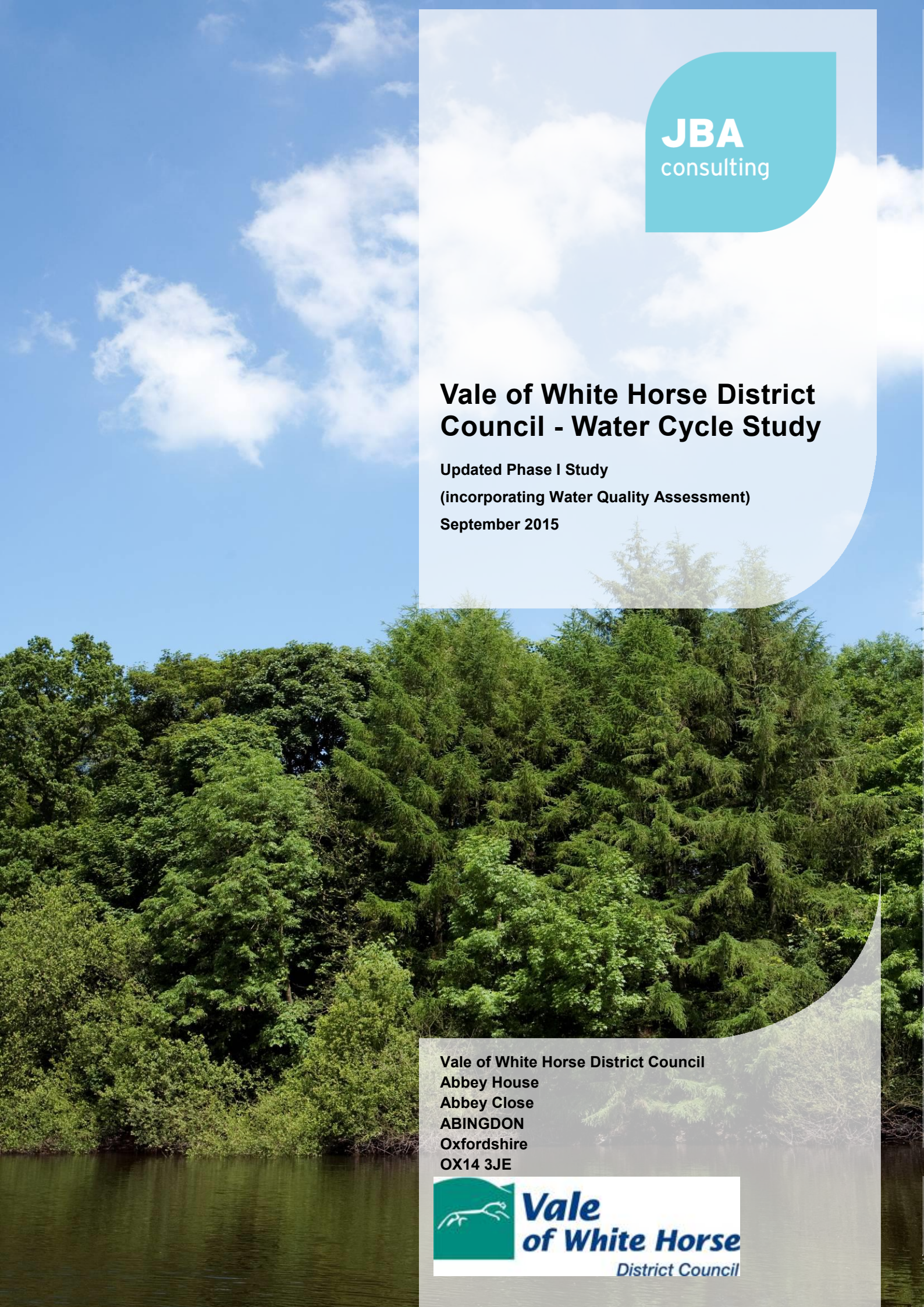


Vale of White Horse District Council - Water Cycle Study

Updated Phase I Study

(incorporating Water Quality Assessment)

September 2015



Vale of White Horse District Council
Abbey House
Abbey Close
ABINGDON
Oxfordshire
OX14 3JE



Vale
of White Horse
District Council

JBA Project Manager

Giovanni Sindoni
8a Castle Street
Wallingford
Oxfordshire
OX10 8DL

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Contract

This report describes work commissioned by Vale of White Horse District Council, by an email dated 30/09/2013. Vale's representatives for the contract were Katherine Pearce and Clare Roberts. Giovanni Sindoni and Paul Eccleston of JBA Consulting carried out this work.

Prepared by Giovanni Sindoni MSc
Senior Analyst

Paul Eccleston BA CertWEM CEnv MCIWEM
C.WEM

Technical Director

Reviewed by Claire Gardner BSc MSc FRGS
Analyst

Alastair Dale BSc PGDip MIAHR

Technical Director

Purpose

This document has been prepared as an update of Phase I Study completed in November 2014 for Vale of White Horse District Council. JBA Consulting accepts no responsibility or liability for any use that is made of this document other than by the Client for the purposes for which it was originally commissioned and prepared.

JBA Consulting has no liability regarding the use of this report except to Vale of White Horse District Council.

Acknowledgements

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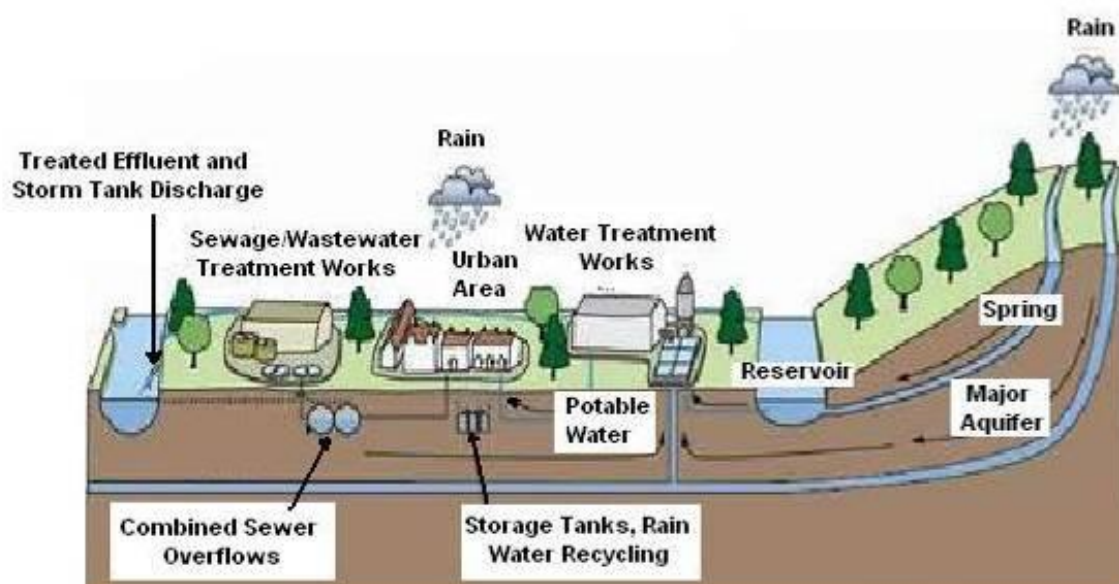
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Executive Summary

In October 2013, JBA Consulting was commissioned to undertake a Phase 1 Water Cycle Study (WCS) for the Vale of White Horse District Council (VoWHDC).

New homes require the provision of clean water, safe disposal of wastewater and protection from flooding. It is possible that allocating large numbers of new homes at some locations may result in the capacity of the existing available infrastructure being exceeded. This situation could potentially lead to service failures to water and wastewater customers, adverse impacts to the environment or high costs for the upgrade of water and wastewater assets being passed on to bill payers. Climate change presents further challenges such as increased intensive rainfall and a higher frequency of drought events that can be expected to put greater pressure on the existing infrastructure. Sustainable planning for water must take this into account. The water cycle can be seen in Figure 1 below, and shows how the natural and man-made processes and systems interact to collect, store or transport water in the environment.

Figure 1: Water cycle study



*Source: Environment Agency – Water Cycle Study Guidance

VoWHDC has identified 21 potential housing allocation sites. These sites and their associated demand for water supply and wastewater services were the key focus of the WCS. Other sites which were under consideration as contingency sites during the period that the WCS was developed were also assessed, but for clarity the main report focusses on the 21 allocations. Information about all sites assessed is included in Appendix A.

The water cycle study has been carried out in co-operation with the Environment Agency and Thames Water. Overall, there are no issues which indicate that the planned scale, location and timing of planned development within the District is unachievable from the perspective of supplying water and wastewater services and preventing deterioration of water quality in receiving waters.

The WCS has identified whether infrastructure upgrades are expected to be required to accommodate planned growth. Timely planning and provision of infrastructure upgrades will be undertaken through regular engagement between Vale of White Horse District Council, Thames Water, the EA and developers.

At project inception the Environment Agency set out a number of questions to be answered by the WCS. Responses to these questions are tabulated in Appendix D.

Development scenarios and policy issues

- The WCS study is based on an assessment of the impact of planned development with the Vale of White Horse District. As outlined in the study brief, growth was defined in three sub-areas as set out in the Local Plan.

- In addition to proposed site allocations, the locations and number of houses with planning permission (at Feb 2014) but which have not yet been constructed were also collated, totalling a net increase of 8624 dwellings, and considered.
- Legal agreements under the Town and Country Planning Act Section 106 agreement, and Community Infrastructure Levy agreements are not intended to be used to obtain funding for water or wastewater infrastructure. It is not, therefore necessary for Vale of White Horse District Council to identify requirements for developers to contribute towards the cost of upgrades in its Local Plan.
- The Water Industry Act sets out arrangements for connections to public sewers and water supply networks, and developers should ensure that they engage at an early stage with the relevant water supplier and sewerage undertaker to ensure that site-specific capacity checks can be undertaken and where necessary additional infrastructure constructed to accommodate the development. Where permitted the water company or sewerage undertaker may seek developer contributions towards infrastructure upgrades. Upgrades to water resources, water treatment works and wastewater treatment works are funded through the company business plans.

Water resources

- The WCS reviewed the Thames Water Final Water Resource Management Plan (2015-2040). Thames Water manage water resources in six Water Resource Zones (WRZs). Their Swindon and Oxfordshire (SWOX) zone covers the whole of Vale of White Horse District, along with Swindon, the majority of Cotswold District, north Wiltshire and the majority of Oxfordshire.
- The WRMP estimates that the SWOX zone had a supply-demand surplus of 26MI/d in 2011, but is forecast to decline and to become a deficit of -21MI/d by 2030 and -32MI/d by 2040. Thames Water intends to address this through promotion of water efficiency activity in the short-term (2015-2020), and further measures including installation of meters for household customers, innovative tariffs, water transfers and development of an additional strategic water resource in the medium to Long-term (2020-2040).
- The EA and Thames Water have taken account of the SHMA housing growth projections in their Water Resources Position Statement, titled 'Assessment of revised housing growth projections in Oxfordshire in the context of water resources'. This position statement is appended to the Thames Water and Environment Agency Statement of Common Ground. Both Thames Water and the EA concluded in their Position Statement that Thames Water will be able maintain the security of supply in its SWOX Water Resource Zone in the next 5 years to 2020 through the annual Water Resources review process and deploying any required mitigation measures identified in the Water Resources Position Statement. Beyond this period, the next review of the Water Resources Management Plan, due to be published in draft form in 2018, will assess and programme future water resource requirements reflecting the revised housing growth projections.

Water supply infrastructure

- Thames Water undertook a review of the capacity of their major water supply assets and their ability to meet increased demand due to planned growth within the District. They confirmed that they are able to supply the planned growth in the settlements in the Abingdon Flow Monitoring Zone (FMZ) (all Abingdon parishes, Kingston Bagpuize, Marcham, Shippon, Southmoor, Sunningwell, and Wooton) and Hagbourne Hill FMZ (Appleford, Drayton, Sutton Courtenay, Milton Heights and Valley Park) without infrastructure upgrades.
- In all other settlements supplied by Thames Water, further modelling by Thames Water will be required to determine the scale of the water supply infrastructure upgrades that may be needed. Whilst it is expected that infrastructure upgrades will be required to serve the planned growth within these settlements, there remains adequate time for this infrastructure to be delivered by Thames Water without restricting the timing, location or scale of planned development.

Wastewater collection

- Thames Water undertook a review of the capacity of their sewerage systems and their ability to meet increased demand due to planned growth within the District. They concluded that it is likely upgrades will be required to all sewage systems however further

modelling will be required to determine the scale of the wastewater infrastructure upgrades that may be needed in all settlements. Although upgrades are likely, it is considered capacity can be provided given sufficient time to implement upgrades as agreed by Thames Water.

- Sewerage Undertakers have a duty under Section 94 of the Water Industry Act 1991 to provide sewerage and treat wastewater arising from new domestic development. A significant proportion of future growth within the District already has planning permission, therefore the sewerage undertakers are already aware of the forthcoming growth. Where strategic upgrades are required to serve very large or multiple developments, infrastructure upgrades are usually only implemented following an application for a connection, adoption or requisition from a developer. Early developer engagement with water companies is therefore essential to ensure that sewerage capacity can be provided without delaying development.

Wastewater treatment works and quality consent assessments

- Thames Water provided an assessment of the available headroom in the flow and quality consents at their existing wastewater treatment works to accommodate additional wastewater flows. In addition, JBA Consulting undertook water quality impact modelling to assess the impact of Additional treated effluent on the receiving watercourses.
- Wastewater treatment works (WwTWs) at Appleton, Faringdon and Wantage are assessed as working close to their existing flow and quality consents and might require some upgrade to accommodate the proposed growth. Didcot, Drayton, Kingston Bagpuize, Oxford and Shivenham WwTWs are assessed as working behind their existing flow and quality consents and will require some upgrades.

Wastewater treatment works odour assessment

- Where new development encroaches upon existing wastewater treatment works, odour from that works may become a cause for nuisance and complaints from residents. Managing odour at WwTWs can add considerable capital and operational costs, particularly when retro-fit to existing WwTWs. An odour screening assessment concluded the potential for two sites (Monks Farm Phase I & II in Wantage and South Drayton in Drayton) that may be at risk of experiencing odour due to their proximity to the existing WwTW. It is recommended that odour impact assessments be undertaken as part of the planning application process. None of the other preferred or reserve sites are likely to be impacted by odour from WwTWs.

Water quality impact assessment

- All WwTWs apart from Abingdon Lagoon are predicted to require some infrastructure upgrades to prevent a WFD deterioration on the receiving watercourses, however the required standard of treatment would be achievable using current Best Available Technology or through other schemes.
- The WQA indicates that it would not be possible to reach Good Ecological Status (GES) for the watercourse receiving discharges from Abingdon WwTW's New Stream discharge in relation to the chemical element ammonia. The constraints are an existing problem and the solutions are not technically possible now. Therefore the EA do not consider that the increased effluent discharge from the proposed growth will cause a failure to reach GES.
- The WQA results for discharges from Wantage WwTW in relation to ammonia are so borderline that it is reasonable to consider that the increased discharge will not prevent GES from being achieved.
- At Oxford WwTW, the EA is proposing through its River Basin Management Plan (RBMP) additional habitat restoration and to tighten Ammonia limits at the Oxford WwTW to 1 mg/l. This is considered technically feasible. In the event that the 1 mg/l limit is exceeded at Oxford WwTW due to growth, with infrastructure upgrades at the WwTW and additional habitat restoration in place, the waterbody's can be appropriately protected.
- It is not possible to reach Good Ecological Status (GES) for the watercourses receiving discharges from all WwTWs but Drayton in relation to the chemical element phosphate. The Environment Agency have confirmed that as part of the River Basin Management Plan (RBMP) they have recently undertaken assessments of what solutions would be required, in the present time, at STWs in order to get to GES in relation to Phosphate. Fundamentally this concludes that the planned allocated growth within the Local Plan has no, or very little, bearing on the ability of the waterbodies getting to GES in relation to Phosphate. It is pertinent to note that trials of what is technically feasible in relation to

Phosphate are being undertaken, the results of which will be available in March 2017. The results will be reviewed in line with water company investigations and the overarching objectives of the WFD.

- The Environment Agency consider the water quality assessment to provide conservative estimates and are satisfied that “there are no limiting factors for growth based on the levels of growth indicated within the Local Plan, subject to the relevant mitigation measures and infrastructure upgrades stated within the Water Quality Assessment being delivered.”
- Sewerage undertakers monitor flow and quality at their WwTWs and their internal planning processes monitor the growth trajectories at each WwTW to ensure that where required additional capacity can be put in place before existing permit limits are reached.

Flood Risk

- The percentage of each site at risk from fluvial or surface water flooding was calculated. This information may be used to supplement the information presented at the settlement scale in the Strategic Flood Risk Assessment.
- In catchments with a large planned growth in population which discharge effluent to a small watercourse, the increase in the discharged effluent might have a negative effect on the risk of flooding. This assessment has been carried out in order to quantify such effect. The impact of increased effluent flows are not predicted to have a significant impact upon flood risk in the receiving watercourses at any of the settlements with planned growth in the District.

Environmental constraints and opportunities

- A desk study exercise to identify environmental risks and opportunities associated with the draft allocation sites has been carried out using GIS analysis of a range of notable environmental designations and features. This should be used in conjunction with Sustainability Appraisals (SA) and/or Strategic Environmental Assessments (SEAs) when these are available.
- Each site was analysed to identify the presence of environmental features within the site area or within a specified distance of the site. These search buffer zones were chosen to reflect the type, nature and potential sensitivity of different environmental designations and features to the development of the sites for residential use. The potential adverse impacts associated with the development of the site were then considered in relation to these features, and potential environmental opportunities, such as habitat creation or recreational opportunities were also identified.
- The environmental assessment provides an overview of the wider environment within the District and the potential risks and opportunities associated with the development of the proposed sites.

Climate change

- A qualitative assessment has been undertaken to assess the potential impacts of Climate Change on the assessments made in this water cycle study. The assessment used a matrix which considers both the potential impact of climate change on the assessment in question, and also the degree to which climate change has been considered in the information used to make the assessments contained within the WCS.
- The capacity of the sewerage system and the water quality of receiving water bodies stand out as two elements of the assessment where the consequences of climate change are expected to be high, but no account has been made of climate impacts in the assessment. This is a matter to be addressed at detailed assessment stage.

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Abbreviations

ALS	Abstraction Licensing Strategy
AMP	Asset Management Plan
BOD	Biochemical Oxygen Demand
CAMS	Catchment Abstraction Management Strategies
CAPEX.....	Capital Expenditure
CSO	Combined Sewer Overflow
DWF.....	Dry Weather Flow
EA	Environment Agency
EP	Environmental Permit
FE	Final Effluent
FFT	Flow to Full Treatment
FMfSW	Flood Map for Surface Water
FMZ.....	Flow Monitoring Zone
FRA.....	Flood Risk Assessment
FZ.....	Flood Zone
HOF	Hands-Off Flow
LPAs	Local Planning Authorities
MLD	Megalitres per Day
NH ₄	Ammonium
OC.....	Occupancy Rate
OfWAT	Water Services Regulation Authority
OPEX.....	Operational Expenditure

PE	Population Equivalent
PCC	Per Capita Consumption
PPG	Planning Policy Guidance
PR	Price Review or Periodic Review
R/A/G	Red / Amber / Green assessment
RBMP.....	River Basin Management Plan
RQP	River Quality Planning tool
RSS.....	Regional Spatial Strategy
SA	Sustainability Appraisal
SDS.....	Strategic Direction Statement
SEA.....	Strategic Environmental Assessment
SFRA	Strategic Flood Risk Assessment
SS	Suspended Solids
TWUL	Thames Water Utilities Limited
SuDS.....	Sustainable Drainage System
VoWHDC	Vale of White Horse District Council
WaSCs.....	Water and Sewerage Companies
WCS.....	Water Cycle Study
WQA	Water Quality Assessment
WRMP.....	Water Resources Management Plan
WRZ.....	Water Resource Zone
WTW	Water Treatment Works
WwTW	Wastewater Treatment Works

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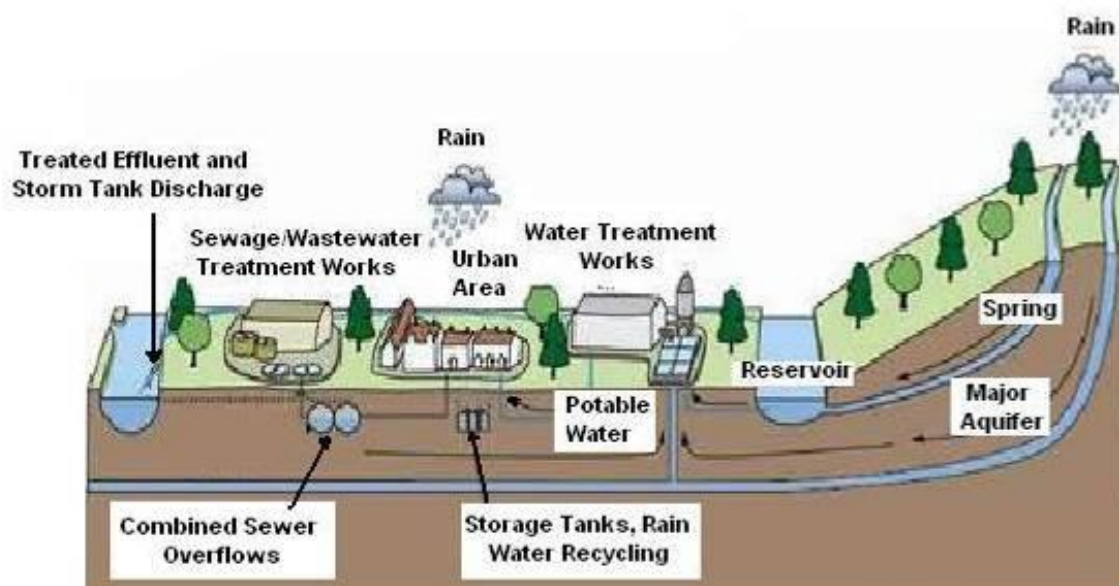
1 Introduction

1.1 Background

In September 2013 JBA Consulting was commissioned to undertake a Phase 1 Water Cycle Study (WCS) for the Vale of White Horse District Council (VoWHDC). New dwellings are planned to be built (or are already consented) throughout the VoWHDC with the main focus for around 70% of planned growth in the South East Vale sub area.

New homes require the provision of clean water, safe disposal of wastewater and protection from flooding. It is possible that allocating large numbers of new homes at some locations may result in the capacity of the existing available infrastructure being exceeded. This situation could potentially lead to service failures to water and wastewater customers, adverse impacts to the environment or high costs for the upgrade of water and wastewater assets being passed on to bill payers. Climate change presents further challenges such as increased intensive rainfall and a higher frequency of drought events that can be expected to put greater pressure on the existing infrastructure. Sustainable planning for water must take this into account. The management of the water environment is carried out on a partnership basis; planning for climate change adaptation and mitigation is acknowledged by all as a challenge over the life of the Plan. The water cycle can be seen in Figure 1-1 below, and shows how the natural and man-made processes and systems interact to collect, store or transport water in the environment.

Figure 1-1: Water cycle study



*Source: Environment Agency – Water Cycle Study Guidance

This study will assist local authorities to select and develop sustainable development allocations where there is minimal impact on the environment, water quality, water resources, infrastructure and flood risk. This has been achieved by identifying areas where there may be conflict between any proposed development and the requirements of the environment and by recommending potential solutions.

The Water Cycle Study should be treated as a living document that is periodically reviewed as further information becomes available. This will provide a better understanding of the impact of the developments on the water supply and wastewater infrastructure and water quality.

1.2 Objectives of the Water Cycle Study

The Vale has proposed strategic site allocations to meet the District's objectively assessed housing needs as identified in the Oxfordshire Strategic Housing Market Assessment 2014 (SHMA).

The Water Cycle Study is required in order to assess the constraints and requirements that will arise from the proposed growth on the water infrastructure.

The overall objective of the Water Cycle Study is to understand the environmental and physical demands of the development planned and identify opportunities for more sustainable planning and improvements that may be required so that proposals do not exceed the existing water cycle capacity. This is assessed by considering the following issues:

- Water Supply;
- Wastewater and Treatment;
- Water Quality and the Environment;
- Demand Management; and
- Flood Risk.

This report focuses upon the proposed site allocations provided by the Council. The report outlines the current status of the environment and infrastructure, identifies the possible constraints to the development, the impacts and demands of the development, and gives recommendations as to any improvements or mitigation required including approximate costings.

1.3 Water Cycle Study Scope

The scope of the phase I WCS was defined by the Environment Agency:

We recommend the following issues are scoped into the Phase 1 WCS:

Water Resources and Water Supply

Environmental capacity

- *Is there capacity in existing licenses for development?*
- *Will existing license remain valid?*
- *Can we reduce abstraction by better management practices?*

Infrastructure capacity

- *If new major infrastructure (reservoirs, water treatment works, boreholes) are needed, can they be provided in time, can they be funded, and are they sustainable?*

Wastewater Collection and Treatment

Environmental capacity

- *Is there volumetric capacity in existing effluent discharge consent for growth?*
- *Will discharge consent be valid to meet future standard (e.g. WFD)?*
- *Will additional discharge be allowed if there is no additional environmental capacity to assimilate it?*

Infrastructure capacity

- *If new major infrastructure (wastewater treatment works, major pumping mains or sewer mains) are needed, can they be provided in time, and can they be funded?*

Environmental Opportunities

- *Are we making the most of our new development?*
- *Are there multi-use options that will provide water resources, flood risk management and water quality benefits?*

Examples:

- *Green roofs and permeable road surfaces for new developments*
- *SuDS designed to provide green infrastructure and biodiversity benefits as well as surface water flood risk and water quality management*

The November 2014 Report detailed the outcomes of Phase 1. This Report provides an update to cover changes to the relevant policies and documents and the actions that have been taken by VoWH, TWUL and the EA since the November 2014 study was published.

1.4 Structure of this report

The structure of this Report is as follows:

Chapter 1: Introduction

This chapter provides the background, the objective and the scope of the project.

Chapter 2: Development Scenarios and Key Developments

This chapter illustrates the scale and locations of the planned developments that were assessed in this study.

Chapter 3: Legislative and Policy Framework

This chapter introduces the policy and legislative framework which drives the management of development and the water environment in England at local, national and European level.

Chapter 4: Water Resources and Water Supply

This chapter looks at the availability of water resources to cover the future demand. It also covers the impact of the planned development on the existing capacity of the water supply infrastructure and highlights where upgrades or new infrastructure might be needed.

Chapter 5: Waster Collection and Treatment

This chapter covers the impact of the planned development on the existing capacity of the sewerage system infrastructure and wastewater treatment works and highlights where upgrades or new infrastructure might be needed. It also looks at the potential impact of odour from the wastewater treatment works on new developments. Finally it covers the water quality impact assessment of discharges from future wastewater treatment works into the receiving watercourses.

Chapter 6: Flood Risk Management

This chapter considers the flood risk to the potential site allocations as well as the potential risk of increased flood flows in watercourses due to additional flows of sewage effluent.

Chapter 7: Environmental Constraints and Opportunities

This chapter looks at the environmental risks and opportunities associated with the allocation sites.

Chapter 8: Climate Change Impact Assessment

This chapter illustrates the qualitative assessment undertaken to assess the potential impacts of Climate Change on the assessments made in this water cycle study.

Chapter 9: Summary and Recommendations

This chapter outlines whether the required upgrades and solutions for all the assessments covered by this study can be delivered where a Red status is scored. This chapter also summaries all the recommendations provided in each chapter.

Where applicable the assessments in this report uses a simple Red / Amber / Green (R/A/G) assessment to identify the degree to which development in a site or settlement may be constrained. Each assessment uses a specific R/A/G definition that is defined in each chapter. An example is shown below from the wastewater treatment works capacity assessment:

Can accommodate the proposed site allocation without upgrades	Can accommodate the proposed site allocation without upgrades but will bring the works close to its current capacity limit	Further modelling will be required and subsequent upgrades may be needed to determine the scale of the upgrades that may be needed.
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Each chapter details the outcome of the assessment and includes relevant recommendations.

Chapter 9 outlines whether the required upgrades and solutions for all the assessments covered by this study can be delivered where a Red status is scored and summaries also the recommendations provided in each chapter.

1.5 Stakeholders and consultation

It is important that a Water Cycle Study brings together all partners and stakeholders knowledge, understanding and skills to help to understand the environmental and physical constraints to

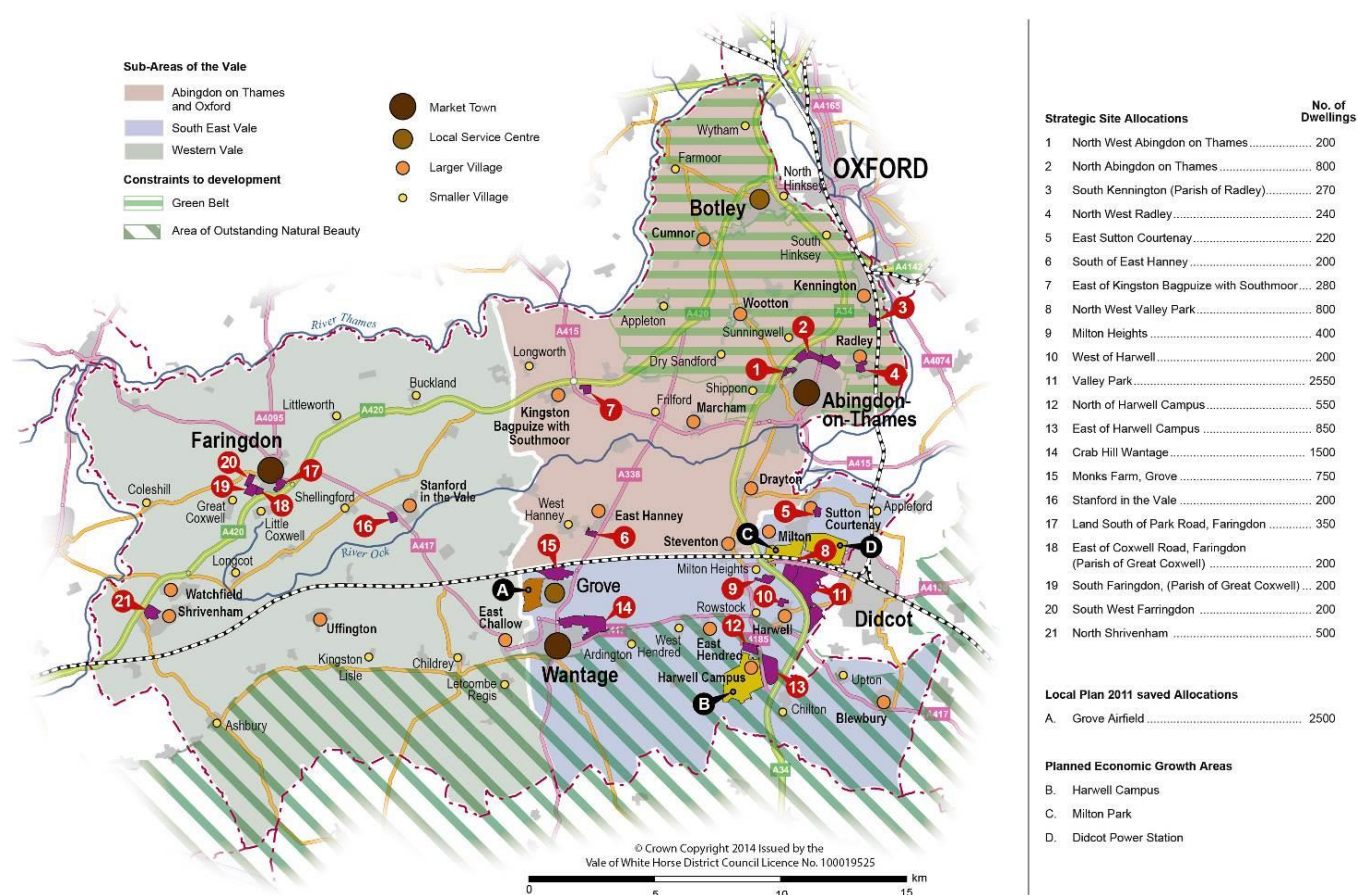
development. The following stakeholders were consulted during this Water Cycle Study and have provided data for use within the study:

- Thames Water Utilities Limited (TWUL)
- Environment Agency (EA)
- Vale of White Horse District Council

1.6 Study Area

The study area is Vale of White Horse District Council area within the county of Oxfordshire. The District covers a largely rural area, with the main towns being Abingdon, Wantage and Faringdon (see Figure 1-2).

Figure 1-2: VoWHDC study area and location of strategic site allocations.



2 Development Scenarios and Key Developments

2.1 Introduction

VoWHDC Local Plan Part 1 divides the district into three "sub-areas" with proposed housing allocations in or around a number of settlements. The Water Cycle Study was undertaken in parallel with the development of the housing allocations. There have been significant additions, removals and rescaling of allocations during development of the WCS. At the outset of the study, the numbers of dwelling listed in the VoWHDC WCS Brief were:

Abingdon on Thames and Oxford sub-area:

- 299 dwellings to allocate between Abingdon on Thames, Kingston Bagpuize with Southmoor, Marcham, Cumnor, Botley, Kennington, Drayton, Sutton Courtenay, Wootton and Radley

South East Vale sub-area:

- 1500 dwellings at Crab Hill, Wantage
- 750 dwellings at Monks Farm, Grove
- 2150 dwellings at Valley Park, Didcot
- 400 dwellings at Harwell Oxford Campus
- 419 dwellings to allocate between Wantage, Grove, west of Didcot, Harwell village, Harwell Oxford Campus, Blewbury, East Hendred, Milton, Steventon, East Hanney and East Challow

Western Vale sub-area:

- 350 South of Park Road, Faringdon
- 337 dwellings to allocate between Faringdon, Shrivenham, Watchfield, Uffington, and Stanford in the Vale.

In order to ensure that the WCS matched as closely as possible to the final proposed allocated sites, a number of iterations of the assessment were necessary. Table 2-1 shows the final list of allocated sites assessed and the number of houses planned for each site.

Table 2-1: Final list of draft allocation sites assessed

Site No.	Location of Site	Number of units proposed
1	North West Abingdon	200
2	North Abingdon	800
3	South Kennington	270
4	North West Radley	240
5	East Sutton Courtenay	220
6	Kingston Bagpuize East	280
7	Milton Heights	400
8	Valley Park	At least 2550
9	North West Valley Park	800
10	West of Harwell	200
11	East of Harwell Campus	850
12	North of Harwell Campus	550
13	East Hanney	200
14	Crab Hill Wantage	1500
15	Monks Farm, Grove	750
16	Land South of Park Road, Faringdon	350
17	Stanford in the Vale	200

Site No.	Location of Site	Number of units proposed
18	South Faringdon, (Parish of Great Coxwell)	200
19	SW Faringdon	200
20	North Shrivenham	500
21	East of Coxwell Road, Faringdon	200

In addition to proposed site allocations, the locations and number of houses with planning permission but which have not yet been constructed were also collated (see Table 2-2). These were required to inform the water supply and wastewater assessments process, as requested by the water companies, in order to have the total volume of additional water to supply and to treat for the full period 2013-31. These sites have not been included in the environment and flood risk assessments on the basis these issues were appropriately addressed when the respective planning permissions were granted.

Table 2-2: Sites with planning permission (as of 14/02/2014) included in the assessment process.

Site classification	Site name	Total houses 2013-31
The Old Gaol Leisure Centre	Under construction	41
Land to the South of Chilton Field	Under construction	199
Timbmet Ltd, Cumnor Hill	Under construction	157
Former Tree Nursery & Cricket Club & Jespers Hill, Park Rd	Under construction	58
Land adj 31 & 34 Simpsons Way	Under construction	1
33 West, St Helen	Planning permission granted	10
Champion House, 12 Wootton Rd	Planning permission granted	24
Challow Country Club, Woodhill Ln	Planning permission granted	14
Nalder Estate & The Old Canal Building, Main St	Planning permission granted	71
Land South of Alfreds Place	Planning permission granted	15
Land adj to Folly Park, Park Rd	Planning permission granted	28
Land adj Coxwell House & Winslow House, Coxwell Rd	Planning permission granted	35
Land at Stockham Farm, Denchworth Rd	Planning permission granted	200
98-100 West Way, Botley	Planning permission granted	10
East of Highworth Rd	Planning permission granted	36
Land between Station Rd & Townsend Rd	Planning permission granted	30
Land Opp Shrivenham Hundred Business Park	Planning permission granted	120
46 Newbury Street	Planning permission granted	23
Ambulance Station, Ormond Rd	Planning permission granted	11
Land West of Witney Road and South of A420	Planning permission granted	108
Land South of Faringdon Rd, Southmoor	Planning permission granted	50
Land adj NE & NW of Tilbury Ln, Botley	Planning permission granted	150
Land off Barnett Rd	Planning permission granted	50
Land at Didcot Road, Great Western Park	Planning permission granted	700

Site classification	Site name	Total houses 2013-31
Broadwater, Manor Rd	Planning permission granted	14
Cowan's Camp Depot, High St	Planning permission granted	100
Land off Lime Rd, Botley	Planning permission granted	136
Major Amey's Site	Planning permission granted	140
17 to 20 Millbrook Sq	Planning permission granted	11
Christ Church, Hobbyhorse Ln	Resolution to grant	15
Anson Field, Morland Rd, Hyde Copse, Howard Cornish Rd	Resolution to grant	51
South of Lamb Ave	Resolution to grant	18
Land east of Chainhill Rd	Resolution to grant	85
Land off Rectory Farm Cl	Resolution to grant	13
Land at Grove Air Field, Denchworth Rd	Application under consideration	2500
Milton Road, Sutton Courtenay	Resolution to grant	70
Land at Causeway Farm, The Causeway	Resolution to grant	31
Land North of Priory Lane	Planning permission granted	18
Land at Milton Hill, Milton	Resolution to grant	48
Land off Walnut Trees Hill	Planning permission granted	18
Land East of A338, Crown Meadow, East Hanney	Planning permission granted	25
Land off Draycott Road	Planning permission granted	98
Land East of Drayton Road	Planning permission granted	160
King's Field, Sheepstead Rd, Marcham	Resolution to grant	43
Alder View, Land South of Grove Road, Harwell	Resolution to grant	55
Chailey House, Bessels Way, Blewbury	Planning permission granted	30
Land North of 92-112 Milton Rd	Resolution to grant	34
Fernham Fields, Land East of Coxwell Rd	Resolution to grant	154
Land West of Portway Villas, Reading Rd	Planning permission granted	21
Land West of the A417	Permissions since Apr 2013	70
Land off Colton Road	Resolution to grant	55
Land South of Downsview Road (Stockham Farm Phase 2)	Resolution to grant	60
LPP2 villages	Remainder of dwellings to find in LPP2	Up to 1000
Small sites	permissions under 10 dwellings	510
Windfall	Assumptions based on previous supply	900
Total number of houses committed or consented in addition to proposed strategic housing site allocations		8624

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3 Legislative and Policy Framework

This section introduces the policy and legislative framework which drives the management of development and the water environment in England.

3.1 National Planning and Sustainable Development Policy

3.1.1 National Planning Policy Framework (NPPF) and Practice Guidance

The National Planning Policy Framework (NPPF)¹ was published on 27th March 2012, as part of reforms to make the planning system less complex and more accessible, to protect the environment and to promote sustainable growth. The main NPPF provides guidance to planning authorities to take account of flood risk and water and wastewater infrastructure delivery in their Local Plans:

- Paragraph 100 of the NPPF states “Local Plans should be supported by a strategic flood risk assessment and develop policies to manage flood risk from all sources, taking account of advice from the Environment Agency and other relevant flood risk management bodies, such as Lead Local Flood Authorities and Internal Drainage Boards. Local Plans should apply a sequential, risk-based approach to the location of development to avoid, where possible, flood risk to people and property and manage any residual risk, taking account of the impacts of climate change”.
- Paragraph 156 of the NPPF states: “Local planning authorities should set out the strategic priorities for the area in the Local Plan. This should include strategic policies to deliver...the provision of infrastructure for transport, telecommunications, waste management, water supply, wastewater, flood risk and coastal changes management, and the provision of minerals and energy”.

In March 2014, the Planning Practice Guidance was issued by Department for Communities and Local Government, with the intention of providing guidance on the application of the National Planning Policy Framework (NPPF) in England. Of relevance to this study;

- Flood Risk and Coastal Change²
- Water Supply, Wastewater and Water Quality³.

3.1.2 Planning Practice Guidance: Flood Risk and Coastal Change

Diagram 1 in the Planning Practice Guidance also sets out how flood risk should be taken into account in the preparation of Local Plans. These requirements are addressed principally in the Council's Strategic Flood Risk Assessment (SFRA)⁴ and Sequential Test⁵.

¹ Department for Communities and Local Government (2012) National Planning Policy Framework

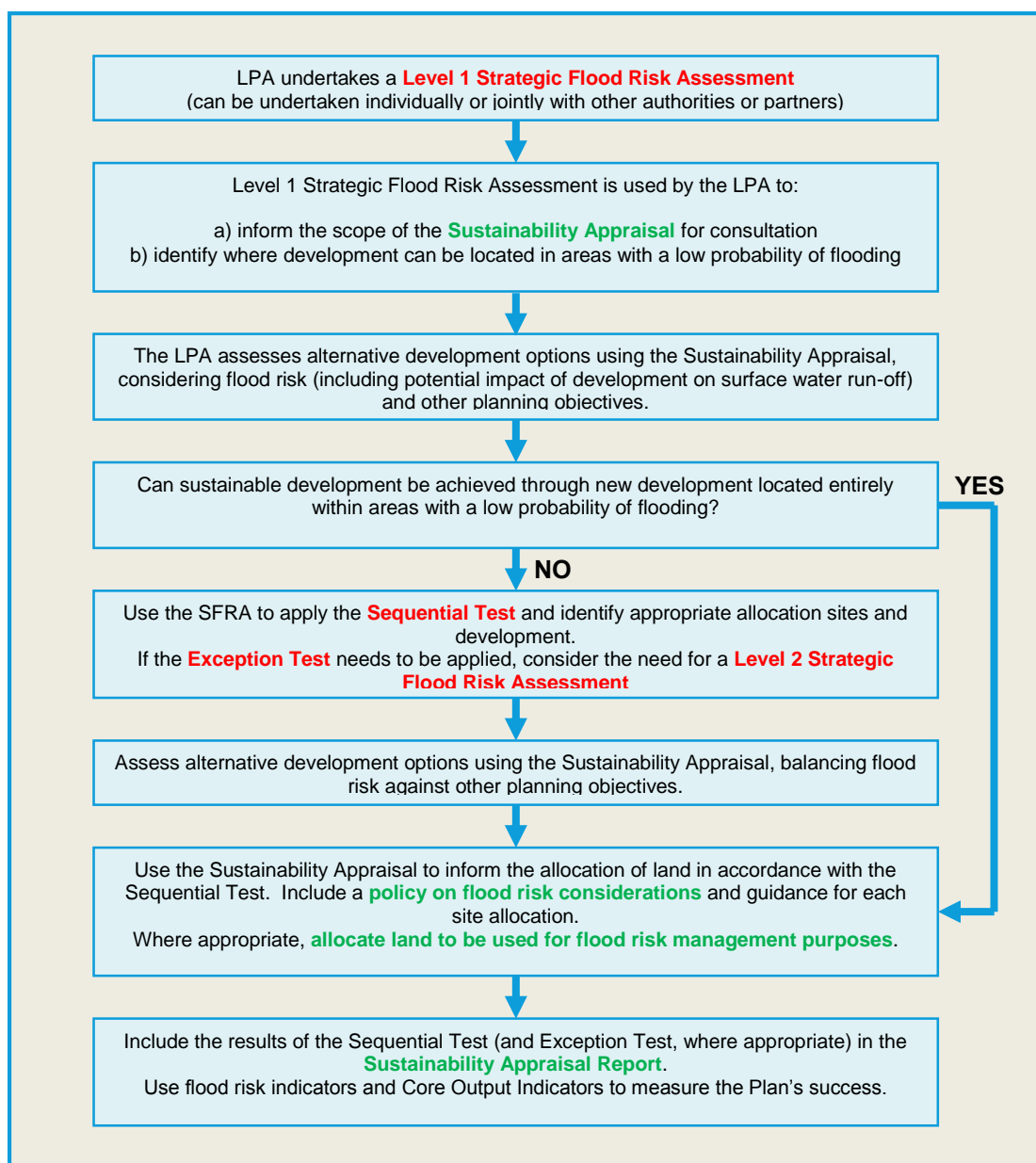
² Department for Communities and Local Government (2014) Planning Practice Guidance: Flood Risk and Coastal Change (2014) Accessed online at <http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/> on 15/04/2014.

³ Department for Communities and Local Government (2014) Planning Practice Guidance: Water supply, wastewater and water quality. Accessed online at <http://planningguidance.planningportal.gov.uk/blog/guidance/> on 15/04/2014

⁴ Vale of White Horse District Council (2014) Strategic Flood Risk Assessment

⁵ Vale of White Horse District Council (2014) Sequential Test

Figure 3-1: Flood risk and the preparation of Local Plans



Based on Diagram 1 of NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 004, Reference ID: 7-021-20140306) March 2014

3.1.3 Planning Practice Guidance: Water Supply, Wastewater and Water Quality

Under the previous system of Planning Policy Statements (PPSs) which were in place before implementation of the NPPF in 2011, there was no equivalent guidance document for planners, although there was some relevant guidance contained in PPS1⁶. Since the introduction of NPPF there had not been any other specific guidance issued on planning for water supply, wastewater and water quality issues.

The Planning Practice Guidance sets out a framework of linked guidance and documents:

- Local Planning Authorities (LPAs) must have regard for Water Framework Directive as implemented in the Environment Agency's River Basin Management Plans⁷.
- The National Policy Statement for Waste Water. This sets out Government policy for the provision of major waste water infrastructure to construct a new wastewater treatment plan

⁶ Department for Communities and Local Government (2005) Planning Policy Statement 1: Delivering Sustainable Development

⁷ Environment Agency (Dec 2009) River basin management plan for the Thames river basin district. Accessed online at:

<https://www.gov.uk/government/publications/thames-river-basin-management-plan>







or increase the capacity of an existing plant to a population equivalent of more than 500,000. None of the proposed developments within the study area would fall into this category.

- Water Cycle Studies (WCS). These are identified as voluntary studies that assist the EA, LPAs and Water and Sewerage Companies (WaSCs) to work together. The EA's Water Cycle Study advice is referenced.
- Planners should consider the contribution that the catchment-based approach can make, for example by improving farming and land management practices to improve water quality, offsetting the need to implement more advanced water or wastewater treatment works. The Defra catchment-based approach guidance is referenced⁸.
- The Environment Agency and OfWAT Drainage Strategy Framework⁹ guidance is referenced. It is expected that public facing drainage strategies will become an integral part of WaSC business plans. However as yet there are none in place for this study area.
- LPAs are advised to discuss growth plans at an early stage with WaSCs, to enable growth to be allowed for in the company's five-yearly business plans. Wastewater treatment works are classified as waste developments, so in a 2-tier area the district and county authorities must co-operate.
- Local authorities should seek opportunities to reduce the overall level of flood risk in the area and beyond. This can be achieved, for instance, through the layout and form of development, including green infrastructure and the appropriate application of sustainable drainage systems.
- Specific guidance on how infrastructure, water supply, wastewater and water quality considerations should be accounted for in both plan-making and planning applications is summarised below in Table 3-1.

⁸ Department for Environment, Food and Rural Affairs (2013) Catchment Based Approach: Improving the quality of our water environment. Accessed online at <https://www.gov.uk/government/publications/catchment-based-approach-improving-the-quality-of-our-water-environment> on 15/04/2014

⁹ Environment Agency / OfWAT (2013) Drainage Strategy Framework. Accessed online at http://www.ofwat.gov.uk/future/sustainable/drainage/rpt_com201305drainagestrategy.pdf on 15/04/2014 .

Table 3-1: Planning practice guidance: Water supply, wastewater and water quality considerations for plan making and planning applications

	Plan-making		Planning applications
Infrastructure	Identification of suitable sites for new or enhanced infrastructure. Consider whether new development is appropriate near to water and wastewater infrastructure. Phasing new development so that water and wastewater infrastructure will be in place when needed.		Wastewater considerations include: first presumption is to provide a system of foul drainage discharging into a public sewer. Phasing of development and infrastructure. Circumstances where package sewage treatment plants or septic tanks are applicable.
Water supply			Planning for the necessary water supply would normally be addressed through the Local Plan ... exceptions might include: large developments not identified in Local Plans; where a Local Plan requires enhanced water efficiency in new developments.
Water quality	How to help protect and enhance local surface water and groundwater in ways that allow new development to proceed and avoids costly assessment at the planning application stage. The type or location of new development where an assessment of the potential impacts on water bodies may be required. Expectations relating to sustainable drainage systems.		Water quality is only likely to be a significant planning concern when a proposal would: involve physical modifications to a water body; indirectly affect water bodies, for example as a result of new development such as the redevelopment of land that may be affected by contamination etc. or through a lack of adequate infrastructure to deal with wastewater.
Wastewater	The sufficiency and capacity of wastewater infrastructure. The circumstances where wastewater from new development would not be expected to drain to a public sewer.		If there are concerns arising from a planning application about the capacity of wastewater infrastructure, applicants will be asked to provide information about how the proposed development will be drained and wastewater dealt with.
Cross-	Water supply and water quality concerns often cross local authority boundaries and can be best considered on a catchment basis. Recommends liaison from the outset.		No specific guidance (relevant to some developments).
SEA and	Water supply and quality are considerations in strategic environmental assessment and sustainability appraisal ... sustainability appraisal objectives could include preventing deterioration of current water body status, taking climate change into account and seeking opportunities to improve water bodies.		No specific guidance (should be considered in applications).

3.1.4 Building Regulations and Code for Sustainable Homes

Part L of the Building Regulations requires that all new homes be designed to ensure that average per capita water consumption does not exceed 125 litres/person/day. Changes due to be introduced in October 2015 include an optional, more restrictive standard (110 l/person/day) which can be set by local authorities in areas defined as water stressed. The Planning Practice Guidance sets out the primary sources of evidence that might support the more restrictive standard, including the Environment Agency's 'Water stressed areas classification' (2013) and the relevant RBMP. Local authorities are not permitted to require higher standards than the above.

The Code for Sustainable Homes (CfSH) was the Government's optional national standard for new housing, and was in place from 2007 to March 2015. The code included six star rating levels

requiring increasingly stringent sustainability measures to be met, including for water consumption, ranging from 120l/person/day for 1 and 2 star to 80l/person/day for 5 and 6 stars. Whilst CfSH has now been withdrawn and will not apply to new allocations, it is still applied in some legacy cases, including where residential developments are legally contracted to apply a code policy (e.g. affordable housing funded through the National Affordable Housing Programme 2015 to 2018) and where planning permission has been granted subject to a condition stipulating discharge of a code level.

3.1.5 Sustainable Drainage Systems (SuDS)

Schedule 3 of the Flood and Water Management Act (FWMA), deals with Sustainable Drainage Systems (SuDS). The Act calls for the establishment of a SuDS Approving Body (SAB) to be set up within Lead Local Flood Authorities (LLFAs). The responsibilities of the SAB can be delegated to other organisations, such as the local planning authority, but the legal responsibility for drainage matters remains with the LLFA.

Schedule 3 requires the inclusion of sustainable drainage of surface water in developments that require planning approval or have drainage implications. It removes the automatic right, established by the Water Industry Act, to connect to public sewers and instead gives powers to local authorities as SABs to approve new drainage systems and their connection to public sewers. SABs will assess proposed SuDS in accordance with a new National Standard. The National Standard has yet to be published in its final form, but it will address the design, construction, maintenance and operation of drainage systems. It is likely to consider run-off destination, peak flow rates, run-off volume and water quality.

The National SuDS standards will consider drainage impacts as a result of changing rainfall intensity due to climate change, and thus will promote adaptation to future surface water flooding risks.

The introduction of these measures has been delayed several times and in September 2014 Defra released a public consultation document proposing that the approval of SuDS drainage systems should be undertaken via the planning system, and outlining various options for maintenance of SuDS including by water companies and by independent management companies¹⁰. Therefore it is possible that approval for SuDS systems will become a responsibility of Local Planning Authorities in the near future.

Various councils have introduced their own guidelines to adopting and designing SuDS, such as Gloucester City Council¹¹ and seven councils in the south east of England¹².

3.1.6 BREEAM

BREEAM (Building Research Establishment Environmental Assessment Methodology) is an internationally recognised method of assessing, rating and certifying the sustainability of buildings. BREEAM can be used to assess the environmental performance of any type of building: new and existing. Standard BREEAM schemes exist for assessment of common domestic and non-domestic building types and less common building types can be assessed by developing bespoke criteria.

Using independent, licensed assessors, BREEAM assesses criteria covering a range of issues in categories that evaluate energy and water use, health and wellbeing, pollution, transport, materials, waste, ecology and management processes. This promotes both climate change mitigation (energy efficiency) and adaptation (water efficiency). Buildings are rated and certified on a scale of 'Pass', 'Good', 'Very Good', 'Excellent' and 'Outstanding'.

BREEAM has expanded from its original focus on individual new buildings at the construction stage to encompass the whole life cycle of buildings from planning to in-use and refurbishment. The standard is regularly revised to improve sustainability, respond to industry feedback and support sustainability strategies and commitments. BREEAM standard can be applied to virtually

¹⁰ Defra (2014) Delivering Sustainable Drainage Systems. <https://consult.defra.gov.uk/water/delivering-sustainable-drainage-systems>

¹¹ Gloucester City Council (2013) 'A Design and Adoption Guide' Accessed Online At

<http://www.gloucester.gov.uk/resident/Documents/Planning%20and%20Building%20Control/SUDS%20for%20GCC%20FINAL%20July%202013%20Document.pdf> 25/09/2014

¹² Lead Local Flood Authorities of the South East of England (2013) Water. People. Places. A guide for master planning sustainable drainage into developments Accessed Online at

[http://www.medway.gov.uk/pdf/SE7%20suds%20masterplanning%20FINAL%20low%20res\[1\].pdf](http://www.medway.gov.uk/pdf/SE7%20suds%20masterplanning%20FINAL%20low%20res[1].pdf) on 25/09/2014

any building and location, with versions for new buildings, existing buildings, refurbishment projects and large developments.

BREEAM certification may be required by procuring organisations but, following the Government's Housing Standards Review, cannot be made a requirement in Local Plans.

3.2 Local Planning and Sustainable Development Policy

3.2.1 Local Plan

The Vale of White Horse District Council has submitted its Local Plan 2031 Part 1¹³ covering the period 2011 to 2031 to the Secretary of State on the 18th March 2015. This will partially replace the existing Local Plan from 2001 to 2011.

The Local Plan identifies the number of jobs and new homes to provide up to 2031. Production of the Oxfordshire Strategic Housing Market Assessment 2014 and accompanying economic forecasts identified the potential for approximately 23,000 additional jobs between 2011 and 2031 and the need for 20,560 additional homes 2011-2031. New facilities such as schools and road improvements are considered as part of the development alongside housing and jobs. The Infrastructure Delivery plan that accompanies the Local Plan sets out infrastructure requirements including capital works.

The sites will be designed to integrate with the local community whilst minimising the effects on the environment. Other requirements include flood protection, open spaces, green infrastructure and recreation provision.

The Local Plan Viability Study factors in a cost for accelerating work on capacity upgrades to water and wastewater assets where needed.

This Water Cycle Study will form one part of the evidence base for the Local Plan, including informing several of the core policies:

¹³ VoWH The new Local Plan 2031 Part1 <http://www.whitehorsedc.gov.uk/services-and-advice/planning-and-building/planning-policy/new-local-plan-2031>

Table 3-2: Local Plan Strategic Objectives relevant to the Water Cycle Study.

Core policy	Aspects this WCS should contribute to:
1: Presumption in favour of sustainable development	Presumption in Favour of Sustainable Development – which provides support for appropriate and sustainable growth.
7: Providing Supporting Infrastructure and Services	Ensure new services and facilities are delivered alongside new housing and employment.
8: Spatial Strategy for the Abingdon-on-Thames and Oxford Fringe Sub-Area	Assesses the impact of future developments and the infrastructure needed to deliver it.
14: Upper Thames Reservoir	Policy to safeguard land for a reservoir and ancillary works between the settlements of East Hanney, Drayton and Steventon, until the examination of Thames Water's Resources Management Plan 2019.
15: Spatial Strategy for the South East Vale Sub-Area	Assesses the impact of future developments and the infrastructure needed to deliver it.
20: Spatial Strategy for the Western Vale Sub-Area	Assesses the impact of future developments and the infrastructure needed to deliver it.
37: Design and Local Distinctiveness	All proposals for new development will be expected to be of high quality design that... is sustainable and resilient to climate change by taking into account landform, layout, building orientation, massing and landscaping to minimise energy consumption and mitigate water run-off and flood risks
38: Design Strategies for Strategic and Major Development Sites	Proposals for housing allocations and major development sites must be accompanied by a site-wide design strategy - this should include integration of SUDs within the public realm and a framework for Green Infrastructure.
40: Sustainable Design and Construction	All new development, including building conversions, refurbishments and extensions, should seek to incorporate climate change adaptation and design measures to combat the effects of changing weather patterns.
42: Flood Risk	The risk and impact of flooding will be minimised through: <ul style="list-style-type: none"> • directing new development to areas with the lowest probability of flooding • ensuring that all new development addresses the effective management of all • sources of flood risk • ensuring that development does not increase the risk of flooding elsewhere, and • ensuring wider environmental benefits of development in relation to flood risk.
43: Natural Resources	All development proposals will be required to make provision for the effective use of natural resources where applicable, including...making efficient use of water, for example through rainwater harvesting and grey water...causing no deterioration in, and where possible, achieving improvements in water quality.
45: Green Infrastructure	A net gain in Green Infrastructure, including biodiversity, will be sought either through on site provision or off-site contributions and the targeted use of other funding sources. A net loss of Green Infrastructure, including biodiversity, through development proposals will be resisted.

The consultation statement for the Local Plan 2031 Part 1 consultation noted the main issues raised in the consultation, including that:

- calls for the provision of infrastructure before development and concerns about the lack of infrastructure to support new development in terms of schools, health care facilities and sewage and water treatment works upgrades.

- loss of Green Belt land in the Abingdon-on-Thames / Oxford Fringe Sub-Area.
- opposition to development in AONB at Harwell campus, including from statutory consultee, Natural England, and by the AONB Management Board
- Oxfordshire County Council expressed concerns about the number of homes proposed on the Milton Heights site on highways capacity and safety grounds
- Oxford City Council objected that the local plan has not addressed Oxford City's un-met housing need identified in the up-to-date Oxfordshire SHMA
- English Heritage (now Heritage England) raised various concerns about heritage and conservation matters including protection for the setting of designated heritage assets

These concerns raise issues regarding water resources as it is important that the development proposals and their location do not adversely impact future water provisions and sewage treatment.

3.2.2 Infrastructure Delivery Plan

The purpose of the Infrastructure Delivery Plan (IDP) is to set out the infrastructure and services required to support the future levels of planned housing and employment in the District, including how, by whom and broadly when it will be provided and expected costs. The IDP identifies sources of funding to assist in the delivery of infrastructure to help upgrade facilities, promote economic growth to ultimately improve the quality of life.¹⁴

The Local Plan aims to sustainably develop towns and districts whilst maintaining a high quality environment. The vision for the Vale of White Horse District is to meet the needs of all the residents by creating safe, sustainable and socially balanced settlements, with sufficient services and facilities available. Housing is proposed in various areas throughout the district including Abingdon, Faringdon, Harwell and west of Didcot. The plan will support the local economy, whilst adapting to climate change by promoting sustainable living along with reducing flood risks in order to safeguard the landscape.

The IDP notes that for the new sites, gas and power supply is needed to accommodate the developments. There is also a need for sewage network upgrades, enhancing pumping station capacities, upsizing rising mains and the provision of storage tanks within the downstream network. Drainage and water supply also needs to be addressed by new developments.

3.3 Environmental Policy

3.3.1 Urban Wastewater Treatment Directive (UWWTD)

The UWWTD is an EU Directive that concerns the collection, treatment and discharge of urban wastewater and the treatment and discharge of waste water from certain industrial sectors. The objective of the Directive is to protect the environment from the adverse effects of the abovementioned wastewater discharges. More specifically Annex II.A (a) sets out the requirements for discharges of phosphates and/or nitrates from urban wastewater treatment plants to sensitive areas which are subject to eutrophication. The values for concentration or for the percentage reduction shall apply. For specific information regarding concentration limits please refer to the UWWTD¹⁵. The Directive has been transposed in to UK legislation through enactment of the Urban Waste Water Treatment (England and Wales) Regulations 1994 and 'The Urban Waste Water Treatment (England and Wales) (Amendments) Regulations 2003'.

3.3.2 Habitats Directive

The EU Habitats Directive aims to protect the wild plants, animals and habitats that make up our diverse natural environment. The directive created a network of protected areas around the European Union of national and international importance called Natura 2000 sites.

These sites include:

- Special Areas of Conservation (SACs) - these support rare, endangered or vulnerable natural habitats, plants and animals (other than birds).

¹⁴ Vale of White Horse District Council (2014) Infrastructure Delivery Plan Accessed Online at

http://www.whitehorsedc.gov.uk/sites/default/files/Microsoft%20Word%20-%20202013_02_26_IDP%20RoD%20Whole%20Document_2.pdf on 01/10/2014

¹⁵ <http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:31991L0271>

- Special Protection Areas (SPAs) - support significant numbers of wild birds and their habitats.

Special Protection Areas and Special Areas of Conservation are established under the EC Birds Directive and Habitats Directive respectively. All in all the directive protects over 1000 animals and plant species and over 200 so called "habitat types" (e.g. special types of forests, meadows, wetlands, etc.), which are of European importance.

3.3.3 The Water Framework Directive

The Water Framework Directive (WFD) was first published in December 2000 and transposed into English and Welsh law in December 2003. It introduced a more rigorous concept of what "good status" should mean than the previous environmental quality measures. The WFD Objective estimated that 95% of water bodies were at risk of failing to meet "good status".

River Basin Management Plans are required under the WFD and are strategies that should influence development plans and be influenced by them. Vale of White Horse District is covered by the Thames¹⁶ RBMPs.

One WFD objective is to have "no deterioration", therefore all water bodies must meet the class limits for its status class declared in the Final Thames and Severn River Basin Management Plans. A second objective requires all water bodies to achieve good ecological status. Future development needs to be planned carefully so that it helps towards achieving the WFD and does not result in further pressure on the water environment and compromise WFD objectives. The WFD objectives are summarised below.

The Environmental Objectives for surface waters are:

- Prevent deterioration in status for water bodies
- Aim to achieve good ecological and good surface water chemical status in water bodies by 2015
- For water bodies that are designated as artificial or heavily modified, aim to achieve good ecological potential by 2015
- Comply with objectives and standards for protected areas where relevant
- Reduce pollution from priority substances and cease discharges, emissions and losses of priority hazardous substances.

The Environmental Objectives for groundwater are:

- Prevent deterioration in the status of groundwater bodies
- Aim to achieve good quantitative and good groundwater chemical status by 2015 in all those bodies currently at poor status
- Implement actions to reverse any significant and sustained upward trends in pollutant concentrations in groundwater
- Comply with the objectives and standards for protected areas where relevant
- Prevent or limit the input of pollutants into groundwater.

3.3.3.1 Protected Area Objectives

The WFD specifies that areas requiring special protection under other EC Directives and waters used for the abstraction of drinking water are identified as protected areas. These areas have their own objectives and standards.

Article 4 of the WFD requires Member States to achieve compliance with the standards and objectives set for each protected area by 22 December 2015, unless otherwise specified in the Community legislation under which the protected area was established. Some areas may require special protection under more than one EC Directive or may have additional (surface water and/or groundwater) objectives. In these cases, all the objectives and standards must be met.

The types of protected areas are:

- areas designated for the abstraction of water for human consumption (Drinking Water Protected Areas);

¹⁶ Environment Agency (2009) Thames River Basing Management Plan
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- areas designated for the protection of economically significant aquatic species (Freshwater Fish and Shellfish);
- bodies of water designated as recreational waters, including areas designated as Bathing Waters;
- nutrient-sensitive areas, including areas identified as Nitrate Vulnerable Zones under the Nitrates Directive or areas designated as sensitive under Urban Waste Water Treatment Directive (UWWTD);
- areas designated for the protection of habitats or species where the maintenance or improvement of the status of water is an important factor in their protection including relevant Natura 2000 sites.

Many WFD protected areas coincide with water bodies, these areas will need to achieve the water body status objectives in addition to the protected area objectives. Where water body boundaries overlap with protected areas the most stringent objective applies, that is the requirements of one EC Directive should not undermine the requirements of another.

The objectives for Protected Areas relevant to this study are as follows:

Drinking Water Protected Areas

- Ensure that, under the water treatment regime applied, the drinking water produced meets the requirements of the Drinking Water Directive; and
- Ensure necessary protection in the Drinking Water Protected Areas with the aim of avoiding deterioration in water quality in order to reduce the level of purification treatment required in producing drinking water.

Economically Significant Species (Freshwater Fish Waters)

- To protect or improve the quality of running or standing freshwater to enable them to support fish belonging to:
- Indigenous species offering a natural diversity; or
- Species the presence of which is judged desirable for water management purposes by the competent authorities of the Member States

Nutrient Sensitive Areas (Nitrate Vulnerable Zones)

- Reduce water pollution caused or induced by nitrates from agricultural sources and
- prevent further such pollution

Nutrient Sensitive Areas (Urban Waste Water Treatment Directive)

- To protect the environment from the adverse effects of urban waste water discharges and waste water discharges from certain industrial sectors.

Natura 2000 Protected Areas (water dependent SACs and SPAs)

The objective for Natura 2000 Protected Areas identified in relation to relevant areas designated under the Habitats Directive or Birds Directive is to:

- Protect and, where necessary, improve the status of the water environment to the extent necessary to achieve the conservation objectives that have been established for the protection or improvement of the site's natural habitat types and species of Community importance in order to ensure the site contributes to the maintenance of, or restoration to, favourable conservation status.

Groundwater Source Protection Zones

The Environment Agency has a Groundwater Protection Policy to help prevent groundwater pollution. In conjunction with this the Environment Agency have defined groundwater Source Protection Zones (SPZs) to help identify high risk areas and implement pollution prevention measures. The SPZs show the risk of contamination from activities that may cause pollution in the area, the closer the activity, the greater the risk. There are three main zones (inner, outer and total catchment) and a fourth zone of special interest which is occasionally applied.

Zone 1 (Inner protection zone)

This zone is designed to protect against the transmission of toxic chemicals and water-borne disease. It indicates the area in which pollution can travel to the borehole within 50 days from any point within the zone and applies at and below the water table. There is also a minimum 50 metre protection radius around the borehole.

Zone 2 (Outer protection zone)

This zone indicates the area in which pollution takes up to 400 days to travel to the borehole, or 25% of the total catchment area, whichever area is the biggest. This is the minimum length of time the Environment Agency think pollutants need to become diluted or reduce in strength by the time they reach the borehole.

Zone 3 (Total catchment)

This is the total area needed to support removal of water from the borehole, and to support any discharge from the borehole.

Zone of special interest

This is defined on occasions, usually where local conditions mean that industrial sites and other polluters could affect the groundwater source even though they are outside the normal catchment area.

3.3.4 Catchment Abstraction Management Strategies

The Catchment Abstraction Management Strategy (CAMS) is prepared by the Environment Agency to manage abstractions in a particular area. The CAMS provides information on the resources available and what conditions might apply to new licences. The licences require abstractions to stop or reduce when a flow or water level falls below a specific point as a restriction to protect the environment and manage the balance between supply and demand for water users. The CAMS is published in a series of documents known as Abstraction License Strategies (ALSs), but for clarity here the term CAMS is used to refer to these.

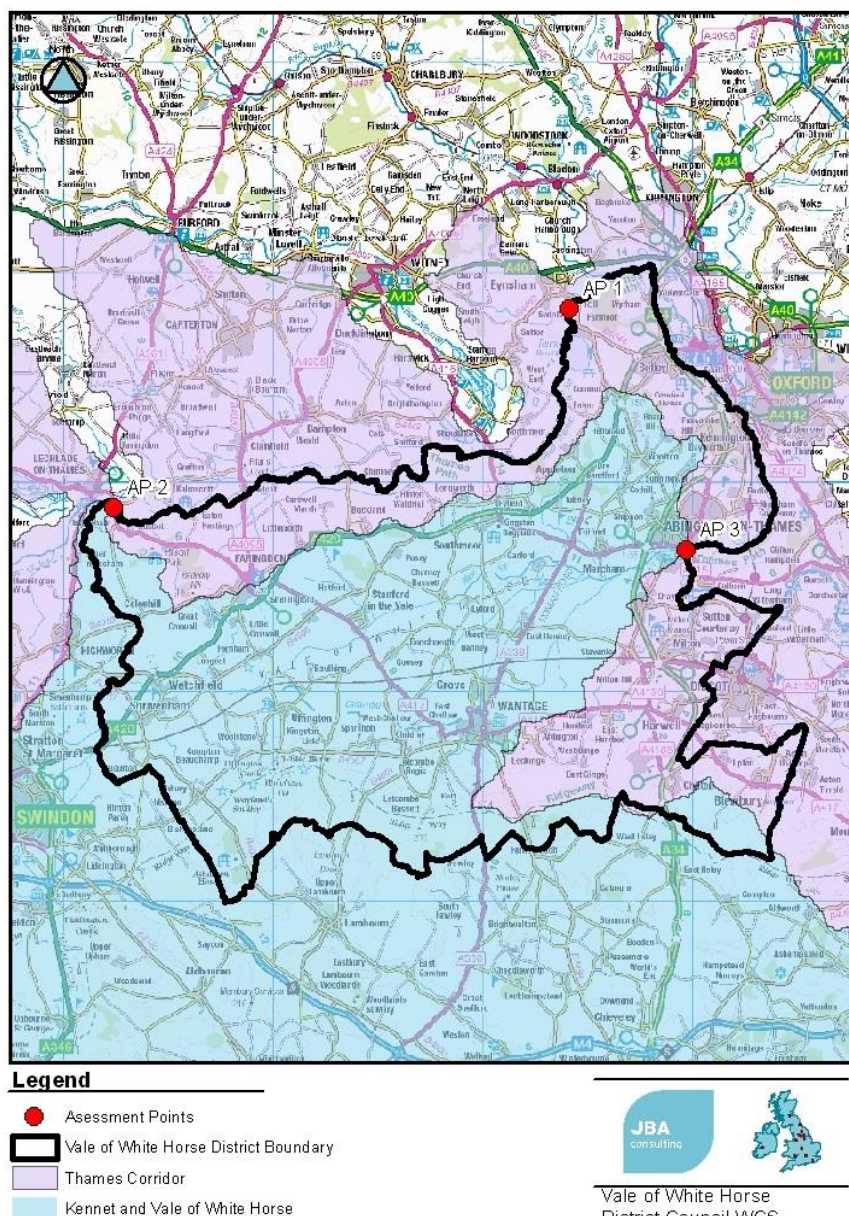
New and varied licences are normally time limited, which allows time for a periodic review of the area as circumstances may have changed since the licences were granted. These are generally given for a twelve year duration, but shorter or longer duration licences can be accepted. This is dependent on local factors such as the lifetime of the infrastructure, the availability of resources and future plans or changes. The licences can be replaced or renewed near to the expiry date.

The CAMS is important in terms of the WRMP as this helps to determine the current and future pressures on water resources and how the supply and demand will be managed by water companies.¹⁷

The Vale of White Horse District is covered by two CAMS, the Thames Corridor and the Kennet and Vale of White Horse which have slightly different abstraction licences due to the local characteristics of the water body. Abstraction licences for the whole region are required if more than 20m³/day of water is withdrawn from a river, lake, reservoir, pond, spring or an underground source. The licence is granted dependent on the amount of water available after the required needs for the environment and existing abstractions, which generally lasts for twelve years. The CAMS boundaries covering the Vale of White Horse District Council are shown in Figure 3-2:

¹⁷ Environment Agency (2013) Managing Water Abstraction Accessed Online at <https://www.gov.uk/government/collections/water-abstraction-licensing-strategies-cams-process> on 23/09/2014

Figure 3-2: Catchment Abstraction Management Strategy Boundaries for the Vale of White Horse District



3.3.4.1 Thames Corridor

The Thames catchment is one of the driest in the UK and is a major water resource for abstractions for the public water supply. The next common end date for all of the licences is the 31 March 2016, which renews again in 2028. Abstractions are prohibited in low flow based on a minimum water level requirement at Kingston gauging station.

In order to meet this requirement the licensing strategy has been adopted whilst still meeting the Water Framework Directive (WFD) goals. A multi-tier “Hands-Off Flow” (HOF) is used to allow abstractions to occur between the water levels of Q21 and Q50. Surface water abstractions can also occur in very high flows or when the river floods, which is approximately 77 days a year. Groundwater abstractions are permitted so long as there is no impact to the surface water and the groundwater level stays the same.¹⁸

¹⁸ Environment Agency (2014) Thames Catchment Abstraction Licensing Strategy Accessed online at <https://www.gov.uk/government/collections/water-abstraction-licensing-strategies-cams-process> on 25/09/2014

3.3.4.2 Kennet and Vale of White Horse

Water abstractions in this catchment are from both surface and groundwater, with the majority of demand coming from public water supply¹⁹. The area consists of Chalk, Upper Greensand and Tertiary deposits with extensive gravel and alluvial deposits close to the River Kennet. Due to the topography in the area, a groundwater divide occurs which feeds the headwaters of the surface watercourses. Groundwater abstractions are permitted dependant on surface water availability unless more information is known on the aquifers or if there are local issues that need protecting.

The rivers in this catchment drain into the Thames which limits the abstractions upstream to protect the river level at Kingston gauging station. Water abstractions are accepted in both low and high flows in the Vale of White Horse District which is available less than 30% of the time.

The CAMS currently in place are presumed to be renewed, but no common end date has been determined. Whilst no common end date has been determined the EA are of the opinion that this would not have significant implications to the conclusion and recommendations of this Water Cycle Study²⁰.

3.3.4.3 Summary of resource availability

Table 3-3 summarises the resource availability at low flows around the district.

Table 3-3: Resource Availability for the Assessment Points within the Vale of White Horse District

Assessment Point Number	Name	Region	Local resource availability at low flows	HOF Q (1)	HOF (ML/d) (2)	Days p.a (3)	Available (ML/d) (4)	Gauging Station (GS) at this AP?	Additional restrictions (assuming average conditions)
1	Eynsham Lock and Weir	Thames Corridor	No water available for licensing	Q21 at Kingston if <2 MLD		77	1568	Eynsham	
2	Cole	Kennet and Vale of White Horse	Water available for licensing	No Local HOF		365	2.7	No	Thames Q50 HOF Abstraction restricted to 182 days per annum
3	Ock	Kennet and Vale of White Horse	Water available for licensing	No Local HOF		365	9.2	No	Thames Q50 HOF Abstraction restricted to 182 days per annum
4	Ray	Kennet and Vale of White Horse	Water available for licensing	No Local HOF		365	37.6	Water Eaton	Thames Q50 HOF Abstraction restricted to 182 days per annum
5	Upper Kennet	Kennet and Vale of White Horse	No water available for licensing	Q75	21.3	274	3.5	Marlborough	Thames Q50 HOF Abstraction restricted to 182 days per annum
6	Og	Kennet and Vale of White Horse	No water available for licensing	Q56	10.4	208	1.2	Marlborough (Poulton Farm)	Thames Q50 HOF Abstraction restricted to 182 days per annum
7	Upper Middle Kennet	Kennet and Vale of White Horse	Restricted water available for licensing	Q75	163.5	274	13.5	No	Thames Q50 HOF Abstraction restricted to 182 days per annum

¹⁹ Environment Agency (2012) Kennet and Vale of White Horse Catchment Abstraction Licensing Strategy Accessed online at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/289893/LIT_2517_39dc0f.pdf on 01/10/2014

²⁰ Environment Agency (2014) Response to draft water cycle study phase I report
Vale of White Horse District Council - Water Cycle Study Final

Assessment Point Number	Name	Region	Local resource availability at low flows	HOF Q (1)	HOF (MI/d) (2)	Days p.a (3)	Available (MI/d) (4)	Gauging Station (GS) at this AP?	Additional restrictions (assuming average conditions)
8	Lower Middle Kennet	Kennet and Vale of White Horse	No water available for licensing	Q75	222.3	274	8.2	Newbury	Thames Q50 HOF Abstraction restricted to 182 days per annum
9	Lambourn	Kennet and Vale of White Horse	Restricted water available for licensing	Q74	86.4	270	1.1	No	Thames Q50 HOF Abstraction restricted to 182 days per annum
10	Enbourne	Kennet and Vale of White Horse	Water available for licensing	No local HOF		365	0	Np	Thames Q50 HOF Abstraction restricted to 182 days per annum
11	Foudry Brook	Kennet and Vale of White Horse	Water available for licensing	No Local HOF		365	57.1	No	Thames Q50 HOF Abstraction restricted to 182 days per annum
12	Lower Kennet	Kennet and Vale of White Horse	Water available for licensing	No Local HOF		365	21.7	No	Thames Q50 HOF Abstraction restricted to 182 days per annum
13	Pang	Kennet and Vale of White Horse	No water available for licensing	Q22	73.5	80	10.4	Pangbourne	Thames Q50 HOF Abstraction restricted to 182 days per annum

(1) Hands off Flow restriction (Q value)

(2) Hands off Flow restriction (MI/D value)

(3) Number of days per annum abstraction may be available

(4) Approximate volume available at restriction (MI/D)

Throughout the district there are a variety of licensing strategies which change the availability of water in low flow conditions. This is due to the protection of other areas of the catchment that require a particular water level to be maintained. Abstractions at all the locations in Table 3-2 are still possible unless there is damage to the environment. The ALS does not consider the capacity of the catchments to provide water supplies for future domestic, industrial or agricultural demands. However, the results in Table 3-3 indicate that, in general, there are limited additional resources which can simply be exploited to meet rising demand.

Recommendations for better management practices

Due to abstraction, several water bodies in the district have fallen below the Ecological Flow Indicator (EFI) demonstrating the need to reduce abstraction by using more efficient management practices. This would increase the sustainability of abstraction and reduce the impacts to the environment.

The main options for this identified in the CAMS are to adopt water efficiency and demand management techniques. Methods include:

- Testing the level of water efficiency before granting an abstraction licence
- Promoting efficient use of water
- Taking actions to limit the demand
- Reducing leakage.

This would ultimately cut the growth in abstraction and limit the impacts on flow and the ecology.

3.3.5 Water stress

Water stress is a measure of the level of demand for water (from domestic, business and agricultural users) compared to the available freshwater resources, whether surface or groundwater. Water stress causes deterioration of the water environment both in the quality and quantity of water, and consequently limits the ability of a waterbody to achieve "Good Status" under the WFD.

The Environment Agency has undertaken an assessment of water stress across the UK. This defines a water stressed area as where:

- "The current household demand for water is a high proportion of the current effective rainfall which is available to meet that demand"; or
- "The future household demand for water is likely to be a high proportion of the effective rainfall available to meet that demand".

This assessment (2013) has classified the Thames Water supply region as an area of "serious" water stress. Under water industry regulations, water companies in areas classified as seriously water stressed need to evaluate compulsory metering alongside other options when preparing water resource management plans (WRMPs).

3.4 Water Industry Policy

3.4.1 The Water industry in England

Water and sewerage services in England and Wales are provided by 10 Water and Sewerage Companies (WaSCs) and 12 'water-only' companies. The central legislation relating to the industry is the Water Industry Act 1991²¹. The companies essentially operate as regulated monopolies within their supply regions, although very large water users and developments are able to obtain water and/or wastewater services from alternative suppliers - these are known as inset agreements.

The Water Act 2014 aims to reform the water industry to make it more innovative and to increase resilience to droughts and floods. Key measures which could influence the future provision of water and wastewater services include:

- All non-domestic customers will be able to switch their water supplier and/or sewerage undertaker.
- New businesses will be able to enter the market to supply these services.
- Measures to promote a national water supply network.
- Enabling developers to make connections to water and sewerage systems.

3.4.2 Economic regulation of the water industry

The water industry is primarily regulated by three regulatory bodies;

- the Water Services Regulation Authority (OfWAT) - economic and customer service regulation
- Environment Agency - environmental regulation
- Drinking Water Inspectorate (DWI) - drinking water quality.

Every five years the industry submits a Business Plan to OfWAT for a Price Review (PR). These plans set out the companies operational expenditure (OPEX) and capital expenditure (CAPEX) required to maintain service standards, enhance service (for example where sewer flooding occurs), to accommodate demand growth and to meet environmental objectives defined by the Environment Agency. OfWAT assesses and compares the plans with the objective of ensuring what are effectively supply monopolies are operating efficiently.

At the time of writing the industry is coming to the end of AMP5 (2010-2015). Their draft plans have been reviewed by OfWAT, and a final "determination" of prices and outcomes was published in December 2014. This will determine the company's objectives and budget for AMP6 (2015-2020).

²¹ <http://www.legislation.gov.uk/ukpga/1991/56/contents>

When considering investment requirements to accommodate growing demand, water companies are required to ensure a high degree of certainty that additional assets will be required before funding them. Longer term growth is, however, considered by the companies in their internal asset planning processes and reported on in their 25-year Strategic Direction Statements (SDS) and Water Resource Management Plans (WRMPs).

3.4.3 Water Resource Management Plans

Water companies are required to prepare 25-year forward looking WRMPs that set out their strategy for maintaining the balance between the supply and demand for water in their regions.,

The WRMPs are updated every 5 years but in reality water companies prepare internal updates more regularly to cover for example unplanned development changes. The updates take in consideration also the outcomes of public consultations on the draft WRMPs.

WRMPs are required to assess:

- Future demand (due to population and economic growth)
- Demand management measures (e.g. water efficiency and leakage reduction)
- How the company will address changes to abstraction licenses
- How the impacts of climate change will be mitigated
- Where necessary, set out the requirements for developing additional water resources to meet growing demand.

The individual WRMP for Thames Water is reviewed in section 4.1.3.

3.4.4 Developer contributions

Developments with planning permission have a right to connect to the public water and sewerage systems, although the Floods and Water Management Act removes the automatic right to connect surface water to sewerage systems.

Developers may either requisition a water supply connection or sewerage system, or self-build the assets and offer these for adoption by the water company or sewerage undertaker. Self-build and adoption are usually practiced for assets within the site boundary, whereas requisitions are normally used where an extension or upgrading of the infrastructure requires construction on third party land.

The costs of requisitions are shared between the Water Company and developer as defined in the Water Industry Act 1991.

Where a water company is concerned that a new development may impact upon their service to customers or the environment (for example by causing foul sewer flooding or pollution) they may request the LPA to impose a Grampian condition, whereby the planning permission cannot be implemented until a third party action, for example the water company upgrading a sewer, is complete.

Legal agreements under the Town and Country Planning Act Section 106, and the Community Infrastructure Levy (CIL)²² may not be used to obtain funding for water or wastewater infrastructure.

²² Department for Communities and Local Government (2011) Community Infrastructure Levy: An Overview. Accessed online at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/6313/1897278.pdf on 03/11/2014

4 Water Resources and Water Supply

4.1 Water resources assessment

When new houses are planned it is important to ensure that there are enough water resources in the area to cover the increase in demand without the risk of shortage in the future or in periods of high demand.

The aims of this assessment are to flag if the actual housing number proposed by VoWHDC exceeds what TWUL has considered in planning the future demands so that actions can be implemented and resources planned to overcome future shortages.

Thames Water (TWUL) is responsible for supplying water for the entire District.

4.1.1 Methodology

The TWUL Water Resource Management Plan (WRMP) 14 final was reviewed. Attention was focussed upon:

- The available water resources and future pressures which may impact the supply element of the supply/demand balance.
- The allowance within those plans for housing and population growth and its impact upon the demand side of the supply/demand balance.

In addition TWUL was provided with the list of sites including the number of houses planned each year and the population equivalent and were invited to comment upon these.

The results were assessed using a red / amber / green traffic light definition to score each water resource zone:

WRMP evidences that the planned increase in demand can be met	Insufficient evidence to confirm that the planned increase in demand can be met.	Adopted WRMP does not take into consideration the planned increase in demand. Additional water resources may be required
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4.1.2 Data collection

The datasets used to assess the water resource capacity were:

- Sites location in GIS format (provided by the VoWHDC)
- Number of planned houses for each year for each site (provided by the VoWHDC)
- Company and water resource zone boundaries (TWUL).
- Water Resource Management Plans (TWUL)

4.1.3 Results

Thames Water manage water resources in six Water Resource Zones (WRZs). Their Swindon and Oxfordshire (SWOX) zone covers the whole of Vale of White Horse District, along with Swindon, the majority of Cotswold District, north Wiltshire and the majority of Oxfordshire. The extents of the SWOX zone are illustrated in Figure 4-1.

Thames Water's Water Resources Management Plan 2015-2040 (WRMP)²³ sets out their proposed 25 year strategy for maintaining the balance between the supply and demand for water in their region. TWUL update their WRMP each new AMP period (TWUL updates its WRMP every five years, in line with the Asset Management planning cycles), and takes into account actual changes in population and consumption, as well as regulatory changes.

The SWOX zone was estimated to have a supply-demand surplus of 26Ml/d in 2015, but is forecast to decline and to become a deficit of -21Ml/d by 2030 and -32Ml/d by 2040. Thames Water intends to address this through:

Short-term (2015-2020)

²³ Thames Water (2014) Water Resource Management Plan 2015-2040. Accessed online at <http://www.thameswater.co.uk/about-us/5392.htm> on 11/08/2015

- promotion of water efficiency activity to help customers use water wisely (direct response to the customer research findings) and promote behavioural change that will stem the underlying increase in water use in the company's baseline forecast. The company will also undertake trials of innovative tariffs to inform the planned roll out across its water supply area commencing in 2022/23.

Medium to Long-term (2020-2040)

- Start rollout of 'full' meter penetration of household customers from 2020. Install 82,531 progressive household meters in the period 2020-30. Achieve total SWOX household meter penetration of 92.7% by 2030. We propose to use smart meter technology as this gives the best ratio of cost to benefit.
- Rollout innovative tariffs during 2020-2025 to promote water efficiency.
- Transfer from SWA (Slough, Wycombe & Aylesbury) WRZ.

The WRMP notes that since the previous WRMP in 2009, regional spatial strategies have been revoked, and government policy upon which spatial planning is based, is now enshrined in the Localism Act. With the exception of London, where the London Plan remains, information for population and property growth was therefore compiled at a local authority level and local authorities are required to develop population and property forecasts as part of their local plans.

To inform the WRMP property and population projections were undertaken by independent consultants Experian, as part of a collaborative project with other water companies. Following a methodology developed in conjunction with the Environment Agency, Experian gathered information to produce three projections:

- Plan-based
- Trend-based
- An Experian own view of the 'most likely' forecast

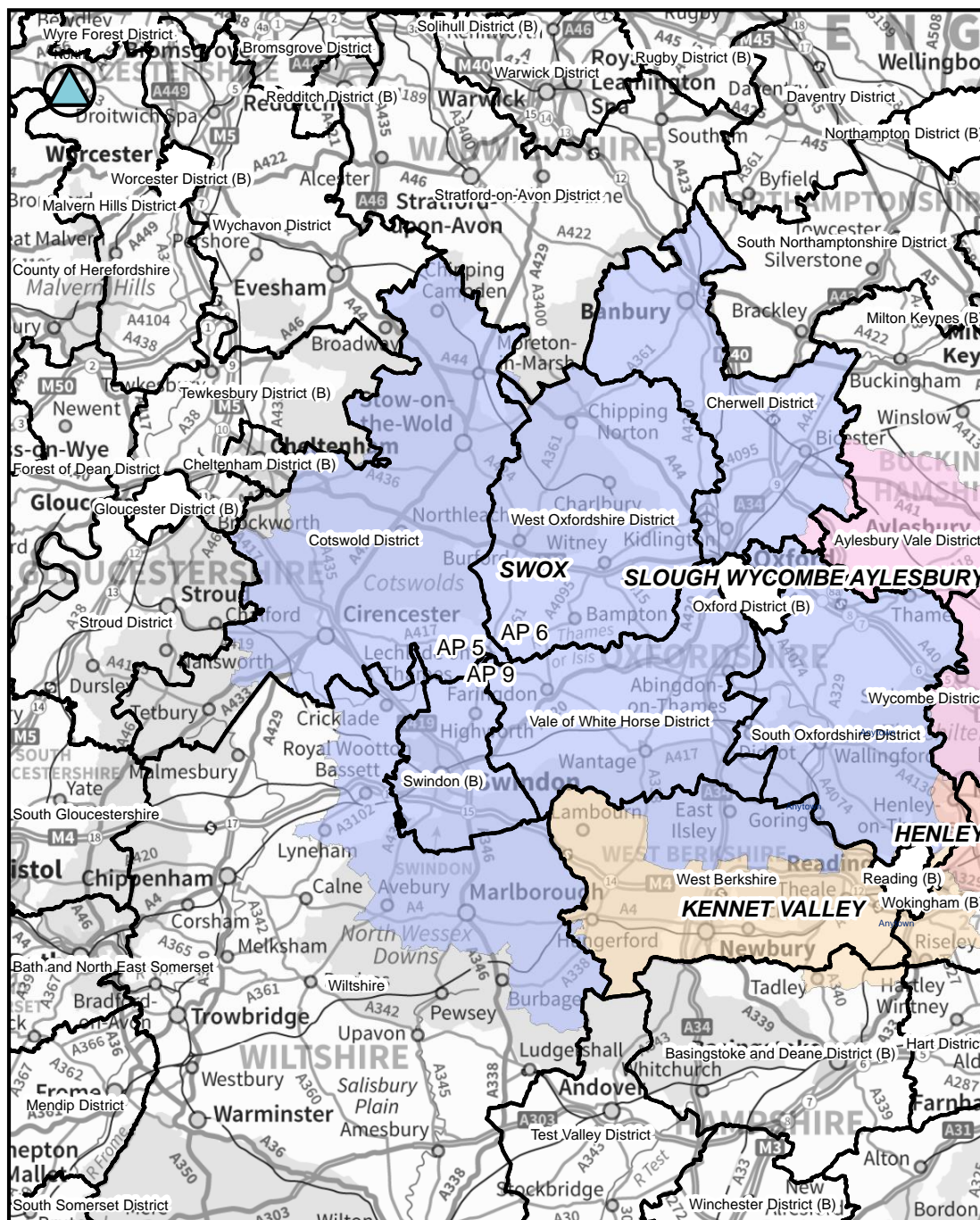
Thames Water selected to base both their population and property forecasts upon the Plan-based scenario and this was confirmed with the Environment Agency. The final growth forecasts in the SWOX zone are summarised below in Table 4-1.

Table 4-1: Population, properties and average occupancy forecasts for SWOX

Parameter	Type	Year						
		11/12	14/15	19/20	24/25	29/30	34/35	39/40
Population (000s)	Unmeasured	478.0	459.9	441.8	421.6	402.3	383.8	363.2
	Measured	473.2	519.5	598.2	659.4	702.9	743.0	786.3
	Non Household	48.8	48.8	48.8	48.8	48.8	48.8	48.8
	Total	1000	1028.2	1088.8	1129.8	1154	1175.6	1198.3
Properties (000s)	Unmeasured	174.3	164.2	153.4	143.6	133.9	124.1	114.4
	Measured	204.7	229.3	266.4	298.9	323.0	345.3	367.9
	Total	379	393.5	419.8	442.5	456.9	469.4	482.3
Occupancy	Unmeasured	2.7	2.8	2.9	2.9	3.0	3.1	3.1
	Measured	2.3	2.2	2.2	2.2	2.2	2.2	2.2

In summary therefore, the WRMP is based on a forecast of 77,900 additional properties in the SWOX zone between 2011/12 and 2029/30.

Figure 4-1: Thames Water's Swindon and Oxfordshire (SWOX) Water Resource Zone



LEGEND

Local Authority Boundaries

Thames Water's Water Resource Zones

GUILDFORD

HENLEY

KENNET VALLEY

NORTH LONDON

SLOUGH WYCOMBE AYLESBURY

SOUTH LONDON

SWOX



Cotswold WCS

Thames Water's Swindon and Oxfordshire (SWOX) Water Resource Zone

Contains Ordnance Survey data ©
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2014.

During preparation of the WCS, the publication of the Oxfordshire Strategic Housing Market Assessment drew attention to the very substantial increase in projected development in the county compared to the situation in 2014 when TWUL' WRMP was published. In order to make a high-

level assessment of potential housing growth within the SWOX zone, the latest figures for all councils covering that Zone were collated as shown in Table 4-2:

Table 4-2: Summary of forecast housing growth within the SWOX water resource zone

Area	Forecast (properties)	Source
Oxfordshire	100,060 (2011-31)	2014 Strategic Market Housing Assessment (SHMA) for Oxfordshire (http://www.whitehorsedc.gov.uk/services-and-advice/planning-and-building/planning-policy/new-local-plan-2031/evidence-base/strategi)
Swindon	22,000 (2011-26)	Local Plan 2026 (Adopted) (http://www.swindon.gov.uk/localplan)
Cotswold District	6,800 – 7,100 (2011-31)	Local Plan Consultation Paper: Preferred Development Strategy May 2013 (http://consult.cotswold.gov.uk/portal/fp/local_plan_2011-2031/development_strategy?pointId=s1365512025054#section-s1365512025054)
TOTAL	Approx. 129,000	

The numbers, which have been confirmed by the respective councils, indicate that current projected growth may be some 51,000 units (65%) greater than those available to TWUL during the preparation of the WRMP (although note that the SWOX zone boundaries do not exactly match all those of the areas in Table 4-2).

In response, Thames Water supplied an assessment of water resource and supply in the Vale of White Horse District²⁴. In summary:

- Housing growth for the period 2015 to 2030 from the supplied site information (20,815 properties) is significantly higher than that allowed for in the latest Water Resource Management Plan (16,710).
- The EA and Thames Water have taken account of the SHMA housing growth projections in their Water Resources Position Statement, titled 'Assessment of revised housing growth projections in Oxfordshire in the context of water resources'. This position statement is appended to the Water Cycle Study Statement of Common Ground. Both Thames Water and the EA concluded in their Position Statement that Thames Water will be able to maintain the security of supply in its SWOX Water Resource Zone in the next 5 years to 2020. The impact of the SHMA population and property numbers will be monitored through Thames Water's annual review of its WRMP, and Thames Water has also identified mitigation measures that can be deployed within 12 months if necessary to maintain a security of supply. Beyond this period, the next review of the Water Resources Management Plan, due to be published in draft form in 2018, will assess and programme future water resource requirements reflecting the revised housing growth projections from all local authorities.

Separately a study has been commissioned by TWUL to examine growth forecasts in detail and this will aid infrastructure development planning rather than the strategic WRMP

In summary an "amber" assessment has been assigned to the water resource situation in Thames Water's SWOX zone, however, the statutory processes associated with Thames Water's current and future WRMP should ensure that this risk is managed.

4.1.4 Conclusions

Table 4-3: Water resource summary

Settlement	Assessment
All settlements	Insufficient evidence to confirm that the planned increase in demand can be met, however, the statutory processes associated with Thames Water's current and future WRMP should ensure that this risk is managed

4.1.5 Recommendations

Table 4-4: Water resource actions

Action	Responsibility	Timescale
Thames Water should monitor actual population and property numbers across SWOX through its annual review of its WRMP and initiate mitigation measures as necessary.	TWUL	Annually
Provide annual updates to TWUL of projected housing growth on an annual basis	VoWH	Annually
Thames Water should take account of the SHMA housing growth projections across SWOX in the next update of the WRMP. This approach has been agreed by the Environment Agency	TWUL	Ongoing
Consider potential for phasing development beyond 2020. Use of Grampian Conditions where appropriate.	VoWHDC	Ongoing
Implement the need for new development to be designed to Building regulations water consumption standard for water scarce areas (110 litres per person per day) as permitted by National Planning Policy Guidance.	VoWHDC	Ongoing
Use the planning system to restrict further development at sites within the District which may be required for future strategic water resources.	VoWHDC	Ongoing

4.2 Water supply infrastructure assessment

Increase in water demand adds pressure to the existing supply infrastructures. An assessment is required to identify whether the existing infrastructure is adequate or whether upgrading will be required. The time required to plan, obtain funding and construct major pipeline works can be considerable and therefore water companies and planners need to work closely together to ensure that the infrastructure is able to meet growing demand.

Water supply companies make a distinction between supply infrastructure, the major pipelines, reservoirs and pumps that transfer water around a WRZ, and distribution infrastructure, smaller scale assets which convey water around settlements to customers. This assessment is focussed on the supply infrastructure. It is expected that developers should fund assessments and the modelling of the distribution systems to assess requirements for local capacity upgrades.

4.2.1 Methodology

TWUL was provided with the list of sites including:

- the number of houses planned each year
- the population equivalent

together with a red / amber / green traffic light definition to score each site:

Can accommodate the proposed site allocation without upgrades	Can accommodate the proposed site allocations without upgrades but will bring the system close to its current capacity limit	Further modelling will be required to determine the scale of the water supply infrastructure upgrades that may be needed
---	--	--

TWUL has assessed each site using the different data set they hold.

4.2.2 Data collection

The datasets used to assess the water supply and distribution capacity are the following:

- Sites location in GIS format (provided by the VoWHDC)
- Number of planned houses for each year for each site (provided by the VoWHDC)

4.2.3 Results

Thames Water supplied an assessment of water resource and supply in the Vale of White Horse District. In summary:

- The overriding principle of water supply into the Vale of White Horse is by transfer from the Beacon Hill reservoir at Farmoor to North Oxfordshire and Swindon. The reservoir provides support to Faringdon, Abingdon and Hinksey. Additionally it provides supplies to the Boars Hill reservoir, which supports Appleton and Cummor.
- There are other water supplies from the Hagbourne Hill reservoir, which supports the local area of Didcot and provides supplies to reservoirs in Wantage, South Oxford, Grove, Drayton, Sutton Courtenay and the East of Didcot. Hagbourne Hill reservoir also provides supplies to Faringdon via a strategic transfer, linking the Beacon Hill and Hagbourne Hill mains.
- Two forecasts have been undertaken for the housing growth in the district, one based on the Thames Water's flow monitoring zones forecasting the level of growth in water demand, and the other based on growth forecasts from the latest WRMP. The WRMP suggests an increase of 20,815 houses, which is significantly higher than the Thames Water forecast of 16,710.
- The FMZs in the VoWHDC are not discreet as there is an overlap with other local authorities, such as West Oxford and Oxford City. The only FMZs wholly within the VoWHDC area are Blewbury, Faringdon, Hagbourne Hill and Wantage.
- There are four principal FMZs of concern relating to water supply within this area. The concerns relate to TWUL's ability to maintain a continuous supply to customer demands during a hot, dry weather period. TWUL plan to ensure they can transfer volumes of water to their service reservoirs in excess of that which their customers demand. These are;
 - a. Abingdon FMZ: Route a will be able to support the proposed levels of growth with only local reinforcements required. The development would be preferred to the North and East of Abingdon, where the transfer mains are located.
 - b. Faringdon FMZ: Route b is the area of greatest concern. The supply from the reservoir is expected to meet the increase level of demand but there is a concern that the mains from the reservoir may be insufficiently sized. The development would be preferred around Faringdon, near to the reservoir, but this may cause issues with existing infrastructure at Shrivenham and Stanford in the Vale. Modelling needs to be undertaken to assess this further.
 - c. Hagbourne Hill FMZ: Route c will be able to support the proposed levels of growth with only local reinforcements required. Development can best be supported in close proximity to Didcot (Valley Park developments).
 - d. Wantage FMZ: Route d will be able to support developments near Didcot (Harwell) with existing infrastructure, but this route may need local reinforcements and possibly a new booster station, as the current one has almost reached its maximum. The development within the Wantage FMZ would need an upgrade of these pumps, but the existing mains should be enough to support the development. Modelling needs to be undertaken to confirm this. The booster upgrade would take a number of years to construct.

The water supply status is summarised below and presented as an R/A/G analysis in Table 4-5:

4.2.4 Conclusions

Table 4-5: Water supply and distribution summary

Settlements	Assessment
Settlements in Faringdon FMZ: Coxwells Craven Faringdon Longworth Shrivenham Stanford	Further modelling will be required to determine the scale of the water supply infrastructure upgrades that may be needed.
Settlements in the Wantage FMZ: Grove Hanneys Harwell Hendreds Wantage	Further modelling will be required to determine the scale of the water supply infrastructure upgrades that may be needed. Route d will be able to support developments near Didcot (Harwell) with existing infrastructure, but this route may need local reinforcements and possibly a new booster station, as the current one has almost reached its maximum. The development within the Wantage FMZ would need an upgrade of these pumps, but the existing mains should be enough to support the development. Modelling needs to be undertaken to confirm this. The booster upgrade would take a number of years to construct
Settlements in Abingdon FMZ: All Abingdon parishes Kingston Bagpuize Marcham Shippon Southmoor Sunningwell Wooton	Can accommodate the proposed site allocation without upgrades. Route a will be able to support the proposed levels of growth with only local reinforcements required. The development would be preferred to the North and East of Abingdon, where the transfer mains are located.
Settlements in Hagbourne Hill FMZ: Appleford Drayton Sutton Courtenay Milton Heights Valley Park	Can accommodate the proposed site allocation without upgrades. Route c will be able to support the proposed levels of growth with only local reinforcements required. Development can best be supported in close proximity to Didcot (Valley Park developments).

4.2.5 Recommendations

Table 4-6: Water supply and distribution actions

Action	Responsibility	Timescale
Undertake a technical study to understand options to provide sufficient bulk and local transfer capacity and communicate findings to VoWHDC.	TWUL	2015
Consider potential for phasing development beyond 2020 in Abingdon, Faringdon and Wantage	VoWHDC	Ongoing
Developers seek early consultation with Thames Water in order to ensure adequate time is available to provide local distribution main upgrades to meet additional demand	Developers	Ongoing

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5 Wastewater Collection and Treatment

Thames Water (TWUL) is the Sewerage Undertaker (SU) for the whole District. The role of sewerage undertaker includes collection and treatment of wastewaters from domestic and commercial premises, and in some areas drainage of surface water from building curtilages to combined or surface water sewers. It excludes, unless adopted by TW, systems that do not connect directly to the wastewater network, e.g. SuDS or highway drainage.

Increased wastewater flows into collection systems due to growth in population or per-capita consumption can lead to overload of infrastructure, increasing the risk of sewer flooding and, where present, increasing the frequency of discharges from Combined Sewer Overflows (CSOs).

Likewise, headroom at wastewater treatment works can be eroded by growth in population or per-capita consumption, requiring investment in additional treatment capacity. As the volume of treated effluent rises, even if the effluent quality is maintained, the pollutant load discharged to the receiving watercourse will increase. In such circumstances the Environment Agency, as the environmental regulator, may tighten the consented effluent consents in order to achieve a "load standstill", i.e. ensuring that as effluent volumes increase the pollutant load discharged does not increase. Again, this would require investment by the water company to improve the quality of the treated effluent.

In combined sewerage systems, or foul systems with surface water misconnections, there is potential to create headroom in the system, thus enabling additional growth, by removal of surface water connections. This can most readily be achieved on redevelopment of brownfield sites with combined sewerage, where there is potential to discharge surface water via sustainable drainage systems (SuDS) to groundwater, watercourses or surface water sewers.

5.1 Sewerage system capacity assessment

New houses add pressure to the existing sewerage system. An assessment is required to identify the available capacity within the existing systems, and the potential to upgrade overloaded systems to accommodate growth. The scale and cost of upgrading works may vary very significantly depending upon the location of development in relation to the network and the receiving WwTW.

It may be possible that an existing sewerage system is already working at its full capacity and further investigations have to be carried out to define which solution is necessary to implement to increase its capacity. New infrastructures may be required if for example a site is not served by an existing system.

Sewerage undertakers must consider growth in demand for wastewater services when preparing their five-yearly Strategic Business Plans (SBPs) which set out investment for the next Asset Management Plan (AMP) period. Typically, investment is committed to provide new or upgraded sewerage capacity to support allocated growth with a high certainty of being delivered. Additional sewerage capacity to service windfall sites, smaller infill development or to connect a site to the sewerage network across third party land are normally funded via developer contributions.

5.1.1 Methodology

TWUL were provided with the list of sites including:

- the number of houses planned each year
- the population equivalent
- the increase in dry weather flow

together with a red / amber / green traffic light definition to score each site:

Can accommodate the proposed site allocation without upgrades	Can accommodate the proposed site allocation without upgrades but will bring the network close to its current capacity limit	Further modelling will be required to determine the scale of the wastewater infrastructure upgrades that may be needed. Capacity can be provided given sufficient time to implement upgrades
---	--	--

TWUL assessed each site using various data sources including models and Drainage Area Plans (DAPs).

5.1.2 Data collection

The datasets used to assess the sewerage system capacity are the following:

- Sites location in GIS format (provided by the VoWHDC)
- Number of planned houses for each year for each site (provided by the VoWHDC)
- Occupancy rate, water demand and % of water that reach the WwTW

5.1.3 Results

For each WwTW catchment, TWUL has provided a plan showing the extents of the foul sewerage catchment, and a schematic showing the general arrangement of the network, pumping stations and treatment works.

TWUL undertook a desktop assessment of WwTW catchments, taking into consideration issues such as size of the receiving sewers, known sewer flooding downstream, local topography and existing planned studies and investment. Catchments were not colour coded following the R/A/G analysis - this has been interpreted subsequently by JBA Consulting. Not all sites were analysed by TWUL.

5.1.4 Conclusions

Table 5-1: Sewerage system summary

TWUL Site ID	Site Name	Waste Response
37041	East Harwell Oxford Campus	Further modelling will be required to determine the scale of the wastewater infrastructure upgrades that may be needed. Capacity can be provided given sufficient time to implement upgrades
32573	East of Coxwell Road, Faringdon	
37039	East Sutton Courtenay	
41813	Great Coxwell Parish, South Faringdon	
41244	Harwell and Milton Parishes east of the A34 adjoining Didcot Town, Valley Park	
20581	Kingston Bagpuize East	
21181	Land at Crab Hill, Land north of A417 of A338, Wantage	
38647	Land East of East Hanney	
39920	Land South of Park Road Faringdon SN7 7PL	
34616	Land West of Harwell	
39900	Milton Parish west of the A34, Milton Heights	
36172	Monks Farm, Grove	
38536	North Abingdon-on-Thames	
41240	North Shrivenham	
37016	North West Abingdon-on-Thames	
37054	North West of Harwell Oxford Campus	Further modelling will be required to determine the scale of the wastewater infrastructure upgrades that may be needed. Capacity can be provided given sufficient time to implement upgrades
37023	North West Radley	
39908	North West Valley Park - Site 11	
38093-	South Kennington	

TWUL Site ID	Site Name	Waste Response
	ALL OTHER SITES	Not assessed

5.1.5 Recommendations

Table 5-2: Sewerage system actions

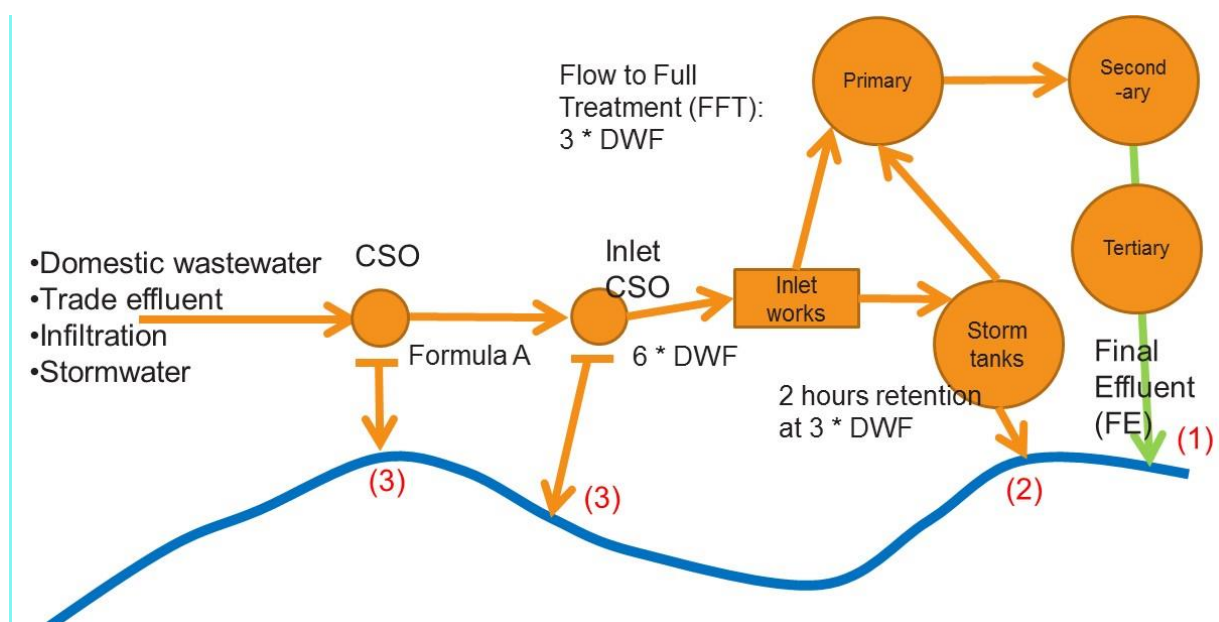
Action	Responsibility	Timescale
Take into account sewerage infrastructure constraints in phasing development in partnership with Thames Water	VoWHDC	Ongoing
Sewerage undertakers to continue to assess growth demands as part of their wastewater asset planning activities and feedback to VoWHDC where concerns arise	TWUL	Ongoing
Thames Water and developers will be expected to work closely and early on in the planning promotion process to develop an outline Drainage Strategy for the site. The Outline Drainage strategy should set out sufficient detail to determine the likely timescales for the delivery of the infrastructure and the likely costs of the infrastructure. The Outline Drainage Strategy should be submitted as part of the planning application submission, and where required, used as a basis for a drainage planning condition to be set	Developers	Ongoing

5.2 Wastewater treatment works flow and quality consent assessment

The EA is responsible for regulating sewage discharge releases via a system of Environmental Permits (EPs). Monitoring for compliance with these permits is the responsibility of both the EA and the plant operators. Figure 5-1 summarises the different types of wastewater releases that might take place, although precise details vary from works to works depending on the design.

During dry weather the final effluent from the sewage treatment works should be the only discharge (1). With rainfall, the storm tanks fill and eventually start discharging to the watercourse (2) and Combined Sewer Overflows (CSOs) upstream of the storm tanks start to operate (3). The discharge of storm sewage from treatment works is allowed only under conditions of heavy rain or snow melt, and therefore the flow capacity of treatment systems is required to be sufficient to treat all flows arising in dry weather and the increased flow from smaller rainfall events. After rainfall, storm tanks should be emptied back to full treatment, freeing their capacity for the next rainfall event.

Figure 5-1: Overview of typical combined sewerage system and sewage treatment works discharges



Environmental permits are used alongside water quality limits as a means of controlling the pollutant load discharged from a WWTW to a receiving watercourse. Sewage flow rates must be monitored for all Wastewater Treatment Works (WwTWs) where the permitted discharge rate is greater than 50 m³/day in dry weather.

Permitted discharges are based on a statistic known as the Dry Weather Flow (DWF). As well as being used in the setting and enforcement of effluent discharge permits, the DWF is used for wastewater treatment works design, as a means of estimating the 'base flow' in sewerage modelling and for determining the flow at which discharges to storm tanks will be permitted by the permit (Flow to Full Treatment, FFT).

WwTW Environmental Permits also consent for maximum concentrations of pollutants, in most cases suspended solids (SS), Biochemical Oxygen Demand (BOD) and Ammonia (NH₄). These are determined by the Environment Agency with the objective of ensuring that the receiving watercourse is not prevented from meeting its environmental objectives, in particular that the Chemical Status element of the Water Framework Directive (WFD) classification.

Increased domestic population and/or employment activity can lead to increased wastewater flows arriving at a WwTW. Where there is insufficient headroom at the works to treat these flows, this could lead to failures of flow consents. As a works operates closer to its capacity the quality of treated effluent may decline, leading the works to breach its quality consents.

5.2.1 Methodology

TWUL were provided with the total extra flow due to the future developments for each WwTW and a red / amber / green traffic light definition to score each of them:

Can accommodate the proposed site allocation without upgrades	Can accommodate the proposed site allocation without upgrades but will bring the network close to its current capacity limit	Further modelling will be required to determine the scale of the WwTW upgrades that may be needed. Capacity can be provided given sufficient time to implement upgrades
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The extra flow has been calculated by:

- Grouping the sites that are served by the same WwTW using the sewerage drainage area boundaries
- Calculating the total number of houses for each WwTW and the population equivalent by using a occupancy rate of 2.4p/h

- Multiplying the population equivalent for the water demand of 134 l/p/d and assuming that 95% of the water consumption reaches the WwTW
- The occupancy rate, water demand and % were agreed with the Sewerage Undertakers.

5.2.2 Data collection

The datasets used to assess the sewerage system capacity are the following:

- Sites location in GIS format (provided by the VoWHDC)
- Number of planned houses for each year for each site (provided by the VoWHDC)
- Sewerage drainage area boundaries (provided by TWUL)
- Occupancy rate, water demand and % of water that reach the WwTW

5.2.3 Results

Thames Water has provided a spreadsheet model known as SOLAR (Strategic Overview of Long term Assets and Resources) for each of their WwTWs that could receive additional flows due to growth in VoWH District. The model assesses the current and future status of the flow and quality consents at each works. The assessment was undertaken using five year cycles to reflect the WRMP using growth figures up to 2031.

5.2.4 Conclusions

Table 5-3: Wastewater treatment works flow and quality consent summary

Receiving WwTW	Comment on WwTW capacity assessment
Abingdon (New Stream Outfall)	Can accommodate the proposed site allocation without upgrades
Abingdon (Lagoon Outfall)	Can accommodate the proposed site allocation without upgrades but will bring the works close to its current capacity limit on its BOD consent by 2021.
Appleton	Can accommodate the proposed site allocation without upgrades but will bring the works close to its current capacity limit on its BOD consent by 2021.
Didcot	Predicted to fail on Ammonia consent by 2030/31. Further modelling will be required to determine the scale of the WwTW upgrades that may be needed. Capacity can be provided given sufficient time to implement upgrades.
Drayton	Predicted to fail on Suspended Solids and BOD consents by 2021 and to be close to its current Ammonia consent by the same date. Further modelling will be required to determine the scale of the WwTW upgrades that may be needed. Capacity can be provided given sufficient time to implement upgrades
Faringdon	Predicted to fail on Suspended Solids consent by 2021 and to be close to its current BOD consent by the same date. Further modelling will be required to determine the scale of the WwTW upgrades that may be needed. Capacity can be provided given sufficient time to implement upgrades.
Kingston Bagpuize	Predicted to fail on Flow and Ammonia consents by 2021 and to be close to its current BOD consent by 2031. Further modelling will be required to determine the scale of the WwTW upgrades that may be needed. Capacity can be provided given sufficient time to implement upgrades.
Oxford	Predicted to fail on Ammonia consent by 2021 and to be close to its current Flow consent by the same date. Further modelling will be required to determine the scale of the WwTW upgrades that may be needed. Capacity can be provided given sufficient time to implement upgrades.
Shrivenham	Predicted to fail on Suspended Solids and Ammonia consents by 2021 and on BOD consent by 2031. Further modelling will be required to determine the scale of the WwTW upgrades that may be needed. Capacity can be provided given sufficient time to implement upgrades.
Stanford-in-the-Vale	Can accommodate the proposed site allocation without upgrades
Wantage	Can accommodate the proposed site allocation without upgrades but will bring the works close to its current capacity limit on its Flow, Suspended Solids and Ammonia consents by 2021.

See appendix A to identify which WwTW each site drains to.

5.2.5 Recommendations

Table 5-4: Wastewater treatment works flow and quality consent actions

Action	Responsibility	Timescale
Take into account WwTW incapacity in phasing development	VoWHDC	Ongoing
Provide annual updates to TWUL of projected housing growth.	VoWH	Annually
TWUL to assess growth demands as part of their wastewater asset planning activities and feedback to VoWHDC where concerns arise.	TWUL	Ongoing
Thames Water, the Council and the EA will work closely to ensure the timely delivery of any necessary sewage treatment works upgrades.	All	Ongoing
Where the water quality assessment indicates that permits may require a higher standard of treatment than currently achievable using Best Available Technologies, the EA should provide clear advice to VoWHDC and TWUL on: <ul style="list-style-type: none"> the approach to permitting, requirements for any additional studies (for example additional water quality sampling, modelling, macro-invertebrate surveys etc.), Advise where water quality constraints may limit the potential for growth. (Timescale: ongoing). 	EA	Ongoing

5.3 Wastewater treatment works odour assessment

Where new development encroaches upon existing wastewater treatment works, odour from that works may become a cause for nuisance and complaints from residents. Managing odour at WwTWs can add considerable capital and operational costs, particularly when retro-fit to existing WwTWs.

National Planning Policy Guidance recommends that plan-makers considering whether new development is appropriate near to sites used (or proposed) for water and wastewater infrastructure, in particular due to the risk of odour impacting on residents and requiring additional investment to address.

5.3.1 Methodology

TWUL's policy is that a new development may need an odour assessment if the site is less than 800m from a WWTW and is encroaching closer to the WwTW than existing urbanised areas.

An ArcGIS exercise was carried out to identify sites that are less than 800m from a WwTW and encroaching closer to the WwTW than existing urbanised areas. If there are no existing houses it is more likely that an odour assessment is needed. Another important aspect is the location of the site in respect to the WWTW because the predominant winds blow from the south west.

A red / amber / green assessment was applied:

Site is unlikely to be impacted by odour from WwTWs	Site location is such that an odour impact assessment is recommended	Site is in an area with confirmed WwTW odour issues
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5.3.2 Data collection

The datasets used to assess the sewerage system capacity are the following:

- Sites location in GIS format (provided by the VoWHDC)

- WwTWs location in GIS format (provided by sewerage undertakers)
- OS maps

5.3.3 Results

Table 5-5 list those development sites where it is recommended that an odour assessment be undertaken.

Table 5-5: Sites where an odour assessment is recommended

Site name	WWTW	Encroachment?	Direction of the WwTW from the site	Site boundary distance from WwTW (m)
Monks Farm Phase I & II	Wantage	Yes	North	215
South Drayton	Drayton	Yes	West	300

5.3.4 Conclusions

Table 5-6: Wastewater treatment odour summary

Sites	Assessment
Monks Farm Grove, South Drayton	Site location is such that an odour impact assessment is recommended as part of the planning application process
All other sites	Site is unlikely to be impacted by odour from WwTWs

5.3.5 Recommendations

Table 5-7: Wastewater treatment odour actions

Action	Responsibility	Timescale
Consider odour risk in selection of site allocations	VoWHDC	
Carry out an odour assessment for Monks Farm, Grove and South Drayton sites	Site promoters	

5.4 Water quality impact assessment

The increased discharge of effluent due to an increase in the population served by a WwTW may impact on the quality of the receiving water. The Water Framework Directive (WFD) does not allow a watercourse to deteriorate from its current class (either water body or element class).

It is EA policy to model the impact of increasing effluent volumes on the receiving watercourse. Where the scale of development is such that a deterioration is predicted, a new consent may be required for the WWTW to improve the quality of the final effluent, so that the extra pollution load will not result in a deterioration in the water quality of the watercourse. This is known as a "no deterioration" or "load standstill".

EA guidance states that a 10% deterioration in the receiving water can be allowed in some circumstances as long as this does not cause a class deterioration to occur.

If a watercourse fails the 'good status' target, further investigations are needed in order to define the 'reasons for fail' and which actions could be implemented to reach such status.

During the preparation of the phase I Water Cycle Study (WCS) the EA advised that it would be necessary to undertake an assessment of the water quality impact of development in the 11 WwTW catchments which will receive the majority of additional flows in the Vale of White Horse District (12 outfalls as Abingdon has 2 outfalls to different watercourses).

The full water quality assessment is included in Appendix B. This section provides a summary of the methodology, results and conclusions.

5.4.1 Methodology

- The assessment required development of a stochastic (statistics based) model of river water quality and flows and wastewater discharge quality and flows for the present day (base case) and future scenarios (2020/21 and 2030/31). The Environment Agency's River Quality Planning (RQP) tool was used.
- The WFD targets for Biological Oxygen Demand (BOD), Ammonia (NH₄) and Phosphate (P) set by the EA are shown in below:

Table 5-8: WFD targets

Determinand	Statistic	1st cycle (2009)	2nd cycle (2013)
BOD	90 percentile	5mg/l	5mg/l
NH ₄	90 percentile	0.6mg/l	0.6mg/l
P	Mean	0.12 mg/l	See Table 2 in Appendix B for reach-specific targets

- Where a treatment works was predicted to lead to either a WFD class deterioration, or a deterioration of greater than 10%, it was necessary to determine a possible future consent value which would prevent either class deterioration or would return the works to a "no deterioration or "load standstill" situation, as follows:
 - For a class deterioration situation, the RQP tool can be set to "calculate required discharge quality" to calculate a consent value that would retain the water body at its current class.
 - For a "no-deterioration" situation, the future scenario presenting the worst case deterioration was used for each determinand. The discharge data Mean Quality and Standard Deviation were iteratively reduced until the present day 90th-percentile value was achieved. The standard deviation was assumed to be 1/3 of the mean.
- Where modelling indicated that a tightening of the consent is likely to be required to prevent deterioration, an assessment was made of the potential to meet that consent by either extending the existing treatment processes on the site or adding additional treatment processes considered as "Best Available Technology" (BAT). Treatment to even higher standards would require additional, potable water treatment technologies to be introduced which would add considerable capital and operational costs to wastewater treatment.

The methodology followed is summarised in the flow chart below:

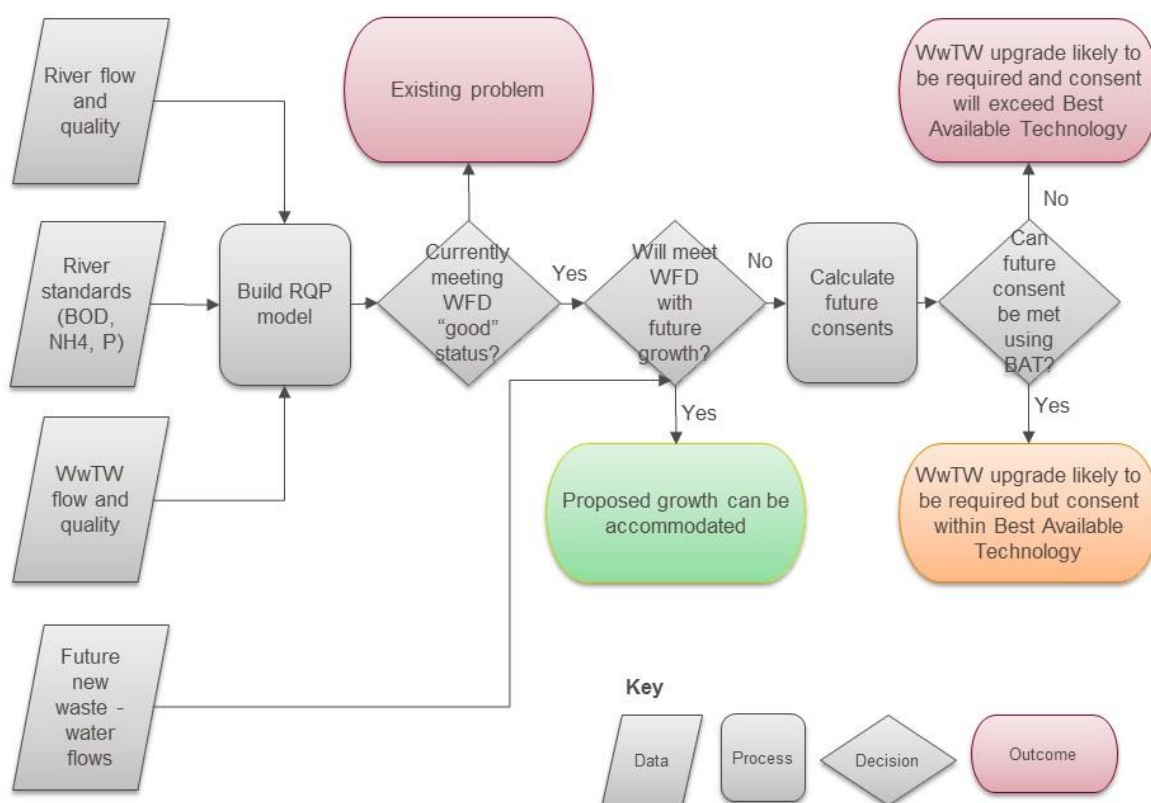


Figure 5-2: Water quality assessment methodology flow chart

5.4.2 Data collection

The datasets used to assess the water quality impact were the following:

Upstream river data:

- Mean flow
- 95% exceedance flow
- Mean for each contaminants
- Standard deviation for each contaminant

Discharge data:

- Mean flow
- Standard deviation for the flow
- Mean for each contaminants
- Standard deviation for each contaminant

River quality target data:

- No deterioration target
- 'Good status' target

Treatment processes:

- Existing treatment process (TWUL)
- Assessment of achievable treatment standards for current wastewater treatment technologies (TWUL).

5.4.3 Results

Table 5-9 summarises the modelling results for assessing the 'Good status' and 'No deterioration' targets for each WwTW using their actual performance for the current situation and the future scenarios. The colour code used for the 'Good status' target is green for achieving it and red for failing it. For the 'No > 10% deterioration' target the table shows green for no deterioration, amber

for $\leq 10\%$ deterioration and red for $> 10\%$ deterioration. The actual upstream river quality input data was used for the assessment.

Table 5-9: Modelling results summary for assessing the 'Good status' the actual situation and 'No $> 10\%$ deterioration' targets. The actual upstream river quality input data were used for the assessment.

Watercourse (STW discharging into it)	Scenario	Failing 'Good status' target?			Failing 'No $> 10\%$ deterioration' target?		
		BOD	Amm	P	BOD	Amm	P
		target achieved			no deterioration		
		NA			deterioration $\leq 10\%$		
		target not achieved			deterioration $> 10\%$		
River Thames (Abingdon Lagoon)	Current	No	No	Yes	NA	NA	NA
	19/20	No	No	Yes	No	No	No
	30/31	No	No	Yes	No	No	No
Odhay Hill Ditches (Abingdon New Stream)	Current	Yes	Yes	Yes	NA	NA	NA
	19/20	Yes	Yes	Yes	2%	10%	No
	30/31	Yes	Yes	Yes	2%	12%	-2%
Marcham Brook (Appleton)	Current	No	No	Yes	NA	NA	NA
	19/20	No	No	Yes	15%	48%	4%
	30/31	No	No	Yes	9%	48%	1%
Moor Ditch (Didcot)	Current	No	Yes	Yes	NA	NA	NA
	19/21	No	Yes	Yes	8%	65%	3%
	30/32	No	Yes	Yes	22%	212%	5%
Ginge Brook (Drayton)	Current	No	No	Yes	NA	NA	NA
	19/21	No	Yes	Yes	9%	66%	13%
	30/32	No	No	Yes	6%	55%	4%
Faringdon Brook (Faringdon)	Current	Yes	Yes	Yes	NA	NA	NA
	19/21	Yes	Yes	Yes	26%	80%	6%
	30/32	Yes	Yes	Yes	21%	85%	3%
River Ock (Kingston Bagpuize)	Current	No	Yes	Yes	NA	NA	NA
	19/22	No	Yes	Yes	11%	40%	3%
	30/33	No	Yes	Yes	10%	52%	1%
Northfield Brook (Oxford)	Current	Yes	Yes	Yes	NA	NA	NA
	19/22	Yes	Yes	Yes	No	8%	No
	30/33	Yes	Yes	Yes	No	7%	-1%
Tuckmill Brook (Shrivenham)	Current	No	No	Yes	NA	NA	NA
	19/22	No	No	Yes	18%	83%	9%
	30/33	No	Yes	Yes	22%	120%	7%
River Ock (Standford in the Vale)	Current	No	No	Yes	NA	NA	NA
	19/23	No	No	Yes	1%	13%	11%
	30/34	No	No	Yes	1%	13%	8%
Letcombe Brook (Wantage)	Current	No	No	Yes	NA	NA	NA
	19/23	No	No	Yes	11%	54%	3%
	30/34	No	No	Yes	27%	159%	5%

Table 5-10 summarises the modelling results for assessing if 'good status' can be achieved. The new permits calculated were compared against BAT.

The EA advised that the following permit values are achievable using Best Available Technology (BAT):

- BOD (95%ile) = 5mg/l
- Ammonia (95%ile) = 1mg/l
- Phosphate (mean) = 0.5mg/l

This does not take in consideration if it is feasible to upgrade each existing STW to such technology considering the variables and constraints that this may involve: cost, timing, space, carbon cost etc. Annex A of Appendix B reports Thames Water's assessment of achievable permit values based on the type and size of each treatment works.

Table 5-10: Modelling results for assessing if 'good status' can be achieved.

Watercourse (WwTW)	Pollutant	Could the development prevent the water body from reaching GES? NB: the actual upstream river water quality situation was used for the modelling calculation reported in this table.
		Passes
		Fails: target is achievable using BAT
		Fails: target is not achievable using BAT or without improving water quality upstream
River Thames (Abingdon Lagoon)	BOD	GES is reached for BOD
	Ammonia	GES is reached for ammonia
	P	GES for P cannot currently be achieved without improving the upstream quality of the river
Odhay Hill Ditches (Abingdon New Stream)	BOD	GES can be achieved for BOD with improvement to the work using BAT
	Ammonia	GES cannot be achieved for ammonia with improvement to the work using BAT
	P	GES cannot be achieved for P with improvement to the work using BAT
Marcham Brook (Appleton)	BOD	GES is reached for BOD
	Ammonia	GES is reached for ammonia
	P	GES for P cannot currently be achieved without improving the upstream quality of the river
Moor Ditch (Didcot)	BOD	GES is reached for BOD
	Ammonia	GES can be achieved for ammonia with improvement to the work using BAT
	P	GES cannot be achieved for P with improvement to the work using BAT
Ginge brook (Drayton)	BOD	GES is reached for BOD
	Ammonia	GES can be achieved for ammonia with improvement to the work using BAT
	P	GES can be achieved for P with improvement to the work using BAT. The 95%ile requested is within the 10% model tolerance/variability
Faringdon Brook (Faringdon)	BOD	GES can be achieved for BOD with improvement to the work using BAT
	Ammonia	GES can be achieved for ammonia with improvement to the work using BAT

Watercourse (WwTW)	Pollutant	Could the development prevent the water body from reaching GES? NB: the actual upstream river water quality situation was used for the modelling calculation reported in this table.
	P	GES for P cannot currently be achieved without improving the upstream quality of the river
River Ock (Kingston Bagpuize)	BOD	GES is reached for BOD
	Ammonia	GES can be achieved for ammonia with improvement to the work using BAT
	P	GES for P cannot currently be achieved without improving the upstream quality of the river
Northfield Brook (Oxford)	BOD	GES can be achieved for BOD with improvement to the work using BAT
	Ammonia	GES cannot be achieved for ammonia with improvement to the work using BAT
	P	GES cannot currently be achieved for P with improvement to the work using BAT
Tuckmill Brook (Shrivenham)	BOD	GES is reached for BOD
	Ammonia	GES can be achieved for ammonia with improvement to the work using BAT
	P	GES cannot currently be achieved for P with improvement to the work using BAT
River Ock (Stanford in the Vale)	BOD	GES is reached for BOD
	Ammonia	GES is reached for ammonia
	P	GES for P cannot currently be achieved without improving the upstream quality of the river
Letcombe Brook (Wantage)	BOD	GES is reached for BOD
	Ammonia	GES cannot be achieved for ammonia with improvement to the work using BAT
	P	GES for P cannot currently be achieved without improving the upstream quality of the river

5.4.4 Additional assessment assuming GES upstream

Following review of the draft results with the EA, further analysis was undertaken for Appleton, Didcot, Oxford and Shrivenham WwTWs assuming that the river upstream of the discharge point has achieved GES and the pollution problem upstream of the work has been addressed. The reason for this was to measure the actual impact of the discharge effluent on the receiving watercourse. The aspects covered were the following:

- will the WWTW remain within its existing permit?,
- will any of the determinands experience a 10% deterioration and this is / is not achievable using the BAT?;
- will any of the determinands experience a class deterioration and this is / is not achievable using the BAT?;
- will any of the determinands experience a failure in reaching good status and this is / is not achievable using the BAT?.

The EA advised that the following permit values are achievable using Best Available Technology (BAT), and that these values should be used for modelling all potential capacity at all WwTWs irrespective of the existing treatment technology and size of the works:

- BOD (95%ile) = 5mg/l
- Ammonia (95%ile) = 1mg/l
- Phosphate (mean) = 0.5mg/l

This does not take in consideration if it is feasible to upgrade each existing WwTW to BAT due to constraints including cost, timing, space, carbon cost etc. Appendix B, Annex A reports Thames Water's assessment of achievable permit values based on the type and size of each treatment works.

Table 5-11 shows a summary of the conclusions using BAT.

Table 5-11: Summary of results assuming BAT is applied

Watercourse (WwTW discharging into it)	DWF Permit Compliant	Pollutant	Could the development cause a greater than 10% deterioration in WQ?	Could the development cause a deterioration in WFD class of any element?	Could the development prevent the water body from reaching GES?
		Passes			
		Fails: target is achievable using BAT or permit capacity is reached.			
		Fails: target is not achievable using BAT or permit capacity is exceeded.			
Marcham Brook (Appleton)	No DWF permit exceedance is predicted	BOD	10% deterioration is predicted for BOD. Upgrade to the WwTW is needed and it is achievable with the best technology available	No class deterioration is predicted for BOD. No WwTW upgrade is required	Good status is reached for BOD
		Amm	10% deterioration is predicted for Amm. Upgrade to the WwTW is needed and it is achievable with the best technology available	Class deterioration is predicted for Amm. Upgrade to the WwTW is needed and it is achievable with the best technology available	Good status is reached for Amm
		P	Predicted deterioration is less than 10% for P. No WwTW upgrade is required	No class deterioration is predicted for P. No WwTW upgrade is required	Good status is not reached for P. Upgrade to the WwTW is needed but it is not currently achievable with BAT also assuming GES upstream. Trials are underway to assess new technology for Phosphate removal, however additional mitigation may still be required

Moor Ditch (Didcot)	No DWF permit exceedance is predicted	BOD	10% deterioration is predicted for BOD. Upgrade to the WwTW is needed and it is achievable with the best technology available	Class deterioration is predicted for BOD. Upgrade to the WwTW is needed and it is achievable with the best technology available	Good status is reached for BOD
		Amm	10% deterioration is predicted for Amm. Upgrade to the WwTW is needed and it is achievable with the best technology available	Class deterioration is predicted for Amm. Upgrade to the WwTW is needed and it is achievable with the best technology available	Good status is not reached for Amm. Upgrade to the WwTW is needed and it is achievable with BAT for Amm also in the current upstream condition.
		P	Predicted deterioration is less than 10% for P. No WwTW upgrade is required	No class deterioration is predicted for P. No WwTW upgrade is required	Good status is not reached for P. Upgrade to the WwTW is needed but it is not currently achievable with BAT for P also assuming GES upstream. Trials are underway to assess new technology for Phosphate removal, however additional mitigation may still be required
Northfield Brook (Oxford)	DWF permit capacity is predicted to be achieved for 2019/20 scenario	BOD	Predicted deterioration is less than 10% for BOD. No WwTW upgrade is required	No class deterioration is predicted for BOD. No WwTW upgrade is required	Good status is not reached for BOD. Upgrade to the WwTW is needed and it is achievable with BAT for BOD also in the current situation.
		Amm	Predicted deterioration is less than 10%. No WwTW upgrade is required	No class deterioration is predicted. No WwTW upgrade is required	Good status is not reached for Amm. Upgrade to the WwTW is needed but it is not currently achievable with BAT also assuming GES upstream. Additional mitigation may be required

		P	Predicted deterioration is less than 10% for P. No WwTW upgrade is required	No class deterioration is predicted for P. No WwTW upgrade is required	Good status is not reached for P. Upgrade to the WwTW is needed but it is not achievable with BAT for P (P has GES in the actual situation). Trials are underway to assess new technology for Phosphate removal, however additional mitigation may still be required
Tuckmill Brook (Shrivenham)	No DWF permit exceedance is predicted	BOD	10% deterioration is predicted for BOD. Upgrade to the WwTW is needed and it is achievable with the BAT	No class deterioration is predicted for BOD. No WwTW upgrade is required	Good status is reached for BOD
		Amm	10% deterioration is predicted for Amm. Upgrade to the WwTW is needed and it is achievable with the BAT. The 95%ile requested is within the 10% model tolerance/variability	Class deterioration is predicted for Amm. Upgrade to the WwTW is needed and it is achievable with BAT. The 95%ile requested is within the 10% model tolerance/variability	Good status is reached for Amm
		P	Predicted deterioration is less than 10% for P. No WwTW upgrade is required	No class deterioration is predicted for P. No WwTW upgrade is required	Good status is not reached for P. Upgrade to the WwTW is needed but it is not currently achievable with BAT also assuming GES upstream. Trials are underway to assess new technology for Phosphate removal, however additional mitigation may still be required

5.4.5 Conclusions

Appendix B contains all the modelling results and detailed results. The main findings are:

- All WwTWs apart from Abingdon Lagoon are predicted to require some infrastructure upgrades to prevent a WFD deterioration on the receiving watercourses, however the

required standard of treatment would be achievable using current Best Available Technology or through other schemes.

- The WQA indicates that it would not be possible to reach Good Ecological Status (GES) for the watercourse receiving discharges from Abingdon WwTW's New Stream discharge in relation to the chemical element ammonia. The constraints are an existing problem and the solutions are not technically possible now. Therefore the EA do not consider that the increased effluent discharge from the proposed growth will cause a failure to reach GES.
- The WQA results for discharges from Wantage WwTW in relation to ammonia are so borderline that it is reasonable to consider that the increased discharge will not prevent GES from being achieved.
- At Oxford WwTW, the EA is proposing through its RBMP additional habitat restoration and to tighten Ammonia limits at the Oxford WwTW to 1 mg/l. This is considered technically feasible. In the event that the 1 mg/l limit is exceeded at Oxford WwTW due to growth, with infrastructure upgrades at the WwTW and additional habitat restoration in place, the waterbody's can be appropriately protected,
- It is not possible to reach Good Ecological Status (GES) for the watercourses receiving discharges from all WwTWs but Drayton in relation to the chemical element phosphate. The Environment Agency have confirmed that as part of the River Basin Management Plan (RBMP) they have recently undertaken assessments of what solutions would be required, in the present time, at STWs in order to get to GES in relation to Phosphate. Fundamentally this concludes that the planned allocated growth within the Local Plan has no, or very little, bearing on the ability of the waterbodies getting to GES in relation to Phosphate. It is pertinent to note that trials of what is technically feasible in relation to Phosphate are being undertaken, the results of which will be available in March 2017. The results will be reviewed in line with water company investigations and the overarching objectives of the WFD.
- The Environment Agency consider the water quality assessment to provide conservative estimates and are satisfied that "there are no limiting factors for growth based on the levels of growth indicated within the Local Plan, subject to the relevant mitigation measures and infrastructure upgrades stated within the Water Quality Assessment being delivered."
- Sewerage undertakers monitor flow and quality at their WwTWs and their internal planning processes monitor the growth trajectories at each WwTW to ensure that where required additional capacity can be put in place before existing permit limits are reached.

Appendix C reports the EA's response to the water quality results. They conclude that:

"We consider that the revised water quality assessment (WQA) is now considered appropriate and accurate for use within the WCS. Its conclusions highlight the potential risks posed to water quality deterioration from significant levels of growth. Notwithstanding this there are no limiting factors for growth based on the levels indicated within the Local Plan, subject to the relevant mitigation measures and infrastructure upgrades indicated within the WQA being delivered."

5.4.6 Recommendations

Table 5-12: Water quality actions

Action	Responsibility	Timescale
Where possible, take into account the water quality constraints when phasing development	VoWHDC	Ongoing
Take into account the findings of the water quality assessment when considering requirements for WwTW upgrades and feedback and work with the EA and VoWHDC to address concerns..	TWUL	Ongoing
Where the water quality assessment indicates that consents may require a higher standard of treatment than currently achievable using Best Available Technologies, provide clear guidance to TWUL and VoWHDC on: <ul style="list-style-type: none"> the approach to consenting, requirements for any additional studies (for example additional water quality sampling, modelling, macro-invertebrate surveys etc.). 	EA	Ongoing

6 Flood Risk Management

This section considers the flood risk to the potential site allocations, as well as the potential risk of increased flood flows in watercourses due to additional flows of sewage effluent.

6.1 Flood risk assessment

6.1.1 Methodology

The VoWHDC Strategic Flood Risk Assessment (SFRA)²⁵ along with the accompanying Sequential Test²⁶ and October 2014 addendum²⁷, is the main source of information regarding the flood risk to settlements and to the proposed strategic site allocations. As both of these documents have been refreshed in 2014, there is no need to reproduce their contents within the WCS. Instead, a simple Red / Amber / Green assessment has been prepared from that information. This was prepared as follows:

Fluvial Flood Risk	Pluvial Flood Risk
>95% of the site is within fluvial Flood Zone 1 (Low Risk). Very unlikely to be a constraint to development as long as access to the site can be maintained	<5% of site is within the Updated Flood Map for Surface Water 1 in 1000 year outline. Potential surface water drainage constraints are extremely low.
90-95% of the site is within fluvial Flood Zone 1 (Low Risk). Unlikely to be a constraint to development as long as access to the site can be maintained	5-20% of site is within the Updated Flood Map for Surface Water 1 in 1000 year outline. Potential surface water drainage constraints are very low to low.
<90% of the site is within fluvial Flood Zone 1 (Low Risk). Some constraint is likely for example housing numbers may be reduced	>20% of site is within the Updated Flood Map for Surface Water 1 in 1000 year outline. Potential surface water drainage constraints are medium to very high

6.1.2 Data collection

The datasets used to assess the risk of flooding have been provided by the EA and are listed below:

- Flood Zone 2 and 3
- Updated Flood Map for Surface Water

6.1.3 Results

The results are included within the final summary of results in section 9.1.8.

6.2 Assess flooding from increased WwTW discharge

In catchments with a large planned growth in population which discharge effluent to a small watercourse, the increase in the discharged effluent might have a negative effect on the risk of flooding. An assessment has been carried out in order to quantify such effect.

6.2.1 Methodology

The following process has been used to assess the potential risk increase of flood due to extra flow reaching a specific WwTW:

- Identify which WwTWs will be receiving the additional flows;
- Calculate the increase in DWF as a result of planned growth;
- Identify point of discharge of these WwTWs;
- At each point of outfall, use the FEH CD-ROM to extract the catchment descriptors;
- Use ReFH spreadsheet to calculate peak 1 in 30 (Q30) and 1 in 100 (Q100) year fluvial flows at the WwTW outfall;

²⁵ Vale of White Horse District Council (2014) Strategic Flood Risk Assessment

²⁶ Vale of White Horse District Council (2014) Sequential Test

²⁷ Vale of White Horse District Council (2014) Strategic Flood Risk Assessment Addendum

- Calculate the additional foul flow as a percentage of the Q30 and Q100 flow.

The risk associated is calculated using the values below:

Additional flow = <5% of Q30 - Low risk discharges will increase fluvial flood risk	Additional flow = >5% of Q30 – Moderate risk discharges will increase fluvial flood risk	Additional flow = >5% of Q100 – High risk discharges will increase fluvial flood risk
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6.2.2 Data collection

The datasets used to assess the risk of flooding are the following:

- Current and predicted future DWF for each WwTW (provided by TWUL)
- Location of WwTW outfall
- Catchment descriptors from FEH CD-ROM

6.2.3 Results

Table 6-1 shows that the effect of the increase of flow due to the future development has a negligible effect on the predicted peak flow for events with return period of 30 and 100 years. The WwTW with the highest flow increase is Kingston Bagpuize with the extra two sites and Wantage where there is respectively a 2.40% and 1.15% increased risk during a 30 year return period event.

Table 6-1: Summary of the predicted DWFs increase

WwTW	Receiving watercourse	ReFH Q30 m3/s	ReFH Q100 m3/s	Current DWF m3/d	Max predicted DWF	Flow increase m3/s	Flow increase % Q30	Flow increase % Q100
WANTAGE	Letcombe Brook	1.2	2	4954	6143	0.01	1.15%	0.69%
ABINGDON	Drain (Oday Ditches)	0.7	1	2331	2367	< 0.01	0.06%	0.04%
ABINGDON	Thames	184.8	227.5	6248	6389	< 0.01	< 0.01%	< 0.01%
OXFORD	Unknown	1.2	1.6	47845	47243	< -0.01	-0.58%	-0.44%
STANFORD IN THE VALE	River Ock	13.9	17.5	312	395	< 0.01	0.01%	0.01%
APPLETON	Drain	1	1.4	831	951	< 0.01	0.14%	0.10%
DIDCOT	Moor Ditch	2.5	3.4	8002	9448	0.02	0.67%	0.49%
SHRIVENHAM	Tuckmill Brook	7.9	10.1	1419	1646	< 0.01	0.03%	0.03%
FARINGDON	Unknown	2.3	3	1113	1388	< 0.01	0.14%	0.11%
DRYTON	Ginge Brook	1.4	2.4	1123	1343	< 0.01	0.18%	0.11%
KINGSTON BAGPUIZE	Unknown	0.2	0.3	544	694	< 0.01	2.40%	1.60%

Note: The above flood estimates are based solely on extracted catchment descriptors. They are suitable only for this simple analysis of the impact of WwTW effluent flows, and should not be used for flood modelling purposes.

6.2.4 Conclusions

The impact of increased effluent flows is unlikely to have a significant impact upon flood risk in the receiving watercourses.

6.2.5 Recommendations

None.

7 Environmental constraints and opportunities

7.1 Methodology

A desk study exercise to identify environmental risks and opportunities associated with the draft allocation sites has been carried out using GIS analysis of a range of notable environmental designations and features. This should be used in conjunction with Sustainability Appraisals (SA) and/or Strategic Environmental Assessments (SEAs) when these are available.

Each site was analysed to identify the presence of environmental features within the site area or within a specified distance of the site. These search buffer zones were chosen to reflect the type, nature and potential sensitivity of different environmental designations and features to the development of the sites for residential use. The potential adverse impacts associated with the development of the site were then considered in relation to these features, and potential environmental opportunities, such as habitat creation or recreational opportunities were also identified.

The environmental assessment provides an overview of the wider environment within the VoWHDC area and the potential risks and opportunities associated with the development of the proposed sites. The traffic-light scoring system has not been applied to this element of the study as its focus is on risks to the water environment, whilst the environmental appraisal has also considered the sensitivity of non-water related features. As such, there may be instances where development does not pose a risk to the water environment but could have a detrimental effect or could lead to an improvement to a sensitive environmental feature i.e., designated habitat, historic monument, etc. Application of the scoring system may therefore result in a misleading outcome in relation to such sites.

7.2 Data collection

Information was collected on a range of environmental designations and features (Table 7-1). This information was provided by the EA and the Vale of White Horse District Council, and was also sourced from OS OpenData. The features were grouped into seven topic areas: Biodiversity, Historic environment, Landscape, Water, Geology and soils, Air and Waste (see Table 7-2).

Table 7-1: Environmental designations and features

Environmental feature	Description
Agricultural Land Classification	<p>Agricultural Land Classification (ALC) is a method for assessing the quality of farmland. The ALC system classifies land into five grades:</p> <p>Grade 1: Excellent</p> <p>Grade 2: Very Good</p> <p>Grade 3: 3a – Good / 3b – Moderate</p> <p>Grade 4: Poor</p> <p>Grade 5: Very Poor</p> <p>The highest quality and most versatile land is defined as Grades 1, 2 and 3a.</p>
Air Quality Management Area	An area that the local authority must declare where national air quality objectives are not likely to be achieved.
Aquifer - Bedrock / Superficial Deposits	<p>Underground layers of water-bearing permeable rock or drift deposits from which groundwater can be extracted. These are split into:</p> <p>Superficial (Drift) - permeable unconsolidated (loose) deposits. For example, sands and gravels.</p> <p>Bedrock -solid permeable formations e.g. sandstone, chalk and limestone. These classifications are further split into the following designations:</p> <p>Principle Aquifers are layers of rock or drift deposits that have high intergranular and/or fracture permeability.</p> <p>Secondary Aquifers include a wide range of rock layers or drift deposits with an equally wide range of water permeability and storage.</p>

Environmental feature	Description
Area for Landscape Enhancement	Areas for landscape enhancement identified in the local plan are areas of damaged or compromised landscape. Proposals within or affecting these areas must provide a landscape scheme which enhances the appearance of the area.
Area of High Landscape Value	A non-statutory area designated by the local planning authority within which the quality of the landscape is of overriding significance. Development should not harm its special character and particular regard should be given to the siting, mass, scale, appearance, external materials used, external lighting and extent of any associated landscape proposals.
Ancient or Semi-Natural Woodland	Ancient woodland is land that has had a continuous woodland cover since at least 1600 AD, and may be ancient semi-natural woodland (ASNW), which retains a native tree and shrub cover that has not been planted.
Area of Outstanding Natural Beauty	An Area of Outstanding Natural Beauty (AONB) is an area of high scenic quality which has statutory protection in order to conserve and enhance the natural beauty of its landscape. AONB landscapes range from rugged coastline to water meadows to gentle lowland and upland moors.
Conservation Area	Conservation Areas are designated for their special architectural and historic interest. Most are designated by the local planning authority and place restrictions on a range of development including property alterations, tree works, advertisements and demolition.
Great Western Community Forest	The Great Western Community Forest is one of England's 12 Community Forests and covers an area of 168 square miles, stretching from Wootton Bassett to Faringdon and the North Wessex Downs to the Thames. The Community Forest aims to deliver long-term environmental improvements by promoting tree planting and sustainable woodland management.
Green Belt	A designation for land around certain cities and large built-up areas. The fundamental aim of Green Belt policy is to prevent urban sprawl by keeping land permanently open. Inappropriate development that is harmful to the Green Belt should not be approved except in very special circumstances.
Green Corridor	Green corridors are areas identified by the council that link development to amenity areas and help to promote environmentally sustainable forms of transport such as walking and cycling within urban areas. They also act as vital linkages for wildlife dispersal between urban and rural areas.
Groundwater Source Protection Zones	Source Protection Zones (SPZs) are defined around large and public potable groundwater abstraction sites. The purpose of SPZs is to provide additional protection to safeguard drinking water quality through constraining the proximity of an activity that may impact upon a drinking water abstraction.
Landfill/Historic Landfill	Landfill sites and Historic landfill sites are places where records indicate waste materials have been buried. Some sites remain open to further waste deposits (landfill), whilst others are now closed or covered (historic landfill).
Listed Building	Listed buildings are buildings or structures of exceptional architectural or historic special interest. Listed buildings have three grades: Grade I buildings are of exceptional interest, sometimes considered to be internationally important; Grade II* buildings are particularly important buildings of more than special interest; and Grade II buildings are nationally important and of special interest.
Local Wildlife Site	Local Wildlife Sites (LWSs) are non-statutory areas of local importance for nature conservation that complement nationally and internationally designated geological and wildlife sites. Local Wildlife Sites are protected

Environmental feature	Description
	within the local planning system. They are a 'material consideration' in the determination of planning applications, and there is a general presumption against development upon them.
National Nature Reserve	A National Nature Reserve (NNR) is one of the finest sites in England for wildlife and/or geology. A NNR is given protection against damaging operations, and any such operations must be authorised by the designating body. It also has strong protection against development on and around it.
National Park	National Parks are areas protected for their outstanding value in terms of natural beauty, ecological, archaeological, geological and other features, and recreational value.
National Trails	National Trails are long distance walking, cycling and horse riding routes through the best landscapes in England and Wales.
Ramsar Site	Ramsar sites are wetlands of international importance, designated under the Ramsar Convention 1971. As a matter of UK Government policy, Ramsar sites are protected as European sites (as set out in the Habitats Regulations).
Registered Battlefield	Registered battlefields are designated heritage assets and are included on the English Heritage Register of Historic Battlefields. Its purpose is to offer them protection and to promote a better understanding of their significance.
Registered/Historic Park and Garden	Registered parks and gardens are designated heritage assets and planning authorities must consider the impact of any proposed development on the landscapes' special character.
Scheduled Monument	Scheduled Monuments are historic sites of national importance and are protected under the Ancient Monuments and Archaeological Areas Act, as amended by the National Heritage Act 1983.
Site of Special Scientific Interest	Protected under a range of UK legislation, a Site of Special Scientific Interest (SSSI) is an area of land of special interest by reason of any of its flora, fauna, geological or physiographical features. An SSSI is given certain protection against damaging operations, and any such operations must be authorised by the designating body.
Special Area of Conservation / Sites of Community Importance	A Special Area of Conservation (SAC) is an area which has been given special protection under the European Union's Habitats Directive (as transcribed into UK law under the Conservation of Habitats and Species Regulations 2010 (As amended) – known as the 'Habitats Regulations'). SACs provide increased protection to a variety of wild animals, plants and habitats and are a vital part of global efforts to conserve the world's biodiversity.
Special Protection Area	A Special Protection Area (SPA) is an area of land, water or sea which has been identified as being of international importance for the breeding, feeding, wintering or migration of rare and vulnerable bird species found within the European Union. SPAs are European designated sites, classified under the European Wild Birds Directive.
Vale Archaeological Constraint Area	Vale Constraint Areas are sites of local archaeological interest identified by Oxfordshire County Council using the Historic Environment Record.
Waste Licence site	An environmental license granted for specific activities. The majority of waste management facilities are licensed under the Waste Management Licensing Regulations 1994.
Watercourse	A river, stream or other riparian feature i.e., ditch, as shown on OS mapping.
Water	The Water Framework Directive (WFD) requires that all 'water bodies'

Environmental feature	Description
Framework Directive (WFD) classification	(rivers, lakes, estuaries, coastal waters and groundwater) achieve good ecological potential by 2015. Under the WFD, all waterbodies are classified by their current and future predicted water quality, and specifically their ecological and chemical status.
World Heritage Site	World Heritage Sites are places of outstanding universal value to all humanity and are of great importance for the conservation of mankind's cultural and natural heritage. They need to be preserved for future generations, as part of a common universal heritage.

Table 7-2: Environmental designations and features buffer zones

Topic	Environmental feature	Search buffer (m)
Biodiversity	Site of Special Scientific Interest (SSSI)	1000m
	Special Area of Conservation (SAC)	2000m
	Special Protection Area (SPA)	2000m
	Ramsar site	2000m
	National Nature Reserve	1000m
	Local Nature Reserves	100m
	Ancient or Semi-Natural Woodland	100m
Historic environment	Scheduled Monument	500m
	Listed Building	100m
	Registered/Historic Park and Garden	500m
	World Heritage Site	500m
	Registered Battlefield	500m
Landscape	Area of Outstanding Natural Beauty (AONB)	1000m
	National Park	1000m
	National Trails	500m
	Green Belt	100m
Water	Watercourse	200m
	Water Framework Directive (WFD) classification	No Buffer applicable
	Groundwater source protection zones (SPZ)	No Buffer applicable
	Aquifer Maps - Superficial Deposits Designation	No Buffer applicable
	Aquifer Maps - Bedrock Designation	No Buffer applicable
Geology and soils	Agricultural Land Classification (ALC)	100m
Waste	Landfill	100m
	Historic Landfill	100m

7.3 Baseline natural environment

The Vale of White Horse area is predominantly rural in character with the River Thames forming the northern boundary of the district and the River Cole flowing along the western boundary. The River Ock and its numerous tributaries flow in an eastwards direction through the centre of the Vale, where the river joins the River Thames at Abingdon.

Abingdon, Wantage and Faringdon form the main urban areas within the Vale, with Didcot, Oxford and Swindon located in close proximity to the district boundary. In addition, there are over 70 villages and small hamlets across the Vale, and many isolated farmsteads in the wider countryside.

The Vale contains a diverse range of sites designated for their nature conservation value. There are two Special Conservation Area (SAC) sites within the district. These are sites designated under the EC Habitats Directive (Council Directive 92/43/EEC of 21 May 1992) and are internationally important for threatened habitats and species. Hackpen Hill SAC, located south west of Wantage, consists of unimproved chalk grassland and scrubland, whilst Cothill Fen SAC,

situated north-west of Abingdon, supports a calcium-rich spring water-fed alkaline fen. In addition, Oxford Meadows SAC, comprising a complex of lowland hay meadow sites, is located on the northern boundary of the district.

There are also 23 Sites of Special Scientific Interest (SSSIs) within the Vale, of which almost all are in 'favourable' or 'favourable – recovering' condition²⁸. Several of these sites are located within the vicinity of the proposed draft allocation sites, and therefore could potentially be affected by pollution, disturbance or a reduction in water resources as a result of their development. In addition, water sensitive sites in the district could be affected by changes in flow conditions in local watercourses and groundwater flow, and impacts on water quality. Such sites include Fernham Meadows SSSI and Grafton Lock Meadows SSSI, and the complex of fens located along the line of Sandford Brook, which is a tributary of the River Ock. These areas are characterised by a variety of vegetation types that are found on groundwater-fed peaty or mineral soils. These may be permanently, seasonally or periodically waterlogged.

At the local level, there are 84 County Wildlife Sites (also known as Local Wildlife Sites), five Local Nature Reserves and nine Regionally Important Geological Sites (RIGS) within the Vale. River corridors also form natural wildlife corridors and are an important feature of the landscape in the district.

The North Wessex Downs Area of Outstanding Natural Beauty (AONB) covers a large area in the south of the Vale (comprising approximately 23% of the area of the district) and consists of extensive areas of chalk downland. In addition, a substantial area in the north of the district is identified as an Area of High Landscape Value, and contains a complex of Ancient Woodland sites associated with the North Corallian Ridge. A Green Belt is present in the northeast of the district on the outer edges of Oxford and Abingdon, further highlighting the high quality and highly valued landscape in much of the Vale.

There are 68 Scheduled Monuments in the Vale, where consent is required for any works affecting the monument from the Secretary of State. In addition, the Vale currently has over 2,000 Listed Buildings, which occur in clusters across the district and are located in the many small villages and market towns. The Vale also has 52 designated Conservation Areas and eight historic parks and gardens that are included in the English Heritage National Register of Parks and Gardens of Special Historic Interest. The Vale Constraint Areas, which are associated with heritage features in the district, are most notable in a swathe along its southern boundary and along the northern boundary stretching across the Vale between Abingdon and Didcot. Scheduled Monuments follow the same pattern as the Vale Constraint Areas although they are more sparsely spread.

The distribution of good quality agricultural land within the Vale varies. A large band of ALC Grade 2 (very good quality) agricultural land stretches across the south of the district, with smaller areas of Grade 2 and Grade 3 land present in the south west. The central area of the Vale has a relatively large area of Grade 4 (poor quality) agricultural land although this is intersected with Grade 3 agricultural land. The north of the district contains a large swathe of Grade 2 land interspersed with smaller areas of Grade 3 and Grade 4 land.

River water quality in the Vale is generally good, with the River Ock and its tributaries recorded as having moderate water quality. Pressures on water quality in the district include phosphate contamination through diffuse pollution from agricultural areas. Much of the south of the Vale is identified as a Principal Aquifer, with a large swathe of the central section of the district classified as a Secondary (A) Aquifer. There are three groundwater Source Protection Zones (SPZs) present in the south of the Vale, which identify groundwater deposits sensitive to contamination, and within which pollution prevention measures may apply.

7.4 Environmental risks

Each of the draft allocation sites has been assessed to determine the presence of environmental features within the site or in within a specified distance from the site. The outcomes of this process are shown in Table 7-3. The presence of an environmental designation or feature may present a constraint to the development of the site or may require the implementation of mitigation measures to enable the development to proceed in a manner that does not have a significant adverse effect on the environment.

²⁸ Vale of White Horse District Council (2012), Core Strategy Sustainability Appraisal Scoping report, September 2012
<http://www.whitehorsedc.gov.uk/sites/default/files/SA%20Scoping%20Report%20FINAL.pdf>

Potential adverse impacts on the environment from the development of the draft allocation sites and associated water supply/sewerage infrastructure improvements include:

- Habitat loss and species disturbance in areas associated with new infrastructure and residential developments and along pipeline routes;
- Increased surface runoff and sediment loading leading to increased turbidity in receiving watercourses;
- Pollutants in chemicals and sewage effluent affecting water quality in surface waters and groundwaters;
- Increased pressure on water resources due to over-abstraction;
- Temporary and permanent landscape and visual impacts associated with ground disturbance, construction activities and the presence of new residential development/water treatment works;
- Loss or disturbance of archaeological features in areas associated with new infrastructure and residential developments and along pipeline routes;
- Increased waterlogging or drying out of buried archaeological features due to changes in groundwater levels and surface water runoff;
- Increased energy consumption and carbon emissions associated with construction and operation of new development, and the piping and treatment of increased volumes of water;
- Temporary air quality impacts associated with dust generated during construction; and
- Noise and vibration generated from construction activities.

Table 7-3: VoWHDC sites with high Environmental Risk potential

Site name	Topic	Environmental risks	Environmental opportunities
Faringdon (S1)	Biodiversity	Wicklesham & Coxwell Pits SSSI is within 1km of the site. The site is designated for its geological features and is of great historical importance. However, it is not likely to be affected by the development of the site. The site is within the Great Western Community Forest (CF). Development of the site will need to demonstrate how they will contribute to the objectives of the CF project. The development site is Greenfield and is likely to contain a range of biodiversity interests. Further assessment and survey will be required prior to development of the site.	Broadleaved tree planting to contribute to the Community Forest project. Vegetation cover will help manage surface water run-off. Restricted development in flood zones could be used to provide flood storage areas and provide a number of other environmental benefits such as biodiversity and recreational benefits. The use of SuDS could help to (or maintain) recharge the groundwater aquifer. Development of the site may present an opportunity to investigate the archaeological remains.
	Historic environment	A Vale Archaeological Constraints Area has been identified in the south west corner of the site, highlighting the potential for prehistoric ring ditches. Appropriate mitigation will need to be agreed with the Council and Oxfordshire County Council to protect these features.	Landscape mitigation measures in the form of vegetation planting may help integrate development into the North Corallian Ridge and could contribute to the management of surface water run-off.
	Landscape	The site lies within an Area of High Landscape Value known as the North Corallian Ridge. Appropriate measures should be taken to help preserve the special character of the	

Site name	Topic	Environmental risks	Environmental opportunities
		area such as massing, scale and appearance of the development, which will need to be agreed with the Council to avoid any adverse impacts on the AHLV.	
	Water	Holywell Brook is located 200m to the east of the site. Appropriate site drainage measures may need to be provided to avoid any risk of an impact on the water quality of this waterbody. The site is within a Secondary (A) Aquifer (bedrock) and measures may be required to avoid the risk of groundwater contamination. This may place restrictions on the use of SuDS in the site.	
	Geology and soils	The southern part of the site is classified as ALC Grade 3. The Council will need to justify the loss of 'best and most versatile land' rather than develop poorer quality land.	
Crab Hill (S2)	Biodiversity	The site is within 40m of Letcombe Brook, which is classified as having Good Ecological Status under the WFD. The watercourse has the potential to contain a range of notable ecological features. The development site is Greenfield and is likely to contain a range of biodiversity interests. Further assessment and survey will be required prior to development of the site.	Mitigation measures such as buffer zones around heritage assets could provide important green space and help manage surface water run-off. There may be an opportunity to enhance the setting of listed buildings and Conservation Areas through removal of intrusive features or appropriate vegetation planting. There is an opportunity to link into the Green Corridor to promote recreational opportunities. The use of SuDS could help to (or maintain) recharge the groundwater aquifer. Development of the site may present an opportunity to investigate the archaeological remains.
	Historic environment	There are three Grade II listed buildings within 100m of the site and two Conservation Areas within 500m of the site. Development of the site will need to demonstrate no adverse impact on the setting of these features. Charlton Historic Core is a Vale Archaeological Constraint Area located along the central southern boundary of the site. Appropriate mitigation will need to be agreed with the Council and Oxfordshire County Council to protect these features.	
	Landscape	The North Wessex Downs AONB is adjacent to the southern boundary of the site. Appropriate mitigation measures may need to be agreed with the Council to avoid any adverse impact on the landscape quality of the AONB. A Green Corridor runs north-south	

Site name	Topic	Environmental risks	Environmental opportunities
		through Wantage and Grove adjacent to the western boundary of the site.	
	Water	Letcombe Brook flows approximately 40m to the west of the site. Appropriate site drainage measures will need to be provided to avoid any risk of an impact on the water quality of this waterbody. The site is located within a Principal Aquifer (bedrock). Measures may be required to avoid the risk of groundwater contamination. This may place restrictions on the use of SuDS on the site.	
	Geology and soils	The majority of the site is classified as ALC Grade 2 land, whilst the western edge of the site is Grade 3 land. The Council will need to justify the loss of 'best and most versatile land' rather than develop poorer quality land.	
	Waste	There is a waste licence site within 100m of the site.	
	Landscape	The site is adjacent to the North Wessex Downs AONB. Development in this area may be restricted and appropriate mitigation will need to be agreed with the Council to avoid any adverse impact on the landscape quality of the AONB.	
Valley Park - North (S3)	Biodiversity	The development site is Greenfield and is likely to contain a range of biodiversity interests. Further assessment and survey will be required prior to development of the site. There are a number of watercourses present within or in close proximity to the development site, which have the potential to contain a range of notable ecological features.	The Council should aim to set back development a minimum of 6m from the unnamed watercourse, providing an 8m buffer strip to 'make space for water' and allow additional capacity to accommodate climate change. Developments should look at opportunities for river restoration, de-culverting and river enhancement as part of the development. Such measures could provide an important contribution to the WFD objectives for the watercourse. Restricted development in flood zones could be used to provide flood storage areas and provide a number of other environmental opportunities such as biodiversity and recreational
	Landscape	The North Wessex Downs AONB is located 850m south of the site. Appropriate mitigation may be required to avoid any adverse impact on the landscape quality of the AONB. There is a large area identified as an Area for Landscape Enhancement approximately 85m to the north of the site.	
	Water	A watercourse (labelled in the RBMP as Moor Ditch and Ladygrove Ditch) flows along the western boundary of the site. In addition, several other	

Site name	Topic	Environmental risks	Environmental opportunities
		<p>small watercourses and drainage ditches flow through the site or in close proximity to the site. An assessment should be made of the impact of site development on the WFD status of each waterbody that site water will drain into. The assessment should consider both water quality and quantity. Measures may need to be provided to avoid any impact on water quality or channel morphology in these waterbodies.</p> <p>The south of the site is within a Principal Aquifer (bedrock) and the north of the site is within a Secondary (undifferentiated) Aquifer (superficial deposits). Measures may be required to avoid the risk of groundwater contamination. This may place restrictions on the use of SuDS on the site.</p>	<p>benefits.</p> <p>Development of the site may present an opportunity to investigate the archaeological remains.</p> <p>The use of SuDS could help to (or maintain) recharge the groundwater aquifer.</p>
	Geology and soils	The site contains ALC Grade 2 and 3 land. The Council will need to justify the loss of 'best and most versatile land' rather than develop poorer quality land.	
Valley Park - South (S4)	Biodiversity	<p>The development site is Greenfield and is likely to contain a range of biodiversity interests. Further assessment and survey will be required prior to development of the site.</p> <p>There is a watercourse present along the eastern boundary of the site, which has the potential to contain a range of notable ecological features.</p>	<p>The Council should aim to set back development a minimum of 6m from the river, providing an 8m buffer strip to 'make space for water' and allow additional capacity to accommodate climate change.</p> <p>Developments should look at opportunities for river restoration, de-culverting and river enhancement as part of the development. Such measures could provide an important contribution to the WFD objectives for the watercourse.</p> <p>Restricted development in flood zones could be used to provide flood storage areas and provide a number of other environmental opportunities such as biodiversity and recreational benefits.</p> <p>Development of the site may present an opportunity to investigate the archaeological remains.</p>
	Landscape	The North Wessex Downs AONB is located immediately south of the site. Appropriate mitigation may be required to avoid any adverse impact on the landscape quality of the AONB.	
	Water	<p>A watercourse flows along the eastern boundary of the site. In addition, several other small watercourses and drainage ditches flow in close proximity to the site. An assessment should be made of the impact of site development on the WFD status of each waterbody that site water will drain into. The assessment should consider both water quality and quantity. Measures may need to be provided to avoid any impact on water quality or channel morphology in these waterbodies.</p>	

Site name	Topic	Environmental risks	Environmental opportunities
		The site is within a Principal Aquifer (bedrock) and the north of the site is within a Secondary (undifferentiated) Aquifer (superficial deposits). Measures may be required to avoid the risk of groundwater contamination. This may place restrictions on the use of SuDS on the site.	The use of SuDS could help to (or maintain) recharge the groundwater aquifer.
	Geology and soils	The site contains ALC Grade 2 and 3 land. The Council will need to justify the loss of 'best and most versatile land' rather than develop poorer quality land.	
Harwell (S5)	Biodiversity	The development site contains Greenfield land and is likely to contain a range of biodiversity interests. Further assessment and survey will be required prior to development of the site. The East Hendred Brook is located to the northwest of the site and is classified under the WFD as having Good Ecological Status. It has the potential to contain a range of notable ecological features.	The use of SuDS could help to (or maintain) recharge the groundwater aquifer. Development of the site may present an opportunity to investigate the archaeological remains.
	Water	East Hendred Brook is located 120m northwest of the site. Appropriate site drainage measures may need to be provided to avoid any risk of an impact on the water quality of this waterbody. The site is within a Principal Aquifer (bedrock) and measures may be required to avoid the risk of groundwater contamination. This may place restrictions on the use of SuDS on the site.	
	Geology and soils	The north of the site is ALC Grade 2 land. The Council will need to justify the loss of 'best and most versatile land' rather than develop poorer quality land.	
	Historic environment	Harwell Conservation Area is located approximately 415m west of the site. Development of the site will need to demonstrate no adverse impact on the setting of the Conservation Area. A Vale Archaeological Constraint Area has been identified within the eastern part of the site and comprises an Iron Age and Roman Settlement. Appropriate mitigation will need to be agreed with the Council and Oxfordshire County Council to protect these features.	

Site name	Topic	Environmental risks	Environmental opportunities
Monks Farm (S6)	Biodiversity	<p>Letcombe Brook flows through the centre of the site and is classified under the WFD as having Good Ecological Status. The river has the potential to contain a range of notable ecological features.</p> <p>The development site is Greenfield and is likely to contain a range of biodiversity interests. Further assessment and survey will be required prior to development of the site.</p>	<p>The Council should aim to set back development a minimum of 6m from Letcombe Brook, providing an 8m buffer strip to 'make space for water' and allow additional capacity to accommodate climate change. Developments should look at opportunities for river restoration, de-culverting and river enhancement as part of the development.</p> <p>There is the opportunity to continue the green corridor through the allocation site along Letcombe Brook. Restricted development in flood zones could be used to provide flood storage areas and provide a number of other environmental opportunities such as biodiversity and recreational benefits.</p> <p>There may be an opportunity to enhance the setting of listed buildings and Conservation Areas through removal of intrusive features or appropriate vegetation planting.</p> <p>Development of the site may present an opportunity to investigate the archaeological remains.</p>
	Historic environment	<p>There are four Grade II listed buildings within the site and three Grade II Listed buildings within 100m of the site. Development of the site will need to demonstrate no adverse impact on the fabric or setting of these structures.</p> <p>Grove Conservation Area is approximately 50m south of the site. Development of the site will need to demonstrate no adverse impact on the setting of the Conservation Area.</p> <p>There is a Vale Constraint Area present within the site and a second area located within 100m of the site. The constraint area within the site is associated with late Bronze Age features as well as undated and medieval inhumation sites. Appropriate mitigation will need to be agreed with the Council and English Heritage to protect these features.</p>	
	Landscape	<p>A Green Corridor runs north-south through Wantage and Grove, ending at the southern boundary of the site.</p> <p>There is also an Area of Landscape Enhancement within 100m west of the site.</p>	
	Water	<p>Letcombe Brook flows through the centre of the site and is classified under the WFD as having Good Ecological Status. All development should assess the impact of site drainage on the WFD status of the waterbody the water will drain into. The assessment should consider both water quality and quantity. Measures may need to be provided to avoid any impact on the water quality in this waterbody.</p> <p>The site is within a Secondary (A) Aquifer (Superficial Deposits) and measures may be required to avoid the risk of groundwater contamination.</p>	

Site name	Topic	Environmental risks	Environmental opportunities
		This may place restrictions on the use of SuDS on the site.	
	Geology and soils	The site is classified as containing ALC Grade 3 land. The Council will need to justify the loss of 'best and most versatile land' rather than develop poorer quality land.	

Environmental characteristics are aspects of the water environment that could be potentially affected by the development of a site i.e., surface water and groundwater quality and quantity, and aquatic biodiversity. Potential wider environmental risks considers whether development of the site could potentially have an adverse effect on other notable or sensitive environmental features such as the historic environment, landscape character and visual amenity, land use or terrestrial ecology. Potential wider environmental opportunities are benefits that development of the site could deliver to the wider environment, such as habitat creation, improvements in river water quality or the creation of new recreation or amenity opportunities.

7.5 Management options and policies

The following management options outline how the proposed strategic site allocations can minimise their impact on the neighbouring watercourses by reducing both diffuse and point sources of pollution.

New developments are required to attenuate surface water runoff and SuDS are the recommended approach as stated in NPPF, paragraph 51 of the Planning Practice Guidance and Building Regulations H. The implementation of SuDS schemes can:

- Mitigate the impact on receiving waters by holding and treating urban surface water runoff at or near to the source;
- Slow down surface runoff during heavy rain, reducing flooding problems;
- Provide new still water (i.e., ponds and ditches) and wetland habitat to benefit biodiversity;
- Offer recreational and amenity opportunities to local residents; and
- Enhance the local landscape character.

HR Wallingford's study, *'Maximising the Ecological Benefits of Sustainable Drainage Schemes'* (2003), advises that the maximum ecological benefits derived from SuDS may come from improvements to the still water aquatic environment and that the best that can often be achieved for the receiving waters is to prevent further deterioration. However, research indicates that whilst ponds and ditches may support quite rich wildlife communities, most SuDS schemes do not fulfil their ecological potential. This is due to inappropriate design features or a lack of maintenance of the structures leading to poor water quality and domination by common plant species. The design of a SuDS scheme would need to be specific to the development site and would need to meet the topographic and hydrological characteristics present there.

Riparian buffer strips can also be provided adjacent to watercourses within the development site or along its periphery. Buffer strips provide an intermediate protection zone between developed land and areas of conservation value, restricting the flow of pollutants and preventing them from being washed from the site into the watercourse. The width of the buffer strips will depend on the size of the water body. Natural England guidance²⁹ in relation to buffer strips adjacent to agricultural land states that *'Generally speaking, the wider the buffer the better the protection for the water body. Current evidence shows that 6m is the minimum effective width.'* Scottish Environmental Protection Agency (SEPA) guidance³⁰ for riparian zones for wildlife benefit states that a strip of at least 10m is recommended.

Impermeable surfaces in urban areas reduce rates of infiltration and therefore reduce rates of recharge to the underlying aquifers. Additional impermeable surfaces in areas with poor groundwater status will potentially reduce groundwater recharge further. The use of SuDS can help return water to groundwater by slowing down rainfall runoff in soakaways, permeable surfaces, ponds and wetlands. It is therefore recommended that SuDS are used wherever possible and particular in areas assessed as having poor groundwater status. SuDS can also provide ecological gain and in doing so have the potential to contribute towards the green infrastructure network in the district. Other examples of green infrastructure include:

Water Sensitive Urban Design (WSUD)

In recent years, the convergence of droughts, frequent flooding, climate change and increasing water demand due to population growth has led to a questioning of the management of urban water in the UK. Traditional engineering practices, for example, treat water drained from urban areas or indeed wastewater effluent as "waste" rather than as a resource.

The concept of WSUD was coined in Australia, where the key drivers for change were declining water quality of urban waterbodies and the prolonged drought of the early 2000s.

The recent CIRIA scoping study^a defined WSUD as "the process of integrating water cycle management with the built environment through planning and urban design." Whilst WSUD encompasses many aspects of SUDS, it also considers water resources and supply, wastewater reuse and the integration of water bodies into urban design.

The CIRIA study identifies that whilst some recent changes have driven more integrated water management (in particular the drive for SUDS to reduce surface water flood risk) there are significant areas which have been given little consideration, for example water efficiency in the home and integrating water into the urban environment. Barriers to application including lack of regulatory direction, lack of understanding and lack of economic incentives.

The role of professionals including town planners, architects, and urban designers in driving a "route map" towards WSUD is seen as more central than that of water engineers, emphasising that the WSUD approach values decentralised approaches integrated into the fabric of towns and cities.

^a CIRIA (2013) Creating water sensitive places - scoping the potential for Water Sensitive Urban Design in the UK
Photo © www.susdrain.net



29 Natural England (2011), Protecting water from agricultural runoff: buffer strips, First edition, September 2011

<http://publications.naturalengland.org.uk/publication/31003><http://publications.naturalengland.org.uk/publication/31003>

30 SEPA (2009), Riparian Vegetation Management Good Practice Guide <http://www.sepa.org.uk/water/idoc.ashx?docid=7c4571aa-4f09-45a1-ae5d-7cca72af65bc&version=-1>

- Woodland;
- Watercourses;
- Playing fields;
- Nature reserves;
- Cemeteries;
- Footpaths;
- Hedgerows; and
- Amenity landscaping.

Further provision of green infrastructure in the district has the potential to achieve a number of benefits. These include:

- Creation of new wildlife habitat and benefits to a range of species;
- Improvements to the local landscape character;
- Contribution to flood risk management; and
- Provision of new amenity assets and recreational opportunities.

7.6 Opportunities

There are a number of environmental opportunities that could be considered for each of the draft allocation sites. Implementation of these opportunities would have the potential to help mitigate the environmental impacts of development of each site and deliver environmental benefits, particularly in relation to biodiversity and water quality. The nature and scale of any environmental benefits achieved would depend upon the site characteristics and sensitivity of the surrounding environment. These environmental opportunities are summarised in Table 7-4.

Table 7-4: Environmental opportunities and benefits

Environmental opportunity	Potential environmental benefits
Allocation of green space for the provision of SuDS	<ul style="list-style-type: none"> • Potential to provide flood risk benefits through interception of surface runoff. • Reduced sediment loading in receiving watercourses and improved water quality. • Amenity value.
Retention and enhancement of existing water features on the site i.e., ponds, ditches and streams through creation of vegetated buffer strips.	<ul style="list-style-type: none"> • Increased biodiversity value, particularly for amphibians, invertebrates and small mammals. • Potential to provide flood risk benefits through interception of surface runoff. • Increased amenity value.
Creation of new water features on site i.e., ponds, ditches and streams.	<ul style="list-style-type: none"> • Increased biodiversity value, particularly for amphibians, invertebrates and small mammals. • Potential to provide flood risk benefits through interception of surface runoff. • Provision of amenity resource.
Terrestrial and marginal vegetation planting along river corridors to increase vegetation cover and improve water quality.	<ul style="list-style-type: none"> • Reduced river bank erosion. • Reduced water temperatures. • Increased biodiversity value, particularly for birds, invertebrates and fish. • Reduced sediment loading in receiving watercourses and improved water quality.
Planting of native broadleaved trees and retention of existing mature trees.	<ul style="list-style-type: none"> • Increased rainfall interception and reduced surface runoff. • Reduced sediment loading in receiving watercourses and improved water quality. • Increased local biodiversity, particularly in relation to birds, invertebrates and small mammals. • Increased shading and reduced heat-island effect. • Improved local air quality. • Increased amenity value.

Environmental opportunity	Potential environmental benefits
Habitat creation and provision of amenity areas in location at risk of flooding.	<ul style="list-style-type: none"> • Maintain floodplain connectivity. • Increased biodiversity value of floodplain, particularly for birds, invertebrates and small mammals. • Reduced flood risk to people and properties. • Reduced sediment loading in receiving watercourses and improved water quality. • Increased amenity value.

7.7 Recommendations

This study has provided a high-level appraisal of the potential environmental risks and opportunities associated with each of the draft allocation sites (see Section 7.4). This should be used in conjunction with Sustainability Appraisals (SA) and/or Strategic Environmental Assessments (SEAs) when these are available. More detailed assessment of the environmental issues associated with the development of each site should be undertaken prior to the approval for development to commence. This should include a thorough desk study and site surveys as required to fully identify sensitive environmental features present on each site.

The following recommendations are proposed in relation to the draft allocation sites:

- Consultation with Vale of White Horse Council ecologist and heritage officer should be undertaken in relation to the development of each site to further identify potential environmental risks and opportunities, and to determine specific requirements for mitigation measures.
- Developers should seek to maximise the water quality and amenity/ecological benefits when installing SuDS for surface water flood management. The design of SuDS schemes should be specific to each allocation site to maximise the environmental benefits derived. Careful planning of SuDS schemes in areas identified as groundwater aquifers or sensitive to groundwater contamination would be required to ensure no adverse impact on groundwater quality. However, provision of SuDS has the potential to maintain or improve groundwater recharge.
- Watercourses should be protected through the inclusion of riparian buffer strips. These zones will increase infiltration of surface runoff with potential benefits in terms of flood risks and water quality in the receiving watercourse.
- Existing water features i.e., ponds, ditches and streams should be retained as a high priority and incorporated into SuDS schemes where appropriate to maintain the aquatic biodiversity value of the sites and to provide a local source of flora and fauna that may naturally colonise new habitats.
- The removal or modification of existing river culverts should be considered where practicable in line with Environment Agency guidance. Modification of culverts has the potential to reduce flood risk due to blockages, create a more natural river bed profile and hydromorphological process, and also benefit a range of aquatic wildlife through new habitat creation or improving access to valuable habitat. Implementation of these measures could contribute towards delivery of the requirements of the Water Framework Directive.

7.8 Summary and Conclusions

Development of the allocation sites has the potential to cause a range of adverse impacts. Further environmental surveys and more detailed assessment are required for each of the sites to determine the acceptability of their development and to inform the requirement for mitigation measures. Allocation sites with the least amount of environmental features should not necessarily be assumed suitable for development. Likewise sites with a greater amount of environmental features should not be assumed unsuitable for development, constraints could be appropriately addressed.

The potential for adverse impacts on the water environment is closely related to the presence and sensitivity of water features on or in close proximity to each site. Where such features exist, adequate protection measures should be implemented in the design of the development to ensure effective protection during both construction and operational phases. Such measures would include the provision of wide vegetated buffer zones adjacent to watercourses, to reduce the risk

of contaminated runoff affecting river water quality and to promote aquatic biodiversity. In addition, measures would be required to protect water quality and water resources in underlying aquifers. The use of SuDS systems would promote infiltration of surface runoff and contribute to groundwater recharge, whilst also offering potential biodiversity, flood risk and amenity benefits.

Development of each site may also result in other environmental risks not specifically related to the water environment. Such effects could include the loss of, or damage to, important archaeological and heritage features, adverse impacts on terrestrial biodiversity, impacts on the setting of landscape or historic environment features, and the loss of high quality agricultural land. Development proposals for these sites would need to consider the sites wider context and planning policy.

There are also a range of potential environmental opportunities that could be delivered through any development proposals. Opportunities include enhancement of existing ecological features, such as watercourses, field margins and trees, the provision of new biodiversity habitats, and the creation of new recreational and amenity areas.

8 Climate Change Impact Assessment

8.1 Methodology

A qualitative assessment has been undertaken to assess the potential impacts of Climate Change on the assessments made in this water cycle study. This has been done using a matrix which considers both the potential impact of climate change on the assessment in question, and also the degree to which climate change has been considered in the information used to make the assessments contained within the WCS (see Table 8-1).

The impacts have been assessed on a district-wide basis; the available climate models are generally insufficiently refined to draw different conclusions for different parts of the District, or doing so would require a degree of detail beyond the scope of this study.

Table 8-1: Climate Change Pressures Scoring Matrix

		Impact of pressure		
		Low	Medium	High
Have climate change pressures been considered in the assessment?	Yes - quantitative consideration			
	Some consideration but qualitative only			
	Not considered			

8.2 Results

Table 8-2: Scoring of Climate Change Consequences for the Water Cycle Study

Assessment	Impact of Pressure	Have climate change pressures been considered in the assessment?	Climate Change Score
Water Resources	High (1) and (2)	Yes - qualitative consideration within WRMPs	
Water Supply	Medium - some increased demand during hot weather (2), (3)	Yes - qualitative consideration within WRMPs	
Sewerage system	High (3) - Intense summer rainfall and higher winter rainfall increases flood risk	No - not considered in company assessments	
Wastewater treatment	Medium (3) - Increased winter flows reduces flow headroom	No - not considered	
WwTW odour	Low	No - not considered	
Water quality	Medium (1, Sanitary Determinands) High (1, Nutrients)	No - not considered	
Flood risk	High (4)	Yes - climate change modelling and mapping	

Sources:

- (1) Thames River Basin Management Plan
- (2) Thames Water's Water Resource Management Plan
- (3) Thames Water's Business Plan 2015-20

(4) VoWHDC Strategic Flood Risk Assessment

8.3 Recommendations

Table 8-3: Climate change actions

Action	Responsibility	Timescale
When undertaking detailed assessments of environmental or asset capacity, consider how climate change can be considered	EA, TWUL	As required
Take "no regrets" decisions in the design of developments which will contribute to mitigation and adaptation to climate change impacts	VoWHDC, developers	

9 Summary and Recommendations

9.1 Water Cycle Study Summary

The water cycle study has been carried out in co-operation with the Environment Agency and Thames Water. Overall, there are no issues which indicate that the planned scale, location and timing of planned development within the District is unachievable from the perspective of supplying water and wastewater services and preventing deterioration of water quality in receiving waters.

The WCS has identified whether infrastructure upgrades are expected to be required to accommodate planned growth. Timely planning and provision of infrastructure upgrades will be undertaken through regular engagement between Vale of White Horse District Council, Thames Water, the EA and developers.

At project inception the Environment Agency set out a number of questions to be answered by the WCS. Responses to these questions are tabulated in Appendix D.

9.1.1 Development scenarios and policy issues

Conclusions

- The WCS study is based on an assessment of the impact of planned development with the Vale of White Horse District. As outlined in the study brief, growth was defined in three sub-areas as set out in the Local Plan.
- In addition to proposed site allocations, the locations and number of houses with planning permission (at Feb 2014) but which have not yet been constructed were also collated, totalling a net increase of 8624 dwellings, and considered.
- Legal agreements under the Town and Country Planning Act Section 106 agreement, and Community Infrastructure Levy agreements are not intended to be used to obtain funding for water or wastewater infrastructure. It is not, therefore necessary for Vale of White Horse District Council to identify requirements for developers to contribute towards the cost of upgrades in its Local Plan.
- The Water Industry Act sets out arrangements for connections to public sewers and water supply networks, and developers should ensure that they engage at an early stage with the relevant water supplier and sewerage undertaker to ensure that site-specific capacity checks can be undertaken and where necessary additional infrastructure constructed to accommodate the development. Where permitted the water company or sewerage undertaker may seek developer contributions towards infrastructure upgrades. Upgrades to water resources, water treatment works and wastewater treatment works are funded through the company business plans.

Recommendations

- VoWHDC will continue to work closely with Thames Water to provide updates of projected housing growth.

9.1.2 Water Resources

Conclusions

- The WCS reviewed the Thames Water Water Resource Management Plan (2015-2040). Thames Water manage water resources in six Water Resource Zones (WRZs). Their Swindon and Oxfordshire (SWOX) zone covers the whole of Vale of White Horse District, along with Swindon, the majority of Cotswold District, north Wiltshire and the majority of Oxfordshire.
- The WRMP estimates that the SWOX zone had a supply-demand surplus of 26MLD in 2011, but is forecast to decline and to become a deficit of -21ML/d by 2030 and -32M l/d by 2040. Thames Water intends to address this through promotion of water efficiency activity in the short-term (2015-2020), and further measures including installation of meters for household customers, innovative tariffs, water transfers and development of an additional strategic water resource in the medium to Long-term (2020-2040). The EA and Thames Water have taken account of the SHMA housing growth projections in their Water Resources Position Statement, titled 'Assessment of revised housing growth projections in Oxfordshire in the context of water resources'. This position statement is appended to the Thames Water and

Environment Agency Statement of Common Ground. Both Thames Water and the EA concluded in their Position Statement that Thames Water will be able maintain the security of supply in its SWOX Water Resource Zone in the next 5 years to 2020 through the annual Water Resources review process and deploying any required mitigation measures identified in the Water Resources Position Statement. Beyond this period, the next review of the Water Resources Management Plan, due to be published in draft form in 2018, will assess and programme future water resource requirements reflecting the revised housing growth projections.

Recommendations

- Thames Water should monitor the actual population and property numbers across SWOX through its annual review of its WRMP and initiate mitigation measures as necessary.
- Provide annual updates to TWUL of projected housing growth on an annual basis
- Thames Water should take account of the SHMA housing growth projections across SWOX in the next update of the WRMP. This approach has been agreed by the Environment Agency
- Implement the need for new development to be designed to Building regulations water consumption standard for water scarce areas (110 litres per person per day) as permitted by National Planning Policy Guidance.
- Consider potential for phasing development beyond 2020. Use of Grampian Conditions where appropriate.
- VoWHDC should use the planning system to safeguard further development at sites within the District which may be required for future strategic water resources.

9.1.3 Water supply Infrastructure

Conclusion

- Thames Water undertook a review of the capacity of their major water supply assets and their ability to meet increased demand due to planned growth within the District. They confirmed that they are able to supply the planned growth in the settlements in the Abingdon Flow Monitoring Zone (FMZ) (all Abingdon parishes, Kingston Bagpuize, Marcham, Shippon, Southmoor, Sunningwell, Wooton) and Hagbourne Hill FMZ (Appleford, Drayton, Sutton Courtenay, Milton Heights and Valley Park) without infrastructure upgrades.
- In all other settlements supplied by Thames Water, further modelling by Thames Water will be required to determine the scale of the water supply infrastructure upgrades that may be needed. Whilst it is expected that infrastructure upgrades will be required to serve the planned growth within these settlements, there remains adequate time for this infrastructure to be delivered by Thames Water without restricting the timing, location or scale of planned development.

Recommendations

- Thames Water to undertake a technical study to understand options to provide sufficient bulk and local transfer capacity and communicate findings to VoWHDC
- Developers seek early consultation with Thames Water in order to ensure adequate time is available to provide local distribution main upgrades to meet additional demand.
- VoWHDC consider potential for phasing development beyond 2020 in Abingdon, Faringdon and Wantage. (Timescale: ongoing).

9.1.4 Wastewater collection

Conclusions

- Thames Water undertook a review of the capacity of their sewerage systems and their ability to meet increased demand due to planned growth within the District. They concluded that it is likely upgrades will be required to all sewage systems however further modelling will be required to determine the scale of the wastewater infrastructure upgrades that may be needed in all settlements. Although upgrades are likely, it is considered capacity can be provided given sufficient time to implement upgrades as agreed by Thames Water
- Sewerage Undertakers have a duty under Section 94 of the Water Industry Act 1991 to provide sewerage and treat wastewater arising from new domestic development. A significant

proportion of future growth within the District already has planning permission, therefore the sewerage undertakers are already aware of the forthcoming growth. Where strategic upgrades are required to serve very large or multiple developments, infrastructure upgrades are usually only implemented following an application for a connection, adoption or requisition from a developer. Early developer engagement with water companies is therefore essential to ensure that sewerage capacity can be provided without delaying development.

Recommendations

- VoWHDC to take into account sewerage infrastructure constraints when phasing development in partnership with Thames Water and stakeholders.
- Thames Water to assess growth demands as part of their wastewater asset planning activities and feedback to VoWHDC where concerns over the timing of development arise.
- Thames Water and developers will work closely and early in the planning promotion process to develop an outline Drainage Strategy for all sites. The Outline Drainage strategy should set out sufficient detail to determine the likely timescales for the delivery of the infrastructure and the likely costs of the infrastructure. The Outline Drainage Strategy will be submitted as part of the planning application submission, and where required, used as a basis for a drainage planning condition to be set. (Timescales: ongoing).

9.1.5 Wastewater treatment works and quality consent assessments

Conclusions

- Thames Water provided an assessment of the available headroom in the flow and quality consents at their existing wastewater treatment works to accommodate additional wastewater flows. In addition, JBA Consulting undertook water quality impact modelling to assess the impact of Additional treated effluent on the receiving watercourses.
- Wastewater treatment works (WwTWs) at Appleton, Faringdon and Wantage are assessed as working close to their existing flow and quality consents and might require some upgrades to accommodate the proposed growth. Didcot, Drayton, Kingston Bagpuize, Oxford and Shivenham WwTWs are assessed as also requiring some upgrades.

Recommendations

- Where possible, VoWHDC should take into account WwTW capacity in phasing development.
- VoWHDC to provide annual updates to TWUL of projected housing growth.
- TWUL to assess growth demands as part of their wastewater asset planning activities and feedback to VoWHDC where concerns arise.
- TWUL, the Council and the EA will work closely to ensure the timely delivery of any necessary sewage treatment works upgrades.
- Where the water quality assessment indicates that permits may require a higher standard of treatment than currently achievable using Best Available Technologies, the EA should provide clear advice to VoWHDC and TWUL on:
 - the approach to permitting;
 - requirements for any additional studies (for example additional water quality sampling, modelling, macro-invertebrate surveys etc.);
 - advise where water quality constraints may limit the potential for growth. (Timescales: ongoing).

9.1.6 Wastewater treatment works odour assessment

Conclusions

- Where new development encroaches upon existing wastewater treatment works, odour from that works may become a cause for nuisance and complaints from residents. Managing odour at WwTWs can add considerable capital and operational costs, particularly when retro-fit to existing WwTWs. An odour screening assessment concluded the potential for two sites (Monks Farm Phase I & II in Wantage and South Drayton in Drayton) that may be at risk of experiencing odour due to their proximity to the existing WwTW. It is recommended that odour impact assessments be undertaken as part of the planning application process. None of the other preferred or reserve sites are likely to be impacted by odour from WwTWs.

Recommendations

- Odour assessments for Monks Farm, Grove and South Drayton sites to be undertaken as part of the planning application process.

9.1.7 Water quality Impact Assessment

Conclusion

- All WwTWs apart from Abingdon Lagoon are predicted to require some infrastructure upgrades to prevent a WFD deterioration on the receiving watercourses, however the required standard of treatment would be achievable using current Best Available Technology or through other schemes.
- The WQA indicates that it would not be possible to reach Good Ecological Status (GES) for the watercourse receiving discharges from Abingdon WwTW's New Stream discharge in relation to the chemical element ammonia. The constraints are an existing problem and the solutions are not technically possible now. Therefore the EA do not consider that the increased effluent discharge from the proposed growth will cause a failure to reach GES.
- The WQA results for discharges from Wantage WwTW in relation to ammonia are so borderline that it is reasonable to consider that the increased discharge will not prevent GES from being achieved.
- At Oxford WwTW, the EA is proposing through its RBMP additional habitat restoration and to tighten Ammonia limits at the Oxford WwTW to 1 mg/l. This is considered technically feasible. In the event that the 1 mg/l limit is exceeded at Oxford WwTW due to growth, with infrastructure upgrades at the WwTWs and additional habitat restoration in place, the waterbody's can be appropriately protected,
- It is not possible to reach Good Ecological Status (GES) for the watercourses receiving discharges from all WwTWs but Drayton in relation to the chemical element phosphate. The Environment Agency have confirmed that as part of the River Basin Management Plan (RBMP) they have recently undertaken assessments of what solutions would be required, in the present time, at STWs in order to get to GES in relation to Phosphate. Fundamentally this concludes that the planned allocated growth within the Local Plan has no, or very little, bearing on the ability of the waterbodies getting to GES in relation to Phosphate. It is pertinent to note that trials of what is technically feasible in relation to Phosphate are being undertaken, the results of which will be available in March 2017. The results will be reviewed in line with water company investigations and the overarching objectives of the WFD.
- The Environment Agency consider the water quality assessment to provide conservative estimates and are satisfied that "there are no limiting factors for growth based on the levels of growth indicated within the Local Plan, subject to the relevant mitigation measures and infrastructure upgrades stated within the Water Quality Assessment being delivered."
- Sewerage undertakers monitor flow and quality at their WwTWs and their internal planning processes monitor the growth trajectories at each WwTW to ensure that where required additional capacity can be put in place before existing permit limits are reached.

Recommendations

- VoWHDC take into account the water quality constraints when phasing development.
- Thames Water should take into account the findings of the water quality assessment when considering requirements for WwTW upgrades and feedback and work with the EA and VoWHDC to address concerns.
- Where the water quality assessment indicates that consents may require a higher standard of treatment than currently achievable using Best Available Technologies, provide clear guidance to TWUL and VoWHDC on:
 - the approach to consenting,
 - requirements for any additional studies (for example additional water quality sampling, modelling, macro-invertebrate surveys etc.),

9.1.8 Flood Risk Conclusions

- The percentage of each site at risk from fluvial or surface water flooding was calculated. This information may be used to supplement the information presented at the settlement scale in the Strategic Flood Risk Assessment.
- In catchments with a large planned growth in population which discharge effluent to a small watercourse, the increase in the discharged effluent might have a negative effect on the risk of flooding. This assessment has been carried out in order to quantify such effect. The impact of increased effluent flows are not predicted to have a significant impact upon flood risk in the receiving watercourses at any of the settlements with planned growth in the District.

Recommendations

- VoWHDC can use the percentage of each site at risk from fluvial or surface water flooding to supplement the information contained within the Strategic Flood Risk Assessment.

9.1.9 Environmental constraints and opportunities Conclusions

- A desk study exercise to identify environmental risks and opportunities associated with the draft allocation sites has been carried out using GIS analysis of a range of notable environmental designations and features. This should be used in conjunction with Sustainability Appraisals (SA) and/or Strategic Environmental Assessments (SEAs) when these are available.
- Each site was analysed to identify the presence of environmental features within the site area or within a specified distance of the site. These search buffer zones were chosen to reflect the type, nature and potential sensitivity of different environmental designations and features to the development of the sites for residential use. The potential adverse impacts associated with the development of the site were then considered in relation to these features, and potential environmental opportunities, such as habitat creation or recreational opportunities were also identified.
- The environmental assessment provides an overview of the wider environment within the District and the potential risks and opportunities associated with the development of the proposed sites.

Recommendations

- Continued consultation with VoWHDC Ecologist and Heritage Team should be undertaken in relation to the development of each site to ensure further identification of potential environmental risks and opportunities, and to determine specific requirements for mitigation measures.
- Developers should seek to maximise the water quality and amenity/ecological benefits when installing SuDS for surface water flood management. The design of SuDS schemes should be specific to each allocation site to maximise the environmental benefits derived. Careful planning of SuDS schemes in areas identified as groundwater aquifers or sensitive to groundwater contamination would be required to ensure no adverse impact on groundwater quality. Provision of SuDS has the potential to maintain or improve groundwater recharge.
- Watercourses should be protected through the inclusion of riparian buffer strips. These zones will increase infiltration of surface runoff with potential benefits in terms of flood risks and water quality in the receiving watercourse.
- Existing water features i.e., ponds, ditches and streams should be retained as a high priority and incorporated into SuDS schemes where appropriate to maintain the aquatic biodiversity value of the sites and to provide a local source of flora and fauna that may naturally colonise new habitats.
- The removal or modification of existing river culverts should be considered where practicable in line with Environment Agency guidance. Modification of culverts has the potential to reduce flood risk due to blockages, create a more natural river bed profile and hydro-morphological process, and also benefit a range of aquatic wildlife through new habitat creation or improving access to valuable habitat. Implementation of these measures could contribute towards delivery of the requirements of the Water Framework Directive.

- Good design principles should be applied to all developments, particularly those located in sensitive or protected landscapes so as to minimise the impact on landscape character and visual amenity. Design advice provided by CDC should be applied and consultation with the Council's landscape officer should be undertaken to inform the design of the development of a site.

9.1.10 Climate change

Conclusions

- A qualitative assessment has been undertaken to assess the potential impacts of Climate Change on the assessments made in this water cycle study. The assessment used a matrix which considers both the potential impact of climate change on the assessment in question, and also the degree to which climate change has been considered in the information used to make the assessments contained within the WCS.
- The capacity of the sewerage system and the water quality of receiving water bodies stand out as two elements of the assessment where the consequences of climate change are expected to be high, but no account has been made of climate impacts in the assessment. This should be addressed at detailed assessment stage.

Recommendations

- When undertaking detailed assessments of environmental or asset capacity, TWUL and EA should consider how climate change can be considered. (Timescale: ongoing).
- VoWHDC and developers should take decisions in the design of developments which will contribute to mitigation and adaptation to climate change impacts. (Timescale: ongoing).

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Warrington

Registered Office

South Barn
Broughton Hall
SKIPTON
North Yorkshire
BD23 3AE

t: +44(0)1756 799919
e: info@jbaconsulting.com

Jeremy Benn Associates
Ltd
Registered in England
3246693



Visit our website
www.jbaconsulting.com