50 days from any point within the zone is classified as being inside zone 1'
- Zone 2 (Outer Protection Zone) – This is defined as the area that 'covers pollution that takes up to 400 days to travel to the borehole, or 25% of the total catchment area – whichever area is the biggest'
- Zone 3 (Total Catchment) - The total catchment is the total area needed to support removal of water from the borehole, and to support any discharge from the borehole.

Depending on the nature of the proposed development and the location of the development area with regards to the SPZs, restrictions may be placed on the types of SuDS appropriate to certain areas. Infiltration into SPZ1 is generally only permitted for clean roof runoff. Runoff from roads and car parks is not acceptable in SPZ1 and is only acceptable in SPZ2 if there are sufficient controls of sources of contamination (e.g. oil separators) and there is sufficient depth between the unsaturated soil into which the water is drained and the saturated water table in the geology below.

It should be noted that the only form of SuDS actually restricted in SPZs are deep soakaways under Policy P4-7 of the Environment Agency's Groundwater Protection: Policy and Practice published in 2008. However, even these may be acceptable in certain circumstances as set out in the policy. Contaminated areas will have stricter controls with regards to the use of SuDS on-site and as such, site-specific SuDS will be dependent on the characteristics of the site, such as pollution potential, presence of contamination, local geology etc. and will require further assessment as part of a site-specific Flood Risk Assessment and/or Drainage Strategy.

The SPZ designations for Thurrock are shown in Figure 5. There are two Zone 1 SPZs in Thurrock which are associated with the public water supply abstractions at Linford (to the East) and Stifford (to the West). These overlie the broad location areas of Grays and East Tilbury.

5.7.3 SuDS Assessment

Table 5.7 provides the constraint assessment criteria for SuDS within Thurrock, whilst Table 5.8 and Table 5.9 provide an assessment of the types of SuDS associated the solid and Drift geologies in Thurrock. Table 5.10 provides the SuDS potential assessment for development in Thurrock.

Table 5.7 SuDS Constraint Assessment Criteria

Surface Water Drainage Assessment	Sustainable Drainage Systems Constraint
The site is not within a Groundwater SPZ or is within SPZ 3.	There is little or no perceived risk to groundwater in the area and therefore there is little or no restriction on type of SuDS used.
The site is in Groundwater SPZ 2.	There is a perceived medium risk to groundwater sources in the area and therefore there is some restriction on the type of SuDS that can used.
The site is in Groundwater SPZ 1.	There is a high risk to groundwater sources in area and therefore, other than clean roof runoff, the use of attenuation SuDS will be required.

Table 5.8: Specific Drift Deposits Geology within Thurrock

Drift Deposit	Permeability	General Characteristics	Locations	SuDS
Alluvium	Variably Permeable	Generally clay with some gravel sand and silt	Found adjacent to the Thames Estuary and within the River Mardyke floodplain	Infiltration and combined infiltration/ attenuation systems and attenuation systems e.g. permeable surfaces, sub surface infiltration, basins and ponds, swales and filter strips i.e. a combined system
River Terrace Deposits	Variably Permeable	Variable, generally dominated by sand and gavel	Mid Thurrock, to the north of the alluvium deposits	Infiltration and combined infiltration/ attenuation systems and attenuation systems e.g. permeable surfaces, sub surface infiltration, basins and ponds, swales and filter strips i.e. a combined system

Table 5.9: Specific Solid Geology within Thurrock

Solid Geology	Permeability	General Characteristics	Locations	SuDS
London Clay Formation	Impermeable	Clay, Orange brown becoming blue grey with depth, variably silty with thin sand and rare pebble beds. Some siltstone nodules and bands and Selenite Crystals, occasional shell fragments	North Thurrock (to the north of the A13)	Surface attenuation systems e.g. basins and ponds, green roofs, tanks, rainwater harvesting etc
Chalk	Permeable	White, grey chalk, nodular and soft with flint seams	Thames Estuary and River Mardyke floodplains	Infiltration and combined infiltration/attenuation systems e.g. permeable surfaces, sub surface infiltration, swales and filter strips i.e. a combined system
Thanet Sand & The Lambeth Group	Variably Permeable	Lambeth Group was formerly known as the Woolwich and Reading Formation and consists of mottled clays sands silts with some shelly beds. Thanet sands.	Band running across mid Thurrock.	Infiltration and combined infiltration/attenuation systems and attenuation systems e.g. permeable surfaces, sub surface infiltration, basins and ponds, swales and filter strips i.e. a combined system

Table 5.10 SuDS Potential Assessment

Broad Location Area		Aquifer	Source Protection Zone (SPZ)	Assessment	
1	Purfleet	Major	None	• It is unlikely there will be any stringent restrictions on the use of infiltration SuDS in this area.	
2	Aveley	Minor	SPZ3 to south east of area	• There may be some restrictions placed on the amount of infiltration that would be permitted in the south eastern section as close to SPZ3 (although area is outside of SPZ) with suitable pollution prevention such as hydrocarbon separators, infiltration SuDS should be acceptable	
3	South Ockendon	Minor	SPZ 2 and 3 to south of site	• There may be some restrictions placed on the amount of infiltration that would be permitted in the south of the area although with suitable pollution prevention such as hydrocarbon separators, infiltration SuDS should be acceptable accept for areas of SPZ3	
4	West Thurrock & Lakeside	Minor	SPZ 3 covers northern half of area SPZ 2 covers north eastern corner SPZ 1 located adjacent to north east boundary	• There will be limitations placed on the amount of infiltration that would be permitted in the east of the area, although with suitable pollution prevention such as hydrocarbon separators, infiltration SuDS should be acceptable. • In the north east area there is likely to be significant restrictions on the type of infiltration SuDS that can be promoted in order to protect the Stifford abstraction for Public Water Supply (SPZ1). It is likely that only clean roof water runoff will be permitted for discharge to ground and there may also be limitations on the industry and other land uses such as garages and petrol stations to accompany residential development. • Surface water runoff reduction will be heavily reliant on surface based attenuation to the north and east of the site.	
5	Grays	Major (South)/ Minor (North)	SPZ 3 covers west of area SPZ 2 covers north western corner SPZ 1 overlies north western corner of area	• There will be limitations placed on the amount of infiltration that would be permitted in the west of the area, although with suitable pollution prevention such as hydrocarbon separators, infiltration SuDS should be acceptable. • In the north west area there is likely to be restrictions on the type of infiltration SuDS that can be promoted in order to protect the Stifford abstraction for Public Water Supply. It is likely that only clean roof water runoff will be permitted for discharge to ground and there may also be limitations on the industry and other land uses such as garages and	

Broad Location Area		Aquifer	Source Protection Zone (SPZ)	Assessment	
				petrol stations to accompany residential development. • Surface water runoff reduction will be heavily reliant on surface water attenuation.	
6	Tilbury	Major	None	• It is unlikely there will be any stringent restrictions on the use of infiltration SuDs in this area although the feasibility of infiltration SuDS may be restricted by rising groundwater levels.	
7	Chadwell St Mary	Minor	SPZ3 overlies north east of the area	• There will be some restrictions placed on the amount of infiltration that would be permitted in the north eastern section although with suitable pollution prevention such as hydrocarbon separators, infiltration SuDS should be acceptable	
8	East Tilbury	Minor	Area overlies SPZ3, SPZ 2 and SPZ1	• The area is likely to have significant restrictions on the type of infiltration SuDS that can be promoted in order to protect the Linford abstraction for Public Water Supply. It is likely that only clean roof water runoff will be permitted for discharge to ground and there may also be limitations on the industry and other land uses such as garages and petrol stations to accompany residential development. • Surface water runoff reduction will be heavily reliant on surface water attenuation.	
9	9.Villages	Minor (South) / None (North)	Southfields overlies SPZ3	• There will be some restrictions placed on the amount of infiltration that would be permitted in Southfields although with suitable pollution prevention such as hydrocarbon separators, infiltration SuDS should be acceptable. • It is unlikely there will be any stringent restrictions on the use of infiltration SuDS in all other villages.	
10a	Stanford-le-Hope & Corringham	Minor (South) / None (North)	None	• It is unlikely there will be any stringent restrictions on the use of infiltration SuDS in this area.	
10b	London Gateway	Minor (South) / None (North)	None	• It is unlikely there will be any stringent restrictions on the use of infiltration SuDS in this area.	

Note: Soil information for restored mineral workings and urban areas is based on fewer observations than elsewhere. A worst case vulnerability classification (H) is therefore assumed for these areas and for current mineral workings. All are given a designation HU until proved otherwise.

5.7.4 Surface Water Runoff Attenuation

Once more is known about the numbers of housing and likely layouts of the sites, it is recommended that the detailed requirements for different types of SuDS as outlined in Appendix D is undertaken as part of a SWMP or in the Detailed WCS.

The storage volumes that will need to be provided on a site-by-site basis will be dependent on the level of infiltration that can be provided, either via green areas or specific infiltration SuDS. This volume can be provided strategically, in large scale storage features such as retention lakes or in combination with site specific features such as rainwater harvesting or smaller scale balancing ponds. The strategic SuDS options should be assessed as part of the SWMP or Detailed WCS, in terms of the volume of attenuation required and the scale of mitigation that would be required to mitigate flood risk from the development. In addition the linkage of these schemes to existing green infrastructure should be considered. In the majority of cases, site specific SuDS will be required and these will be decided by the individual site developers.

5.7.5 SuDS Adoption and Maintenance

The adoption and maintenance of SuDS features can be a task that is often overlooked in the early stages of the planning process. Section 2.2.5 of the National SuDS Working Group's 'Interim Code of Practice for Sustainable Drainage Systems' states the "*Maintenance of SuDS differs from that for conventional systems, so it is important to allocate responsibility for the maintenance of SuDS early in discussion before planning approval for the development is given*".

It is important that SuDS adoption and maintenance is given consideration during the SWMP or Detailed WCS to ensure that developers and planners sign-up at an early stage to the proposed flood mitigation measures and drainage systems.

5.8 Surface Water Management

The Level 1 SFRA (Reference 5) identified several areas in Thurrock that are recorded as facing surface water flooding issues. These include the main urban centres of Purfleet, Grays, Thurrock, Tilbury and Stanford-le-Hope. The proposed increase in development in each of the Broad Areas for Regeneration has the potential to increase the quantity, intensity and timing of surface water runoff from these areas. To ensure that there is no downstream increase in flood risk to neighbouring areas it is recommended that surface water flood risk is fully assessed and managed on a strategic scale.

To this end it is recommend that Thurrock BC undertake a Surface Water Management Plan (SWMP) in order to fully identify the suitability of a strategic SuDS scheme, for example regional flood attenuation, rainwater harvesting, property-level SuDS.

One of the objectives of a SWMP is to extend the identification of known localised problems determined in the SFRA and build upon data collected during the Summer 2007 event, examining the causes, extent and effects of surface water flooding events. This will culminate in the identification and the prioritisation of Critical Drainage Areas (CDAs). This information will be used to establish a shared understanding of flood risk from all sources which will aid in future drainage asset management and will help with coordination of future investments and the operational response to future flooding events.

6 Wastewater Treatment and Collection

6.1 Introduction

The wastewater treatment and collection assessment addresses two key areas for wastewater: the baseline with respect to treatment of wastewater and how much 'spare' capacity is available in existing wastewater treatment facilities; and, the baseline with respect to wastewater or sewer network and whether there is scope to use the existing and/or planned network system[9] before upgrades are required.

An important aspect of the spare capacity of the existing wastewater treatment facilities is the assessment of the environmental capacity of the receiving watercourses. Discharge of additional treated wastewater from new development could have a detrimental impact on:

- the water quality of receiving waters;
- the hydrological/hydraulic regime of receiving waters and associated habitats; and,
- flood risk downstream of the discharge.

In conjunction with the findings of the Flood Risk, Water Quality and Ecology constraints assessments (Sections 5, 7 and 7.4), the constraints of future wastewater treatment have been identified.

6.2 Current Wastewater Treatment

Tilbury Wastewater Treatment Works (WwTW) is the only WwTW within the Thurrock Study Area. It serves a population equivalent of approximately 160,000 and discharges directly to the Thames Estuary southeast of Tilbury. Tilbury WwTW is owned and operated by AWS.

There is one further WwTW located on the northwestern boundary of Thurrock at Upminster; Upminster WwTW. The works discharges to the River Mardyke which flows through western Thurrock and joins the Thames Estuary at Purfleet. There are no plans by AWS to transfer any additional wastewater flows generated by new development in Thurrock to Upminster WwTW and therefore the capacity and downstream impacts of this works have not been considered in the Thurrock WCS.

Figure 6a shows the location of both Tilbury and Upminster WwTW and the receiving watercourses.

6.2.1 Tilbury WwTW Volumetric Consent Capacity

The current and future volumetric capacity of Tilbury WwTW has been assessed to identify if there are constraints with transferring additional wastewater to the works under future planned growth. The volumetric capacity ('headroom') refers to the difference between the maximum Dry Weather Flow (DWF) that AWS are permitted to discharge under the discharge consent and the current DWF that is treated from the existing population. DWF is a unit of measure, used by the Environment Agency in a consent to describe the maximum volume AWS can discharge from wastewater treatment works[10]. Tilbury WwTW has a DWF consent of 32,000m^3/d. As no information has been provided by AWS relating to process capacity (see Section 6.2.2), the capacity of the works has been calculated based on the volumetric capacity alone.

[9] The network of pipes and pumping stations which are used to transmit wastewater from buildings to treatment facilities.
[10] It is defined as "The average daily flow of sewage during seven consecutive days without rain following seven days during which the rainfall did not exceed 0.25mm on any one day, averaged over a summer and winter period". In industrial towns the seven days are replaced by five working days.

This is based on the assumption that AWS would seek the funding required to upgrade the processes in the works (if necessary) to treat the additional flow to the standard required under the existing licence.

At the time of undertaking the assessments reported in this Outline Study, the volumetric capacity of Tilbury WwTW was being investigated by AWS and therefore it was not possible to make use of AWS's confirmed flow figures. Therefore the capacity and any associated upgrades will need to be assessed as part of the Detailed WCS. AWS provided the following information in relation to the current and proposed consent at Tilbury WwTW:

"*The consented DWF is 32,000 m3/d, the measured DWF us 30,893 m^3/d and the calculated DWF is 22,095 m^3/d. As part of the regional flow audit we [AWS] have an agreed revised DWF of 42,514 m^3/d, however the revised figure is to account for seasonal variations and as such there is no capacity to accommodate any further growth under this consent. A further application will need to be sought to account for the proposed growth."*

The proposed consent of 42,514 m^3/d is based upon the measured DWF of 30,893 m3/d. However, there is a large discrepancy between this measured flow and the calculated flow of 22,095 m^3/d. AWS are investigating these differences to confirm the current (and future) capacity of the works. It is known that significant additional flows are attributed to the sludge treatment process and imported sludge from Rochford but that AWS are looking at possibly taking these to Basildon WwTW. However, even taking these into account, the difference between the measured and calculated flows are significant.

If the measured flows are confirmed as being correct, then the impact would be such that a revised consent on top of the 42,514 m^3/d will be required to account for the proposed growth figures. This would require an upgrade to the hydraulic capacity of the treatment process which would not be expected to take place before 2016 at the earliest and would need to be assessed further in the Detailed WCS.

Due to the uncertainty surrounding the existing DWF being treated at the works, a separate high level assessment of the current volumetric capacity at the works has been undertaken for the Outline WCS to verify the calculated DWF and 'potential' capacity at the WwTW. This corroborates the AWS calculated DWF and suggests that the measured DWF is much higher than expected.

However, until such time as AWS confirm the existing capacity of the works, it is assumed that the WwTW has limited capacity to accommodate further strategic growth and as such, will require further assessment as part of the Detailed WCS.

Tilbury WwTW Volumetric Consent Assessment

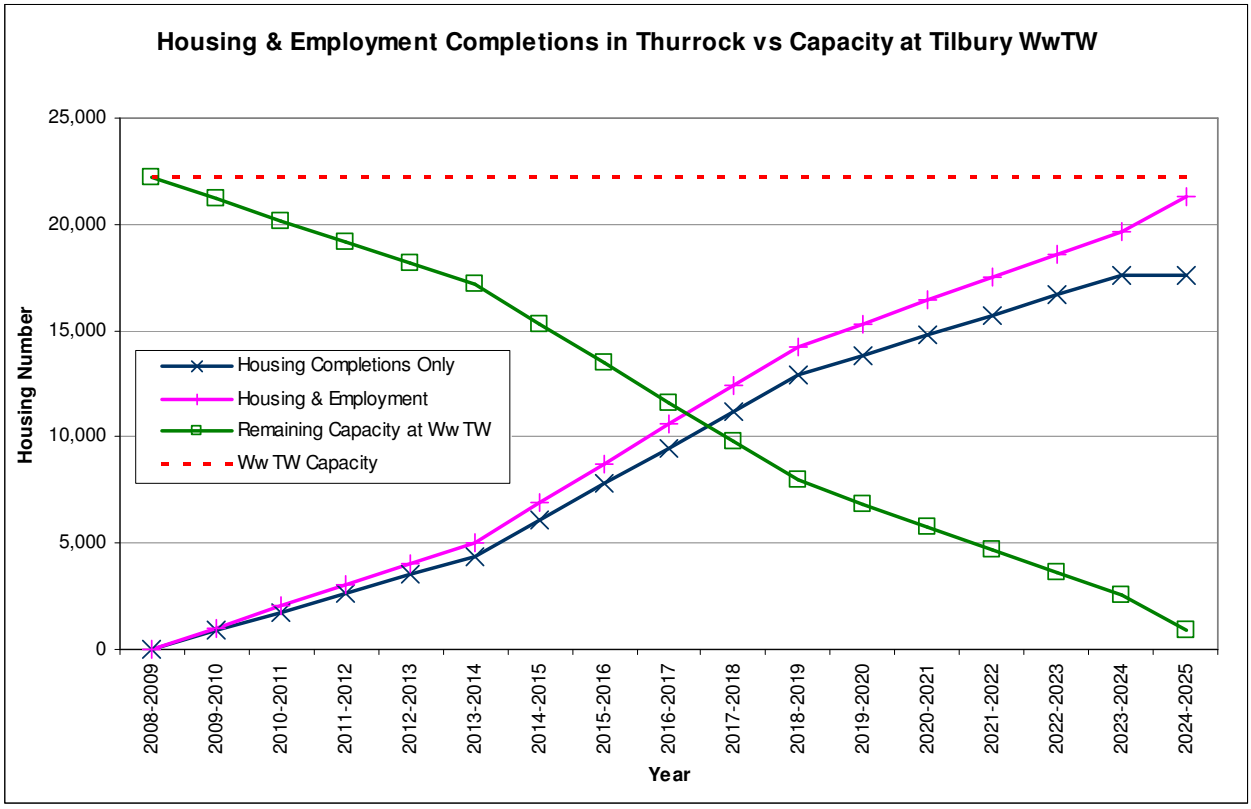
Tilbury WwTW is currently treating a population equivalent of approximately 160, 000 which generates a DWF of around 24,500m^3/d according to calculations undertaken for this study (details provided in Appendix E). This concurs well with AWS calculations that calculate the DWF as 22,095m^3/d. This means that there is a capacity of at least 7,500m^3/d (23%) at the works to treat the additional wastewater generated from planned housing and employment development within Thurrock up to 2025.

Table 6.1 and Graph 6.1 show the capacity (in terms of the number of new dwellings that can be built) at Tilbury WwTW up to 2025, based on the housing and employment phasing of growth as provided by Thurrock BC. The volumetric capacity assessment shows that if the full planned growth goes ahead within Thurrock, Tilbury WwTW will have to treat an additional DWF of 6,675m^3/d. The works has sufficient volumetric capacity at Tilbury WwTW to treat this additional flow but will be approaching capacity by 2025.

Table 6.1 Tilbury WwTW Volumetric Capacity 2009 - 2025

	Baseline (2009)	2009 – 2014	2014 – 2019	2019 – 2025
Housing	0	4,370	12,900	17,624
Employment	0	8,150	16,300	26,000
Capacity (dwellings)	22,196	17,150	7,944	2,415
DWF Capacity (m^3/d)	7,491	5,788	2,681	815
DWF Capacity (%)	23%	18%	8%	3%

Graph 6.1 Tilbury WwTW Volumetric Capacity 2009 - 2025



Note: Capacity at Tilbury WwTW is defined in terms of the number of dwellings that can be accommodated at the works based on an occupancy rate of 2.16 and a per capita consumption of 125 l/h/d for new properties.

6.2.2 Tilbury WwTW Process Capacity

It has not been possible at this stage in the study to accurately determine the process capacity at Tilbury WwTW. Process capacity refers to the amount of flow that can be treated to the required quality as set under the discharge consent. AWS have stated that the effluent discharge form the works currently complies with the consent requirements and that Tilbury has adequate process capacity at the works to treat the proposed additional wastewater.

6.2.3 Tilbury WwTW Quality Consent Capacity

Tilbury WwTW is permitted to discharge to the Thames Estuary under a Water Resources Act discharge consent issued by the Environment Agency in June 2000. This discharge consent has several conditions that must be met by the treated effluent discharged by the WwTW (Table 6.2).

Table 6.2 Tilbury WwTW Quality Consents (as issued by the Environment Agency June 2000)

Type		Consent	
Dry Weather Flow (DWF)		32,000 m^3/d (current) 42,514 m^3/d (proposed)	
Sanitary	BOD & Ammonia	For any 12 month period the arithmetic mean of the sum of the Biochemical Oxygen Demand in 5 days at 20 degrees Celsius (nitrification suppressed with allythiourea) and three times the ammoniacal nitrogen calculated for each shall not exceed 140 mg/l.	
Metals		Concentration (ug/l)	Load (kg/yr)
	Mercury	1	10
	Cadmium	5	142
	Chromium	24	673
	Arsenic	7	191
	Iron	1720	48,215
	Boron	2800	78,489
	Copper	33	990
	Zinc	166	4,654
	Nickel	124	3,476
	Lead	11	292

Discharging to a tidal rather than fluvial inland river system means that different, often less rigid, restrictions are placed upon the discharge consent and requirements to meet Environment Agency and future WFD water quality standards, where they exist. In part this is due to the larger dilution effect offered by transitional (tidal) waters and the difficultly associated with assigning water quality objectives to these stretches of water. The water quality consents are set based on the DWF consent at the works and as such an increasing population should not have an impact on water quality consents until the effluent flow reaches the consented flow. At this point, either the consent needs to be tightened to ensure the WwTW removes more of the effluent load, or there is a risk of noncompliance with the water quality objectives. It has been shown that the additional wastewater generated by new development within Thurrock will not require an increase in the DWF consent and therefore there is unlikely to be any requirement to tighten discharge consents at the works. This assumes that no changes are required to the discharge consents as a result of the Water Framework Directive (which in the majority of cases sets more stringent water quality standards than the current water quality legislation – see Section 7). However, at present draft WFD water quality standards are only available for Dissolved Inorganic Nitrogen (DIN) and Dissolved Oxygen (DO) for tidal watercourses and as such at this stage it is not possible to assess the impacts of the WFD upon the discharge consents at Tilbury WwTW. This will need to be discussed and agreed with the Environment Agency as part of the Detailed Study.

The volumetric consent capacity for Tilbury WwTW is currently being investigated by AWS. Due to the method of assessment of DWF recently changing to a statistical method based on measured flows the DWF consent for Tilbury will be increased. However, the revised consent includes no capacity for growth

and as such a revised consent application will be required to take account of growth. The outcome of the investigation will determine whether a new flow and associated quality consents will be required. If AWS conclude that there is adequate volumetric consent capacity at the WwTW to treat and discharge the wastewater generated from the proposed development then there will be no requirements to upgrade the works and no requirement to tighten water quality consents (except, potentially, as part of the WFD Programme of Measures). If however a new flow consent is required, the associated quality consents will need to be defined by AWS and agreed with the Environment Agency.

The need for new flow and water quality consents will need to be reviewed as part of the Detailed WCS.

6.3 Wastewater Treatment Strategy

All wastewater flows generated by the proposed development within Thurrock up to 2025 will be transferred to Tilbury WwTW which has adequate capacity to accommodate the additional flows without requiring an upgrade to the works (subject to volumetric and process capacity being confirmed by AWS). There are no plans at present, and no requirements identified within this study, to recommend that any alternative wastewater treatment strategy should be considered at this stage.

6.4 Current Wastewater Network

The wastewater network currently serving Thurrock is illustrated in Figure 6a. This shows a good coverage of the network through existing urban areas within Thurrock. The existing strategic network consists of foul, combined and surface water sewers and a number of combined sewer overflows (CSOs)[11]. The sewers are both gravity fed and pumped throughout the catchment, with several pumping stations distributed across the area.

A high level assessment of current wastewater network has been undertaken for the Thurrock Outline WCS to identify the existing strategic wastewater network within the Borough and highlight where there are known capacity issues within the existing sewers and CSOs which could limit the ability of the wastewater network to accommodate the proposed growth within Thurrock.

6.4.1 Strategic Sewer Network

Figure 6b shows the key strategic foul sewers within Thurrock which drain wastewater from the Broad Areas for Regeneration (BAR) to Tilbury WwTW.

The strategic sewer network within Thurrock has been assessed and key sections of the network have been identified where there are large volumes of growth planned for the BAR and/or where there are known existing network problems. The housing phasing numbers provided by Thurrock BC have been used to provide and indication of when capacity within the sewers may be reached.

Knowing the capacity of the sewer that is available to domestic flow, based on pipe sizes, the theoretical maximum population that can drain to the sewer has been assessed using the formula:

$DWF_{peak} = P_f(PG) + I$ *where:* *Peak Factor (Pf) was taken as 6*

G was taken as 140l/c/d (i.e. 90% of a per capita water demand of 156litres being returned to sewer.)

[11] A combined sewer overflow (CSO) is the discharge of untreated wastewater and stormwater from a combined sewer system directly into a water body during very wet or storm weather. These discharges occur to relieve the sewer system as it becomes overloaded with normal sewer flow and increased storm run-off. Overflow frequency and duration varies both from system to system, and from outfall to outfall, within a single combined sewer system.

Infiltration (I) was taken as 25% of PG

The theoretical maximum population was converted to properties by assuming a property occupancy ratio of 2.4 people per property. This is based on current occupancy rates within Thurrock.

The number of existing properties that are already draining to that section of sewer and the planned development in that area was deducted from the theoretical maximum number of properties that can be served by the sewer to give an indication of current and future capacity.

Table 6.3 provides the wastewater network constraint assessment undertaken for the Thurrock wastewater network. Table 6.4 details the strategic sewer network currently serving Thurrock and the strategic sewer network capacity assessment.

It should be noted that there are significant potions of the study area that have combined sewers. As a result of the complexity of the sewer network, the effect of surface water drainage has not been taken into account. This, together with the inevitable gross uncertainty in the accuracy of the parameters listed above means that the results of this assessment are only indicative. It is assumed that the sewer network will be modelled as part of the Detailed Study/by AWS in order to ascertain the existing capacity of the wastewater network and the impact of the proposed new sewer serving the Purfleet and West Thurrock areas.

Table 6.3 Wastewater Network Constraint Assessment Criteria

Wastewater Network Assessment	Wastewater Network Constraint
Wastewater network already serves area. Capacity within the existing network is not predicted to be exceeded by 2025.	There is capacity within the existing wastewater network to drain wastewater generated from new development.
Wastewater network already serves most of area. Existing network is predicted to be close to capacity or exceeding capacity by 2025. AWS have planned upgrades to infrastructure to address known constraints in the area.	There is limited capacity within the existing wastewater network to drain wastewater generated from new development but there are strategic plans by AWS to address this problem.
No current wastewater network serving area. Capacity within the existing network is predicted to be exceeded by 2025. There are no known AWS planned upgrades to infrastructure in the area.	New infrastructure will be required to serve development in this area. There is no capacity within the existing wastewater network to drain wastewater generated from new development and there are no strategic plans by AWS to address this problem.

Table 6.4 Strategic Wastewater Network in Thurrock

Broad Area for Regeneration		Sewer Type	Main Sewer Size	Discharge Location	Downstream BAR	Assessment	
1	Purfleet	Gravity	600mm/ 300mm	East	West Thurrock & Lakeside (4)	• Predominantly gravity drained network through Purfleet from west to east. • There are less connections and established network than other more residential areas so more local connections and pipes may be required to accommodate proposed development dependent on the location of the development. • There are two main gravity drained sewers that serve the area and drain wastewater to West Thurrock & Lakeside. • Downstream of Purfleet the wastewater is pumped from W Thurrock-London Rd SPS easterly through West Thurrock & Lakeside. • The cumulative impacts of development in area on downstream West Thurrock & Lakeside will result in the West Thurrock network exceeding capacity by 2025. AWS plan to address this by building a new sewer to serve the Purfleet and West Thurrock area.	
2	Aveley	Gravity	275mm (E) 300mm (S) 225mm (W)	East South West	Purfleet (1)	• Wastewater is gravity drained to Purfleet from the east, south and west of Aveley via three pipes. • The largest pipe is to the south of the area and joins the east pipe before joining the western pipe at Aveley-Love St SPS in northwest Purfleet. From here the wastewater is pumped 6.5m and is gravity drained easterly through Purfleet. • The cumulative impacts of development in area on downstream West Thurrock & Lakeside will result in the West Thurrock network exceeding capacity by 2025. AWS plan to address this by building a new sewer to serve the Purfleet and West Thurrock area..	
3	South Ockendon	Gravity	600mm	Southeast	Grays (5)	• Wastewater is pumped downstream (southerly) to Grays from southeast of area via Stifford-Corran Way SPS. • Good coverage of gravity drained network through area. • Receives pumped discharge from Grangewaters Water Sports Centre and works to the northeast of the area along a 150mm pipe. • No capacity constraints up to 2025.	
4	West Thurrock & Lakeside	Pumped	500mm	East	Grays (5)	• Pumped discharge through area from west to east. • Pumped from W Thurrock-London Rd SPS to Grays along strategic pipe that takes flows from the pumped drains from W Thurrock-Tunnel Foul SPS (300mm) and Grays-Lakeside W Thurrock Wy SPS (300mm) from the north of the catchment. • There are no connections to the south of the strategic pipe so if development	

Broad Area for Regeneration		Sewer Type	Main Sewer Size	Discharge Location	Downstream BAR	Assessment	
						was proposed for here these would need to be added. • The sewer will exceed capacity by 2025, in part due to the cumulative impacts from development upstream in the network in Purfleet and Aveley. AWS plan to address this by building a new sewer to serve the Purfleet and West Thurrock area..	
5	Grays	Pumped and Gravity	1050mm (G) 600mm (P) 750mm (G)	East East Southeast	Tilbury WwTW Tilbury WwTW Tilbury (6)	• Pumped drain runs along the south of the study area and takes flows from upstream West Thurrock & Lakeside before draining east of Grays between Chadwell St Mary and Tilbury before draining to Tilbury WwTW. This incorporates gravity drained flows along 1050mm pipe from North Grays and pumped flows from east of Grays (Gray-Dock Rd SPS – 250mm). • Gravity drained network takes flows from southwest of Grays and drains to Tilbury via 750mm pipe to southeast of area. • No network coverage in North East Grays and local connections would be needed here to serve proposed development. • No capacity constraints up to 2025.	
6	Tilbury	Gravity	900mm	Southeast	Tilbury WwTW	• Gravity drained network which discharges via a 900mm drain to Tilbury WwTW. • Receives flow from South Grays but majority of flows from other areas do not flow through this area and instead are transferred directly to Tilbury WwTW. • No capacity constraints up to 2025.	
7	Chadwell St Mary	Gravity	300mm	South	Tilbury (6)	• Gravity fed network downstream of area to Tilbury (6). • Good coverage of network throughout the area. • No capacity constraints up to 2025.	
8	East Tilbury	Pumped	600mm/ 350mm	Northeast Southeast	Tilbury WwTW	• Wastewater is pumped from area to Tilbury WwTW via Linford-Princess Margaret Rd SPS (which incorporates flows from Standford-le-Hope & Corringham – 600mm) in northeast of area and E Tilbury-Bata (Linford) TPS (350mm) to south of area. • No capacity constraints up to 2025.	
9	Villages	Gravity (Pumped d/s)	225mm (G) 300mm (G) 300mm (G) 125mm (P)	Bulphan Horndon Orsett Southfields	Stanford-le-Hope & Corringham (10a) Grays (5) Tilbury WwTW	• Wastewater gravity drained from Bulphan (225mm) to Bulphan-Church La SPS and then pumped to Horndon on the Hill. • Gravity drained downstream of Horndon on the Hill (300mm) to Standford-le-Hope & Corringham. • Gravity drained from Orsett and then pumped downstream of Orsett (250mm) from Orsett_Fen La SPS to Grays.	

Broad Area for Regeneration		Sewer Type	Main Sewer Size	Discharge Location	Downstream BAR	Assessment	
						• Pumped through majority of village from Orsett-Welling Road SPS and Orsett-Sfields Colingwd Ln SPS and then gravity fed downstream of Southfields to E Tilbury-Low St SPS then pumped to Tilbury WwTW (225mm). • Good network coverage throughout areas. • No capacity constraints up to 2025.	
10a	Standford-le-Hope & Corringham	Pumped	600mm	Southwest	East Tilbury (8) Tilbury WwTW	• Corringham-Lampits Hill SSO located in north east of area. • Good sewer network coverage throughout area. • Takes some flows from outside area to the east. • Wastewater from the villages (9) of Horndon on the Hill and Bulphan drain to northwest of area. • Wastewater is pumped downstream of area to Tilbury WwTW via Stanford Le Hope TPS (600mm pipe) and East Tilbury (8). • No capacity constraints up to 2025.	
10b	London Gateway	None	None		Unknown	• No foul network is currently connected to the London Gateway area and will need to be built to serve the proposed employment development in this area.	

6.4.2 Combined Sewer Overflows (CSOs)

A combined sewer overflow (CSO) is the discharge of untreated wastewater and stormwater from a combined sewer system directly into a water body during very wet or storm weather. These discharges occur to relieve the sewer system as it becomes overloaded with normal sewer flow and increased storm run-off. Overflow frequency and duration varies both from system to system, and from outfall to outfall, within a single combined sewer system.

There are several CSOs on the Thurrock sewer network (as shown in Figure 6b) and the Environment Agency policy is that proposed increases in flows must not lead to deterioration in river water quality as a result of greater frequency of operation or volume of discharge.

The Stifford Corran Way Sewage Pumping Station (SPS), to the South of South Ockendon, already overflows excessively to the River Mardyke and causes water quality problems in the lower reaches of the river. The Environment Agency have raised significant concerns regarding the pumping station and would like to see it improved. An improvement to the pumping station was listed as a scheme under the National Environment Programme (see Section 7.3.2) for investment in AMP5. However, AWS have confirmed that this scheme has not been supported by Ofwat in their final determination, and therefore AWS will need confirmation that the proposed growth in South Ockendon will not lead to an increase in the frequency or volume of the discharge from the CSO and/or a deterioration in the quality of the River Mardyke. Therefore AWS, this will require further assessment as part of the Detailed WCS, especially as growth proposed for South Ockendon up to 2025 could increase the population upstream of the CSO by around 20%.

The West Thurrock – London Road SPS should also be further investigated as part of the Detailed WCS due to the significant volume of growth planned for Purfleet which will see up to a 60% increase in population upstream of the CSO at this location.

6.4.3 Wastewater Network Assessment

Using the constraints criteria provided in Table 6.3, and the findings form the strategic sewer network and CSO assessments, the overall strategic wastewater network assessment has been undertaken (Table 6.5). This is based on the proposed phasing of housing and employment development in Thurrock and provides an indication of when capacity within the existing network will be reached.

Table 6.5 Strategic Wastewater Network Assessment

Broad Area for Regeneration		Phasing			
		Baseline (2009)	2009 – 2014	2014 - 2019	2019 - 2025
1	Purfleet				
2	Aveley				
3	South Ockendon				
4	West Thurrock & Lakeside				
5	Grays				
6	Tilbury				
7	Chadwell St Mary				
8	East Tilbury				
9	Villages				
10a	Standford-le-Hope & Corringham				
10b	London Gateway				

The assessment shows that existing wastewater network serving the west of Thurrock is almost at capacity and development in the Purfleet, Aveley and West Thurrock area will require an upgrading of the network to increase capacity. This is due to the cumulative impacts from the developments in the three areas that all need to be pumped through the West Thurrock sewer to Grays and Tilbury WwTW. Individually, the areas may be able to support the planned development but for the purposes of the WCS the cumulative impacts need to be assessed. This corroborates previous findings in the Thurrock Infrastructure Deficit Study (Reference 22) which concluded that there is limited spare capacity in the wastewater network (sewerage system) across Thurrock, particularly within the west of the Borough. Discussions with AWS have confirmed these findings and they have planned an upgrade to the existing wastewater network to serve future proposed development to the west of the Borough as part of their next AMP Capital Scheme (AMP5). They plan to build a 1800mm sewer to increase the capacity to service and transport the waste in the west of the Thurrock.

There is currently no existing sewer network serving the London Gateway area. This will need to be investigated as part of the Detailed WCS and options considered for the building of new sewers to serve this area and connect into the Thurrock strategic wastewater network.

The Stifford Corran Way SPS, to the South of South Ockendon, is already known to overflow excessively and cause water quality problems in the lower reaches of the River Mardyke. The Environment Agency have raised significant concerns regarding the pumping station and AWS have confirmed that an improvement scheme for the SPS has not been supported by Ofwat in their draft determination. Therefore, at present, there is not considered to be any capacity at this SPS and therefore it will need to be proved that increased flows to the SPS from future development, upstream in South Ockendon, will not lead to an increase in the frequency or volume of the discharge from the CSO and/or a deterioration in the quality of the River Mardyke. This will require further investigation as part of the Detailed WCS.

The calculations of the sewer capacity assessment are provided in Appendix E.

6.5 Wastewater Network Strategy

AWS are planning to build a new trunk sewer to serve future proposed development to the west of the Borough as part of their next AMP Capital Scheme (AMP5). They plan to build a 1800mm sewer to increase the capacity to service and transport the waste in the west of the Thurrock. This should alleviate the predicted capacity issues in the west of the region and particularly with draining wastewater from the West Thurrock & Lakeside area.

The only BAR where an alternative wastewater network strategy may be required is for London Gateway (Area 10b) where there is currently no wastewater network to serve the area. It is possible that there may be on-site treatment facilities but it is likely that wastewater generated in this area will need to be collected and transferred to Tilbury WwTW and connect to the existing wastewater network (potentially to the south or southwest of Stanford-le-Hope).

Further investigation of the Stifford Corran Way SPS/CSO and West Thurrock – London Road SPS/CSO may indicate that upgrades and/or new wastewater infrastructure may be required to serve development in South Ockendon and West Thurrock/Purfleet to ensure that water quality environments are not deteriorated as a result of the proposed development.

As the majority of development within Thurrock will be infill development it is assumed that there will be no issues associated with providing local connections to the existing wastewater sewers to collect wastewater from new development.

Figure 6c shows the wastewater network strategy for Thurrock up to 2025.

7 Water Quality

7.1 Introduction

A review of water-related environment baseline is essential to ensure that: the water related environment has the capacity to absorb further discharges (from WwTW and/or surface water) to the receiving watercourse; and there is no unacceptable deterioration in the quality of the water related environment as a result of the proposed development.

The water quality capacity of the receiving watercourses, i.e. how much more waste products (albeit treated) and/or surface water can be discharged to the receiving watercourse before water quality standards imposed to protect the integrity and ecology of a watercourse are reached, has been assessed and constraints identified. This has identified where constraints are already present prior to the proposed development and any proposed mitigation measures.

Information pertaining to the water quality of the smaller watercourses, ditches and drains within the study area is scarce and therefore for the purposes of this study, the water quality assessment will focus on the Thames Estuary and River Mardyke, as these are likely to be the main rivers affected by the proposed development within the Borough.

7.2 Current Water Quality

7.2.1 Introduction

Historically the Environment Agency have used River Quality Objectives (RQOs), planned targets for water quality, to help protect and improve the quality of the water in watercourses. The principal non-statutory RQO system is the River Ecosystem (RE) Classification scheme which comprises five hierarchical classes in order of decreasing quality, ranging from ‘very good quality’ to ‘poor quality’. Each stretch of river is given a RE target such that if the river achieves this target it means that the river will be of adequate quality to support the required ecosystem.

Whereas the Environment Agency used RQOs for planning purposes (i.e. for setting water quality targets and assessing compliance with those targets), the General Quality Assessment (GQA) scheme was designed to provide an assessment of the general state of water quality and changes in this state over time. The GQA scheme comprises several separate aspects of water quality falling under chemical (inc. nutrients) and biological monitoring and assessment. A monitoring programme at a set number of sites has been undertaken on a monthly basis to assess the quality of individual stretches of river.

Tidal rivers, as opposed to inland river systems, have historically had less rigid or no water quality objectives due in part to the difficulty associated with assigning water quality objectives and monitoring water quality in these stretches of water which are typically affected by flow levels, tides and temperature.

However, the existing statutory targets and legislation relating to water quality are being replaced with a new set of water quality standards under the umbrella of the Water Framework Directive (WFD) which was passed into UK law in 2003 (Reference 24). The competent authority responsible for its implementation is the Environment Agency in England and Wales. The overall requirement of the directive is that all water bodies in the UK must achieve “good ecological and good chemical status” by 2015 unless there are grounds for derogation. The United Kingdom Technical Advisory Group (UKTAG) has derived a series of water quality standards for both fresh and transitional waters against which compliance with the WFD will

be assessed. As such, the Water Framework Directive standards have been used to determine the impact of future development on water quality as part of the Outline WCS.

Water quality within the Borough of Thurrock has been assessed using monitoring records from the GQA assessments undertaken in the period 2004-2008 (under the current legislative drivers) and the WFD classifications for waterbodies (as provided in the Thames River Basin Management Plan, Reference 26) and proposed WFD standards (Reference 24). Further information on both the Environment Agency's current water quality classification system and the WFD is provided in Appendix F. This should be read in conjunction with the results presented within this section.

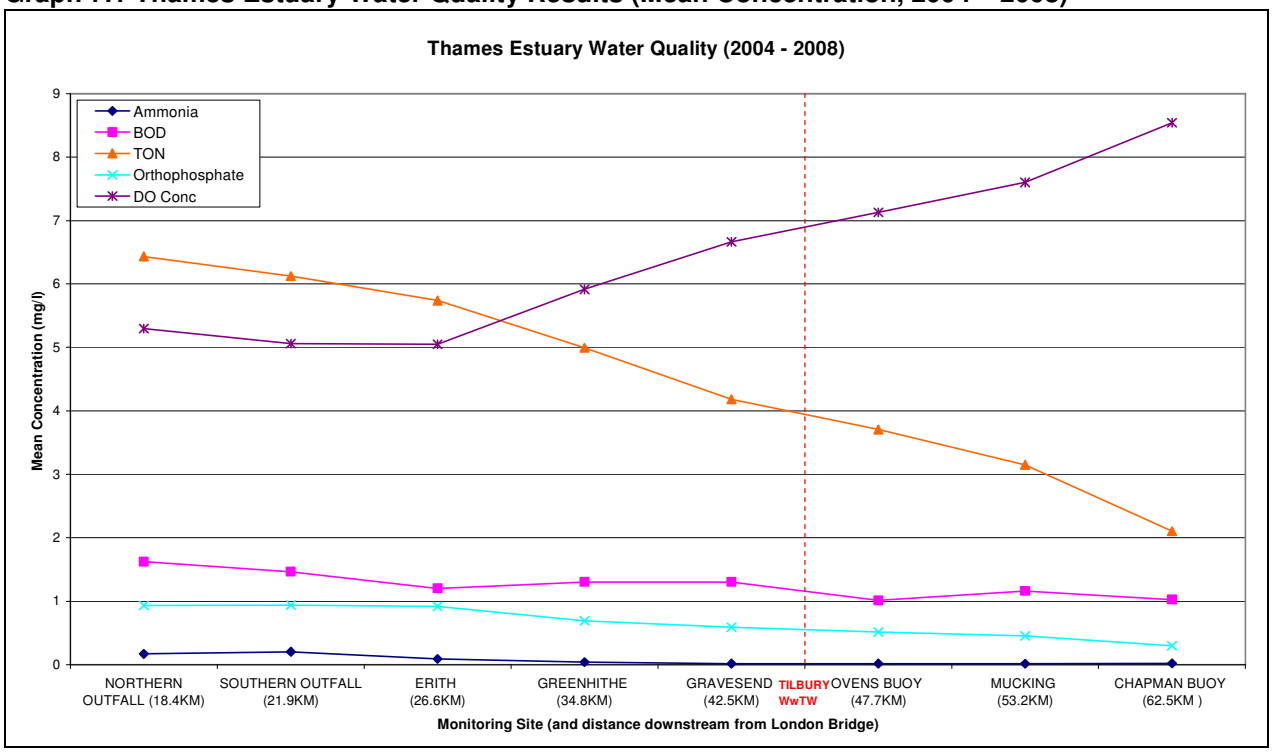
7.2.2 Thames Estuary

The Thames Estuary is the main watercourse within Thurrock that will be affected by the planned growth within the area, being the receiving watercourse for the effluent discharge from Tilbury WwTW. Additionally poorly managed surface water runoff from the BARs of Purfleet, West Thurrock & Lakeside, Grays, Tilbury and London Gateway have the potential to impact water quality within the bordering Thames Estuary. Under the existing Environment Agency River Ecosystem Classification there is no statutory water quality standard for the Thames Estuary stretch to the south of Thurrock as it is a transitional watercourse and is therefore downstream of the freshwater limit where traditionally, water quality standards have been applied. Water quality monitoring observations provided by the Environment Agency at several monitoring stations along the Thames (downstream of London Bridge, see Figure 7) show that Ammonia, Biological Oxygen Demand (BOD), Dissolved Oxygen (DO) and Total Organic Nitrogen (TON) concentrations decrease downstream along the Tidal River, and there is no evidence to suggest that and surface water inputs from Thurrock, including the discharge at Tilbury WwTW, are increasing mean concentrations of the aforementioned determinands in the Thames Estuary (Graph 7.1).

The Tidal Thames is characterised by significant urban development including the City of London and the industrial, port areas in the outer Estuary and flood defence structures. The Thames is one of the most ecologically diverse estuaries in England and Wales, with over 45 species of fish resident at some stage in their lifecycle, 350 benthic invertebrates and plays a major role in supporting North Sea fish stocks. The catchment is also home to a number of invasive non-native species, including Mitten Crab and Zander.

DO levels are one of the most important indicators of water quality in the Thames Estuary. DO is sensitive to discharges from CSOs, flow levels, tides and temperature. Increasing temperatures as a result of climate change could further reduce DO levels, adversely affecting fish and invertebrate life within the Thames.

Graph 7.1 Thames Estuary Water Quality Results (Mean Concentration, 2004 – 2008)



7.2.3 River Mardyke

The River Mardyke is the main inland watercourse within Thurrock and flows through the western part of the Borough, joining the Thames Estuary at Purfleet. Although no increases in effluent discharges are planned for this watercourse, there is the potential for flow increases and a reduction in water quality if surface water within the catchment is poorly managed, especially within the BARs of Purfleet, Aveley, South Ockendon, West Thurrock & Lakeside, and Grays which all border the River Mardyke. In addition, joining the Thames Estuary to the southwest of Thurrock and upstream of Tilbury WwTW, the water quality within this watercourse, in combination with upstream tributaries of the Thames Estuary, effluent discharges and Combined Sewer Overflows have the potential to impact the water quality within the Thames Estuary through Thurrock.

The River Mardyke is a designated cyprinid freshwater fishery and in the last monitoring period (2007) was compliant with imperative standards but failed guideline standards. Many species of fish occur in the Mardyke river valley; the most common being Roach, Carp, Eel, Perch and Chub in the upper reaches and Tench, Rudd and Flounder mainly restricted to lower river sections. However, whilst there is species diversity, stocks of each species are poor and problems with water and habitat quality are believed to be the main contributory factors.

The water quality target in the upper reaches of the Mardyke (upstream of Thurrock) is RE5 which is water of 'poor quality' where as RE target for the lower reaches of the Mardyke (which run through the urban area of Thurrock), is RE3, which is water of 'fairly good quality'. In the last three reporting years (2005 - 2007) the chemical water quality has been recorded as poor or bad, whilst the biological value has been recorded as good or fairly good. There has been a gradual decline in the river achieving its RE targets over the past 10 years, which has largely resulted in the lower reaches of the river failing the RE target (Table 7.1). Table 7.2 provides the GQA results for the period 2005-2007 and Figure 7 shows the water quality monitoring locations along the River Mardyke.

Table 7.1 River Mardyke RE Compliance Assessment (2000 – 2008)

	Stretch	Sample Point Code	Length (Km)	Target	2000	2001	2002	2003	2004	2005	2006	2007	Latest - to June 2008
Downstream ↓	Headwaters to Upminster WwTW (WT)	MD0505	6	RE5									
	Upminster WwTW to East Tributary (WT)	MD05	2	RE5									
	Headwaters to West Tributary (ET)	MD04	8	RE5									
	Confluence of the Tribs to Stifford Clays	MD02	6	RE4									
	Stifford Clays to Stifford Bridge	MD02	1.5	RE4									
	Stifford to Aveley Tributary	MD02	2	RE3									
	Aveley Tributary to T B M Intake	MD01	2	RE3									
	T B M Intake to Sluice	MD01	2	RE3									

Pass	Marginal Pass	Fail

Note: WT = West Tributary of River Mardyke, ET = East Tributary of River Mardyke

Table 7.2 River Mardyke GQA Results (2005 – 2007)

Determinand	Year	River Stretch (Downstream →)							
		Headwaters to Upminster WwTW	Upminster WwTW to East Tributary	Headwaters to West Tributary	Confluence of the Tributaries to Stifford Clays	Stifford Clays to Stifford Bridge	Stifford to Aveley Tributary	Aveley Tributary to T B M Intake	T B M Intake to Sluice
Chemistry	2005	C	D	C	E	E	E	E	E
	2006	D	D	D	E	E	E	E	E
	2007	D	D	D	E	E	E	F	F
Ammonia	2005	C	C	B	C	C	C	C	C
	2006	C	C	A	C	C	C	C	C
	2007	C	C	A	C	C	C	B	B
DO	2005	C	D	C	E	E	E	E	E
	2006	D	D	D	E	E	E	E	E
	2007	D	D	D	E	E	E	F	F
Biology	2005	E	C	C	C	C	C	C	C
	2006	E	C	C	C	C	C	C	C
	2007				B	B	B	B	B
Phosphate	2005	5	6	5	6	6	6	6	6
	2006	5	6	5	6	6	6	6	6
	2007	5	6	5	6	6	6	6	6
Nitrate	2005	4	5	3	4	5	5	4	4
	2006	4	4	3	4	4	4	4	4
	2007	4	4	3	4	4	4	3	3

Very Good or Good/ Very Low and Low	Fairly Good or Fair/ Moderately Low and Moderate	Poor or Bad/ High and very High

The water quality of the River Mardyke is generally fair to poor along the entire length with water quality deteriorating downstream as the river flows through the urban area of Thurrock.

The lower reaches of the Mardyke have a history of suffering from low Dissolved Oxygen (DO) levels as a result of 'ponding' which occurs when the tidal flap at the outfall is closed on the highest tides and freshwater begins to back up. In some cases saline water can enter the freshwater system and exacerbate the problem. This is evidenced in the GQA results for the lower reaches of the Mardyke which show 'poor' water quality for the last three years for DO and chemistry.

Within the river, Nitrates are Moderately Low to Moderate and Phosphates are excessively high. Phosphorus is usually the limiting nutrient in inland freshwaters and gives an indication of the likelihood of eutrophication within a water environment. There are guidelines on concentrations that should occur to protect the overall health of the water body. Some sources of P to water bodies are regulated by legislation, such as emissions from WwTWs (Urban Wastewater Treatment Directive, (91/271/EEC)).

During AMP4 (2005-2010) Anglian Water Services have undertaken a scheme to tighten Ammonia consent limits at Upminster WwTW (completed in 2008) which is located un the upper reaches of the River Mardyke (outside the study area). This scheme will improve river quality in the Mardyke and will maintain and improve compliance with the Freshwater Fish Directive Imperative and Guideline standards. There are no Freshwater Fish Directive schemes proposed within the next AMP5 period (2011-2015), though an investigation into the impact of intermittent discharges from Stifford Corran Way Sewage Pumping Station (SPS) is proposed under the Biodiversity Action Plan (BAP) and the WFD (Reference 23). However, AWS have confirmed that this scheme has not been approved by Ofwat in their draft determination and therefore, at present, it is uncertain whether this scheme will go ahead in AMP5.

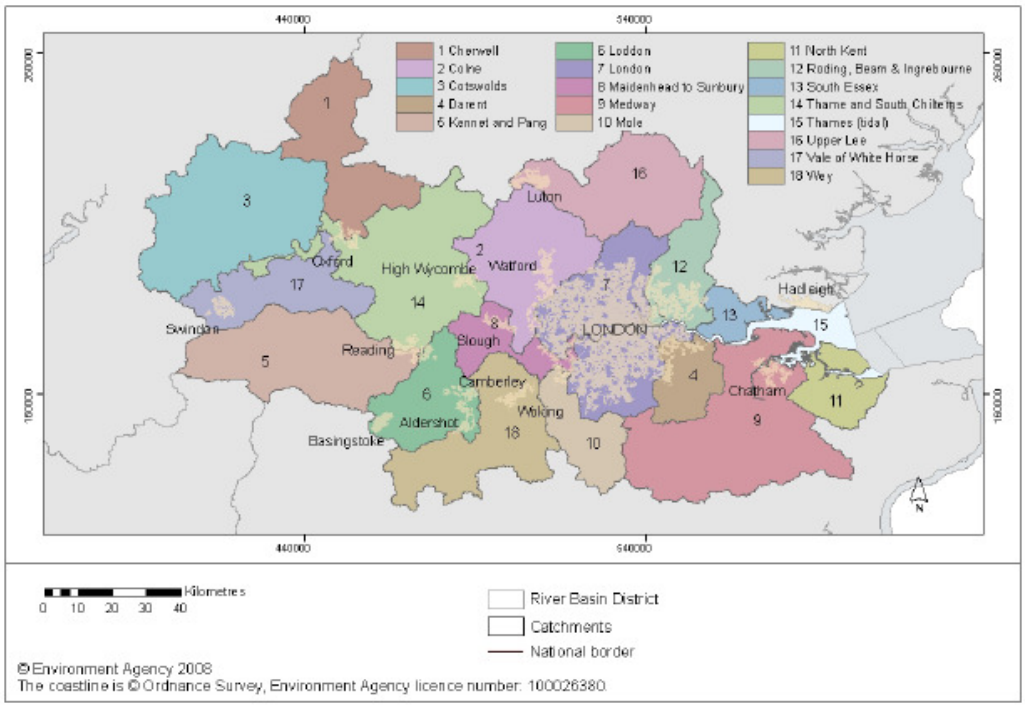
7.3 Water Framework Directive (WFD)

7.3.1 Baseline Assessment

Thurrock's river systems are included in the Thames River Basin District (RBD) which covers an area of 16,133 km^2. The Thames RBD has been divided into a number of river catchments; Thurrock lies within the South West Essex Catchment and borders the Thames Tidal Catchment (Box 7.1).

The Thames Estuary has a historic legacy of physical modification (a major issue under the WFD) to support the various uses of the river, from flood defence to navigation. As a consequence, the Thames Estuary has been designated as a Heavily Modified Water Body (HMWB) due to flood defence and ports / navigation uses. The status of HMWB dictates that the objective for this water body will be to achieve Good Ecological Potential (GEP) as opposed to Good Ecological Status (GES). Both the morphology and water quality issues will need to be addressed for GEP to be achieved.

Box 7.1 Thames River Basin District River Catchments (Source: Environment Agency)



An assessment has been undertaken, using information provided in the Thames River Basin District River Basin Management Plan (Table 7.3, Reference 26). Fobbing Creek, Manor Way Creek, Stanford Brook, Gobions Sewer, West Tilbury Main and Chadwell Cross Sewer/Pincocks Trough, to the south and east of the study area, and the Thames Estuary are all classed as HMWBs due to flood protection/defences and land drainage within the water bodies. These water bodies may have been modified to accommodate flood defences and improve land drainage and therefore reduce flood risks. Some of these waterbodies are marsh drains which border the Thames Estuary and Marshes SPA and have controlled outflows. However, as these watercourses are not regularly sampled, relatively little further information is available about them.

None of the watercourses within or bordering Thurrock (where assessed) are currently achieving good ecological status or potential. The elements most commonly preventing good status in all water bodies by 2015 are DO, Ammonia, Phosphorous and Invertebrates. It is expected that by 2015 this will still be the case with most water bodies aiming to achieve 'good ecological status' or potential by 2027.

The main water quality concerns for the Thames Estuary centre around the impacts of the combined sewer overflow discharges. These discharge to the Thames Estuary and Tideway and frequently result in drops in dissolved oxygen, aesthetic pollution, risk to health and fish kills. The impact of effluent discharges to the Thames from the five major sewage treatment works which serve London (Mogden, Beckton, Crossness, Riverside and Longreach) are also of concern; though these are located upstream of Thurrock, but their impacts could be witnessed downstream.

Table 7.3 Water Framework Directive Water Quality Assessment

Water Body ID	Water Body Name	Des	Rivers	Current Overall Status/ Potential	Current Ecological Status/ Potential	Current Chemical Status/ Potential	Biological	Ammonia	Dissolved Oxygen	Phosphate (P)
GB106037028200	Mardyke	×	River Mardyke (Stifford to Sluice)	Poor	Poor	Good	Poor	Good	Bad	Bad
GB106037027990	Mardyke	×	River Mardyke (Confluence of the Tribs to Stifford Bridge)	Moderate	Moderate	N/A	Not Stated	Good	Bad	Bad
GB106037028040	Mardyke (West Trib)	×	River Mardyke - West Tributary (Upminster WwTW to East Tributary)	Poor	Poor	Good	Poor	Moderate	Moderate	Poor
GB106037028080	Mardyke (West Trib)	×	River Mardyke - West Tributary (Headwaters to Upminster WwTW)	Moderate	Moderate	N/A	Not Stated	Not Stated	Not Stated	Moderate
GB106037028070	Mardyke (East Trib)	×	River Mardyke - East Tributary (Headwaters to West Tributary)	Poor	Poor	N/A	Poor	High	Moderate	Poor
GB106037027970	Mardyke and Fobbing	HMWB (*Flood Protection)*	Gobions Sewer, West Tilbury Main	Moderate	Moderate	N/A	Not Stated	Not Stated	Not Stated	Not Stated
GB106037028030	Mardyke and Fobbing	HMWB (*Flood Protection)*	Stanford Brook	Moderate	Moderate	N/A	Not Stated	Not Stated	Not Stated	Not Stated
GB106037028010	Mardyke and Fobbing	HMWB (*Land Drainage)*	Fobbing Creek	Moderate	Moderate	N/A	Not Stated	Not Stated	Not Stated	Not Stated
GB560604017900	West Thurrock Lagoon	Artificial (*Coastal Protection)*	Thames Estuary	Moderate	Moderate	N/A	Not Stated	Not Stated	Not Stated	Not Stated
GB560604017800	Mucking Flats and Marshes	Artificial (*Coastal Protection)*	Thames Estuary	Moderate	Moderate	N/A	Not Stated	Not Stated	Not Stated	Not Stated
GB530603911402	Thames Middle	HMWB *(Coastal Protection, Flood Protection, Navigation)*	Thames Estuary	Moderate	Moderate	Fail	Moderate	Moderate (DIN*)	Moderate	Not Stated
GB530603911401	Thames Lower	HMWB (*Flood Protection, Navigation)*	Thames Estuary	Moderate	Moderate	Fail	Moderate	Moderate (DIN*)	High	Not Stated

Note: Individual physico-chemical elements are reported using environmental classes on a high, good, moderate, poor and bad scale but when used derive the overall ecological status only the three classes of high, good and moderate are used. In effect the environmental classes of poor and bad are incorporated into moderate status for this assessment.
The River Mardyke is defined as lying within a low altitude, calcerous catchment resulting in a WFD assignment of lowland and high alkalinity typology.
* Transitional water bodies are not assessed for Ammonia. Instead Dissolved Inorganic Nitrogen (DIN) is measured and assessed against WFD standards.

WFD Classification Status					
High Status	Good Status	Moderate Status	Poor Status	Bad Status	N/A - Does not require assessment

7.3.2 WFD and Water Company Planning

An important consideration in the WFD planning process is the timing with respect to the statutory water company planning and funding process. At present, there is a discrepancy between the two planning timelines. The RBMPs were finalised in December 2009 and therefore the Programme of Measures which sets out what changes will need to be implemented in order to achieve 'good' status or potential in all water bodies, was not known until this point. However, the current PR09 and AMP5 timelines are such that the water companies submitted their business plans, which set out the investment requirements for AMP5 (2010-2015), in early 2009 before the RBMPs plans were finalised. It is therefore uncertain how much of the investment required to meet with programme of measures can be planned for and funded in the next AMP period and that much of the investment required to meet good status will not be forthcoming until AMP6 (2015-2020).

Whilst it is not just water companies which will be affected by the programme of measures, it is considered that water companies such as AWS will have a key role to play in implementing the measures and helping to achieve 'good' status in time for the 2015 deadline as required by the WFD, or by 2027 as identified by the RBMP.

Studies such as the WCS have a role to play in identifying likely impacts of the WFD and where future investment is most likely to be required in order to move key water bodies towards good status based on the interim risk characterisations. Use of the draft standards and RBMP is essential such that early decisions can be taken on where investment is most likely to be required in order to meet with the future programme of measures and attainment of 'good' status.

The RBMP and Environment Agency's National Environment Programme (NEP) has identified the measures provided in Table 7.4 to address current water quality related issues in the South Essex Catchment. Some of these measures apply to assets outside of the Thurrock Study Area but will impact on the Borough due to potential impacts in downstream water quality.

Table 7.4 Water Industry Specific Measures to Address Water Quality Impacts from Point Sources up to 2015 (as identified in the RBMP, Reference 26)

Pressure	Description of the Action			Comments
	What Will Happen	When By	Where	
Priority Hazardous Substances, Priority Substances and Specific Pollutants, Nutrients, Organic Pollutants	Reduction in priority Pollutants & Hazardous substances.	2010	• Upminster SO • Upminster WwTW	This scheme has been completed.
Priority Hazardous Substances, Priority Substances and Specific Pollutants, Nutrients, Organic Pollution	Identified as an unsatisfactory intermittent discharge. There is currently DO non-compliance in the water body and the Overflow impacts on DO failure in the River Mardyke. The SPS overflows 30+ times per year. Repeated discharge of raw sewage into the Mardyke. The Mardyke is an important wildlife corridor & supports a water vole population (BAP species). Also affects the habitat enhancement works undertaken by the Mardyke Valley project - river channel & floodplain grazing marsh. Also extensive educational & community engagement activities have been developed.	2012	• Stifford, Corran Way SPS	Funding for improving the operation of this Pumping Station has not been supported by Ofwat in their final determination. At this stage it is not clear whether this scheme will go ahead.

7.4 Water Quality Constraint Assessment

The water quality constraints have been assessed for each BAR based on the criteria in Table 7.5. The assessment if provided in Table 7.6. Stifford Corran Way SPS is located to the southeast of South Ockendon (see Figure 6b) and pumps sewage from this area to North Grays. Therefore, as the SPS has been identified as having an adverse impact on water quality in the River Mardyke, the South Ockendon BAR is considered to have a more significant constraint to development in terms of water quality than the other BARs in Thurrock.

Table 7.5 Water Quality Constraints Assessment Criteria

Water Quality Assessment	Water Quality Constraint
Existing River Quality classification is Good – A/B/C under GQA or High/Good under Water Framework Directive.	Water Quality is currently good and already achieving Good Ecological Status under WFD. Further surface water and effluent discharges to watercourse will need to maintain this quality.
Existing River Quality classification is Moderate under GQA or Moderate under Water Framework Directive.	Water Quality is currently moderate and measures will be required to reach Good Ecological Status under WFD. Further surface water and effluent discharges will need to be mitigated to improve water quality in catchment.
Existing River Quality is Bad under GQA or Poor/Bad under Water Framework Directive.	Water Quality is currently poor or bad and measures will be required to reach Good Ecological Status under WFD. Further surface water and effluent discharges will need to be mitigated to improve water quality in catchment.

Table 7.6 Water Quality Constraints Assessment

BAR		Watercourse	Assessment
1	Purfleet	River Mardyke/Thames Estuary	
2	Aveley	River Mardyke	
3	South Ockendon	River Mardyke	
4	West Thurrock & Lakeside	River Mardyke/Thames Estuary	
5	Grays	River Mardyke/Thames Estuary	
6	Tilbury	River Mardyke/Thames Estuary	
7	Chadwell St Mary	None	
8	East Tilbury	None	
9	Villages	River Mardyke Tributary	
10a	Stanford-le-Hope & Corringham	None	
10b	London Gateway	Thames Estuary	

8 Ecology & Biodiversity

8.1 Introduction

The Ecological and Biodiversity assessment identifies any water dependent sites within and linked to Thurrock and assesses whether abstraction for the Public Water Supply associated with the proposed development within the Borough is likely to impact upon any of these sites, thereby presenting a constraint to development.

A Habitats Regulations Assessment is being undertaken to assess the impacts that the levels and locations of development set out in the Core Strategy will have on European Sites (Special Areas of Conservation, Special Protection Areas and, as a matter of Government policy, Ramsar sites) and the findings of this study have been reviewed and built upon to identify constraints specific to the planned growth in Thurrock.

8.1.1 Objectives and Approach

A Water Cycle Study (WCS) should ensure that any proposed development protects and enhances all important conservation features and as such consideration needs to be given to designated ecological sites that are located within the WCS Study Area. Additionally, sites outside the Study Area that may be affected by the planned growth (e.g. by increases in abstraction or discharge through identified pathways[12]) should be considered. WCS guidance (Reference 3) states that in order to ensure compliance with the Habitats Directive, it is necessary to have consideration for the impacts of water resource and disposal options when developing a WCS. The purpose of this assessment is therefore to identify if there are any ecological constraints to the proposed development within the Study Area.

A Habitat Regulations Assessment of the Thurrock Local Development Framework (LDF) Core Strategy was completed for Thurrock Council by Scott Wilson in October 2007 (Reference 8) to assist the Council in undertaking an Appropriate Assessment (AA) of the potential effects of the LDF on European sites. The initial AA (which is being updated to cover the pre-submission stage Core Strategy) was based on a number of assumptions regarding growth within the area including:

- Growth of 13,830 new houses between 2007 and 2021;
- A potential short-term increase in local abstractions (up to 2014/15) to supply the water for development and after this all water would be sourced from the (at the time) proposed Abberton Reservoir Scheme;
- All wastewater would be treated at Tilbury wastewater treatment works (WwTW) before being discharged to the tidal River Thames; and,
- There will be no increase in surface water discharge from new development.

Whilst the updated development plans for Thurrock allow for a higher number of dwellings and employment than those assessed (17,164 dwellings and 26,000 jobs up to 2025), all other assumptions remain unchanged. However, the Abberton Reservoir Scheme is now formally approved and has been subject to its own appropriate assessment. As well as the European Sites potentially affected, the assessment has considered other nationally, regionally and local designated sites such that a comprehensive assessment of ecological impacts of the WCS is considered. The ecological sites within Thurrock are illustrated in Figure 8a.

[12] A pathway can be defined as a route by which a change in activity within the development area can lead to an effect upon a European site. These pathways, in terms of water related impacts, could include recreational impacts, water resources, water quality and coastal squeeze.

8.2 Methodology

The need for Appropriate Assessment is set out within Article 6 of the EC Habitats Directive 1992, and interpreted into British law by Regulation 48 of the Conservation (Natural Habitats &c) Regulations 1994 (Box 8.1). The ultimate aim of appropriate assessment is to "maintain or restore, at favourable conservation status, natural habitats and species of wild fauna and flora of Community interest" (Habitats Directive, Article 2(2)). This aim relates to habitats and species, not the European sites themselves, although the sites have a significant role in delivering favourable conservation status.

Box 8.1 The legislative basis for "appropriate assessment"

Habitats Directive 1992

Article 6 (3) states that:

"Any plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives."

Conservation (Natural Habitats &c. Regulations) 1994

Regulation 48 states that:

"*A competent authority, before deciding to … give any consent for a plan or project which is likely to have a significant effect on a European site … shall make an appropriate assessment of the implications for the site in view of that sites conservation objectives*".

"… The authority shall agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the European site".

In the past, the term "Appropriate Assessment" has been used to describe both the overall process and a particular stage of that process (see below). Within recent months, the term Habitat Regulations Assessment has come into use in order to refer to the process that leads to an "Appropriate Assessment", thus avoiding confusion. Throughout this report, Habitat Regulations Assessment is used to refer to the overall procedure required by Regulation 48 of the Conservation (Natural Habitats &c.) Regulations 1994 (as amended).

In practice, Habitats Regulations Assessment of projects can be broken down into three discrete stages, each of which effectively culminates in a test. The stages are sequential, and it is only necessary to progress to the following stage if a test is failed. The stages are:

8.2.1 Stage 1 – Likely Significant Effect Test

This is essentially a risk assessment, typically utilising existing data, records and specialist knowledge. The purpose of the test is to decide whether 'full' Appropriate Assessment is required. The essential question is:

- *"Is the project, either alone or in combination with other relevant projects and plans, likely to result in a significant adverse effect upon European sites?"*

If it can be demonstrated that significant effects are unlikely, no further assessment is required.

8.2.2 Stage 2 – Appropriate Assessment

If it cannot be satisfactorily demonstrated that significant effects are unlikely, a full "Appropriate Assessment" will be required. In many ways this is analogous to an Ecological Impact Assessment, but is focussed entirely upon the designated interest features of the European sites in question. Bespoke survey work and original modelling and data collation are usually required. The essential question here is:

- "*Will the project, either alone or in combination with other relevant projects and plans, actually result in a significant adverse effect upon European sites, without mitigation?"*

If it is concluded that significant adverse effects will occur, measures will be required to either avoid the impact in the first place, or to mitigate the ecological effect to such an extent that it is no longer significant. Note that, unlike standard Ecological Impact Assessment, compensation for significant adverse effects (i.e. creation of alternative habitat) is not permitted at the Appropriate Assessment stage.

8.2.3 Stage 3 – Imperative Reasons of Overriding Public Interest (IROPI) Test

If a project will have a significant adverse effect upon a European site, and this effect cannot be either avoided or mitigated, the project cannot proceed unless it passes the IROPI test. In order to pass the test it must be objectively concluded that no alternative solutions exist. The project must be referred to Secretary of State on the grounds that there are Imperative Reasons of Overriding Public Interest as to why the plan should nonetheless proceed. The case will ultimately be decided by the European Commission.

This assessment essentially reports the findings from the first stage of Habitat Regulations Assessment – the Likely Significant Effect Test.

Background information on the interest features of each European site are included in Appendix G.

8.3 Pathways of Impact

8.3.1 Pathways

A pathway can be defined as a route by which a change in activity within the development area can lead to an effect upon a European site. While the Appropriate Assessment of the Thurrock Local Development Framework Core Strategy considers wider issues such as recreational pressure and coastal squeeze, the WCS is entirely concerned with abstraction, treated effluent discharge and flood risk. As such, this report concerns itself exclusively with those pathways of impact.

8.3.2 Designated Sites

Considering the pathways above, it is determined that the following European sites may be linked to impacts associated with abstraction or wastewater discharge as a result of the development of housing in Thurrock. All but one of these (the Thames Estuary & Marshes SPA & Ramsar site) lie outside the Thurrock boundary (Figure 8b):

- Thames Estuary & Marshes SPA & Ramsar site (linked since Tilbury WwTW discharges upstream of the site);
- Abberton Reservoir SPA (linked as the main new potable water source for Thurrock);
- Benfleet & Southend Marshes SPA (linked since Tilbury WwTW discharges upstream of the site);
- Dengie SPA (linked since Tilbury WwTW discharges upstream of the site);

- Foulness SPA (linked since Tilbury WwTW discharges upstream of the site);
- Crouch & Roach Estuaries SPA (linked since Tilbury WwTW discharges upstream of the site);
- Colne Estuary SPA (linked since Tilbury WwTW discharges upstream of the site);
- Blackwater Estuary SPA (linked since Tilbury WwTW discharges upstream of the site);
- Essex Estuaries SAC (linked since Tilbury WwTW discharges upstream of the site);
- Medway Estuary & Marshes SPA (linked since Tilbury WwTW discharges upstream of the site);
- The Swale SPA (linked since Tilbury WwTW discharges upstream of the site); and
- Thanet Coast SAC/Thanet Coast & Sandwich Bay SPA (linked since Tilbury WwTW discharges upstream of the site)

Other designated sites within the Thurrock Study Area that have the potential to be impacted by development within Thurrock include:

- Inner Thames Marshes SSSI;
- West Thurrock Lagoon & Marshes SSSI;
- Grays Chalk Pit SSSI; and,
- Vange and Fobbing Marshes SSSI.

8.3.3 Other Projects and Plans

The other projects and plans that will need consideration in combination with the impacts of development within Thurrock are the development to be delivered in other authorities that will be serviced by the Abberton Reservoir Scheme and the other Core Strategies of surrounding authorities who will also discharge a large proportion of their treated effluent to the River Thames (particularly the tidal Thames). This must however also include the numerous schemes that are being delivered by Thames Water in particular and are aimed at improving the overall quality of the Tidal Thames during the lifetime of the Core Strategy.

In local terms, the most significant project that will affect water quality in the Tidal Thames is probably the Shell Haven development. Shell Haven constitutes a large expanse of low-lying land immediately adjacent to Thames Estuary & Marshes SPA and Ramsar site and will create the UK's largest container port and 10 million sq ft of commercial development over a period of 10-15 years.

8.4 Screening assessment – European sites

8.4.1 Water Quality

Any new development in Thurrock is most likely to discharge treated effluent to the Tidal River Thames via Tilbury WwTW. The most likely possible effects that require consideration are therefore:

- Increased phosphorus load (and potentially concentration), coupled with an increase in total oxidized nitrogen, potential lowering of dissolved oxygen for a stretch and an increase in biological oxygen demand and nitrogen for a given distance; and
- Potential increase in velocity and levels, notable at lower to normal flows for a distance downstream as a result of the additional wastewater volumes entering the river.

Despite this, while nutrient levels within the Thames Estuary are high, this does not result in the smothering macroalgal growth that is having an adverse effect upon other European marine sites, due to a combination of tidal energy and erosion[13]. As a result, it is considered that the Thames Estuary & Marshes SPA is not vulnerable to adverse effects as a result of an increase in nutrients in the Estuary due to increased volume of effluent discharged into the Estuary from Tilbury WwTW.

Moreover, the development of housing within Thurrock will take place at a time when water quality improvements to the Thames Tideway as a whole will be implemented through various Thames Water/Environment Agency schemes including the interception and storage of wastewater from a large number of Combined Sewer Overflows (CSOs) in London which currently discharge directly to the River Thames during periods of heavy rainfall and expansions to the treatment capacity of Thames Water's Crossness, Riverside, Long Reach and Beckton Sewage Treatment Works which will enable them to treat greater quantities of wastewater to a higher standard than is currently the case. As such, the overall water quality of the River Thames should actually improve over the delivery period.

Finally, it has been established that while the discharge from Tilbury WwTW will increase beyond current levels it is likely to remain within the limits of the current consent and as such, impacts on European sites and any necessary remedial measures will have been covered through the Environment Agency Review of Consents process.

Therefore, any increase in the volume of treated sewage effluent discharged into the Thames Estuary as a result of the increased number of dwellings that will result from proposed development in Thurrock upon the qualifying features of the Thames Estuary & Marshes SPA or any of the other European sites that are downstream of the Tilbury WwTW discharge point (Benfleet & Southend Marshes SPA, Dengie SPA, Foulness SPA, Crouch & Roach Estuaries SPA, Colne Estuary SPA, Blackwater Estuary SPA, Essex Estuaries SAC, Medway Estuary & Marshes SPA, The Swale SPA or Thanet Coast SAC/Thanet Coast & Sandwich Bay SPA) does not require further investigation as part of this Water Cycle Study unless it is identified by AWS investigations that an increase will be required to the Tilbury WwTW to treat the wastewater from the proposed development up to 2026. The requirement for further investigation will need to be reviewed as part of the Detailed WCS when confirmation of capacity at Tilbury WwTW is known.

8.4.2 Sediment Regimes

Increased volumes of effluent being discharged to the River Thames may have an effect on local sediment regimes principally through increased erosion. However, this effect is likely to be very locally restricted to the immediate vicinity of the Tilbury outfall and will have already been covered through the Environment Agency Review of Consents process as necessary since the increased volume will still be within the consented volume limits. This issue does not therefore require further investigation as part of this Water Cycle Study unless proposals to increase the consented discharge volumes are developed.

8.4.3 Water Resources

The potable water for Thurrock is currently transferred from central Essex and south Suffolk. This requires abstraction from some or all of the Rivers Crouch, Roach and Blackwater, or from tributaries of these watercourses. There are no Public Water Supply abstractions from the watercourses that feed Mucking Flats & Marshes SSSI (Thames Estuary & Marshes SPA).

In the long-term any possible shortfall in the potable water supply needs of Thurrock will be met through the Abberton Reservoir dam raising scheme, which has now been given planning permission by Colchester Borough Council and was subject to its own Appropriate Assessment. The scheme will involve

[13] Dave Lowthion, Environment Agency Supra-Area Marine Team Leader, Southern Region, personal communication during the preparation of the Appropriate Assessment of the draft South East Plan in 2006

raising the dam and putting in transfer enhancements to meet the future potable water requirements of the catchment, including Thurrock. ESW plan to start construction in January 2010 and the scheme is due to come online in 2014/15. The increased volume of the reservoir will increase the habitat available for the internationally important bird populations, leading to a positive effect. Since the Abberton Scheme has already been subject to its own Appropriate Assessment; as such, there is no need for it to be reconsidered in this Water Cycle Study.

Until the scheme comes online ESW will continue to operate with a supply/demand shortfall and will seek to address this through demand management measures. It is expected that during this period there will be no need to increase the existing Groundwater and/or surface water licenses which currently supply water to Thurrock. Moreover, the existing spare capacity in these consents, which may be required to serve the new development up to 2014/15, has already been evaluated for its potential to result in adverse effects on European sites through the Environment Agency's Review of Consents process (which always assesses the full licensed volume irrespective of whether the current actual volume is lower) and therefore do not need to be reconsidered as part of this Water Cycle Study.

8.4.4 Conclusion

It has therefore been possible to conclude that there is no requirement to consider impacts the impacts of water resources on European sites any further in this Water Cycle Study for the following reasons:

1. The long-term water supply strategy for Thurrock will be reliant on the Abberton Reservoir dam raising scheme. However, this scheme has now been consented and has been subject to its own Appropriate Assessment as part of that process; and
2. While Thurrock will continue to rely on water supplied from north Essex and south Suffolk in the short-intermediate term, there will be no requirement for current licensed abstraction volumes to be increased. As such, impacts on European sites will have already been covered by the Environment Agency Review of Consents process.

However, there may be a requirement for further investigation to consider the impacts of water quality and sediment regime on European Sites dependent on the findings of the AWS investigation into the capacity at Tilbury WwTW. The requirement for further investigation will need to be reviewed as part of the Detailed WCS when confirmation of capacity at Tilbury WwTW is known.

8.5 Screening assessment – Sites of Special Scientific Interest

There are five Sites of Special Scientific Interest (SSSI) located within Thurrock:

- Holehaven Creek SSSI
- Inner Thames Marshes SSSI
- West Thurrock Lagoon and Marshes SSSI
- Grays Chalk Pit SSSI; and
- Vange and Fobbing Marshes SSSI

All sites, except Holehaven Creek SSSI are upstream of Tilbury WwTW and therefore unlikely to be impacted by water quality issues.

Holehaven Creek is downstream of the Tilbury outfall and is tidal such that it could potentially be affected by declining water quality in the tidal Thames. However, it needs to be borne in mind that the development

of housing within Thurrock will take place at a time when water quality improvements to the Thames Tideway as a whole will be implemented through various Thames Water/Environment Agency schemes including the interception and storage of wastewater from a large number of Combined Sewer Overflows (CSOs) in London which currently discharge directly to the River Thames during periods of heavy rainfall and expansions to the treatment capacity of Thames Water's Crossness, Riverside, Long Reach and Beckton Sewage Treatment Works which will enable them to treat greater quantities of wastewater to a higher standard than is currently the case. As such, the overall water quality of the tidal River Thames should actually improve over the delivery period. For this reason, adverse water quality effects can be **screened out** as an impact of the development in Thurrock upon this site.

8.5.1 Conclusion

It is therefore considered that impacts on the Sites of Special Scientific Interest mentioned above do not require further investigation as part of this Water Cycle Study.

9 Broad Area for Regeneration Assessment

9.1 Introduction

An assessment has been undertaken for each of the Broad Areas for Regeneration (BAR) based on the findings of the water resources, flood risk, wastewater treatment and collection, water quality and ecology assessments undertaken in Sections 4 – 8. The key constraints have been identified for each of the BARs based on the constraint matrix identified in Section 2.4 and Table 2.2. The phasing information provided by Thurrock BC has been used to identify when the potential constraints may arise in the planned development period up to 2025.

It is important to note that a colour coding of red does not mean that the proposed development cannot take place within the BAR, merely that if development where to take place here greater, more significant, constraints would have to be overcome which would likely involve a higher level of infrastructure investment or greater strategic planning.

The BAR Assessments are provided Sections 9.2 – 9.12.

9.2 Broad Area for Regeneration 1: Purfleet

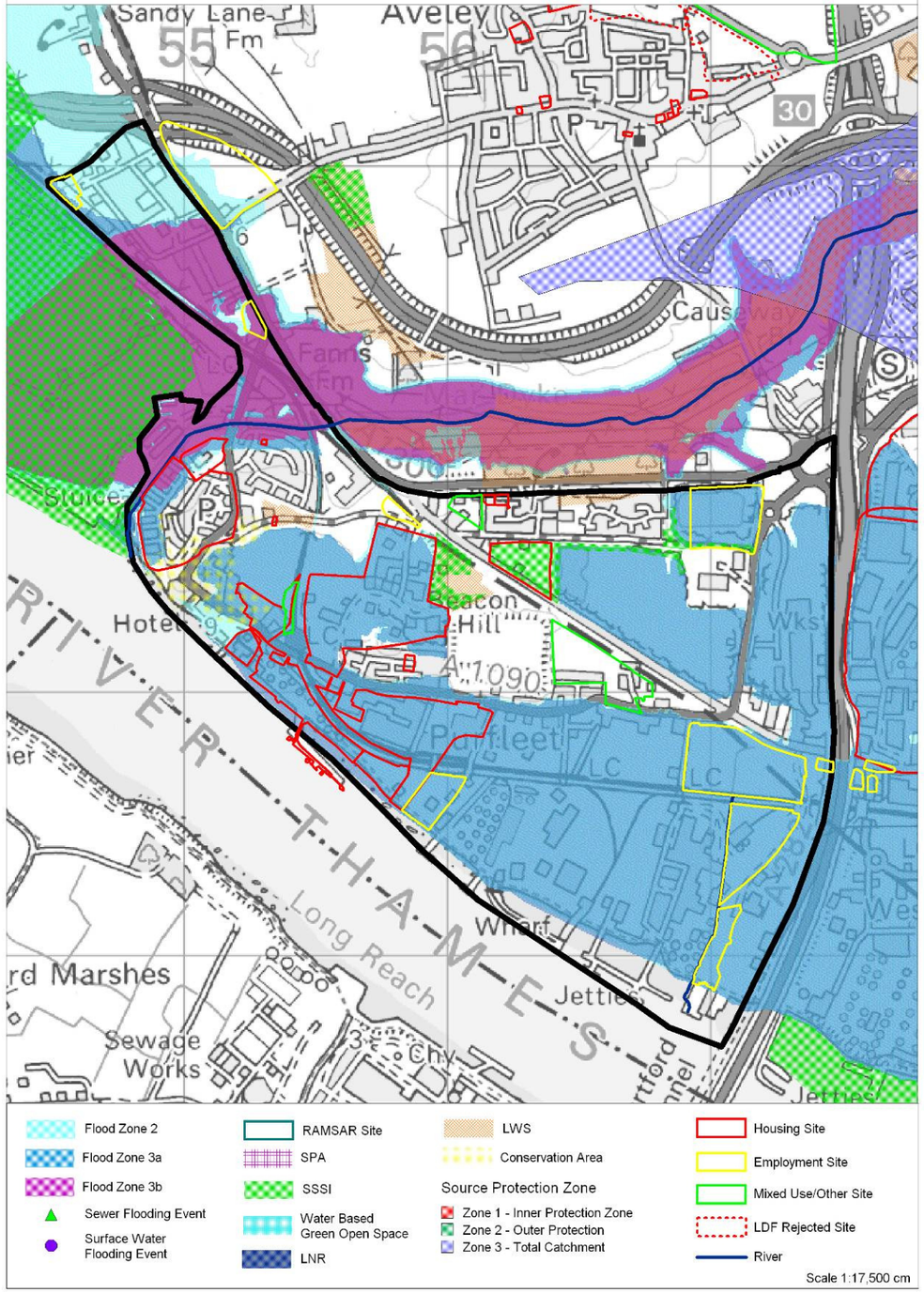
9.2.1 Water Cycle Constraints Assessment

Water Cycle Area	Summary	Overall Assessment
Water Resources and Water Supply	• There is no water available for further abstraction within Thurrock. • Water will be sourced from Abberton Reservoir from 2014/15 – prior to this ESW will be operating at a supply/demand shortfall in dry years and therefore there is a greater risk of a reduction in levels of service during drought years as a result of additional development. • There is considered to be water available to supply all new development up to 2025. • Will exert third largest water demand from new development • Water efficiency measures are planned to improve water efficiency in existing and new dwellings to work towards achieving 'water neutrality'.	
Flood Risk, SuDS and Surface Water Management	• Contains Flood Zones 2 & 3a and Extreme Hazard Rating • Recorded Surface Water Flooding • Sequential Approach needed within development area • Not within an SPZ • Unlikely to have stringent restrictions on use of infiltration SuDS	
Wastewater Treatment and Collection	• AWS are currently investigating the volumetric capacity of Tilbury WwTW and until this is completed and either identifies sufficient capacity at the works or the requirement for (and granting of) a new flow (and quality) consent and associated upgrades (AMP6 funded) there is considered to be limited capacity to treat and discharge wastewater from proposed development. • Wastewater drains east to West Thurrock & Lakeside • Existing wastewater network capacity problems • New AWS trunk sewer planned to serve this area and West Thurrock but limited capacity until built	
Water Quality	• River Mardyke flows through east of area • Thames Estuary borders south of area • Cumulative impact on Thames Estuary through increased effluent discharge from Tilbury WwTW • Need to ensure no deterioration or increase in surface water runoff to River Mardyke or Thames Estuary	
Ecology and Biodiversity	• Borders Inner Thames Marshes SSSI to west • Borders Thames Estuary to south and is upstream of the Thames Estuary & Marshes Ramsar & SPA • Surface water runoff from development in this area will need to be controlled to ensure no deterioration to bordering ecological sites	

9.2.2 Phasing Assessment

Phase	Dwellings	Employment	Constraints				
			Water Resources and Water Supply	Flood Risk, SuDS and SWM	Wastewater Treatment & Collection	Water Quality	Ecology & Biodiversity
Baseline (2009)	-	-					
2009 - 2014	1,225	350					
2014 - 2019	1,894	350					
2019 - 2025	105	300					
Total	3,224	1,000					

Broad Area for Regeneration 1: Purfleet



9.3 Broad Area for Regeneration 2: Aveley

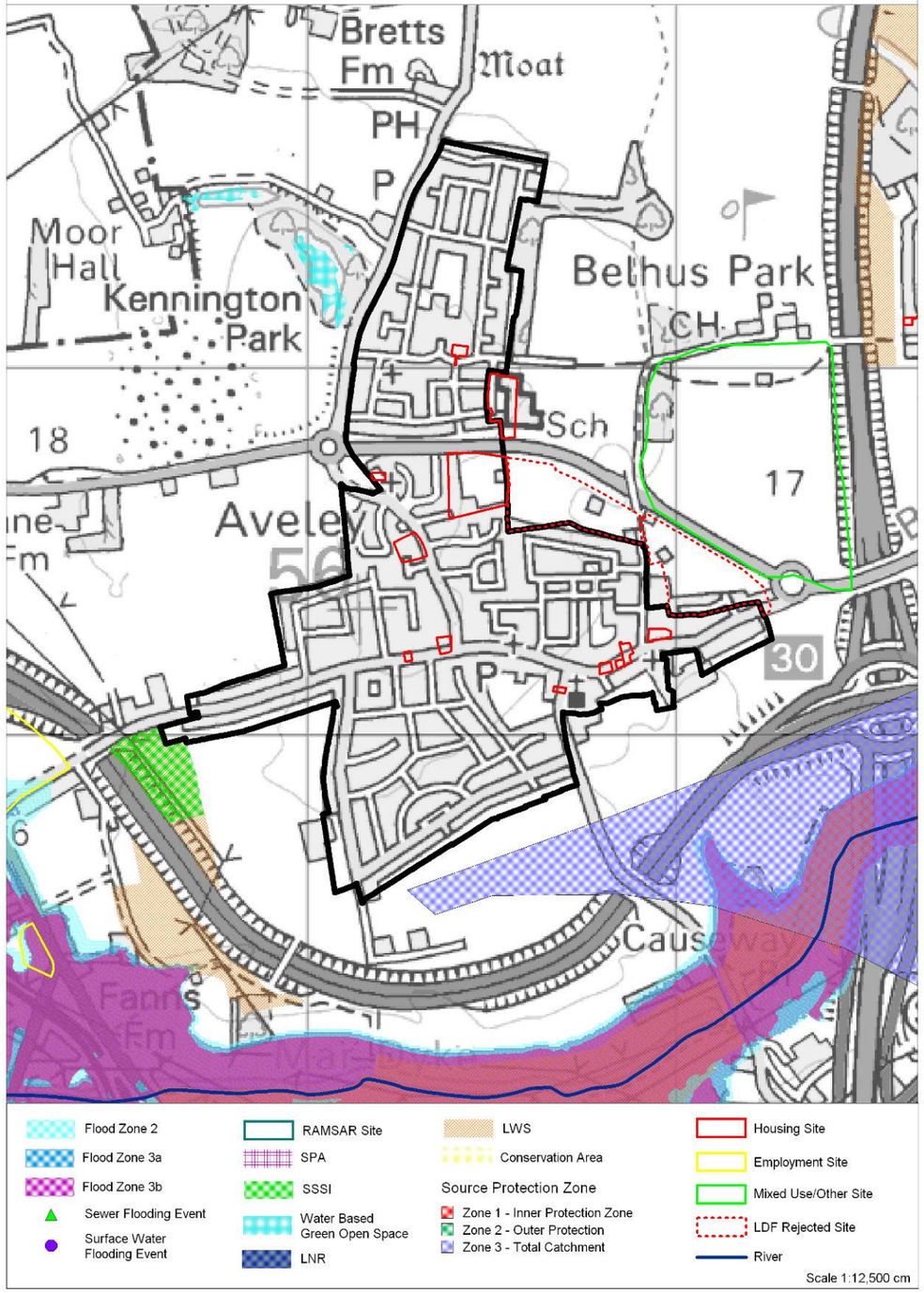
9.3.1 Water Cycle Constraints Assessment

Water Cycle Area	Summary	Overall Assessment
Water Resources and Water Supply	• There is no water available for further abstraction within Thurrock. • Water will be sourced from Abberton Reservoir from 2014/15 – prior to this ESW will be operating at a supply/demand shortfall in dry years and therefore there is a greater risk of a reduction in levels of service during drought years as a result of additional development. • There is considered to be water available to supply all new development up to 2025. • Water efficiency measures are planned to improve water efficiency in existing and new dwellings to work towards achieving 'water neutrality'.	
Flood Risk, SuDS and Surface Water Management	• Located in Flood Zone 1 • No recorded sewer or surface water flooding • Sequential Test passed • Not in SPZ but SPZ 3 to south and east of area • May be some restrictions placed on the amount of infiltration SuDS	
Wastewater Treatment and Collection	• AWS are currently investigating the volumetric capacity of Tilbury WwTW and until this is completed and either identifies sufficient capacity at the works or the requirement for (and granting of) a new flow (and quality) consent and associated upgrades (AMP6 funded) there is considered to be limited capacity to treat and discharge wastewater from proposed development. • Wastewater from area drains to south to Purfleet • May be future wastewater network capacity issues	
Water Quality	• River Mardyke flows to south of area • Cumulative impact on Thames Estuary through increased effluent discharge from Tilbury WwTW • Need to ensure no deterioration or increase in surface water runoff to River Mardyke catchment	
Ecology and Biodiversity	• No ecological sites within area • Surface water runoff from development in this area will need to be controlled to ensure no deterioration to bordering ecological sites	

9.3.2 Phasing Assessment

Phase	Dwellings	Employment	Constraints				
			Water Resources and Water Supply	Flood Risk, SuDS and SWM	Wastewater Treatment & Collection	Water Quality	Ecology & Biodiversity
Baseline (2009)	-	-					
2009-2014	147	-					
2014-2019	72	-					
2019-2025	-	-					
Total	219	-					

Broad Area for Regeneration 2: Aveley



9.4 Broad Area for Regeneration 3: South Ockendon

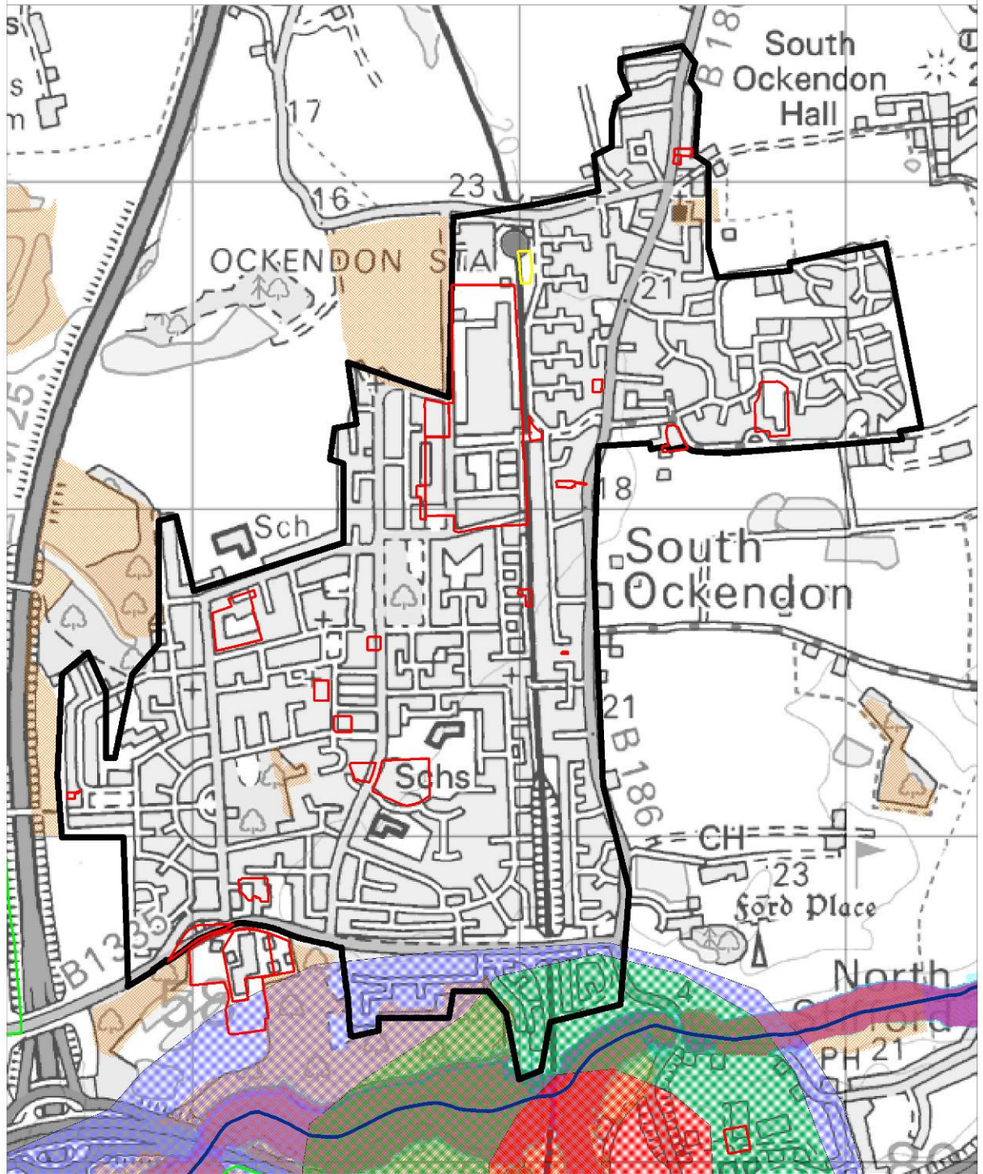
9.4.1 Water Cycle Constraints Assessment

Water Cycle Area	Summary	Overall Assessment
Water Resources and Water Supply	• There is no water available for further abstraction within Thurrock. • Water will be sourced from Abberton Reservoir from 2014/15 – prior to this ESW will be operating at a supply/demand shortfall in dry years and therefore there is a greater risk of a reduction in levels of service during drought years as a result of additional development. • There is considered to be water available to supply all new development up to 2025. • Water efficiency measures are planned to improve water efficiency in existing and new dwellings to work towards achieving 'water neutrality'.	
Flood Risk, SuDS and Surface Water Management	• Located in Flood Zone 1 • No recorded sewer or surface water flooding • Sequential Test passed • SPZ 2 and 3 to south of area • May be some restrictions placed on the amount of infiltration SuDS in south	
Wastewater Treatment and Collection	• AWS are currently investigating the volumetric capacity of Tilbury WwTW and until this is completed and either identifies sufficient capacity at the works or the requirement for (and granting of) a new flow (and quality) consent and associated upgrades (AMP6 funded) there is considered to be limited capacity to treat and discharge wastewater from proposed development. • Wastewater from area drains to south to Grays • No known sewer network capacity issues but Stifford Corran Way SPS is known to have adverse impact on water quality in River Mardyke, and any future growth (and associated wastewater) must ensure no increase in frequency of spill or spill volume into the Mardyke.	
Water Quality	• River Mardyke borders south of area • Cumulative impact on Thames Estuary through increased effluent discharge from Tilbury WwTW • Stifford Corran Way SPS is located to southeast of area and has been identified as having an adverse impact on water quality in the River Mardyke. An AMP5 scheme to investigate the impact of the SPS and improve the operation of the SPS has not been supported by Ofwat. • Need to ensure no deterioration or increase in surface water runoff to River Mardyke catchment	
Ecology and Biodiversity	• No ecological sites within area • Surface water runoff from development in this area will need to be controlled to ensure no deterioration to bordering ecological sites	

9.4.2 Phasing Assessment

Phase	Dwellings	Employment	Constraints				
			Water Resources and Water Supply	Flood Risk, SuDS and SWM	Wastewater Treatment & Collection	Water Quality	Ecology & Biodiversity
Baseline (2009)	-	-					
2009-2014	163	-					
2014-2019	1,388	-					
2019-2025	55	-					
Total	1,606	-					

Broad Area for Regeneration 3: South Ockendon



9.5 Broad Area for Regeneration 4: West Thurrock & Lakeside

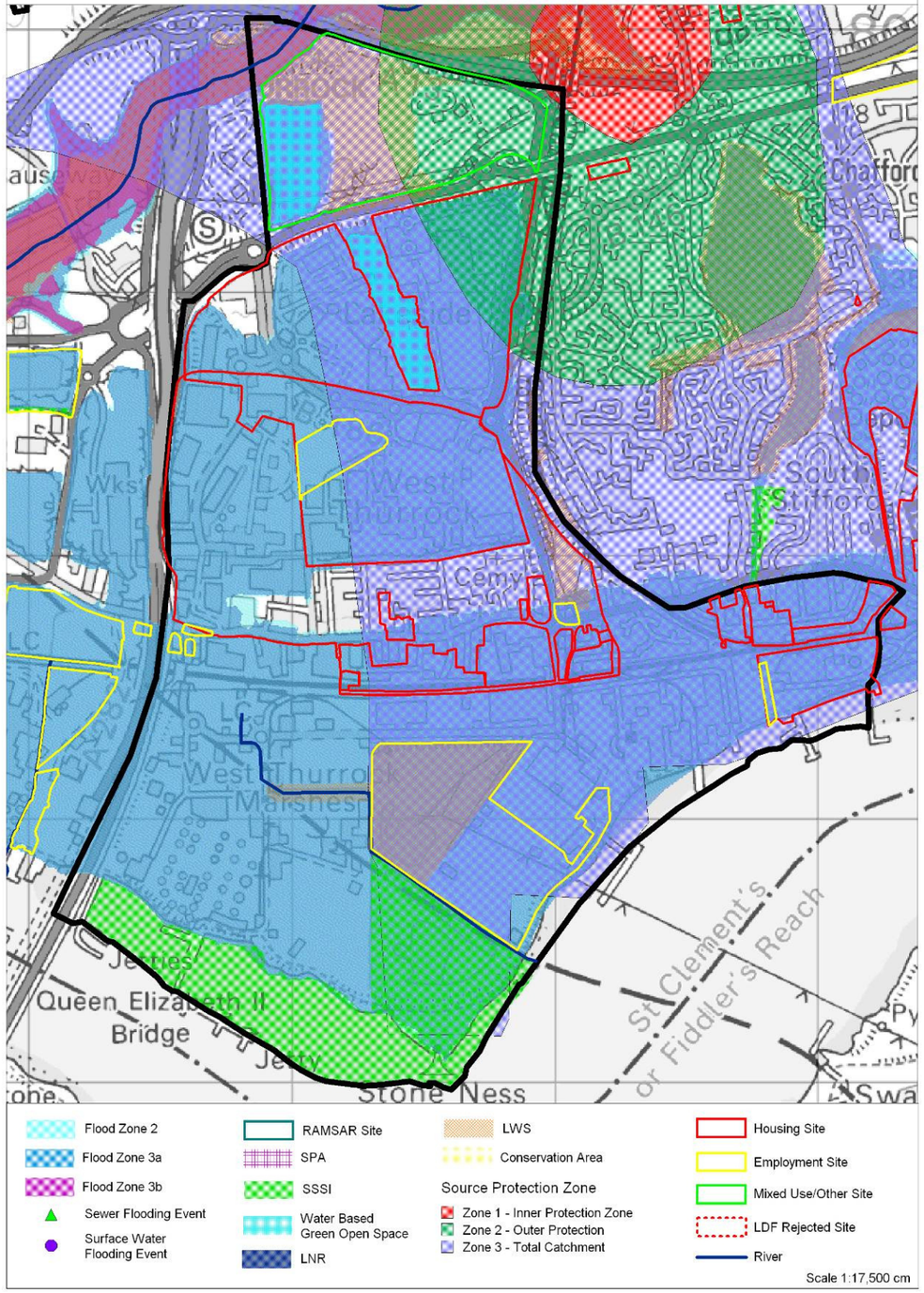
9.5.1 Water Cycle Constraints Assessment

Water Cycle Area	Summary	Overall Assessment
Water Resources and Water Supply	• There is no water available for further abstraction within Thurrock. • Water will be sourced from Abberton Reservoir from 2014/15 – prior to this ESW will be operating at a supply/demand shortfall in dry years and therefore there is a greater risk of a reduction in levels of service during drought years as a result of additional development. • There is considered to be water available to supply all new development up to 2025. • Water efficiency measures are planned to improve water efficiency in existing and new dwellings to work towards achieving 'water neutrality'.	
Flood Risk, SuDS and Surface Water Management	• Contains Flood Zones 2 & 3a and Extreme Hazard Rating. • Sequential Approach needed within development area. • SPZ 2 and 3 and SPZ 1 to northeast of site. • Limitations on amount of infiltration SuDS in north and east of area. Attenuation SuDS likely to be required.	
Wastewater Treatment and Collection	• AWS are currently investigating the volumetric capacity of Tilbury WwTW and until this is completed and either identifies sufficient capacity at the works or the requirement for (and granting of) a new flow (and quality) consent and associated upgrades (AMP6 funded) there is considered to be limited capacity to treat and discharge wastewater from proposed development. • Wastewater from area drains to east to Grays • Existing wastewater network capacity problems • New AWS trunk sewer planned to serve this area and West Thurrock but limited capacity until built	
Water Quality	• River Mardyke flows through northwest of area • Thames Estuary borders south of area • Cumulative impact on Thames Estuary through increased effluent discharge from Tilbury WwTW • Need to ensure no deterioration or increase in surface water runoff to River Mardyke or Thames Estuary	
Ecology and Biodiversity	• Area includes West Thurrock Lagoon & Marshes SSSI to south • Borders Thames Estuary to south and is upstream of the Thames Estuary & Marshes Ramsar & SPA • Surface water runoff from development in this area will need to be controlled to ensure no deterioration to bordering ecological sites	

9.5.2 Phasing Assessment

Phase	Dwellings	Employment	Constraints				
			Water Resources and Water Supply	Flood Risk, SuDS and SWM	Wastewater Treatment & Collection	Water Quality	Ecology & Biodiversity
Baseline (2009)	-	-					
2009-2014	428	2,500					
2014-2019	1,128	2,500					
2019-2025	1,379	2,500					
Total	2,935	7,500					

Broad Area for Regeneration 4: West Thurrock & Lakeside



9.6 Broad Area for Regeneration 5: Grays

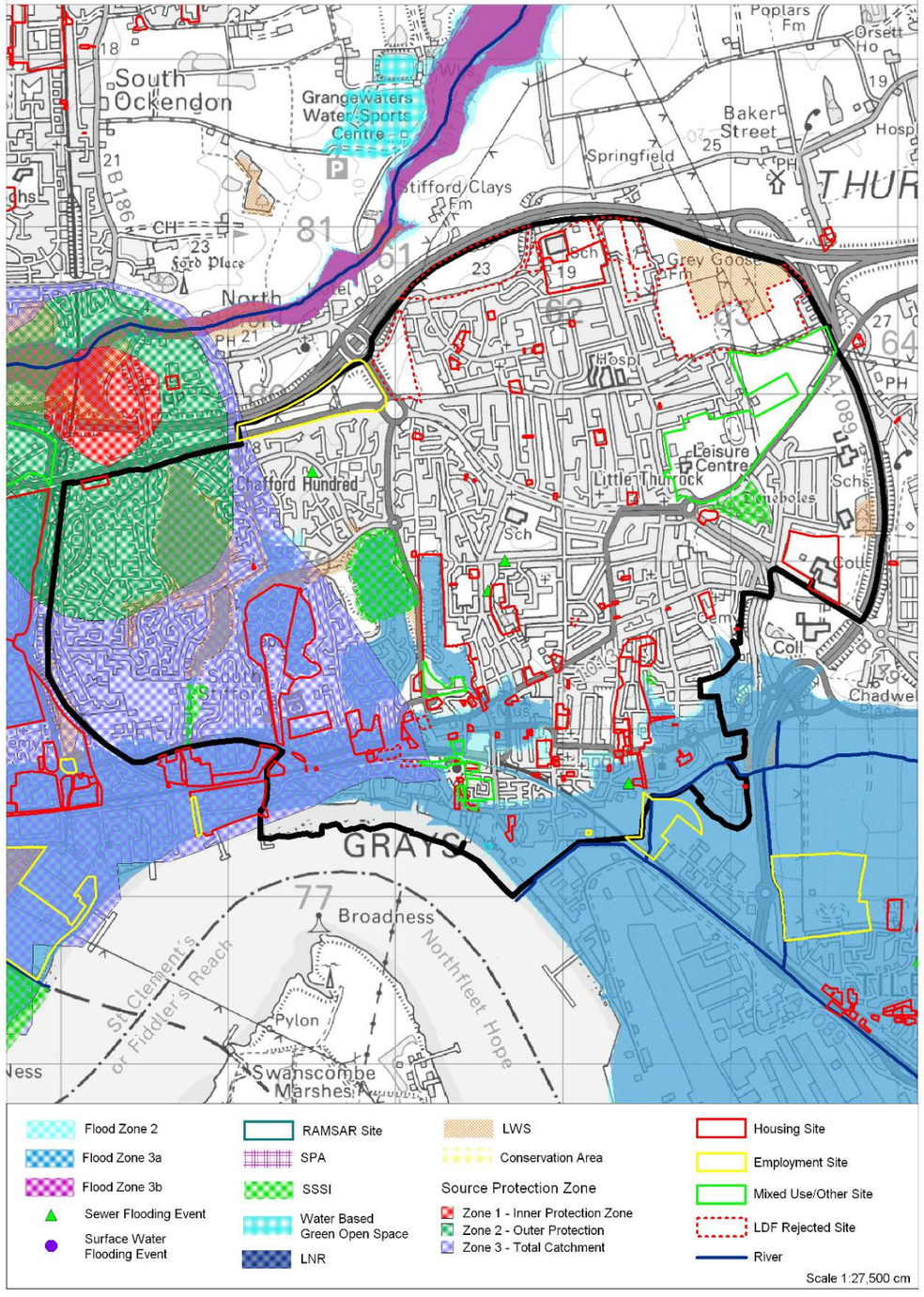
9.6.1 Water Cycle Constraints Assessment

Water Cycle Area	Summary	Overall Assessment
Water Resources and Water Supply	• There is no water available for further abstraction within Thurrock. • Water will be sourced from Abberton Reservoir from 2014/15 – prior to this ESW will be operating at a supply/demand shortfall in dry years and therefore there is a greater risk of a reduction in levels of service during drought years as a result of additional development. • There is considered to be water available to supply all new development up to 2025. • Will exert largest demand on water for new development • Water efficiency measures are planned to improve water efficiency in existing and new dwellings to work towards achieving 'water neutrality'.	
Flood Risk, SuDS and Surface Water Management	• Contains Flood Zones 2 & 3a and Extreme Hazard Rating • Sewer flooding recorded in area • Sequential Approach needed within development area • SPZ 2 and 3 and SPZ 1 to northwest of site. • Limitations on amount of infiltration SuDS in west of area. Attenuation SuDS likely to be required.	
Wastewater Treatment and Collection	• AWS are currently investigating the volumetric capacity of Tilbury WwTW and until this is completed and either identifies sufficient capacity at the works or the requirement for (and granting of) a new flow (and quality) consent and associated upgrades (AMP6 funded) there is considered to be limited capacity to treat and discharge wastewater from proposed development. • Wastewater from area drains to east to Tilbury and Tilbury WwTW • No wastewater capacity constraints	
Water Quality	• River Mardyke flows to north of area • Thames Estuary borders south of area • Cumulative impact on Thames Estuary through increased effluent discharge from Tilbury WwTW • Need to ensure no deterioration or increase in surface water runoff to Thames Estuary	
Ecology and Biodiversity	• Area includes Grays Chalk Pit SSSI • Borders Thames Estuary to south and is upstream of the Thames Estuary & Marshes Ramsar & SPA • Surface water runoff from development in this area will need to be controlled to ensure no deterioration to bordering ecological sites	

9.6.2 Phasing Assessment

Phase	Dwellings	Employment	Constraints				
			Water Resources and Water Supply	Flood Risk, SuDS and SWM	Wastewater Treatment & Collection	Water Quality	Ecology & Biodiversity
Baseline (2009)	-	-					
2009-2014	1,840	1,350					
2014-2019	2,815	1,350					
2019-2025	2,274	1,300					
Total	6,929	4,000					

Broad Area for Regeneration 5: Grays



9.7 Broad Area for Regeneration 6: Tilbury

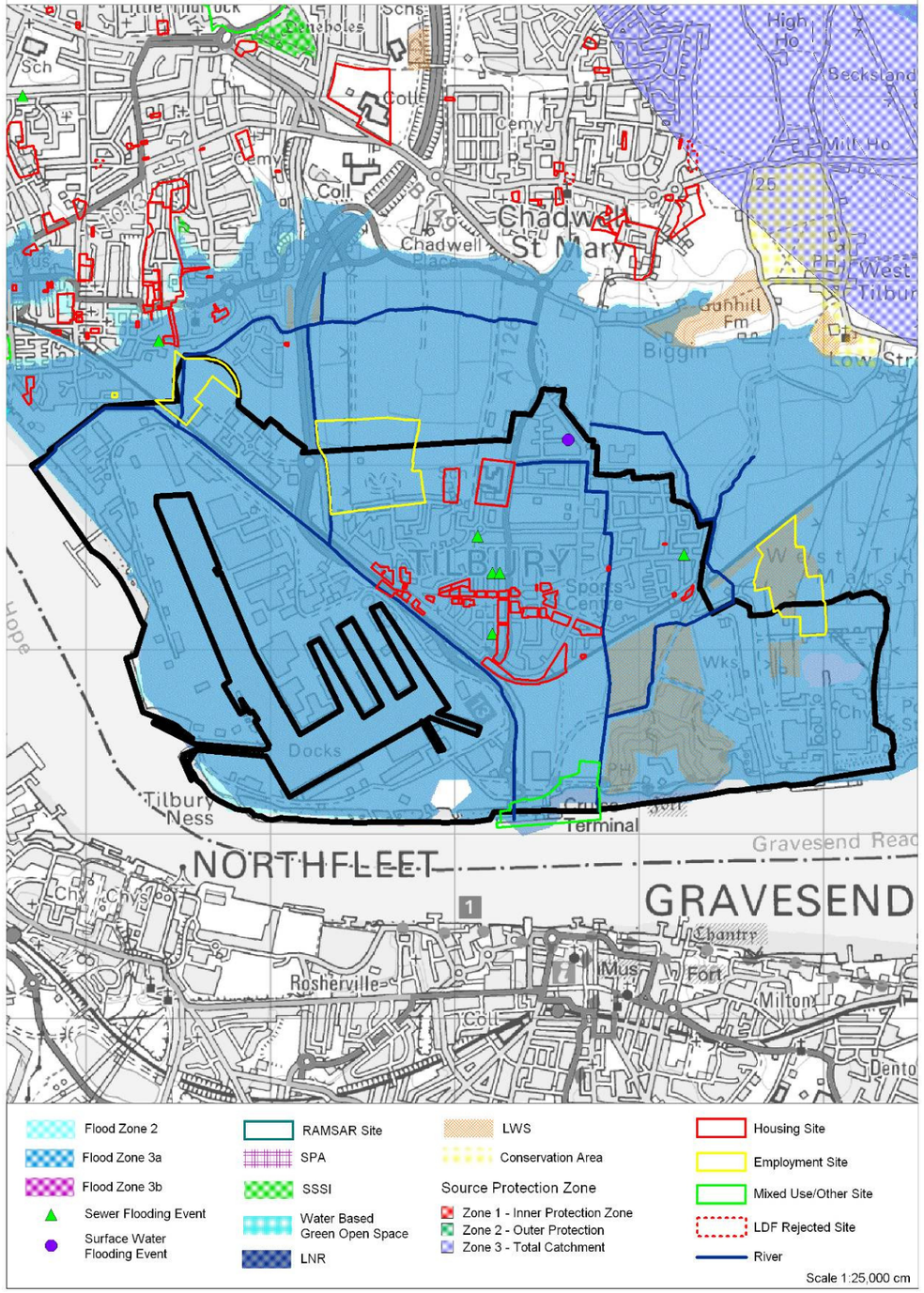
9.7.1 Water Cycle Constraints Assessment

Water Cycle Area	Summary	Overall Assessment
Water Resources and Water Supply	• There is no water available for further abstraction within Thurrock. • Water will be sourced from Abberton Reservoir from 2014/15 – prior to this ESW will be operating at a supply/demand shortfall in dry years and therefore there is a greater risk of a reduction in levels of service during drought years as a result of additional development. • There is considered to be water available to supply all new development up to 2025. • Water efficiency measures are planned to improve water efficiency in existing and new dwellings to work towards achieving 'water neutrality'.	
Flood Risk, SuDS and Surface Water Management	• Contains Flood Zones 3a and Extreme Hazard Rating • Recorded sewer flooding • Exception Test needed within development area • Not in SPZ • Unlikely to have stringent restrictions on use of infiltration SuDS	
Wastewater Treatment and Collection	• AWS are currently investigating the volumetric capacity of Tilbury WwTW and until this is completed and either identifies sufficient capacity at the works or the requirement for (and granting of) a new flow (and quality) consent and associated upgrades (AMP6 funded) there is considered to be limited capacity to treat and discharge wastewater from proposed development. • Wastewater from area drains to east to Tilbury WwTW through several pipes • No known wastewater capacity issues	
Water Quality	• Tilbury Dock Sewer and other minor watercourses flows through area • Thames Estuary borders south of area • Cumulative impact on Thames Estuary through increased effluent discharge from Tilbury WwTW • Need to ensure no deterioration or increase in surface water runoff to Thames Estuary or minor watercourses	
Ecology and Biodiversity	• No ecological sites contained within area • Borders Thames Estuary to south and is upstream of the Thames Estuary & Marshes Ramsar & SPA • Surface water runoff from development in this area will need to be controlled to ensure no deterioration to bordering ecological sites	

9.7.2 Phasing Assessment

Phase	Dwellings	Employment	Constraints				
			Water Resources and Water Supply	Flood Risk, SuDS and SWM	Wastewater Treatment & Collection	Water Quality	Ecology & Biodiversity
Baseline (2009)	-	-					
2009-2014	247	350					
2014-2019	103	350					
2019-2025	689	300					
Total	1,039	1,000					

Broad Area for Regeneration 6: Tilbury



9.8 Broad Area for Regeneration 7: Chadwell St Mary

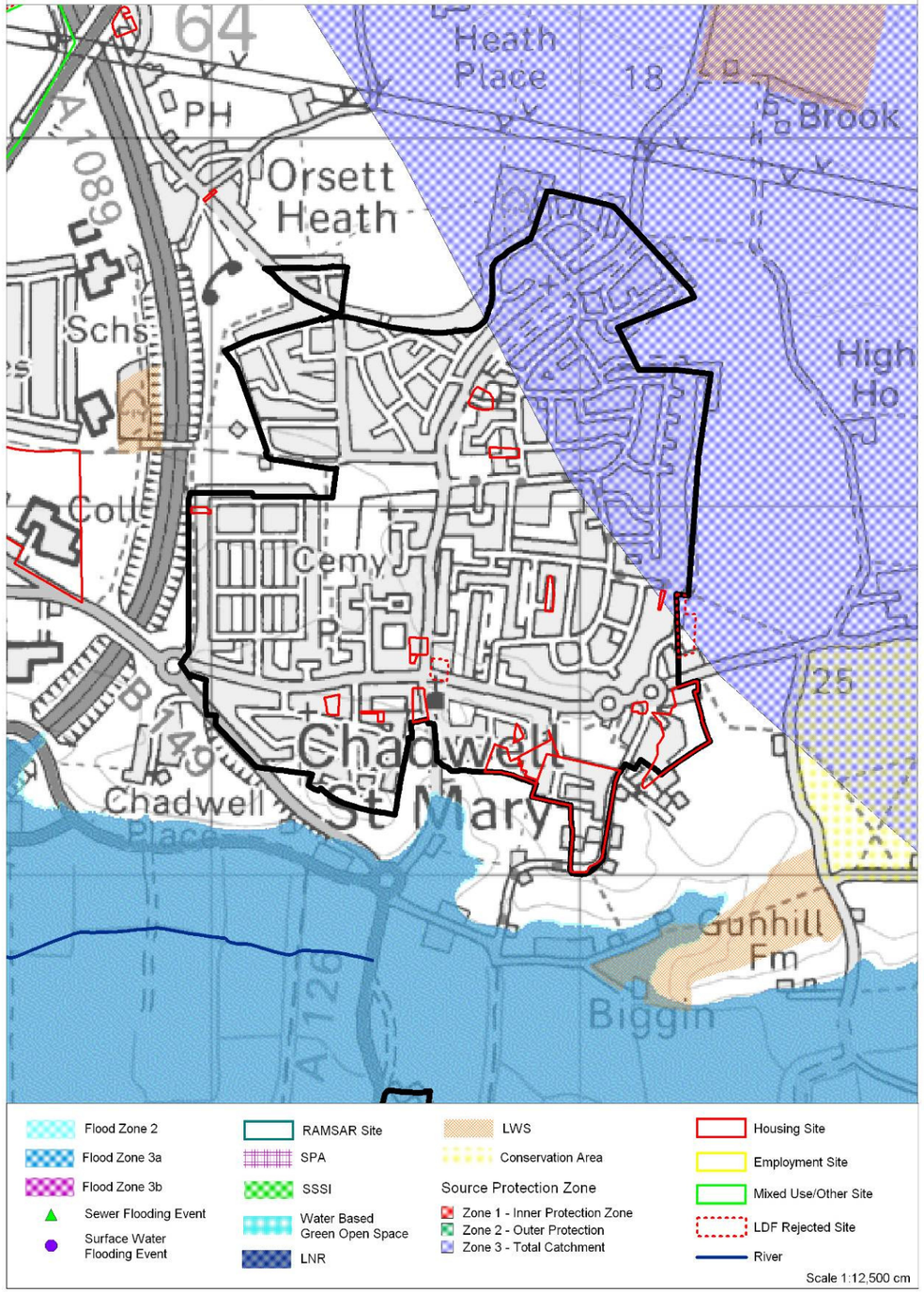
9.8.1 Water Cycle Constraints Assessment

Water Cycle Area	Summary	Overall Assessment
Water Resources and Water Supply	• There is no water available for further abstraction within Thurrock. • Water will be sourced from Abberton Reservoir from 2014/15 – prior to this ESW will be operating at a supply/demand shortfall in dry years and therefore there is a greater risk of a reduction in levels of service during drought years as a result of additional development. • There is considered to be water available to supply all new development up to 2025. • Water efficiency measures are planned to improve water efficiency in existing and new dwellings to work towards achieving 'water neutrality'.	
Flood Risk, SuDS and Surface Water Management	• Located in Flood Zone 1 • No recorded sewer or surface water flooding • Sequential Test passed • SPZ 3 • May be some restrictions placed on the amount of infiltration SuDS in northeast of area.	
Wastewater Treatment and Collection	• AWS are currently investigating the volumetric capacity of Tilbury WwTW and until this is completed and either identifies sufficient capacity at the works or the requirement for (and granting of) a new flow (and quality) consent and associated upgrades (AMP6 funded) there is considered to be limited capacity to treat and discharge wastewater from proposed development. • Wastewater from area drains to south to Tilbury • No know wastewater capacity issues	
Water Quality	• Area does not contain any watercourses • Cumulative impact on Thames Estuary through increased effluent discharge from Tilbury WwTW	
Ecology and Biodiversity	• No ecological sites contained within area • Surface water runoff from development in this area will need to be controlled to ensure no deterioration to bordering ecological sites	

9.8.2 Phasing Assessment

Phase	Dwellings	Employment	Constraints				
			Water Resources and Water Supply	Flood Risk, SuDS and SWM	Wastewater Treatment & Collection	Water Quality	Ecology & Biodiversity
Baseline (2009)	-	-					
2009-2014	45	-					
2014-2019	344	-					
2019-2025	11	-					
Total	400	-					

Broad Area for Regeneration 7: Chadwell St Mary



9.9 Broad Area for Regeneration 8: East Tilbury

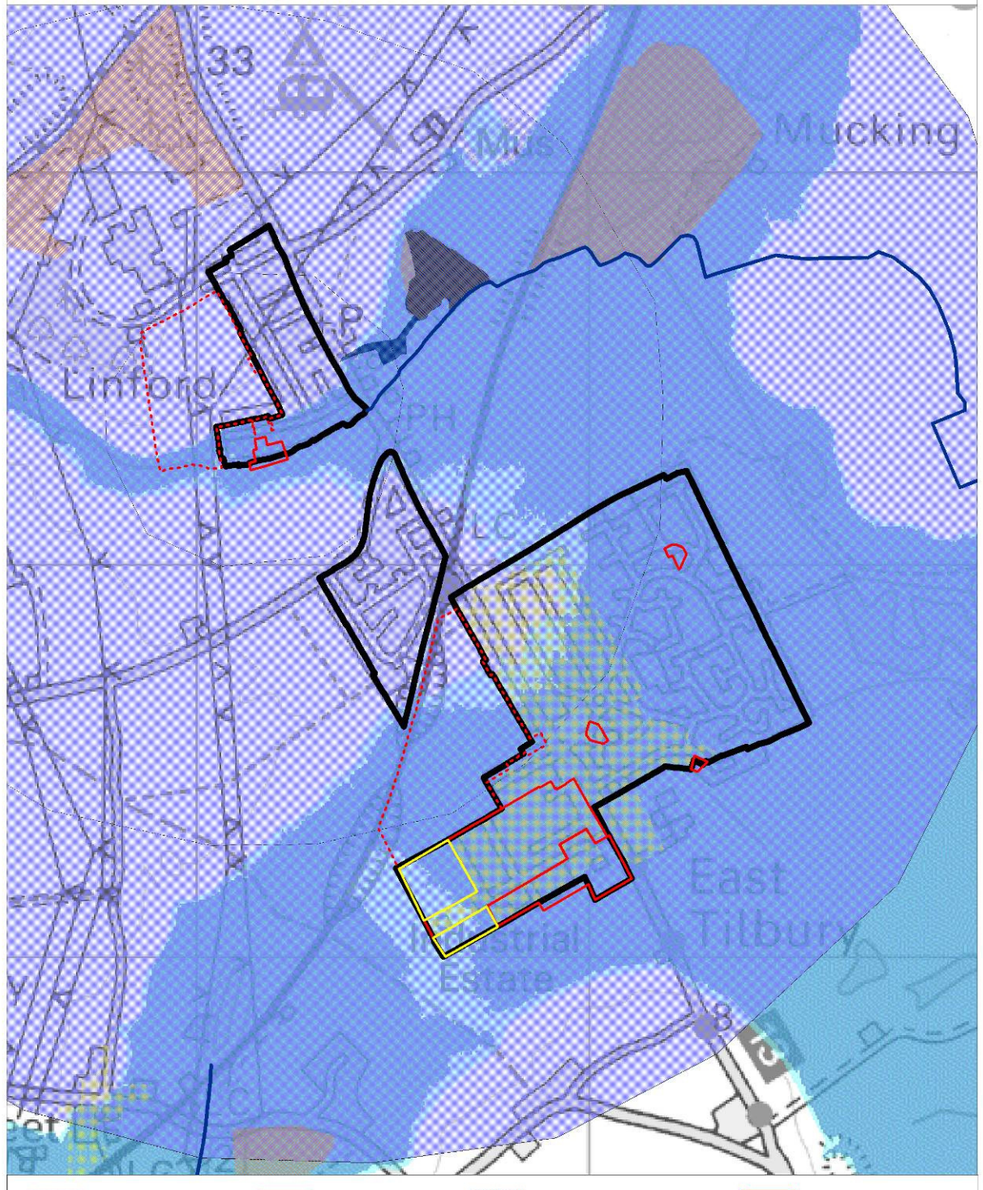
9.9.1 Water Cycle Constraints Assessment

Water Cycle Area	Summary	Overall Assessment
Water Resources and Water Supply	• There is no water available for further abstraction within Thurrock. • Water will be sourced from Abberton Reservoir from 2014/15 – prior to this ESW will be operating at a supply/demand shortfall in dry years and therefore there is a greater risk of a reduction in levels of service during drought years as a result of additional development. • There is considered to be water available to supply all new development up to 2025. • Water efficiency measures are planned to improve water efficiency in existing and new dwellings to work towards achieving 'water neutrality'.	
Flood Risk, SuDS and Surface Water Management	• Contains Flood Zones 2 & 3a and Extreme Hazard Rating • Sequential Approach needed within development area • SPZ 1,2 and 3 • Significant restrictions on the type of infiltration SuDS that can be promoted - likely that only clean roof water runoff will be permitted for discharge to ground. Attenuation SuDS will be required.	
Wastewater Treatment and Collection	• AWS are currently investigating the volumetric capacity of Tilbury WwTW and until this is completed and either identifies sufficient capacity at the works or the requirement for (and granting of) a new flow (and quality) consent and associated upgrades (AMP6 funded) there is considered to be limited capacity to treat and discharge wastewater from proposed development. • Wastewater from area drains to southwest to Tilbury WwTW • No know wastewater capacity issues	
Water Quality	• Gobions Sewer flows through north of area • Cumulative impact on Thames Estuary through increased effluent discharge from Tilbury WwTW • Need to ensure no deterioration or increase in surface water runoff to Gobions Sewer	
Ecology and Biodiversity	• No ecological sites contained within area • Has potential to impact Thames Estuary & Marshes Ramsar & SPA (Mucking Flats SSSI) though poorly managed surface water runoff to Gobions Sewer which drains to the SSSI • Surface water runoff from development in this area will need to be controlled to ensure no deterioration to bordering ecological sites	

9.9.2 Phasing Assessment

Phase	Dwellings	Employment	Constraints				
			Water Resources and Water Supply	Flood Risk, SuDS and SWM	Wastewater Treatment & Collection	Water Quality	Ecology & Biodiversity
Baseline (2009)	-	-					
2009-2014	11	-					
2014-2019	211	-					
2019-2025	21	-					
Total	243	-					

Broad Area for Regeneration 8: East Tilbury



9.10 Broad Area for Regeneration 9: Villages

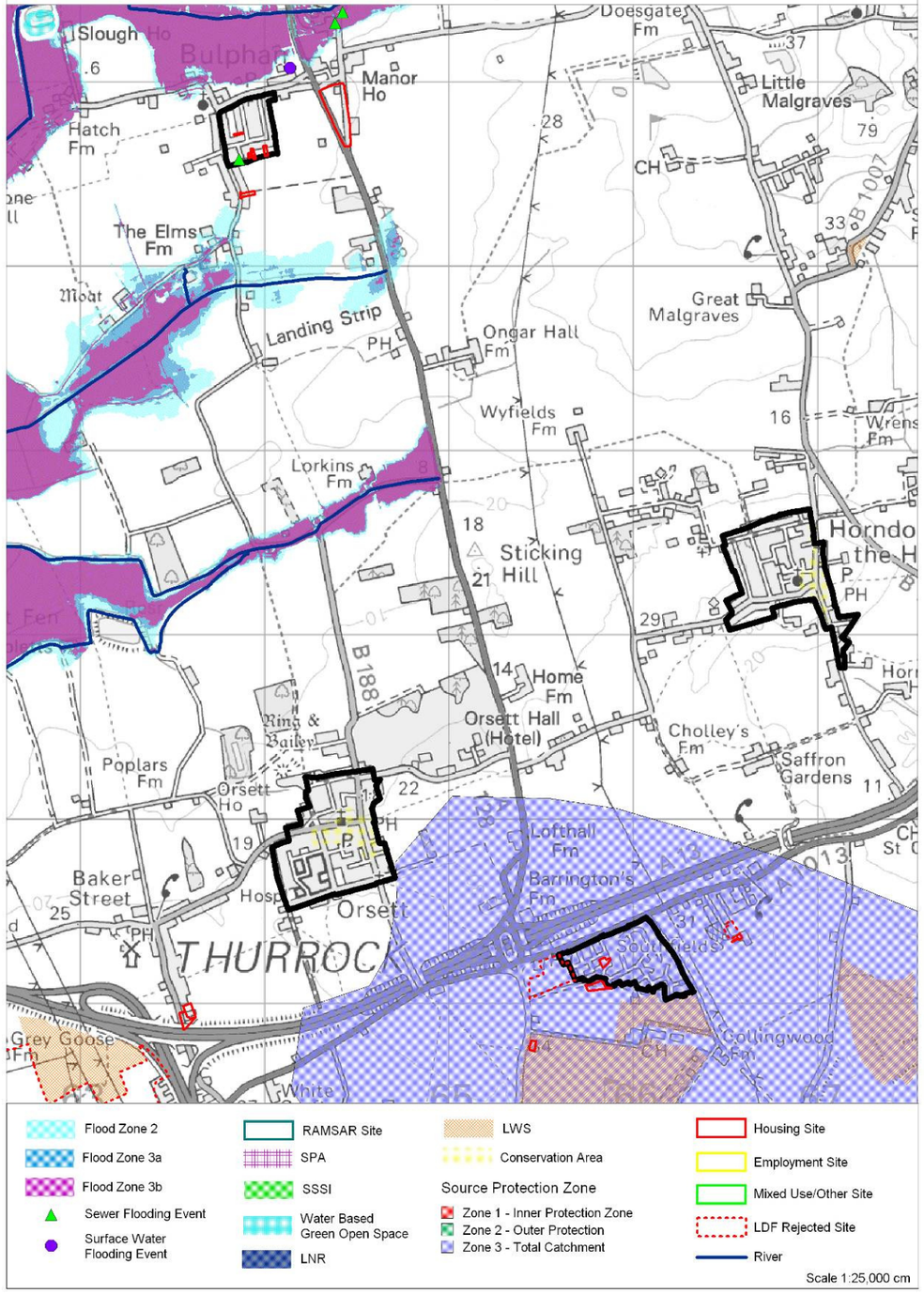
9.10.1 Water Cycle Constraints Assessment

Water Cycle Area	Summary	Overall Assessment
Water Resources and Water Supply	• There is no water available for further abstraction within Thurrock. • Water will be sourced from Abberton Reservoir from 2014/15 – prior to this ESW will be operating at a supply/demand shortfall in dry years and therefore there is a greater risk of a reduction in levels of service during drought years as a result of additional development. • There is considered to be water available to supply all new development up to 2025. • Water efficiency measures are planned to improve water efficiency in existing and new dwellings to work towards achieving 'water neutrality'.	
Flood Risk Management, SuDS and Surface Water Management	• Located in Flood Zone 1 • Sewer and surface water flooding in area • Sequential Test passed • SPZ 3 covers Southfields. No SPZ in other villages. • May be some restrictions placed on the amount of infiltration SuDS in Southfields. • Unlikely to have stringent restrictions on use of infiltration SuDS in Orsett, Bulphan and Horndon on the Hill.	
Wastewater Treatment and Collection	• AWS are currently investigating the volumetric capacity of Tilbury WwTW and until this is completed and either identifies sufficient capacity at the works or the requirement for (and granting of) a new flow (and quality) consent and associated upgrades (AMP6 funded) there is considered to be limited capacity to treat and discharge wastewater from proposed development. • Wastewater from area drains to south to Stanford-le-Hope & Corringham and Grays • No known sewer capacity issues	
Water Quality	• Only watercourse flowing close to area is the East Tributary of the River Mardyke to the north of Bulphan • Cumulative impact on Thames Estuary through increased effluent discharge from Tilbury WwTW	
Ecology and Biodiversity	• No ecological sites within area • Surface water runoff from development in this area will need to be controlled to ensure no deterioration to bordering ecological sites	

9.10.2 Phasing Assessment

Phase	Dwellings	Employment	Constraints				
			Water Resources and Water Supply	Flood Risk, SuDS and SWM	Wastewater Treatment & Collection	Water Quality	Ecology & Biodiversity
Baseline (2009)	-	-					
2009-2014	20	-					
2014-2019	-	-					
2019-2025	-	-					
Total	20	-					

Broad Area for Regeneration 9: Villages



9.11 Broad Area for Regeneration 10: Stanford-le-Hope & Corringham

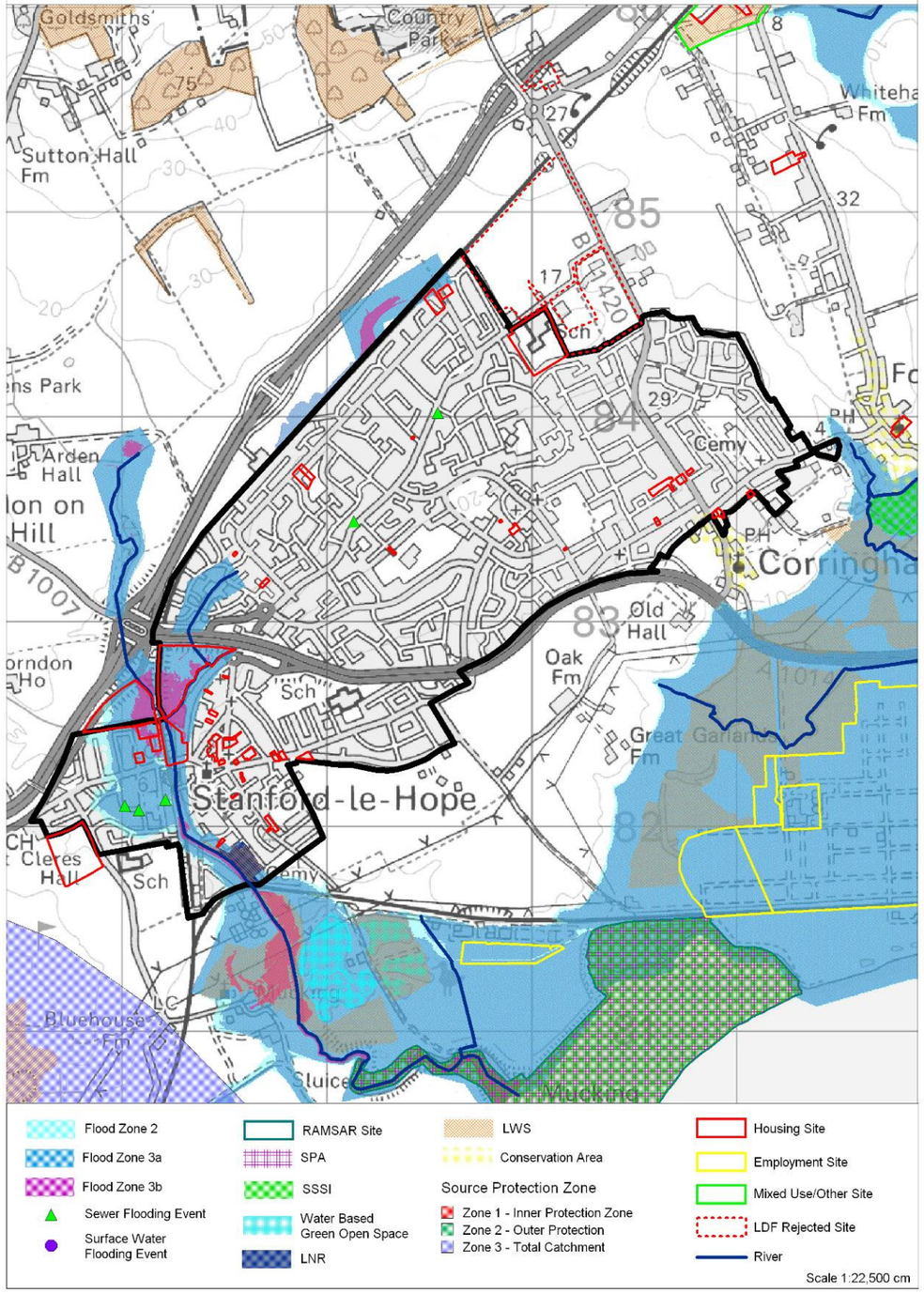
9.11.1 Water Cycle Constraints Assessment

Water Cycle Area	Summary	Overall Assessment
Water Resources and Water Supply	• There is no water available for further abstraction within Thurrock. • Water will be sourced from Abberton Reservoir from 2014/15 – prior to this ESW will be operating at a supply/demand shortfall in dry years and therefore there is a greater risk of a reduction in levels of service during drought years as a result of additional development. • There is considered to be water available to supply all new development up to 2025. • Water efficiency measures are planned to improve water efficiency in existing and new dwellings to work towards achieving 'water neutrality'.	
Flood Risk Management, SuDS and Surface Water Management	• Contains Flood Zones 2 & 3a and Extreme Hazard Rating • Sewer and surface water flooding recorded in area • Sequential Approach needed within development area • No SPZ in area • Unlikely to have stringent restrictions on use of infiltration SuDS	
Wastewater Treatment and Collection	• AWS are currently investigating the volumetric capacity of Tilbury WwTW and until this is completed and either identifies sufficient capacity at the works or the requirement for (and granting of) a new flow (and quality) consent and associated upgrades (AMP6 funded) there is considered to be limited capacity to treat and discharge wastewater from proposed development. • Wastewater from area drains to southwest to East Tilbury • No known sewer capacity issues	
Water Quality	• Stanford Brook flows through the west of the site and Fobbing Creek and other minor watercourses border the sites to the south and east • Cumulative impact on Thames Estuary through increased effluent discharge from Tilbury WwTW • Need to ensure no deterioration or increase in surface water runoff to Stanford Brook, Fobbing Creek and other minor watercourses bordering area	
Ecology and Biodiversity	• No ecological sites within area but Stanford Brook in west of site drains to Thames Estuary and Marshes Ramsar and SPA (Mucking Flats SSSI) • Surface water runoff from development in this area will need to be controlled to ensure no deterioration to bordering ecological sites	

9.11.2 Phasing Assessment

Phase	Dwellings	Employment	Constraints				
			Water Resources and Water Supply	Flood Risk, SuDS and SWM	Wastewater Treatment & Collection	Water Quality	Ecology & Biodiversity
Baseline (2009)	-	-					
2009-2014	163	-					
2014-2019	564	-					
2019-2025	190	-					
Total	917	-					

Broad Area for Regeneration 10a: Stanford-le-Hope & Corringham



9.12 Broad Area for Regeneration 10b: London Gateway

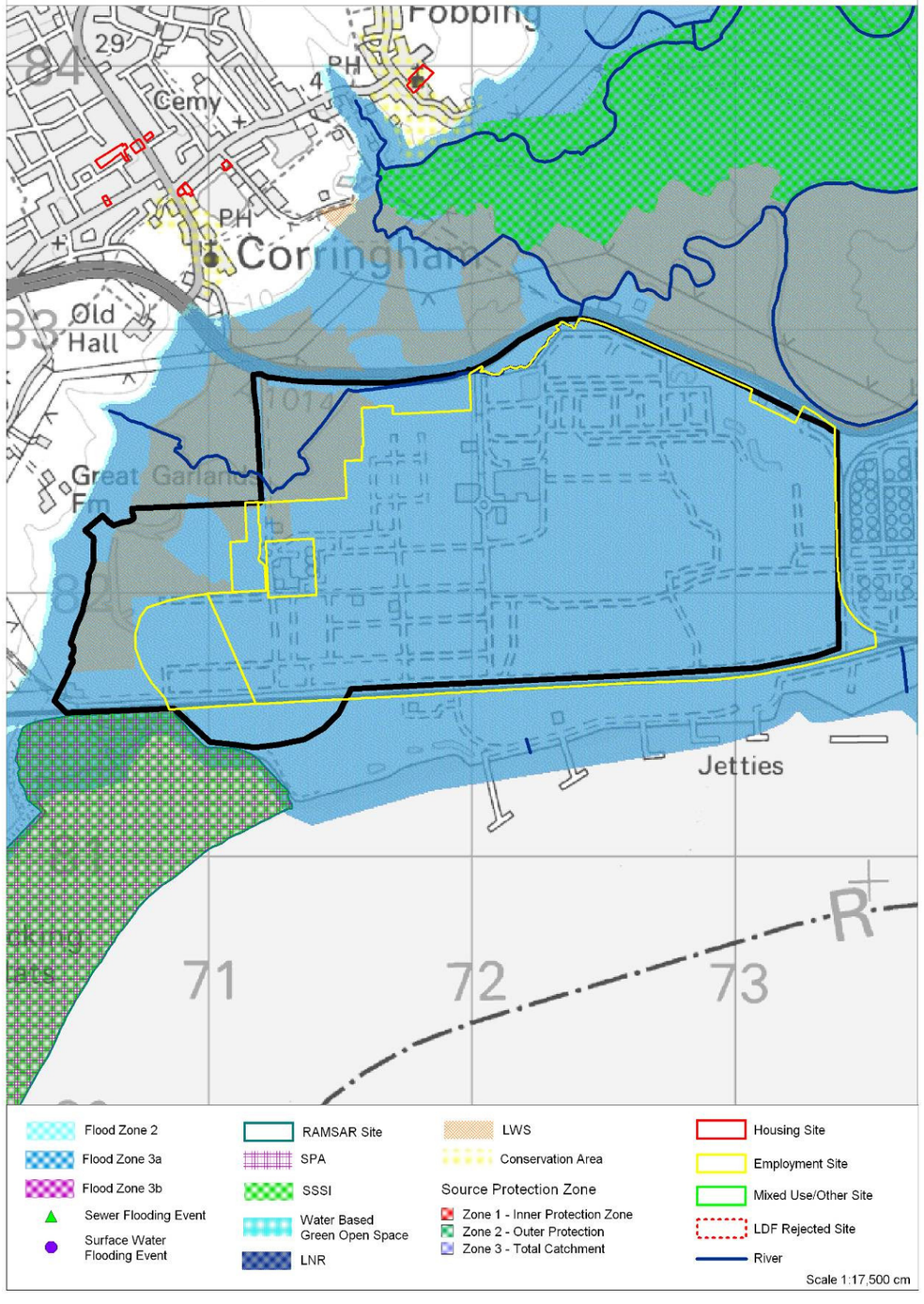
9.12.1 Water Cycle Constraints Assessment

Water Cycle Area	Summary	Overall Assessment
Water Resources and Water Supply	• There is no water available for further abstraction within Thurrock. • Water will be sourced from Abberton Reservoir from 2014/15 – prior to this ESW will be operating at a supply/demand shortfall in dry years and therefore there is a greater risk of a reduction in levels of service during drought years as a result of additional development. • There is considered to be water available to supply all new development up to 2025. • Water efficiency measures are planned to improve water efficiency in existing and new dwellings to work towards achieving 'water neutrality'.	
Flood Risk Management, SuDS and Surface Water Management	• Contains Flood Zones 2 & 3a and Extreme Hazard Rating • Sewer and surface water flooding recorded in area • Exception Test needed within development area • No SPZ in area • Unlikely to have stringent restrictions on use of infiltration SuDS	
Wastewater Treatment and Collection	• No existing wastewater network serving area • May be on-site treatment facilities but likely that connections to Tilbury WwTW will be required to serve development in this area. • AWS are currently investigating the volumetric capacity of Tilbury WwTW and until this is completed and either identifies sufficient capacity at the works or the requirement for (and granting of) a new flow (and quality) consent and associated upgrades (AMP6 funded) there is considered to be limited capacity to treat and discharge wastewater from proposed development.	
Water Quality	• Stanford Boundary Drain flows through area to the north • Thames Estuary borders south of area • Potential cumulative impact on Thames Estuary through increased effluent discharge from Tilbury WwTW • Need to ensure no deterioration or increase in surface water runoff to Thames Estuary or Stanford Boundary Drain	
Ecology and Biodiversity	• No ecological sites within area but area borders Thames Estuary and Marshes Ramsar and SPA (Mucking Flats SSSI) to the southwest • Surface water runoff from development in this area will need to be controlled to ensure no deterioration to bordering ecological sites	

9.12.2 Phasing Assessment

Phase	Dwellings	Employment	Constraints				
			Water Resources and Water Supply	Flood Risk, SuDS and SWM	Wastewater Treatment & Collection	Water Quality	Ecology & Biodiversity
Baseline (2009)	-	-					
2009-2014	-	4,200					
2014-2019	-	4,200					
2019-2025	-	4,100					
Total	-	12,500					

Broad Area for Regeneration 10b: London Gateway



10 Policy, Developer Guidance & Funding Mechanisms

An important outcome of a completed WCS is to ensure a link between the planning process and the infrastructure required to meet growth requirements. The Detailed WCS will define in more detail the infrastructure requirements for the proposed development areas, but a further key outcome will be the timing of implementation of that infrastructure and how it is funded.

The Detailed Thurrock WCS will ultimately produce a programme or timeline for development with detail of the infrastructure required in order to facilitate this development. The timeline will also demonstrate when funding would need to be sought by AWS and ESW as well as the implementation of mechanisms for ensuring sufficient developer contribution towards strategic infrastructure required to meet the requirements of the overall Water Cycle Study.

It is intended that the completed Thurrock WCS will produce an overall strategy that each of the key Stakeholders can sign up to. This will aid in the process of delivering development in Thurrock by helping to ensure that objections to proposed development on the grounds of water issues such as flood risk and abstraction are avoided. By producing a completed WCS that is agreed by AWS, ESW, Natural England, the Environment Agency and Thurrock Borough Council, it will aid developers in understanding the requirements they need to meet in order to comply with the strategy produced from the WCS. It will also set the framework for how funding will be sought for the different water infrastructure requirements.

In order to achieve this, the Thurrock WCS is required to produce the following:

- guidance on planning policy with respect to development and the water cycle that Thurrock BC can use to input into their DPDs and SPDs being formulated as part of the LDF;
- guidance for developers in terms of what they need to achieve in order to comply with the overall water cycle strategy, such as flood risk mitigation; this will be in the form of a developer checklist and it is envisaged that this will eventually be a document which, if its criterion are all met for a proposed development, will help to ensure no objection from the Environment Agency or LPA on the grounds of water cycle issues. This type of checklist document has been successfully developed for other WCS such as the inaugural WCS completed for Corby;
- agreement on funding mechanisms, particularly for strategic, development wide infrastructure required i.e. strategic scale surface water attenuation schemes;
- planning timelines for provision of water infrastructure against growth to aid AWS in planning for water infrastructure within relevant business plans; and
- to provide justification for AWS and ESW in seeking funding through the Periodic Review (PR) and Asset Management Plan (AMP) process for the required infrastructure.

In terms of the overall funding mechanism, it is important to consider that the Government has laid down strict rules on how water companies are funded, especially with regard to domestic development, and this overall process is regulated by the industry's economic regulator – Ofwat. Essentially, AWS has the responsibility for providing wastewater treatment and ESW the responsibility for water supply costs and this is funded through charges to customers within their respective operating areas through the Price Review Process and AMP process. Developers are required to contribute to the cost of sewers and mains to serve new development through the requisition process. They may also be required to contribute to strategic flood management infrastructure.

11 Recommendations for the Detailed WCS

The next stage of the Thurrock Water Cycle Study is to progress to the Detailed Stage. The Detailed Stage will build on the findings of the Outline Study and should define what specific infrastructure and mitigation is required to facilitate development, once the decisions have been made on the location of allocations and the likely intensity and type of development within them. Based on the findings from this Outline WCS, the key recommendations for the Detailed Study for Thurrock are provided below.

Water Resources & Water Supply

- Assessment of the Final Water Resources Management Plan (when published) and implications for growth in Thurrock;
- Determine phasing and outline costing of water supply infrastructure (reinforcement works for existing water supply infrastructure) required to facilitate growth in Thurrock, based on liaison with ESW, following the 'final determination' by Ofwat of ESW's business plan for AMP5,
- Calculate the costs of the infrastructure that developers can contribute to and identify developer contribution mechanisms through section 106 agreements and tariff systems..

Flood Risk Management, SuDS & Surface Water Management

- Further assessment of flood risk to the development sites is not required for the detailed study, as each of the development sites are being sequentially tested and exception tested through the ongoing Level 2 SFRA. The outputs from the Level 2 SFRA should be reviewed, and where any strategic flood management infrastructure required to ensure that a potential development area meets with the PPS25 Exception Test has been identified, provide an outline cost for this infrastructure;
- It is recommended that a separate Surface Water Management Plan should be undertaken to assess surface water management within Thurrock, including SuDS utilisation, acceptable runoff rates and the protection of water quality in the Mardyke. The findings from this assessment should be summarised in the Detailed WCS.

Water Quality, Wastewater Treatment and Collection

- In conjunction with the Environment Agency and AWS, identify the solution to the WwTW capacity deficit at Tilbury WwTW. This will require the determination of a new discharge consent based on the volume of and timing of proposed growth in Thurrock. To determine the new consent it will be necessary to:
    - calculate the additional wastewater generated by the proposed growth in Thurrock and the phasing of additional wastewater;
    - determine how much additional volumetric discharge will have to be added to the consent conditions to allow this wastewater to be treated and discharged;
    - determine how the quality conditions will have to be altered as a result of additional discharge in order to meet WFD, and Shellfish/Bathing Water Directive requirements in the Thames Estuary;
    - determine whether the additional discharge will impact on any downstream ecological designations (habitats regulation assessment impact);

- determine whether Tilbury WwTW has the process (i.e. treatment processes) capacity to treat the additional wastewater flow to the higher quality conditions required to meet legislation; and.
- determine any upgrade works required at Tilbury WwTW and how these upgrades will affect phasing of development in Thurrock and feed this into the overall infrastructure timeline for the WCS.

- In consultation with AWS, following the 'final determination' by Ofwat of AWS's business plan for AMP5, determine where and when upgrades and/or new strategic sewers are required and/or planned.
- Calculate the costs of the infrastructure that developers can contribute to through Section 106 agreements and tariff systems.
- Determine phasing of wastewater infrastructure required to facilitate growth in Thurrock.

Ecology & Biodiversity

- Based on the findings of the Tilbury WwTW assessment and the recommendations of the Environment Agency and Natural England, the habitats regulation assessment for Thurrock may need to be reviewed and updated to determine whether the additional discharge from Tilbury WwTW will impact on any downstream ecological designated sites. This will need to decided following confirmation of the capacity at Tilbury WwTW by AWS.

Development Area Assessment

- Assessment of individual housing/employment development sites and growth figures within key constrained Broad Areas for Regeneration i.e. Purfleet, Lakeside, Grays, Tilbury, East Tilbury and London Gateway.
- Produce infrastructure timelines of the phasing of all water services infrastructure required to facilitate all growth in Thurrock, taking into account water company funding timelines (AMP process) and the EIA and planning lead in times of key infrastructure;.

11.1.1 Policy, Developer Guidance & Funding Mechanisms

- Production of a developer checklist to give guidance for developers on what they need to address and cover in their proposals and planning applications to meet with the strategy, and hence ensure minimisation of Environment Agency, Natural England and other stakeholder objections to developer proposals.
- Provide recommended policies to feed into the DPDs or SPDs as necessary.
- Development of LDF and AAP (or other DPD/SPD) policies based on technical water assessments (i.e. target water efficiency standards).

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Appendix A – Figures

Appendix B – Data Catalogue

THURROCK WATER CYCLE STUDY
OUTLINE STAGE
DATA CATALOGUE

Date Source Number	Data Description	Data Provider	Priority	Date Received	Comments
1	Any updates/changes to the Draft Water Resource Plans (2009).	ESW	1	29/01/2009	Statement of Consultation Response
2	Data from sewerage and treated water capacity assessment studies in support of the development of Business Plans for Price Review 09.	ESW	1	29/01/2009	Commercially confidential
3	Information of growth forecasts already catered for in ST AMP5 planning (to compare to RSS).	ESW	1	29/01/2009	Await final WRMP tables. Possibly Sept 09
4	Confirmation of the WRZ and Water supply zones supplying Thurrock & Existing Water Volumes being supplied to the Thurrock district and/or WRZ.	ESW	2	29/01/2009	
5	Water balance required for Thurrock WCS study area	ESW	1	29/01/2009	N/A
6	WTW current and projected outputs (capacities) and locations.	ESW	2	29/01/2009	
7	Clean water supply network layout for Borough, including pipe sizes and any problem areas with regards to pressures.	ESW	1	29/01/2009	Unavailable due to Defra Security Notes
8	Location of service and supply reservoirs and information on size.	ESW	1	29/01/2009	Unavailable due to Defra Security Notes
9	Confirmation on coverage and reliability status of any clean water supply network models for each development location (to consider for use in detailed study).	ESW	2	29/01/2009	
10	Existing water consumption control measures (to support those included in the WRMP demand management proposals).	ESW	2	29/01/2009	
11	Asset reports outlining what is required to upgrade/refurbish existing assets in Thurrock.	ESW	2	29/01/2009	Covered, if required, in companies Business Plans to Ofwat
12	Flow and quality consent details (& treatment type if available) of Tilbury WwTW	AWS	1	12/12/2008	
13	WwTW volumetric capacities, process capacities (if available) PE figures, trade flow figures, infiltration assumptions.	AWS	2	12/12/2008	
14	Existing Sludge treatment and disposal information.	AWS	3	12/12/2008	
15	Sewerage Network layout, pipe diameter, capacities and CSOs, (Combined Sewer Overflows) and pumping stations locations for development areas - including proposed pipe network to serve new development (if available).	AWS	1	13/02/2009	Part Received Awaiting further info
16	Confirmation on coverage and reliability of wastewater network models (to consider for use in detailed study).	AWS	2		N/A
17	Any known problem locations for the existing sewer network including flooding incident locations and details - DG5 register data if possible.	AWS	1	13/02/2009	
18	Any information on surface water flooding - known problem areas, records or accounts of historic flood events, photographs etc.	EA	1	13/02/2009	
19	Any information on ground water flooding issues - locations, records or accounts of past events, photographs etc.	EA	1	23/01/2009	Provided where available
20	Anticipated growth figures for each development area including initial phasing proposals (if developed).	TBC	1	23/07/2009	
21	Confirmation of the site allocations being considered for area and hence to be assessed in the WCS and the corresponding GIS Layers.	TBC	1	14/07/2009	
22	Confirmation of locations for committed developments (GIS)	TBC	1	14/07/2009	
23	Raw Water Abstraction Volumes (last 3 complete years), Licences limits and locations	EA	1	12/01/2009	
24	River flow gauging location and measurements (2000 - 2008) for River Mardyke and Tidal River Thames (if available)	EA	1	23/01/2009	Provided where available
25	River Quality observations (2000 - 2008) for River Mardyke and Tidal River Thames, upstream and downstream of WwTW discharges including location of water quality sites	EA	1	19/03/2009	Provided where available
26	Confirmation of water quality standards (current and future WFD) and requirements for discharges into the Tidal River Thames.	EA	1	19/03/2009	
27	Cross sections of the watercourses in proximity to the settlements proposed for development	EA	1	23/01/2009	Provided where available
28	Information from SIMCAT Models (local and/or National SIMCAT Models (for the region) and supporting reports for rivers in the Thurrock Council area	EA	3	09/01/2009	Not available at present - awaiting QA
29	Source Protection Zone Maps	EA	2	23/01/2009	From Website
30	Actual sewage effluent discharge measurements (2000 - 2008)	EA/AWS	2	19/03/2009	Provided where available
31	Review of Consent - Stage 3 (and Stage 4 where available) RoC reports for affected sites	EA	1	09/01/2009	Awaiting further info - from Thames Region
32	Review of Consent - Stage 4 reports for local SAC's	EA	1	09/01/2009	Awaiting further info - from Thames Region
33	PR09 Business Plan (if available)	ESW/AWS	1	20/04/2009	

Appendix C – Water Resources Assessment

Water Resources

Future Residential Demand

The estimates in growth from residential demand for Thurrock are included in Table C.1.

To calculate these demands, it is necessary to multiply the number of new homes to be built by the average occupancy rate (OR) and in turn by the average water use per person. In the case of the Thurrock area, ESW's metered households, typically have an OR of 2.0. The average water consumption rate for its metered customers is 143 litres/head/day ($lh^{-1}d^{-1}$).

Non-Residential Demands

The estimates for growth from non-residential demand in Thurrock are included in Table C.2.

The UK Water Industry has traditionally used complex econometric forecasting models to assess what may happen to the demands from industry in the future. For the Thurrock WCS, our estimates of non-residential demand are based on the relationship which exists between non-residential and residential water demands as reported by Ofwat (2007-2008, Reference 16). In the case of ESW, the non-residential metered demand is around 52% of the residential metered demand. Assuming Thurrock to be similar to the wider area served by ESW, then the non-residential demand will be approximately half of the residential demand.

In order to apportion which areas will see the highest non-residential demands, then information on the amount of land area to be used for employment purposes (both primary and secondary use) is taken into account. The source of this information was Council's Employment Site Allocations (November 2007) - Technical Site Appendices.

Total Water Demand

Table C.3 shows the combined residential and non-residential demand figures for the Thurrock area including an allowance for 10% headroom.

Table C.1: Residential Water Demands in Thurrock

No.	Development Areas	Nos. dwellings	Water Company Forecast	Code for Sustainable Homes Rating 1/2 120 $lh^{-1}d^{-1}$	Code for Sustainable Homes Rating 3/4 105 $lh^{-1}d^{-1}$	Code for Sustainable Homes Rating 5/6 80 $lh^{-1}d^{-1}$	Range of Estimates Min (Col 7)	Range of Estimates Max (Col 4)
			Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 4	Scenario 1
			(Mld^{-1}) *1	(Mld^{-1})*2	(Mld^{-1})*3	(Mld^{-1})*4	(Mld^{-1})	(Mld^{-1})
1	Purfleet	3224	0.92	0.77	0.68	0.52	0.52	0.92
2	Aveley	219	0.06	0.05	0.05	0.04	0.04	0.06
3	South Ockendon	1606	0.46	0.39	0.34	0.26	0.26	0.46
4	West Thurrock & Lakeside	2935	0.84	0.70	0.62	0.47	0.47	0.84
5	Grays	6929	1.98	1.66	1.46	1.11	1.11	1.98
6	Tilbury	1039	0.30	0.25	0.22	0.17	0.17	0.30
7	Chadwell St Mary	400	0.11	0.10	0.08	0.06	0.06	0.11
8	East Tilbury	243	0.07	0.06	0.05	0.04	0.04	0.07
9	Villages*1	20	0.01	0.00	0.00	0.00	0.00	0.01
10	Stanford-le-hope & Corringham	917	0.26	0.22	0.19	0.15	0.15	0.26
11	London Gateway	0	0.00	0.00	0.00	0.00	0.00	0.00
12	Other (Windfall)	92	0.03	0.03	0.02	0.01	0.01	0.03
	Thurrock Total	**17,624**	**5.04**	**4.23**	**3.70**	**2.82**	**2.82**	**5.04**

**1 Assuming 143 l/h/d supplied for ESW area. The occupancy rates of 2.0 assumed (Ofwat 2007-08)*
**2 Code for Sustainable Homes - Water consumption targets for Code 1/2 homes and an assuming occupancy rate of 2.0 (Ofwat 2007-08)*
**3 Code for Sustainable Homes - Water consumption targets for Code 3/4 homes*
**4 Code for Sustainable Homes - Water consumption targets for Code 5/6 homes*
**5 Allowance for headroom in-line with WCS Methodology (4/6/08) [+10%?]*
**6 Villages - Orsett, Bulphan, Horndon on the Hill and Southfields*

Table C.2 Non-residential Water Demand in Thurrock

	Development Areas	Nos. Dwellings (JCS Preferred Option)	Water Company Forecast	Estimate of Water to be supplied for Non-Residential	Primary development areas (Non-residential)[*8]	Secondary development areas (Non-residential)[*8]	Weighting based on primary development areas (Non-Residential)	Weighting based on secondary development areas (Non-Residential)
			Scenario 1	Scenario 1	Scenario 1	Scenario 1	Scenario 1	Scenario 1
			(Mld^{-1})	(Mld^{-1})[*2]	Hectares (ha)	Hectares (ha)	(Mld^{-1})	(Mld^{-1})
1	Purfleet	3,224	0.92	-	88.5	5.4	0.59	0.03
2	Aveley	219	0.06	-	0.4	0.0	0.00	0.00
3	South Ockendon	1,606	0.46	-	See Aveley	See Aveley	-	-
4	West Thurrock & Lakeside	2,935	0.84	-	See Purfleet	See Purfleet	-	-
5	Grays	6,929	2.41	-	22.9	15.4	0.15	0.10
6	Tilbury	1,039	0.30	-	28.9	15.2	0.19	0.10
7	Chadwell St Mary	400	0.11	-	See East Tilbury	See East Tilbury	-	-
8	East Tilbury	243	0.07	-	0.0	3.1	0.00	0.02
9	Villages	20	0.01	-	0.0	0.0	0.00	0.00
10	Stanford-le-hope & Corringham	917	0.26	-	0.0	4.2	0.00	0.00
11	London Gateway	0	0.00	-	243.2	0.0	1.63	0.00
12	Other (Windfall)	92	0.03	-	0.0	0.0	0.00	0.00
	Thurrock Total	**17,624**	**5.46**	**2.62**	**383.9**	**43.3**	**2.57**	**0.25**

**1 Assuming 143 l/h/d supplied for ESW area. The occupancy rates of 2.0 assumed (Ofwat 2007-08)*
**2 Code for Sustainable Home - Water consumption targets for Code 1/2 home and an assuming occupancy rate of 2.0 (Ofwat Report 2007-08)*
**3 Code for Sustainable Homes - Water consumption targets for Code 3/4 homes*
**4 Code for Sustainable Homes - Water consumption targets for Code 5/6 homes*
**5 Non-residential demand assumed to be 52% of total metered supply (Ofwat 2007-08). Note demand estimated on the basis of ESW 143 l/h/d*
**6 Employment sites based on information provided by Thurrock BC (2007)*

Table C.3 Total Water Demand in Thurrock

	Development Areas	Total Supply (Residential & Non-residential)	Range of Estimates Minimum	Range of Estimates Maximum	Including an allowance for headroom	Including an allowance for headroom
		Scenario 1	Scenario 4	Scenario 1	Scenario 1	Scenario 4
		(Mld^{-1}) *1	(Mld^{-1}) *2	(Mld^{-1}) *2	(Mld^{-1}) *3	(Mld^{-1}) *3
1	Purfleet	1.55	1.00	1.55	1.70	1.10
2	Aveley	0.06	0.04	0.06	0.07	0.04
3	South Ockendon	0.46	0.26	0.46	0.51	0.28
4	West Thurrock & Lakeside	0.84	0.47	0.84	0.92	0.52
5	Grays	2.23	1.31	2.23	2.46	1.44
6	Tilbury	0.59	0.39	0.59	0.65	0.43
7	Chadwell St Mary	0.11	0.06	0.11	0.13	0.07
8	East Tilbury	0.09	0.05	0.09	0.10	0.06
9	Villages	0.01	0.00	0.01	0.01	0.00
10	Stanford-le-hope & Corringham	0.26	0.15	0.26	0.29	0.16
11	London Gateway	1.63	1.26	1.63	1.79	1.39
12	Other (Windfall)	0.03	0.01	0.03	0.03	0.02
	Thurrock Total	**7.86**	**5.01**	**7.86**	**8.65**	**5.51**

Water Efficiency

Towards Water Neutrality in the Thames Gateway

In November 2007, the Environment Agency, Department for Environment, Food and Rural Affairs (Defra) and Communities and Local Government (CLG) published a study investigating how water neutrality could be achieved within the Thames Gateway (Reference 27). The Thames Gateway is Europe's largest regeneration project, stretching for 40 miles along the Thames Estuary, from London Docklands to Southend in Essex and Sheerness in Kent, and there are plans to build around 160,000 homes by 2016.

The study explores the feasibility of making the Gateway area 'water neutral', where total water used after new development is no more than that used before the development. By 2016, the area could be using no more water than that used at present provided that new homes and offices are built to high standards of water efficiency, a high number of existing homes and buildings are retrofitted with water-saving devices such as low-flush toilets and low-flow taps and showerheads; and water metering becomes compulsory. The study showed that, even with the forecast new development, population growth and increases in water demand, water neutrality is technically possible to achieve.

The study explored the technical feasibility of moving to 'water neutrality' in the Thames Gateway by 2016, looking specifically at: establishing the current demand for water in the area; forecast future water demand under a business-as-usual (BAU) scenario up to 2016; and model the effects of different strategies leading to neutrality, taking into account financial costs and carbon emissions. The feasibility of achieving water neutrality was assessed through a series of scenarios using assumptions based around increased standards of water efficiency in new homes (through greater uptake of the Code for Sustainable Homes (CSH) and the retrofitting of water-efficient devices in existing housing. Water efficiency in non-households (such as businesses and public buildings) and compulsory metering and variable water tariffs were also explored.

Total water demand in the Thames Gateway in the baseline year 2005-06 was found to be 521 million litres per day (Ml/d). Approximately 90 percent of this (461 Ml/d) was for public water supply.

Unmetered households made the largest demand for water. Carbon emissions associated with the provision of water and treatment of wastewater were estimated to be around 117,085 tonnes CO2 per year.

Water neutrality is technically feasible, and can be achieved in a number of ways, but is an ambitious goal that will require much effort from all parties involved.

The total costs for households range from £127 million to £181 million, which accounts for around two-thirds of the water savings needed to achieve neutrality. The range of costs for new homes is £275 to £765, averaged across all homes built in the Gateway between 2005 and 2016. The cost for existing hoes (to pay for retrofitting, fitting a meter and applying tariffs were applicable) is £135 to £154 per house, with costs average across all existing households in the gateway in 2005 to 2006.

The report found that compulsory metering is a fundamental requirement to achieve neutrality, with variable tariffs likely to provide further incentives to reduce demand and reduce the cost of meeting neutrality.

Water Efficiency in Existing Homes

There are possibilities within existing development to achieve significant savings and to improve efficiency and reduce the baseline water consumption. Existing homes can be retrofitted with a range of fixtures to increase efficiency in these homes, this can include:

- Metering;
- Water efficient fixtures and fittings – for example, flow restrictors or aerating fixtures;
- Low flush or dual flush toilets;
- Water efficient dishwashers and washing machines
- Installation of water butts for garden use; and
- Additionally, education of the existing population about water efficiency and in particular about water efficient fixtures, fittings and appliances can help to reduce water demand. This can be achieved through, for example, water audits or community education programmes.

Based on findings from the Environment Agency report Water Efficiency in the South East of England (Reference 28), some of these measures have been considered as a guide to potential reductions in water demand through the use of water efficient measures (Table C.4).

Table C.4 Potential Water Savings

Water Saving Method	Potential saving*	Comments/uncertainty.
Ultra Low Flush replacement Scheme	50-55l/hhold/d	4.5l toilet assumed to be used. Need incentive to replace old toilets with low flush toilets.
Variable flush retrofit device	21-29l/hhold/d	Need incentive to buy equipment and install the equipment. Potential problems with operation particularly if installed incorrectly.
Low flow shower head scheme	12-14l/hhold/day	Cannot be used with electric, power or low pressure gravity fed systems.
Metering Scheme	5-10% reduction. = 33.5/hhold/d saved	This can be implemented through compulsory metering or through metering on change of occupancy.
Low use fittings:	49.9l/hhold/day (conservative estimate)	This includes fitting Low use taps, Low flow Showerhead and a variable flush device.

Note: * Based on the national average occupancy of 2.3 people per household

Water Efficiency in New Homes

New homes can be fitted with a range of fittings to reduce demand, in addition, new developments can have community wide measures to reduce the demand in water, this can range from rainwater harvesting to grey water recycling – the use of wash water from showers and sinks in toilets after on site treatment.

The Code for Sustainable Homes (CSH) sets out the minimum water demand required to meet the different levels of water use in new homes. The CSH sets out the maximum water usage permitted for each code level. This provides a flexible outline for improving the overall sustainability of a house. Table C.5 outlines the water efficiency that needs to be achieved to reach each of the sustainable levels.

Table C.5 Code for Sustainable Homes – Water consumption targets for the different code levels and examples of how these targets can be attained in new build

Code for sustainable homes levels.	Amount of Water (litres per person per day)	Examples of how to achieve water efficiency level.
1	120	Install efficient equipment within the home – 18l max volume dishwasher and 60l max volume washing machine. Install 4/6l dual flush toilets. Install 6-9l/min showers. Educate users about how to be efficient water users. Installation of water meters.
2	120	
3	105	As above. In addition, install water butts and equipment to use rainwater in the garden. Install aerating fixtures into bathrooms and kitchens. Include surface water management in the surrounding development.
4	105	
5	80	As above, in addition: Grey water recycling, reduction of surface water from the development. Provide water audits for people to show them where they can reduce water usage.
6	80	

The examples of water efficiency measures include in Table C.5 are an outline of the possible ways to improve water efficiency. There are many more possibilities that are site specific. Many of these are shown in the Ofwat water efficiency initiatives (Reference 29) for water and sewerage companies and it is recommended that these are assessed and considered for inclusion in new development as part of the Detailed WCS as the preferred options for development come forward. Other steps which should be considered in new builds include: rainwater harvesting from roofs and paved areas (through the use of permeable surfaces); grey water recycling (with some mains support) which can provide enough water to run all toilets, a washing machine and outside taps.

New developments offer the opportunity to work towards a much higher level of water efficiency. The eco-towns water cycle worksheet (Reference 30) shows examples of where community schemes have been used as a way to improve efficiency for example, through the collection and supply of rainwater for use in toilets; these kind of initiatives could be considered for Thurrock on a strategic scale to further reduce water demand. However, it is acknowledged that attainment of levels 5 and 6 is generally restricted to high grade eco-homes which are purpose built to reach status such as carbon neutral and that attainment of this level (on the basis of water consumption) is unlikely for the new housing planned for Thurrock.

Appendix D – Sustainable Drainage Systems (SuDS)

The SuDS Hierarchy

The Environment Agency and Defra currently suggest that the SuDS management train is adopted when considering SuDS techniques to be adopted for new development. This lists the order in which different SuDS techniques should be considered for a site in terms of their requirement to mitigate against surface water and flood risk (Reference 20).

The management train considers SuDS options which first 'prevent' the generation of runoff i.e. green roofs, rainwater harvesting; followed by techniques which control runoff at the source, such as infiltration to ground through permeable paving; then followed sequentially by site wide and regional wide techniques. When considering disposal of attenuated surface water, Part H of the Building Regulations (Reference 31) requires that the first choice of surface water disposal should be to discharge to infiltration systems where practicable. In development sites over 1 hectare the Environment Agency will always seek that infiltration is the method of surface water disposal if feasible as the method mimics natural drainage methods.

A SuDS hierarchy should be followed looking at infiltration methods first, then attenuation followed by discharge straight to sewer. The last options to consider are hard engineered solutions such as attenuation tanks. Infiltration for developments can occur via individual house soakaways through to infiltration lagoons. Attenuation, as a second option, should be provided so the runoff post-development is as a minimum no higher than the pre-development runoff rate, and as close to the site greenfield runoff rate as possible.

Table D.1 lists the order in which different SuDS techniques should be considered for a site in terms of their considered mitigation against surface water and flood risk. SuDS techniques at the top of the hierarchy are preferable for their infiltration and runoff prevention benefits. The management train provided below also states the additional potential ecological and water quality benefits that could be achieved by employing the proposed SuDS techniques.

Infiltration SuDS

Infiltration is a key factor in reducing runoff rates and volumes, as it reduces reliance on surface or engineered storage systems such as balancing ponds or storage tanks. Some infiltration SuDS have the additional benefit of being able to encourage habitat creation and water quality benefits (see Table D.1). However, natural infiltration by creation of open grassland landscaping (where contamination is not an issue) should be encouraged, first for large developments to maximise natural runoff rate reduction, and second to encourage natural recharge of groundwater systems.

Green areas and open space should be maximised for large development areas where the soil and geology is sufficiently permeable to make it a feasible option. Infiltration can also be encouraged via managed SuDS techniques such as soakaways, swales or infiltration trenches. Given that some of the study area is underlain by permeable geology such as Chalk or Sands and Gravels, infiltration is a key consideration for new development in Thurrock, particularly to the south of the Borough. Despite this, the Chalk underlying Thurrock is considered a Major Aquifer used for public supply (at Linford and Stifford) therefore due regard needs to be paid to protection of groundwater from pollution pathways that can be created by poorly managed or badly located infiltration SuDS, and as such, there are restrictions on the types of infiltration SuDS systems permitted within developments.

An assessment of the SuDS potential, based on groundwater vulnerability and source protection zones is provided in Table D.2.

Table D.1 SuDS Management Train (Surface Water and Flood Risk Mitigation)

Management Train			Component	Description	Water Quantity	Water Quality	Amenity Biodiversity
	Source	Prevention	Green roofs	Layer of vegetation or gravel on roof areas providing absorption and storage.	●	●	●
			Rainwater harvesting	Capturing and reusing rainwater for domestic or irrigation uses.	●	○	○
			Permeable pavements	Infiltration through the surface into underlying layer.	●	●	○
			Filter drains	Drain filled with permeable material with a perforated pipe along the base.	●	●	
			Infiltration trenches	Similar to filter drains but allows infiltration through sides and base.	●	●	
			Soakaways	Underground structure used for store and infiltration.	●	●	
			Bio-retention areas	Vegetated areas used for treating runoff prior to discharge into receiving water or infiltration	●	●	●
			Swales	Grassed depressions, provides temporary storage, conveyance, treatment and possibly infiltration.	●	●	○
			Sand filters	Provides treatment by filtering runoff through a filter media consisting of sand.	●	●	
Regional	Site		Basins	Dry depressions outside of storm periods, provides temporary attenuation, treatment and possibly infiltration.	●	●	○
			Ponds	Designed to accommodate water at all times, provides attenuation, treatment and enhances site amenity value.	●	●	●
			Wetland	Similar to ponds, but are designed to provide continuous flow through vegetation.	●	●	●

Table D.2 SuDS Options

Soil Permeability	Source Protection Zone	SuDS Method															
		Green or Brown Roofs	Rainwater Harvesting and Water Butts	Soakaways	Filter Strips	Filter Trench	Swales	Bio-Retention Area	Pervious Pavement	Infiltration Basin	Detention Basins	Ponds	Stormwater Wetlands	Sand Filters	Pre-Treatment Devices	Geocellular/Modular	Large Diameter Pipes, Culverts or Tanks
Low	SPZ 1	✓	✓				✓L	✓L			✓L	✓L		✓L	✓	✓L	✓
	SPZ 2	✓	✓		✓	✓	✓	✓			✓	✓				✓	
	SPZ 3	✓	✓		✓	✓	✓	✓			✓	✓				✓	
Medium	SPZ 1	✓	✓		✓L	✓L	✓L	✓L	✓L		✓L	✓L		✓L	✓	✓L	✓
	SPZ 2	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓				✓	
	SPZ 3	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓				✓	
High	SPZ 1	✓	✓		✓L	✓L	✓L	✓L	✓L		✓L	✓L	✓L	✓L	✓	✓L	✓
	SPZ 2	✓	✓	✓	✓	✓	✓	✓L	✓	✓	✓	✓L	✓L			✓	
	SPZ 3	✓	✓	✓	✓	✓	✓	✓L	✓	✓	✓	✓L	✓L			✓	

Note: ✓L = Must be lined

Appendix E – Wastewater Capacity Assessment

Wastewater Treatment Capacity

The aim of the wastewater capacity assessment is to determine the current and future Thurrock wastewater treatment works and wastewater network[14] capacity and the current and future downstream water quality condition against proposed growth up to 2025. The assessment defines the likely impacts and the likely mitigation required to ensure that future water quality and wastewater treatment meet WFD standards for 'good ecological status' without causing deterioration to the water environment.

Data Availability

Data was provided by the Environment Agency, Anglian Water Services (AWS) and Thurrock BC to undertake this assessment (Table E.1).

Table E.1 Data Provided to Undertake Wastewater Capacity Assessment

Data	Source	Assessment		
		WwTW Capacity	Wastewater Treatment	Wastewater Network
Proposed development within Broad Areas for Regeneration in Thurrock between 2009 and 2025	Thurrock BC	✓	✓	✓
Dry Weather Flow (DWF) and Quality Consents for Tilbury WwTW	AWS	✓	✓	×
Current domestic, non-domestic, trade effluent and tankering population equivalents for Tilbury WwTW	AWS	✓	✓	✓
Current and future consumption figures for Thurrock	AWS (Website)	✓	✓	✓
Current and Future Occupancy Rates in Thurrock	Thurrock BC (Website)	✓	✓	✓
Water quality monitoring records (2000 - 2008) for water quality monitoring sites upstream and downstream of Tilbury WwTW on the Tidal River Thames	Environment Agency	×	✓	×
UKTAG WFD proposed water quality standards	UKTAG (Website)	×	✓	×
Anglian River Basin District Draft River Basin Management Plan	Environment Agency (Website)	×	✓	×

Wastewater Treatment Capacity Assessment

AWS provided current domestic, non-domestic, trade effluent and tankering population equivalents for Tilbury WwTW which were used to calculation the Dry Weather Flow (DWF) currently being treated at Tilbury WwTW.

[14] the network of pipes and pumping stations which are used to transmit wastewater from buildings to treatment facilities

The current and future headroom capacity at Tilbury WwTW has been is calculated from the volumetric capacity (i.e. the difference between the maximum DWF that AWS are permitted to discharge under the discharge consent and the current DWF that is treated from the existing population). This is based on the assumption that AWS would seek the funding required to upgrade the processes in the works (if necessary) to treat the additional flow to the standard required under the existing licence.

Using the assumptions defined below, the number of future homes and population equivalent that could be accommodated in the future can be estimated, and when new infrastructure upgrades to the WwTW may be required.

The following global assumptions, based on latest available data, have been used for the Tilbury wastewater treatment capacity assessment:

- The resident (domestic) population (Pd) and non-resident (holiday) population (Ph) represent the current population being served by the WwTWs at June 2008;
- The per capita consumption for the domestic population (Gd – water used per head, per day) is taken as 156 l/h/d (the average water consumption in the ESW area);
- The per capita consumption for the non-resident population (Gh – water used per head, per day) is taken as 55 l/h/d;
- The per capita consumption for commercial jobs (Gc) is taken as 28 l/h/d;
- Dry Weather Flow[15] (DWF) is calculated as PG + I + E where E is the volume of trade effluent discharged in the catchment (m^3/d);
- The infiltration (I) rate[16] is calculated as 25% of the domestic and holiday population multiplied by the stated per capita consumptions (PG = (Domestic Population (Pd) x Domestic Consumption (Gd)) + (Holiday Population (Ph) x Holiday Consumption (Gh))) and that for future calculation of I, the additional infiltration is calculated as 25% of future PG;
- Flow to Full Treatment[17] (FtFT) is calculated as 3PG + I + 3E;
- The future per capita consumption for new development (Gf – water used per head, per day) is taken as 125 l/h/d.;
- No increase in non-resident consumption has been assumed; and
- The occupancy rate is currently 2.4 per dwelling and by 2025 will be 2.16.

The calculations undertaken for this assessment are provided below.

It should be noted that the method of assessment of DWF has recently changed to a statistical method based on measured flows. As part of this change the DWF consent for Tilbury will be increased. However, the revised consent includes no capacity for growth and a revised consent application will be required to take account of growth. Until the new flow and associated water quality consent have been agreed with the Environment Agency, there is considered to be no capacity at Tilbury WwTW to treat and discharge the wastewater generated by the proposed development within Thurrock.

[15] Dry Weather Flow (DWF) is a unit of measure, used by the Environment Agency in a consent to describe the maximum volume Anglian Water Services (AWS) can discharge from wastewater treatment works. This is calculated using a statistical method based on measured flows.
[16] Infiltration in this sense is defined as the amount of water that enters the drainage system from other sources such as ingress of groundwater through defective pipes or joints in either public sewers or private sewers and drains.
[17] Flow to Full Treatment (FtFT) is the minimum flow that must be treated at a WwTW before storm discharge is permitted.

Calculations

Page 1 of 3

Job Title	**Thurrock Outline Water Cycle Study**					Date	Project Number
Element	WwTW Volumetric Capacity Assessment					15/02/2010	D122361
Originator	Checked	Revision	Suffix	Orig			
SK			Date	Check			

Purpose of Calculation
To undertake an assessment of the volumetric capacity of Tilbury WwTW and calculate available headroom.

Method of Calculation
Spreadsheet

Source/Reference Documents Used
Tilbury WwTW population and current measured DWF (provided by Anglian Water Services)
Tilbury WwTW Consent (Issued by Environment Agency)
Development Levels and Phasing provided by Thurrock BC
OFWAT Security of Supply Rpt 2006-2007

Key Parameters Used
Dry Weather Flow (DWF)
Flow to Full Treatment (FtFT)
Current Population Served by WWTW (P)
Current Trade Flow Treated at WWTW (E)
Per Capita Water Demand (G)
Infiltration (I)
Property Occupancy Ratio (OR)

Calculated DWF = PG+I+E

where: PG=Pd*Gd+Ph*Gh
I=25%PG
E=trade flows m3/d

where: Pd=domestic poluation
Ph=holiday poluation
Gd=domestic per capita consumption (144 l/h/d)
Gh=holiday per capita consumption (55 l/h/d)
Gc=commercial per capita consumption (28 l/h/d)

Calculated FtFT = 3PG+I+3E

The crrent Occupancy Rate (OR) is 2.4 and future OR os 2.16
The commercial employment per capita consumption (Gc) is 28 l/h/d
The future domestic per capita consumption (Gf) is 137 l/h/d

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Calculations

Job Title	Thurrock Outline Water Cycle Study					Date	Project Number
Element	**Tilbury WwTW Volumetric Capacity Assessment**					15/02/2010	D122361
Originator	Checked	Revision	Suffix	Orig			
SK			Date	Check			

Site Name: Tilbury STW
Site Location: TQ 6565 7531
Receiving Watercourse: Thames Estuary

Base Data - Provided by AWS from June 2008 Return			
Total PE		159,095	PE
Domestic PE	Pd	120,084	PE
Holiday PE	Ph	0	PE
Trade Flow	E	39,011	PE
Dry Weather Flow Consent	DWF	32,000	m3/d
Flow to Full Treatment Consent	FtFT	-	m3/d
Measured Dry Weather Flow	mDWF	30,893	m3/d

Parameters			
Consumption			
Gd	Domestic	0.156	m3/d
Gh	Holiday	0.055	m3/d
Gc	Commercial	0.028	m3/d
Gi	Industry	0.028	m3/d
Gf	Future Domestic	0.125	m3/d
Dwelling Occupancy			
OR	Occupancy Rate	2.16	people

Current Calculated Flow			
Population Consumption	PG = (Pd*Gd)+(Ph+Gh)	18,733	m3/d
Infitration	I = 0.25*PG	4,683	m3/d
Trade Flow	E	1,092	m3/d
Calculated DWF	PG+I+E	24,509	m3/d
Calculated FtFT	3PG*I*3E	64,160	m3/d

Current Headroom Calculations				
DWF Capacity	DWF - mDWF	7,491	m3/d	*Based on calculated DWF*
FtFT Capacity	FTFT - Calculated FtFT	-	m3/d	
Population Capacity		47,942	PE	
Dwelling Capacity	Population Capacity/OR	22,196	dwellings	

Future Housing Allocations			
Number of Dwellings	Hf	17,624	dwellings
Additional Population	Phf = Hf*OR	38,068	PE
Additional Flow from Housing	PGhf = Phf*Gf	4,758	m3/d
Additional Infiltration from Housing	Ihf = 0.25*PGHf	1,190	m3/d

Future Employment			
Number of Commercial Jobs	Ecf	26,000	Jobs
Number of Industrial Jobs	Eif	0	Jobs
Additional Flow from Employment	Eef = (Ecf*Gc)+(Eif*Gi)	728	m3/d

Future Calculated Flow			
Additional DWF from Future Dev	aDWF = PGhf + Ihf +Eef	6,676	m3/d
Future Calculated DWF	fDWF = mDWF + aDWF	31,185	m3/d
Future Calculated FtFT	fFTfT=cFtFT+3PGhf*Ihf*3	81,809	m3/d

Future Headroom Calculations			
DWF Capacity	DWF - Calculated DWF	815	m3/d
FtFT Capacity	FTFT - Calculated FtFT	-	m3/d
Population Capacity		5,216	PE
Dwelling Capacity	Population Capacity/OR	2,415	dwellings

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Calculations

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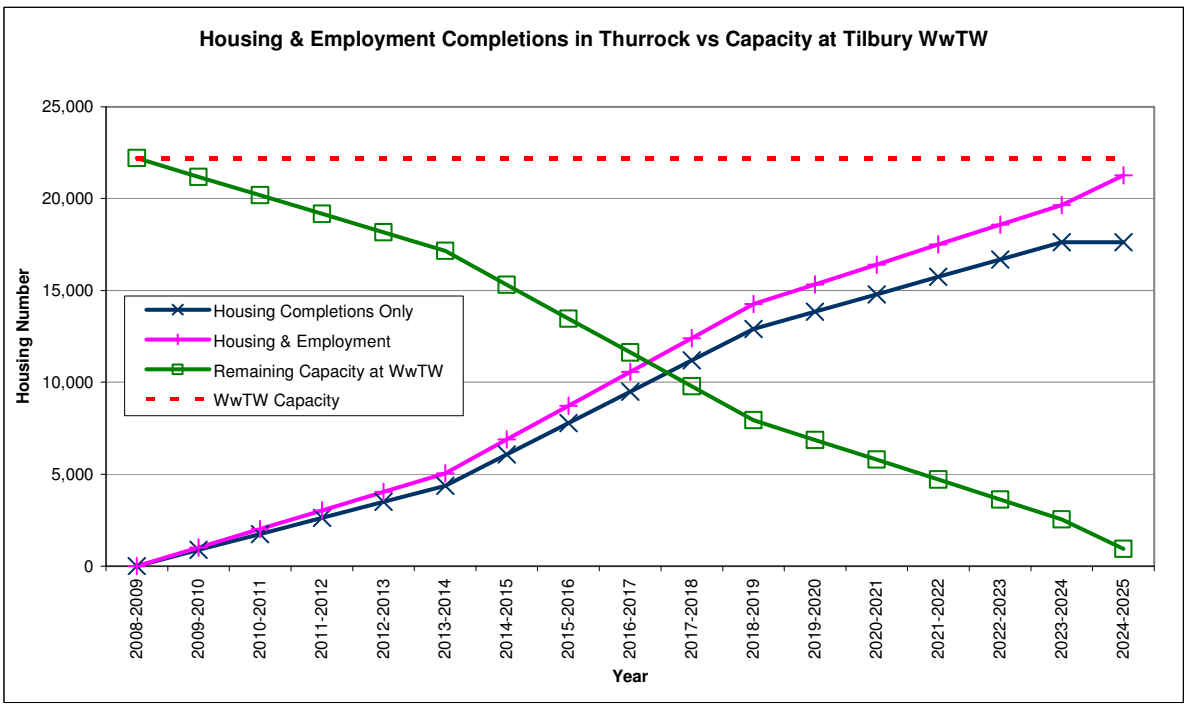
Job Title	Thurrock Outline Water Cycle Study					Date	Project Number
Element	**Tilbury WwTW Volumetric Capacity Assessment**					15/02/2010	D122361
Originator	Checked	Revision	Suffix	Orig			
SK			Date	Check			

The calculations below relate only to housing growth and exclude any employment growth in the period 2008 - 2025

Proposed Phasing of Future Housing Allocations in Thurrock

Year	Housing	Employment	Housing Total	Employment Total	Capacity
2008-2009	0	0	0	0	22,196
2009-2010	874	1,630	874	1,630	21,188
2010-2011	874	1,630	1,748	3,260	20,178
2011-2012	874	1,630	2,622	4,890	19,167
2012-2013	874	1,630	3,496	6,520	18,160
2013-2014	874	1,630	4,370	8,150	17,150
2014-2015	1,706	1,630	6,076	9,780	15,310
2015-2016	1,706	1,630	7,782	11,410	13,467
2016-2017	1,706	1,630	9,488	13,040	11,627
2017-2018	1,706	1,630	11,194	14,670	9,787
2018-2019	1,706	1,630	12,900	16,300	7,944
2019-2020	944	1,630	13,844	17,930	6,865
2020-2021	945	1,630	14,789	19,560	5,784
2021-2022	945	1,630	15,734	21,190	4,705
2022-2023	945	1,630	16,679	22,820	3,624
2023-2024	945	1,630	17,624	24,450	2,545
2024-2025	0	1,550	17,624	26,000	933
Total Delivery	**17,624**	**26,000**			



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Wastewater Network Capacity

A wastewater network capacity assessment has been undertaken to determine, at a high level, the current and future capacity within the existing wastewater network. High level calculations for critical sections of the existing trunk sewer have been undertaken to highlight any potential issues within the existing network to accommodate the proposed growth within Thurrock. Key sections of the network have been identified where there are large volumes of growth planned for the BAR and/or where there are known existing network problems. The following areas have been assessed:

In undertaking the assessment of the capacity of critical sections of the gravity sewers, the following parameters were used:

- The size of the sewer has been obtained from GIS sewer records provided by AWS;
- The gradient of the sewer has been assumed to be 1 in 400;
- A pipe roughness (ks) value of 3mm has been used;
- Maximum allowable proportional depth of sewer has been taken as 0.75; and
- Where the sewer drains a catchment that has existing industrial/commercial developments, i.e. Purfleet, West Thurrock, Grays and Tilbury 15% of the sewer capacity has been set aside for trade effluent. This percentage has been derived from the volume of flow currently being treated at the works from trade (5%) and the trade effluent PE compared to the total PE being treated at the works (25%).

In undertaking the assessment of the capacity of the critical sections of sewer rising mains, the following parameters were used:

- The size of the sewer has been obtained from GIS sewer records provided by AWS;
- A maximum flow velocity of 1.8m/s has been assumed. (This is in line with recommendations of Sewers For Adoption (Reference 32)); and
- Existing industrial/commercial development draining to Tilbury WwTW same as for gravity sewers.

Knowing the capacity of the sewer that is available to domestic flow, the theoretical maximum population that can drain to the sewer has been assessed using the formula:

$DWF_{peak} = P_f(PG) + I$ *where:*

- Peak Factor (Pf) was taken as 6
- G was taken as 140l/c/d (i.e. 90% of a per capita water demand of 156litres being returned to sewer.)
- Infiltration (I) was taken as 25% of PG

The theoretical maximum population was converted to properties by assuming a property occupancy ratio of 2.4 people per property. This is based on current occupancy rates within Thurrock.

To obtain an indicative property headroom of the sewer, the number of existing properties that are already draining to that section of sewer was deducted from the theoretical maximum no of properties that can be served by the sewer (Table E.2). It should be noted that there are significant potions of the study area that have combined sewers. As a result of the complexity of the sewer network and the absence of a network model, the effect of surface water drainage has not been taken into account. This together with the inevitable gross uncertainty in the accuracy of the parameters listed above means that the results of this assessment are only indicative and are not intended to provide an accurate assessment of the existing and future wastewater network capacity.

Table E.2 Wastewater Network Assessment

	Broad Area for Regeneration	Upstream BAR	Downstream BAR	Type	Size (mm)	Approx. Sewer Capacity (l/s)	Assessed	Current Properties Served (est.)	Additional Properties (2009 - 2025)	Approx. Current Sewer Capacity (l/s)	Approx. Future Sewer Capacity (l/s)
1	Purfleet	Aveley	West Thurrock	Gravity	600	215	✓	5,904	3,443	71	11
2	Aveley	None	Purfleet	Gravity	300	34	✓	3,735	219	4	2
				Gravity	300	34	✓			4	2
				Gravity	375	62	✓			32	30
3	South Ockendon	None	Grays	Pumped	600	433	✓	7,777	1,606	243	215
4	West Thurrock & Lakeside	Purfleet	Grays	Pumped	500	300	✓	10,688	6,378	40	-72
5	Grays	West Thurrock & South Ockendon & Orsett	Tilbury	Gravity	1050	943	✓	5,646	2,310	805	764
			Tilbury WwTW	Pumped	600	433	✓	16,334	8,688	34	-118
			Tilbury	Gravity	1500	2,412	✓	14,035	3,921	2,070	2,001
6	Tilbury	Chadwell St Mary and Grays	Tilbury WwTW	Gravity	900	628	✓	13,033	2,776	310	257
			Tilbury WwTW	Gravity	1600	2,859	✓	9,039	2,376	2,638	2,592
		North Grays	Tilbury WwTW	Gravity	700	323	✓	3,833	1,363	230	206
		North Grays	Tilbury WwTW	Gravity	700	323	✓	3,833	1,363	230	206
7	Chadwell St Mary	None	Tilbury	Gravity	300	73	✓	3,994	400	24	21
				Gravity	300	73	✓			24	21
8	East Tilbury	Stanford-le-Hope	Tilbury WwTW	Pumped	600	433	✓	12,458	1,049	129	111
			Tilbury WwTW	Pumped	350	147	✓	1,286	122	116	114
9	Villages (Bulphan)	None	Horndon	Gravity	225		×	613	5		
			Horndon	Pumped	225		×				
	Villages (Horndon)	Bulphan	Standford-le-Hope	Gravity	300		×	613	5		
	Villages (Southfields)	None	Tilbury WwTW	Gravity	225		×	613	5		
			Tilbury WwTW	Pumped	125		×				
	Villages (Orsett)	None	Grays	Gravity	300		×	613	5		
			Grays	Pumped	250		×				

	Broad Area for Regeneration	Upstream BAR	Downstream BAR	Type	Size (mm)	Approx. Sewer Capacity (l/s)	Assessed	Current Properties Served (est.)	Additional Properties (2009 - 2025)	Approx. Current Sewer Capacity (l/s)	Approx. Future Sewer Capacity (l/s)
10a	Standford-le-Hope & Corringham	Horndon on the Hill	East Tilbury	Pumped	600	433	✓	11,172	927	160	144
10b	London Gateway	None					×	2,317	0		

Sewer has capacity	Sewer is close to capacity or exceeds capacity but other strategic sewers serving area	Capacity of sewer is exceeded and is only strategic sewer serving area

Appendix F - Water Quality Classification

Environment Agency's River Ecosystem Classification and General Quality Assessment

Historically the Environment Agency have used River Quality Objectives (RQOs), planned targets for water quality, to help protect and improve the quality of the water in watercourses. The principal non-statutory RQO system is the River Ecosystem (RE) Classification scheme which comprises five hierarchical classes in order of decreasing quality, ranging from 'very good quality' to 'poor quality' (Table F.1). Each stretch of river is given a RE target such that if the river achieves this target it means that the river will be of adequate quality to support the required ecosystem.

Table F.1 Environment Agency River Ecosystem Classification Summary

Class	Quality	Description/Use
RE1	Very good quality	Suitable for all fish species
RE2	Good quality	Suitable for all fish species
RE3	Fairly good quality	Suitable for high-class coarse fisheries
RE4	Fair quality	Suitable for course fisheries
RE5	Poor quality	Likely to limit fish populations

Whereas the Environment Agency use RQOs for planning purposes (i.e. for setting water quality targets and assessing compliance with those targets), the General Quality Assessment (GQA) scheme is designed to provide an assessment of the general state of water quality and changes in this state over time. The GQA scheme comprises several separate aspects of water quality falling under chemical (inc. nutrients) and biological monitoring and assessment (Table F.2). A monitoring programme at a set number of sites has been undertaken on a monthly basis to assess the quality of individual stretches of river.

Table F.2 General Quality Assessment (GQA) Classes for Chemistry and Biology

Chemistry Assessment			Biology Assessment		
Grade	Quality	Likely Uses and Characteristics[18]	Grade	Quality	Description
A	Very Good	• All abstractions • Very good salmonid fisheries • Salmonid fisheries • Cyprinid fisheries • Natural ecosystems	A	Very Good	• Biology similar to that expected for an unpolluted river
B	Good	• All abstractions • Cyprinid fisheries • Ecosystems at or close to natural	B	Good	• Biology is a little short of an unpolluted river
C	Fairly Good	• Potable supply after advanced treatment • Other abstractions • Good cyprinid fisheries • Natural ecosystems, or those corresponding to good cyprinid • Fisheries	C	Fairly Good	• Biology worse than expected for unpolluted river
D	Fair	• Potable supply after advanced treatment • Other abstractions • Fair cyprinid fisheries • Impacted ecosystems	D	Fair	• A range of pollution tolerant species present

[18] Provided other standards are met

Chemistry Assessment			Biology Assessment		
Grade	Quality	Likely Uses and Characteristics[18]	Grade	Quality	Description
E	Poor	• Low grade abstraction for industry • Fish absent or sporadically present, vulnerable to pollution[19] • Impoverished ecosystems	E	Poor	• Biology restricted to pollution tolerant species
F	Bad	• Very polluted rivers which may cause nuisance • Severely restricted ecosystems	F	Bad	• Biology limited to a small number of species very tolerant of pollution

As well as the chemical and biological quality, river systems are also sampled to determine the concentration of nutrients in given reaches. Excessive nutrients (especially phosphorus) can allow eutrophication if other factors are not limiting. This allows nuisance species such as algae to proliferate at an undesirable level and at the expense of other aquatic life which rely on the system (fish and aquatic plants); the overall effect is to reduce biodiversity. The two most important nutrients in terms of eutrophication are nitrogen (N) and phosphorus (P); these are each assessed using a separate GQA grade (Table F.3).

Table F.3 General Quality Assessment (GQA) Classes for Nutrients

Nitrate Grades	Grade limit (mg NO3/l) (Mean)	Description	Phosphate Grades	Grade limit (mg P/l) (Mean)	Description
1	5	Very Low	1	0.02	Very Low
2	10	Low	2	0.06	Low
3	20	Moderately Low	3	0.1	Moderate
4	30	Moderate	4	0.2	High
5	40	High	5	1.0	Very High
6	>40	Very High	6	>1.0	Excessively High

Nutrient concentrations in rivers exhibit considerable spatial and seasonal variability, and in common with other GQA sampling, monthly 'grab' samples will not reflect the true temporal variation. Storm events, for example, can mobilise nutrients from several sources and transient, but potentially very important, large concentrations of substances such as N and P will not be captured by monthly sampling regimes. There are also seasonal effects, such as a natural 'flush' of nitrate from soil during early autumn as the soil reaches field capacity and field drains begin to flow.

A grade from 1 to 6 is derived for both phosphate and nitrate based on the average concentration over the previous three years. There are no set 'good' or 'bad' concentrations for nutrients in rivers in the way that is used to describe chemical and biological quality. Rivers in different parts of the country have naturally different concentrations of nutrients. 'Very low' nutrient concentrations, for example, are not necessarily good or bad; the classifications merely state that concentrations in this river are very low relative to other rivers.

Of all forms of P, it is desirable to determine the concentrations of Soluble Reactive Phosphorus (SRP) as this form of P is most immediately available to aquatic macrophytes and algae. Phosphorus is usually the limiting nutrient in inland freshwaters and gives an indication of the likelihood of eutrophication within a water environment.

[19] Where the grade is caused by discharges of organic pollution

Freshwater Fish Directive

As well as the RE Classification scheme and GQA, waters are also designated and assessed against the Freshwater Fish Directive. The EC Freshwater Fish Directive (78/659/EEC) was adopted in 1978 and updated in 2006 (2006/44/EC), and seeks to protect those fresh water bodies identified by Member States as waters suitable for sustaining fish populations[20]. For those waters it sets physical and chemical water quality objectives for salmonid and cyprinid waters:

- **Salmonid fish** (salmon and trout) - these are generally fast flowing stretches of river that have a high oxygen content and a low level of nutrients; and
- **Cyprinid fish** (coarse fish - carp, tench, barbel, rudd, roach) - these are slower flowing waters, that often flow through lowlands.

The Directive sets different standards for salmonid and cyprinid waters (Table F.4). There are two types of standards within each water category:

- Imperative values - these are standards that must be met if the stretch is to pass the Directive (for the stretch to be 'compliant'). Values have been set for dissolved oxygen, pH, non-ionised ammonia, total ammonium, total residual chlorine, zinc and (for thermal discharges) temperature; and
- Guideline values - these are quality standards that should be achieved where possible. Values have been set here for other chemical parameters, such as copper, biochemical oxygen demand and suspended solids.

In 2013, this directive will be repealed and waters currently designated as Fish Directive waters will become protected areas under the Water Framework Directive.

Table F.4: Freshwater Fish Directive Imperative and Guideline Standards

Parameter	Units	Salmonid Standard	Cyprinid Standard	Notes
Imperative Standards				
Temperature	℃	1.5	3.0	Increase due to thermal discharge
	℃	21.5	28.0	Maximum at monitoring site
	℃	10	10.0	Maximum for breeding season
Dissolved Oxygen	mg/l	>9	>7	50% of samples must meet this standard. Absolute minimum.
pH	-	6 – 9	6 - 9	Derogation allowed in naturally acidic areas.
Non-ionised ammonia	mg/l	0.025	0.025	Calculated from temperature, total ammonia and pH
Total ammonium	mg/l	1	1	Relaxed standard of 3 mg/l can be applied where there is good evidence of healthy fish populations.
Total residual chlorine	mg/l	0.005	0.005	
Total zinc (standard is dependent on the average yearly hardness)	mg/l	0.03	0.3	Hardness <= 10 mg $CaCO_3$ / litre
	mg/l	0.2	0.7	Hardness <= 50 & > 10 mg $CaCO_3$ / litre
	mg/l	0.3	1.0	Hardness <= 100 & > 50 mg $CaCO_3$ / litre
	mg/l	0.5	2.0	Hardness > 100 mg $CaCO_3$/ litre

[20] See http://www.defra.gov.uk/environment/water/quality/fwfish/

Guideline Standards				
Dissolved oxygen	mg/l	>9	>8	50% of samples must meet this standard.
	mg/l	>7	>5	100% of samples must meet this standard.
Suspended solids	mg/l	25	25	
BOD	mg/l	3	6	
Nitrites	mg/l	0.01	0.03	
Non-ionised ammonia	mg/l	0.005	0.005	
Total ammonium	mg/l	0.04	0.2	
Dissolved copper (standard is dependent on the average yearly hardness)	mg/l	0.005	0.005	Hardness <= 10 mg $CaCO_3$ / litre
	mg/l	0.022	0.022	Hardness <= 50 & > 10 mg $CaCO_3$ / litre
	mg/l	0.04	0.04	Hardness <= 100 & > 50 mg $CaCO_3$ / litre
	mg/l	0.112	0.112	Hardness > 100 mg $CaCO_3$ /litre

Water Framework Directive

Introduction

Over the next two to three years, the existing statutory targets and legislation relating to water quality will be replaced with a new set of water quality standards under the umbrella of the Water Framework Directive (WFD) which was passed into UK law in 2003. The competent authority responsible for its implementation is the Environment Agency in England and Wales. The overall requirement of the directive is that all water bodies in the UK must achieve *"good ecological and good chemical status"* by 2015 unless there are grounds for derogation.

The WFD will for the first time combine water quantity and water quality issues together. The directive combines previous water legislation and in certain areas strengthens existing legislation. An integrated approach to the management of all freshwater bodies, groundwaters, estuaries and coastal waters at the river basin level will be adopted. Involvement of stakeholders is seen as key to the success in achieving the tight timescales and objectives set by the directive. The WFD states that all countries in the European Union have to:

- prevent deterioration in the classification status of aquatic ecosystems, protect them and improve the ecological condition of waters;
- aim to achieve at least good status for all waters. Where this is not possible, good status should be achieved by 2021 or 2027;
- promote sustainable use of water as a natural resource;
- conserve habitats and species that depend directly on water;
- progressively reduce or phase out releases of individual pollutants or groups of pollutants that present a significant threat to the aquatic environment;
- progressively reduce the pollution of groundwater and prevent or limit the entry of pollutants; and
- contribute to mitigating the effects of floods and droughts.

The water environment within England and Wales has been divided into units called 'water bodies' and designated as rivers, lakes, estuaries, the coast or groundwater. Some water bodies have been designated as artificial or heavily modified if they are substantially modified or created for water supply, urban purposes, flood protection and navigation. This designation is important because it recognises their uses, whilst making sure that ecology is protected as far as possible. All water bodies will be designated a status. For surface waters, the status has an ecological and a chemical component; Ecological status is measured on the scale high, good, moderate, poor and bad; and good chemical status as pass or fail. For groundwater, good status has a quantitative and a chemical component, which together provide a single final classification: good or poor status. Good ecological status is defined as a slight variation from undisturbed natural conditions, but artificial and heavily modified waters are not able to achieve natural conditions. Instead the target for these waters is good ecological potential. This is also measured on the scale high, good, moderate, poor and bad. The chemical status of these water bodies is measured in the same way as natural water bodies.

WFD Standards

Standards are being developed by the UK Technical Advisory Group (UKTAG) with which to measure status covering a range of criteria including water quality, biological quality, and morphology (Reference 25). The environmental standards assess whether environmental conditions are good enough to support appropriate aquatic life for the system. The status of each surface water body is judged using separate 'Ecological classification' and 'Chemical classification' systems. The overall status of the water body will be determined by whichever of these is the poorer. To achieve 'good status' overall, a water body must achieve both good ecological and good chemical status.

One of the key objectives of the WFD is to 'prevent deterioration of the status of all water bodies of surface water'. This states that there should be a prevention of deterioration between status classes, which applies to each water body. The status class reported for a surface water body will be dictated by the quality element worst affected by human activity. However, a 'less stringent objective' does not mean that (a) the other quality elements are permitted to deteriorate to the status dictated by the worst affected quality element or (b) the potential for improvement in the condition of other quality elements can be ignored.

The proposed WFD water quality standards for inland water bodies is provided in Table F.5.

Table F.5 WFD Standards for Lowland, High Alkalinity River Water Bodies

	Ammonia (mg/l) 90%ile	BOD (mg/l) 90%ile	DO (% saturation) 10%ile	SRP[21] (mg/l) AA	pH
HIGH	0.3	4	70	0.05	>=6 to <=9 (9 and 95%ile)
GOOD	0.6	5	60	0.12	
MODERATE	1.1	6.5	54	0.25	4.7 (10%ile)
POOR	2.5	9	45	1.0	4.2 (10%ile)

The water quality standards for transitional or tidal/estuarial waters are less well defined, in part due to the difficulty in assigning water quality standards to these watercourses. Currently only standards for Dissolved Oxygen (DO) (Table F.6) and Dissolved Inorganic Nitrogen (Table F.7) have been derived. The DO standards take no account of the reducing solubility of oxygen as salinity increase; if standards need to be set for particular areas of transitional waters then they are derived from Graph F.1.

[21] SRP = Total Reactive Phosphorous

Table F.6 WFD Standards for Dissolved Oxygen for Transitional Waters

	Freshwater	Marine
	5-percentile (mg/l)	
HIGH	7	5.7
GOOD	5 - 7	4.0 - 5.7
MODERATE	3 - 5	2.4 – 4.0
POOR	2 - 3	1.6 - 2.4
BAD	2	1.6

Graph F.1 WFD Standards for Dissolved Oxygen for Transitional Waters

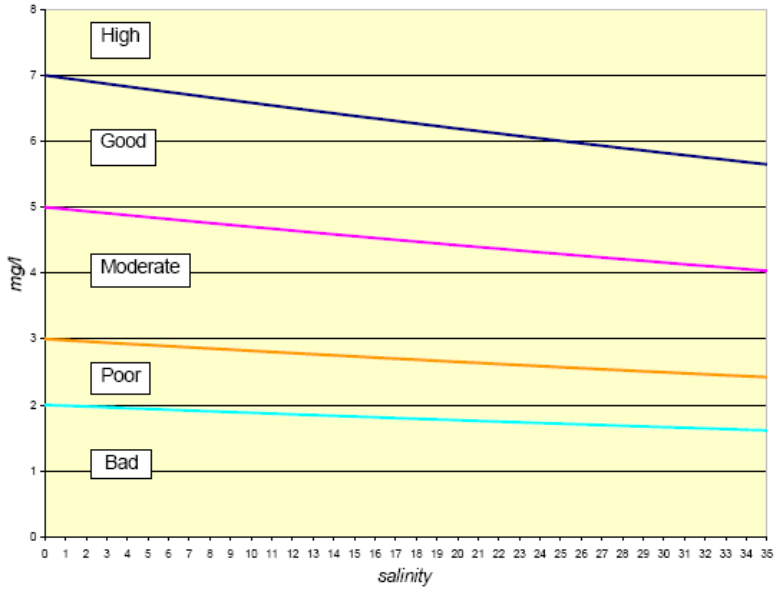

Table F.7 WFD Standards for Dissolved Inorganic Nitrogen for Transitional Waters

Area	Salinity	Dissolved Inorganic Nitrogen (micromoles per litre)	
		Winter Mean	Winter Mean
		High-Good	Good - Moderate
Transitional (type clear at salinity 25)	<30	20	30

If a transitional water fails the Good Boundary, the turbidity and type should be assessed

Turbidity and type of transitional water (at salinity 25)		Winter Mean	99-percentile
		Good - Moderate	
Very turbid, TW1, TW3	<30	30	270
Medium turbidity, TW2, TW4		30	180
Intermediate/Clear, TW5, TW6		30	70

The WFD water quality standards are currently in draft form and will not be finalised until the RBMPs are published in December 2009. However, because the WFD requirements will largely supersede the current statutory and guideline environmental standards from 2010, it is important that the WCS considers the

requirements for meeting them such that the impact of growth on future compliance with legislative requirements is understood and can be managed at an early stage in the planning.

River Basin Management Plans

As stated, the aim is for all water bodies to reach 'good status' or higher by 2015. In order to do so, the Environment Agency have developed a series of River Basin Management Plans (RBMPs) for the major River Basins in England and Wales. The final RBMPs were signed off by the Secretary of State in December 2009, and set out detailed proposals for the next 6 years which include the Programme of Measures to bring about the changes necessary in order to bring the water bodies which are currently failing the required standards up to good status. The measures in the plans have been developed with the assistance of the River Basin Liaison Panels, and include Government and Environment Agency actions, as well as actions delivered by others. The River Liaison Panels include representatives from businesses, planning authorities, environmental organisations, agriculture, forestry, consumers, fishing bodies, ports, drainage boards and regional government, which will all have key roles to play in implementing the plan.

The River Basin Management Plans focus on achieving the protection, improvement and sustainable use of the water environment including surface freshwaters (lakes, streams and rivers), groundwater, ecosystems such as some wetlands that depend on groundwater, estuaries and coastal waters (out to one nautical mile). The plans set out the proposed measures to improve water quality to the required standard and achieve the set environmental objectives. The WFD allows the Environment Agency, where costs would be disproportionate or where it isn't technically feasible to achieve the objectives by 2015, to work on a longer timescale (to 2021 or 2027) or to set lesser objectives, provided certain conditions are met.

Appendix G – Background Information - Key Designated Sites

Local Sites Assessment

Special Protection Areas (SPA)

Thames Estuary and Marshes SPA

The Thames Estuary & Marshes is both a Ramsar site and a Special Protection Area (SPA) due to the nationally and internationally important numbers of wintering wildfowl and wading birds. The majority of this site is situated within Kent but one element, the Mucking Flats & Marshes SSSI, is situated within Thurrock.

Mucking Flats & Marshes is an internationally important feeding habitat for birds, particularly during the overwintering period. Mucking Flats & Marshes is by far the most important part of the SPA for feeding avocets and has supported a single flock in March 2003 of 1395 birds. This is the largest single count of avocet ever recorded in the UK and represents 1.9% of the international population. Mucking Flats & Marshes is also the most important location in the Thames Estuary for grey plover, black-tailed godwit and redshank.

There is anecdotal evidence for the movement of species between the Thames and habitats inland, emphasising the crucial importance of land outwith the SPA boundary to the functioning of the European site. Lapwing roost on the Thames foreshore during the day and then move inland to feed at night; species including Golden Plover, Ringed Plover and Dunlin have are known to use the inland rough grazing and cultivated areas in significant numbers. Common Snipe feed and roost in fields inside the sea wall, and also utilise the intertidal zone of the Thames. Migrating waders such as Green Sandpiper and Greenshank can be present in both habitats, but seem to favour the dykes and ditches inside the sea wall.

The site is designated as a SPA under Article 4.1 of the Birds Directive (79/409/EEC) due to the internationally important populations of Ringed Plover (*Charadrius hiaticula*), Avocet (*Recurvirostra avosetta*) and Hen Harrier (*Circus cyaneus*). The designated area as a whole also qualifies under Article 4.2 of the Directive (79/409/EEC) by regularly supporting at least 33,433 waterfowl.

The SPA qualifying species are referred to as interest features when they occur within the European marine site. For each interest feature, sub-features (habitats) have also been identified to highlight the ecologically important components of the SPA. In the case of Thames Estuary and Marshes SPA, key sub features are:

- Intertidal mudflats;
- Intertidal saltmarsh; and
- Intertidal shingle.

Abberton Reservoir

Abberton Reservoir is located close to the coast of Essex in eastern England. It is a large, shallow, freshwater storage reservoir built in a long, shallow valley and is the largest freshwater body in Essex. It is one of the most important reservoirs in Britain for wintering wildfowl, with a key role as a roost for wildfowl

and waders feeding in adjacent estuarine areas. The site is also important for winter feeding and autumn moulting of waterbirds. The margins of parts of the reservoir have well developed plant communities that provide important opportunities for feeding, nesting and shelter. Abberton Reservoir is important especially as an autumn arrival area for waterbirds that subsequently spend the winter elsewhere.

The reservoir is designated for supporting populations of European importance of the following migratory species:

- Golden Plover
- Cormorant
- Gadwall
- Shoveler
- Teal

The site also supports a bird assemblage of international importance by regularly supporting 39,155 waterfowl.

Sites of Special Scientific Interest (SSSI)

Holehaven Creek SSSI

Holehaven Creek is situated on the opposite side of Shell Haven from Mucking Flats and Marshes SSSI and effectively serves as the southeast boundary of Thurrock. Although it is not part of any European site, the tidal creek system acts as the principal drain for the surrounding grazing marshes, which are important supporting habitat for waterfowl for which the SPA was designated, and forms a confluence at Holehaven with the River Thames. The site is therefore linked geographically and functionally with the wider Thames Estuary and thus the Thames Estuary & Marshes SPA.

The intertidal mudflats and saltmarsh habitats of Holehaven Creek regularly support an assemblage of over 8,000 waterfowl during the winter, with black-tailed godwit, curlew Numenius arquata and dunlin Calidris alpina occasionally occurring in nationally important numbers. Furthermore, Holehaven Creek supports two of the three basic saltmarsh communities characteristic of south-east and east England. These are formerly grazed saltmarshes with saltmarsh-grass Puccinellia maritima and sea aster Aster tripolium often in extensive pioneer mid-marsh zones, and ungrazed or lightly grazed saltmarshes, typically with sea-purslane Atriplex portulacoides being dominant.

Inner Thames Marshes SSSI

The Inner Thames Marshes form the largest remaining expanse of wetland bordering the upper reaches of the Thames Estuary, and extends from the east to the western extent of the Borough of Thurrock. The site is of particular note for its diverse ornithological interest and especially for the variety of breeding birds with wintering teal populations reaching levels of international importance. The Marshes also support a wide range of wetland plants and insects.

The site comprises a major relic of low-lying grazing marsh with a variety of grassland communities dissected by a network of fresh to brackish water drains. The series of lagoon habitats are complemented by more restricted areas of naturally derived saltmarsh and intertidal mud along the Thames foreshore.

West Thurrock Lagoon & Marshes SSSI

West Thurrock Lagoon and Marshes is one of the most important sites for wintering waders and wildfowl on the Inner Thames Estuary. The combination of extensive intertidal mudflats together with a large and secure high tide roost, attracts waders in nationally important numbers, with significant populations of other bird species. The adjacent Stone Ness saltings constitute the largest area of saltmarsh in the inner Thames estuary, and are characteristically high marshes of low salinity. Stone Ness is one of the few sites where it occurs outside the sea wall, and is unusually large in extent.

Grays Chalk Pit SSSI

Grays Thurrock Chalk Pit is situated in the SW of Essex. Active mineral extraction ceased in the early 1920s and since that time natural colonisation of the pit bottom has created a range of woodland, scrub and calcareous grassland habitats that are important for the assemblage of invertebrate fauna they support. The site is also part of the Essex Wildlife Trust Nature Reserve. The assemblage of invertebrate fauna mean this site has the best concentration and diversity of calcareous invertebrate fauna in Essex.

Vange and Fobbing Marshes SSSI

Vange & Fobbing Marshes covers and area of 165 hectares and lies on the alluvial plain of the lower River Thames. The unimproved coastal grassland and associated dykes and creeks support a diversity of maritime grasses, herbs, invertebrates and birds. Many of these species are nationally uncommon or rare, and together form an outstanding assemblage of plants.

Downstream Sites

Special Areas of Conservation (SAC) & Special Protection Areas (SPA)

The Mid-Essex Estuaries

The Mid-Essex Estuaries (Benfleet and Southend Marshes SPA & Ramsar site, Dengie SPA & Ramsar site, Colne Estuary SPA & Ramsar site, Crouch & Roach Estuaries SPA & Ramsar site, Foulness SPA & Ramsar site, Blackwater Estuary SPA & Ramsar site and Essex Estuaries SAC) have many features in common:

- They all require very similar environmental conditions for maintenance of favourable conservation status;
- They are all likely to be subject to similar pressures from development within Thurrock; and,
- They form an interconnected complex of sites with internationally important bird populations and mobile marine organisms moving from estuary to estuary.

As such they are treated together within this assessment. Table G.1 provides a description and the qualifying features in The Mid-Essex Estuaries designated sites.

Table G.1: The Mid-Essex Estuaries Designated Sites

Site	Description
Benfleet & Southend Marshes SPA & Ramsar	An extensive series of salt marshes, mudflats, scrub and grassland which support a diverse flora and fauna. Nationally uncommon plants occur in all of the habitats and parts of the area are of outstanding importance for scarce invertebrates.
Blackwater Estuary SPA & Ramsar	The largest estuary in Essex and is one of the largest estuarine complexes in East Anglia.
Colne Estuary SPA & Ramsar	A branching estuary that has a narrow intertidal zone predominantly composed of flats of fine silt with mud-flat communities typical of southeastern English estuaries. The estuary is of importance for a range of wintering wildfowl and waders, and there is a wide variety of coastal habitats which include mud-flat, saltmarsh, grazing marsh, sand and shingle spits, disused gravel pits and reedbeds which provide feeding and roosting opportunities for the large numbers of waterbirds that use the site.
Crouch and Roach Estuaries SPA & Ramsar	Located on the coast of south Essex in the intertidal zone along the Rivers Crouch and Roach is 'squeezed' between the sea walls along both banks and the river channel. Unlike more extensive estuaries elsewhere in Essex, this leaves a relatively narrow strip of tidal mud which, nonetheless, is used by significant numbers of birds.
Dengie SPA & Ramsar	Located on the coast of Essex it is a large and remote area of tidal mud-flats and saltmarshes at the eastern end of the Dengie peninsula, between the adjacent Blackwater and Crouch Estuaries. The saltmarsh is the largest continuous example of its type in Essex.
Essex Estuaries SAC	The site comprises the non-avian interest features of the Blackwater, Colne, Crouch and Roach estuaries and is important as an extensive area of contiguous estuarine habitat. Essex Estuaries contains a very wide range of characteristic marine and estuarine sediment communities and some diverse and unusual marine communities in the lower reaches, including rich sponge communities on mixed, tide-swept substrates. Sublittoral areas have a very rich invertebrate fauna, including the reef-building worm Sabellaria spinulosa, the brittlestar Ophiothrix fragilis, crustaceans and ascidians. The site also has large areas of saltmarsh and other important coastal habitats.
Foulness SPA & Ramsar	Located on the coast of Essex, north of the mouth of the Thames estuary. The site is part of an open coast estuarine system comprising grazing marsh, saltmarsh, intertidal mud-flats, cockle-shell banks and sand-flats.

The North Kent Estuaries

There are four coastal/marine European sites (Medway Estuary & Marshes SPA, The Swale SPA, Thanet Coast & Sandwich Bay SPA and Thanet Coast SAC) which could potentially be affected by increased discharges of treated sewage effluent into the River Thames, since they are all hydraulically connected to the Thames Estuary. Table G.2 provides a description and the qualifying features in The North Kent designated sites.

Table G.2: The North Kent Designated Sites

Site	Description
Medway Estuary & Marshes SPA	The Medway Estuary feeds into and lies on the south side of the outer Thames Estuary. It forms a single tidal system with the Swale and joins the Thames Estuary between the Isle of Grain and Sheerness. It has a complex arrangement of tidal channels, which drain around large islands of saltmarsh and peninsulas of grazing marsh. The mud-flats are rich in invertebrates and also support beds of Enteromorpha and some Eelgrass Zostera spp. Small shell beaches occur, particularly in the outer part of the estuary. Grazing marshes are present inside the sea walls around the estuary. The complex and diverse mixes of coastal habitats support important numbers of waterbirds throughout the year. In summer, the estuary supports breeding waders and terns, whilst in winter it holds important numbers of geese, ducks, grebes and waders. The site is also of importance during spring and autumn migration periods, especially for waders.
The Swale SPA	The Swale is located on the south side of the outer part of the Thames Estuary. The Swale is an estuarine area that separates the Isle of Sheppey from the Kent mainland. To the west it adjoins the Medway Estuary. It is a complex of brackish and freshwater, floodplain grazing marsh with ditches, and intertidal saltmarshes and mud-flats. The intertidal flats are extensive, especially in the east of the site, and support a dense invertebrate fauna. These invertebrates, together with beds of algae and Eelgrass Zostera spp., are important food sources for waterbirds. Locally there are large Mussel Mytilus edulis beds formed on harder areas of substrate. The SPA contains the largest extent of grazing marsh in Kent (although much reduced from its former extent). There is much diversity both in the salinity of the dykes (which range from fresh to strongly brackish) and in the topography of the fields. The wide diversity of coastal habitats found on the Swale combine to support important numbers of waterbirds throughout the year. In summer, the site is of importance for Marsh Harrier Circus aeruginosus, breeding waders and Mediterranean Gull Larus melanocephalus. In spring and autumn migration periods, as well as during winter, the Swale supports very large numbers of geese, ducks and waders.
Thanet Coast & Sandwich Bay SPA Thanet Coast SAC	Thanet Coast is both a Special Area of Conservation and a Special Protection Area (the latter known as Thanet Coast and Sandwich Bay). It is located at the northeastern tip of Kent. It is a coastal site consisting of a long stretch of rocky shore, adjoining areas of estuary, sand dune, maritime grassland, saltmarsh and grazing marsh. The site holds important numbers of Turnstone Arenaria interpres, and is also used by large numbers of migratory birds as they make landfall in Britain in spring or depart for continental Europe in autumn.