South East Strategic Reservoir Option (SESRO)

Technical Supporting Document B2

Terrestrial Environmental Appraisal Report

Notice

Position Statement

This document has been produced as the part of the process set out by RAPID for the development of the Strategic Resource Options (SROs). This is a regulatory gated process allowing there to be control and appropriate scrutiny on the activities that are undertaken by the water companies to investigate and develop efficient solutions on behalf of customers to meet future drought resilience challenges.

This report forms part of suite of documents that make up the 'Gate 2 submission.' That submission details all the work undertaken by Thames Water and Affinity Water in the ongoing development of the proposed SROs. The intention of this stage is to provide RAPID with an update on the concept design, feasibility, cost estimates and programme for the schemes, allowing decisions to be made on their progress and future funding requirements.

Should a scheme be selected and confirmed in the companies' final Water Resources Management Plan, in most cases it would need to enter a separate process to gain permission to build and run the final solution. That could be through either the Town and Country Planning Act 1990 or the Planning Act 2008 development consent order process. Both options require the designs to be fully appraised and in most cases an environmental statement to be produced. Where required that statement sets out the likely environmental impacts and what mitigation is required.

Community and stakeholder engagement is crucial to the development of the SROs. Some high level activity has been undertaken to date. Much more detailed community engagement and formal consultation is required on all the schemes at the appropriate point. Before applying for permission Thames Water and Affinity Water will need to demonstrate that they have presented information about the proposals to the community, gathered feedback and considered the views of stakeholders. We will have regard to that feedback and, where possible, make changes to the designs as a result.

The SROs are at a very early stage of development, despite some options having been considered for several years. The details set out in the Gate 2 documents are still at a formative stage and consideration should be given to that when reviewing the proposals. They are for the purposes of allocating further funding not seeking permission.

Disclaimer

This document has been written in line with the requirements of the RAPID Gate 2 Guidance and to comply with the regulatory process pursuant to Thames Water's and Affinity Water's statutory duties. The information presented relates to material or data which is still in the course of completion. Should the solution presented in this document be taken forward, Thames Water and Affinity Water will be subject to the statutory duties pursuant to the necessary consenting process, including environmental assessment and consultation as required. This document should be read with those duties in mind.

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Glossary

Term	Definition
Agricultural Land Classification (ALC)	ALC provides a framework for classifying land according to the extent to which its physical or chemical characteristics impose long-term limitations on agricultural use. It classifies agricultural land in five categories according to versatility and suitability for growing crops: • Grade 1 – excellent quality agricultural land; • Grade 2 – very good quality agricultural land; • Grade 3 – split into Subgrade 3a of good quality agricultural land, and Subgrade 3b of moderate quality agricultural land; • Grade 4 – poor quality agricultural land; and • Grade 5 – very poor quality agricultural land. Grades 1, 2 and 3a are classed as best and most versatile (BMV) and greater consideration of these soil resources are made during planning applications.
Ancient and veteran trees	An ancient tree is one that has passed beyond maturity and is old, or aged, in comparison with other trees of the same species. Veteran is a term describing a tree with habitat features such as wounds or decay. All ancient trees are veteran, but not all veterans are old enough to be ancient. An ancient tree is exceptionally valuable. Attributes include its: 1) great age; 2) size; 3) condition; 4) biodiversity value as a result of significant wood decay and the habitat created from the ageing process; 5) cultural and heritage value. (Sources: https://www.gov.uk/guidance/ancient-woodland-ancient-trees-and-veteran-trees-advice-for-making-planning-decisions and https://www.woodlandtrust.org.uk/media/1836/what-are-ancient-trees.pdf)
Ancient Tree Inventory	An inventory database of ancient, veteran and notable trees identified across the UK.
Ancient Woodland	Any area that's been wooded continuously since at least 1600 AD, or a date otherwise specified by the Overseeing Organisation including: 1) ancient semi-natural woodland mainly made up of trees and shrubs native to the site, usually arising from natural regeneration plantations on ancient woodland sites; 2) replanted with conifer or broad-leaved trees that retain ancient woodland features, such as undisturbed soil, ground flora and fungi; 3) wood pastures identified as ancient; 4) historic parkland, which is protected as a heritage asset in the relevant planning policy.

Term	Definition
	(Source: https://www.gov.uk/guidance/ancient-woodland-ancient-trees-and-veteran-trees-advice-for-making-planning-decisions)
Ancient Woodland Inventory (AWI)	An inventory database identifying confirmed ancient woodland sites based on presence of woods from old maps, information about the wood's name, shape, internal boundaries, location relative to other features, ground survey, and aerial photography.
Annoyance (dust)	Loss of amenity due to dust deposition or visible dust plumes, often related to people making complaints, but not necessarily sufficient to constitute a nuisance according to legal definition.
Annual Average Daily Flow (AADF)	The average over a full year of the number of vehicles passing a point in the road network each day (1-way traffic)
Annual Average Daily Traffic (AADT)	The total volume of vehicle traffic on a highway or road for a year divided by 365 days.
Annual Average Weekday Traffic (AAWT)	The total volume of vehicle traffic, weekdays only, on road or motorway for a year divided by the number weekdays in the year.
Area of Outstanding Natural Beauty (AONB)	Land protected by the Countryside and Rights of Way Act 2000 on account of factors such as landscape or scenic quality, relative wildness or tranquility, and / or natural or cultural heritage features. It protects the land to conserve and enhance its natural beauty. (Source: Natural England)
A-weighting	A frequency weighting that relates to the response of the human ear
Background noise level	Prevailing noise level in a specified environment measured in the absence of the noise being studied
Baseline data	Data used to describe the current conditions of the environment, against which future predictions can be made.
Benefits	Positive impacts on wellbeing.
Best and Most Versatile (BMV)	Defined as Grades 1, 2 and 3a by policy guidance. This is the land which is most flexible, productive and efficient in response to inputs and which can best deliver future crops.
Biodiversity Net Gain (BNG)	Biodiversity Net Gain is an approach to development that leaves biodiversity in a measurably better state than before.
Carbon Sequestration	The uptake and storage of carbon, for instance by absorption of carbon dioxide by trees and plants which then release the oxygen.

Term	Definition
Conceptual Model (CM)	A written or pictorial representation of sources, pathways, and receptors at potentially contaminated sites, in line with LCRM guidance.
Conservation Area	Defined by the Planning (Listed Buildings and Conservation Areas) Act 1990 as an area 'of special architectural or historic interest, the character of which it is desirable to preserve or enhance'.
Construction	Any activity involved with the provision of a new structure (or structures), its modification or refurbishment. A structure will include a residential dwelling, office building, retail outlet, road, etc.
Construction Environmental Management Plan (CEMP)	A document which sets out site-specific procedures and mitigation measures to monitor and control environmental impacts throughout the construction phase of the project.
Contaminated land	Defined in Part 2A of the Environmental Protection Act 1990 as land where significant harm is being caused or there is a significant possibility of such harm being caused; or significant pollution of controlled waters is being, or is likely to be caused.
Demolition	Any activity involved with the removal of an existing structure (or structures). This may also be referred to as de-construction, specifically when a building is to be removed a small part at a time.
Deposited dust	Dust that is no longer in the air and which has settled onto a surface. Deposited dust is also sometimes called amenity dust or nuisance dust, with the term nuisance applied in the general sense rather than the specific legal definition.
Disbenefits	Negative impacts on wellbeing.
Discounting	A method for translating future costs or benefits into present values using a discount rate.
Dust	Solid particles that are suspended in air, or have settled out onto a surface after having been suspended in air. The terms dust and particulate matter (PM) are often used interchangeably, although in some contexts one term tends to be used in preference to the other. In this assessment the term 'dust' has been used to include the particles that give rise to soiling, and to human health (i.e. PM10 or PM2.5) and ecological effects. Note: this is different from the definition given in BS 6069-2:1994, where dust refers to particles up to 75µm in diameter.
Earthworks	Covers the processes of soil-stripping, ground-levelling, excavation and landscaping.

Term	Definition
Ecosystem	A dynamic complex of living things (animals, plants and micro-organisms) and their physical environment interacting as a functional unit.
Ecosystem Services	Functions of the natural environment, that directly or indirectly provide benefits for people.
Environmental Impact Assessment (EIA)	Statutory process under (for the Proposed Scheme) the Town and Country Planning (EIA) Regulations 2017 (as amended), consisting of: 1. Preparation of an Environmental Statement 2. Consultation 3. Examination by the competent authority of the information contained within the Environmental Statement 4. The reasoned (justified or evidenced) conclusion by the competent authority on the significant effects of the project on the environment 5. The reasoned (justified or evidenced) decision by the competent authority to grant or refuse development consent.
European Protected Species (EPS)	Species listed in Schedule 2 and Schedule 4 of the Conservation of Habitats and Species Regulations 2019, as amended.
European Protected Species Mitigation Licence (EPSML)	The licence required to derogate from the law concerning species listed in Schedule 2 and Schedule 4 of the Conservation of Habitats and Species Regulations 2019, as amended.
Eutrophic	Rich in organic and mineral nutrients and supporting an abundant plant life, which in the process of decaying depletes the oxygen supply for animal life.
Façade noise level	The noise level is that determined 1 m from a vertical surface (e.g., at a window or door on the façade of a building). Sound is reflected from the surface, resulting in an increase above the equivalent free field level of approximately 3 dB.
Free field noise level	The noise level measured in an environment where there is no reflective surfaces.
GDP (Gross Domestic Product)	The value of output or national income of a country over a 12 month period.
GDP Deflator	An index of the general price level in the economy, measured by the ratio of Gross Domestic Product (GDP) in nominal terms to GDP at constant prices.
Habitat	A place where an organism or community of organisms normally live.
Heavy Duty Vehicle (HDV)	Goods vehicles and buses greater than 3.5 tonne (t) gross vehicle weight.

Term	Definition
Historic Landscape Character	Historic Landscapes are defined by perceptions that emphasise the evidence of the past and its significance in shaping the present landscape. The definition encompasses all landscapes, including the countryside, townscapes and industrial landscapes as well as designed landscapes, such as gardens and parks.
Important hedgerow	A hedgerow that is at least 30 years old and meets at least one of the criteria set out in the Hedgerow Regulations 1997 and, as such, afforded protection from damage or destruction. (Source: https://www.gov.uk/guidance/countryside-hedgerows-regulation-and-management)
Intervisibility	If there is intervisibility between a development feature and a receptor, the development feature is visible from the receptor and the receptor, or its location, is visible from the development.
Key characteristics (landscape)	The elements or combination of elements that are particularly important to the current distinctive character of the landscape and help to give an area its particularly distinctive sense of place. (Source: GLVIA3)
L90	Noise level of noise that is exceeded 90% of the time
LAeq	A steady noise level (weighted) which over a period of time has the same sound energy as the time varying noise
LAmax	LAmax is the maximum sound pressure level (weighted) measured over a measurement period.
Landscape and Visual Appraisal (LVA)	An appraisal of the nature of changes to the landscape as a resource and people's views and visual amenity, that is carried out informally and falls outside the requirements of the EIA Directive and Framework. In carrying out appraisals, similar principles and process as LVIA may be applied but conclusions are not drawn regarding the likely significance of effects. (Source: GLVIA3)
Landscape and Visual Impact Assessment (LVIA)	An assessment to identify and assess the significance of and the effects of change resulting from a project on both the landscape as a resource and on people's views and visual amenity. (Source: GLVIA3)
Landscape Character	A distinct, recognisable and consistent pattern of elements in the landscape that makes one landscape different from another, rather than better or worse. (Source: GLVIA3)

Term	Definition
Landscape Character Area (LCA)	A discrete geographical area of a particular landscape type. (Source: GLVIA3)
Landscape Character Assessment	Process of identifying and describing variation in character of the landscape - the unique combination of elements and features that make landscapes distinctive - to assist in managing change in the landscape. (Source: GLVIA3)
Landscape Character Type (LCT)	Distinct types of relatively homogeneous landscape, generic in nature but which share broadly similar combinations of geology, topography, drainage patterns, vegetation and historical land use and settlement pattern, and perceptual and aesthetics attributes. (Source: GLVIA3)
Landscape elements	Individual parts of the landscape include physical influences (geology, soils, landform, drainage, and water bodies); land cover (different types of vegetation, patterns, and types of tree cover); and human influences (land use and management, character of settlements of buildings, and pattern and type of fields and enclosure). (Source: GLIVA3)
Landscape establishment period	A period after initial planting requiring intervention such as weed control to allow for successful plant establishment. (Source: LA107)
Landscape receptor	Defined aspect of the landscape resource that potentially could be affected by the project. (Source: GLIVA3)
Landscape Value	Relative value or importance attached to different landscapes by society on account of their landscape qualities, including natural and cultural heritage, landscape condition, associations, distinctiveness, recreational value, perceptual value (scenic/wildness and tranquility) and functionality. (Source: GLVIA3 and Landscape Institutes Technical Guidance Note; TGN 02/21 'Assessing landscape value outside national designations')
LAX	An approximation to a noise event SEL calculated from LAmax and the 10dB down duration (for which the sound level lies within 10dB of (LAmax)
Light Duty Vehicle (LDV)	Cars and small vans less than 3.5 t gross vehicle weight.
Listed building	A building or structure designated under section 69 of the Planning (Listed Building and Conservation Areas) Act 1990 as being of 'special architectural or historic interest'.

Term	Definition
Local Geological Sites (LAGS)	Non-statutory sites that have been identified by local geo-conservation groups as being of importance, according to their value for education, scientific study, historical significance or aesthetic qualities. Formerly known as Regionally Important Geological Sites (RIGS).
Mineral Safeguarding Areas (MSA)	Areas of known mineral resources that are of sufficient economic or conservation value (such as building stones) to warrant protection for generations to come.
National Nature Reserve (NNR)	A statutory designation afforded to land declared under the National Parks and Access to the Countryside Act 1949 or Wildlife and Countryside Act (1981) as amended, and include some of the best examples of wildlife and geology.
National Planning Policy Framework (NPPF)	Sets out the Government's economic, environmental and social planning policies. A revised National Planning Policy Framework was published by the Ministry of Housing, Communities and Local Government in July 2021 which replaced the previous NPPF published in March 2012 and revised in February 2019.
Natural Capital	Stocks of the elements of nature that have value to society, such as forests, fisheries, rivers, biodiversity, land and minerals. Natural capital includes both the living and non-living aspects of ecosystems. Stocks of natural capital provide flows of environmental or 'ecosystem' services over time. These services, often in combination with other forms of capital (human, produced and social) produce a wide range of benefits
Noise enclosure	A structure built around a machine to reduce noise
Nuisance	The term nuisance dust is often used in a general sense when describing amenity dust. However, this term also has specific meanings in environmental law: (a) statutory nuisance, as defined in S79(1) of the Environmental Protection Act 1990 (as amended); (b) private nuisance, arising from substantial interference with a person's enjoyment and use of their land; and (c) public nuisance, arising from an act or omission that obstructs, damages or inconveniences the rights of the community. Each of these applies as far as the nuisance relates to the unacceptable effects of emissions. It is recognised that a significant loss of amenity may occur at lower levels of emission than would constitute a statutory nuisance.
Particulate matter	Airborne particulate matter is made up of a collection of solid and/or liquid materials of various sizes that range from a few nanometres in diameter (about the size of a virus) to around 100 microns (about the thickness of a human hair).
Phase 1 habitat survey	The Phase 1 habitat classification and methodology is a widely used and industry accepted technique for habitat survey across the UK.

Term	Definition
Photomontage	A visualisation which superimposes an image of a proposed development upon a photograph or series of photographs.
PM_{10}	Particulate matter with an aerodynamic diameter of 10 microns or less.
$PM_{2.5}$	Particulate matter with an aerodynamic diameter of 2.5 microns or less.
Present Value	The sum of a stream of future values discounted at an appropriate discount rate (such as the Green Book social discount rate) to bring them to today's value.
Public Right of Way (PRoW)	A public right of way is a right by which the public can pass along linear routes over land at all times. Although the land may be owned by a private individual, the public have a legal right across that land along a specific route. (Source: https://www.devon.gov.uk/prow/what-are-public-rights-of-way/
Registered Historic Parks and Gardens	Parks and gardens which, due to their historic interest have been added to the Register by Historic England.
Replacement Cost	The cost of providing a substitute good or engineering solution that performs a similar function to the environmental good. For example, wetlands that provide flood protection may be valued on the basis of the cost of building man-made defences of equal effectiveness. Since wetlands provide a range of ecosystem services, this costing would be a minimum estimate of the value of a wetland.
Residual noise	Ambient noise remaining when specific noise is suppressed
Reverberant sound	The sound in an enclosed space that results from repeated reflections at the reflective boundaries
Risk	The likelihood of an adverse event occurring.
Scheduled Monument	A monument which has been scheduled is protected against disturbance. The Secretary of State must be informed about any work which might affect a monument above or below ground, and English Heritage gives advice to the Government on each application. In assessing each application the Secretary of State will try to ensure that damage done to protected sites is kept to a minimum.
Single Event Level (SEL)	The SEL (also sometimes called the Sound Exposure Level) is the sound level over one second which have the same energy content as the whole event.
Sense of place	The essential character and spirit of an area (genius loci - spirit of the place). (Source: LA107)

Term	Definition
Sensitivity	Term applied to specific receptors, combining judgements of the susceptibility of the receptor to specific type of change proposed and the value related to that receptor. (Source: GLIVA3)
Setting	Contribution of the surroundings to the appearance of an area or feature and the interrelationship of the area or feature to the wider context and sense of place. (Source: LA107)
Silencer	A device used for reducing noise within air and gas flow systems. Can be fitted to exhausts of construction plant
Site of Special Scientific Interest (SSSI)	Sites of Special Scientific Interest represent the best examples of habitats present within the UK, and the designation provides statutory protection and a duty for the landowner to maintain the habitats
Sound Absorption Coefficient (α)	The dimensionless ratio of sound energy absorbed by a surface. A high coefficient material could be effectively used to reduce reflections/ reverberant sound
Sound Power Level, Lw	Sound power is the sound energy radiated per unit time by a sound source, measured in Watts (W). Sound power level, Lw (SWL) is measured on a decibel scale
Sound Pressure Level, Lp	Sound pressure is the fluctuations in air, measured in Pascals (Pa). Sound Pressure Level, Lp (SPL) is measured on a decibel scale
Special Area of Conservation (SAC)	Special Areas of Conservation are strictly protected sites designated under the EC Habitats Directive.
Special quality	Landscape qualities of nationally designated landscapes, such as the components of natural beauty of an AONB. (Source: Landscape Institutes Technical Guidance Note; TGN 02/21 'Assessing landscape value outside national designations')
Study area	Study areas are used to define the spatial extent of environmental assessments. Each environmental factor defines its own study area(s) individually, taking account of relevant guidance.
Susceptibility	Ability of a defined landscape or visual receptor to accommodate the specific proposed change without negative consequences. (Source: GLIVIA3)

Term	Definition
Trackout	The transport of dust and dirt from the construction/demolition site onto the public road network, where it may be deposited and then re-suspended by vehicles using the network
Tranquility	A state of calm and quietude associated with peace, considered to be a significant asset of landscape. (Source: GLIVIA3)
Value transfer	The process of inferring the size of an economic benefit or cost at the site under consideration from previous research at another site, paying careful attention to contextual changes.
Visual amenity	Overall enjoyment of a particular area, surroundings, or views in terms of people's activities - living, recreating, travelling through, visiting, or working. (Source: GLIVIA3)
Visual receptor	Individuals and/or defined groups of people who potentially could be affected by a project. (Source: GLIVIA3)
Visual Value	Relative value attached to views, on account of recognition of a view through planning designations and / or in relation to heritage assets; and / or value attached to views by visitors, as indicated by appearance in guidebooks or on tourist maps, provision of facilities for their enjoyment and / or references in literature or art. (Source: GLIVIA3)
World Heritage Site	A site which has been listed by the United Nations Educational, Scientific and Cultural Organization (UNESCO) due to its cultural or physical significance.
Zone of theoretical visibility (ZTV)	Map produced (usually digitally) to specific criteria to illustrate the area(s) from which a project can theoretically be visible. (Source: GLIVIA3)

Abbreviations

Abbreviation	Full Term
AADT	Annual Average Daily Traffic
ACWG	All Companies Working Group
ADC	Auxiliary Drawdown Channel
ALC	Agricultural Land Classification
AONB	Area of Outstanding Natural Beauty
AQMA	Air Quality Management Area
AQOs	Air Quality Objectives
BOCC	Birds of Conservation Concern
BMV	Best and Most Versatile
BNG	Biodiversity Net Gain
BNL	Basic Noise Level
BoCC	Birds of Conservation Concern
BS	British Standard
Capex	Capital expenditure
CAR	Conservation, access and recreation
CEMP	Construction Environmental Management Plan
CL:AIRE	Contaminated Land: Applications In the Real Environment
CM	Conceptual Site Model
CNR	Calculation of Railway Traffic Noise
CPRE	Campaign to Protect Rural England
CRTN	Calculation of Road Traffic Noise
CWS	County Wildlife Site
DBA	Desk-Based Assessment
Defra	Department for Environment, Food and Rural Affairs
DfT	Department for Transport
DM	Do Minimum
DMRB	Design Manual for Roads and Bridges

Abbreviation	Full Term
DPC	Direct Procurement for Customers
DS	Do Something
EAL	Environmental Assessment Level
EAR	Environmental Appraisal Report
EC	European Commission
EIA	Environmental Impact Assessment
ENCA	Enabling a Natural Capital Approach guidance
EPA	Environmental Protection Act
EPSML	European Protected Species Mitigation Licence
EPUK	Environmental Protection UK
EQS	Environmental Quality Standard
EU	European Union
FTE	Full-time exployment
GDP	Gross Domestic Product
GIR	Ground Investigation Report
GLVIA3	Guidelines for Landscape and Visual Impact Assessment Third Edition
GVA	Gross Value Added
GWML	Great Western Main Line
HDV	Heavy Duty Vehicle
HEAT	Health Economic Assessment Tool
HER	Historic Environment Record
HLC	Historic Landscape Character
HoPI	Habitats of Principal Importance
HRA	Habitats Regulations Assessment
IAQM	Institute of Air Quality Management
IMD	Index of Multiple Deprivation
JULES	Joint UK Land Environmental Simulator
LAQM	Local Air Quality Management

Abbreviation	Full Term
LCRM	Land Contamination Risk Management
LCT	Landscape Character Type
LDV	Light Duty Vehicle
LED	Light-Emitting Diode
LGS	Local Geological Sites
LNR	Local Nature Reserve
LOAEL	Lowest Observed Adverse Effect Level
Lp	Sound Pressure Level
LPA	Local Planning Authority
LSOA	Lower Layer Super Output Areas
LVA	Landscape and Visual Appraisal
LVIA	Landscape and Visual Impact Assessment
Lw	Sound Power Level
LWS	Local Wildlife Site
MMP	Materials Management Plan
MSA	Mineral Safeguarding Area
NAC	Noise Advisory Council
NCA	Natural Capital Assessment
NERC	Natural Environment and Rural Communities
NEVO	Natural Environment Valuation Online tool
NGR	National Grid Reference
NNR	National Nature Reserve
NOEL	No Observed Effect Level
NOx	Oxides of Nitrogen
NO_2	Nitrogen Dioxide
NPPF	National Planning Policy Framework
NPS	National Policy Statement
NPSE	National Policy Statement for England

Abbreviation	Full Term
NRMM	Non-Road Mobile Machinery
NSIP	Nationally Significant Infrastructure Project
ONS	Office for National Statistics
Opex	Operation expenditure
ORVal	Outdoor Recreational Valuation
OS	Ordnance Survey
OWLS	The Oxfordshire Wildlife and Landscape Study
PCBs	Polychlorinated Biphenyls
PEA	Preliminary Ecological Appraisal
PFAS	Polyfluoroalkyl and Polyfluoroalkyl Substances
PM	Particulate Matter
PROW	Public Right of Way
RAF	Royal Air Force
RAPID	Regulators' Alliance for Progressing Infrastructure Development
RCV	Regulatory Capital Value
SAC	Special Area of Conservation
SEA	Strategic Environmental Assessment
SESRO	South East Strategic Reservoir Option
SG	Supplementary Guidance
SINC	Sites of Importance for Nature Conservation
SMP	Soil Management Plan
SNCI	Site of Nature Conservation Importance
SOAEL	Significant Observed Adverse Effect Level
SoPI	Species of Principal Importance
SPA	Special Protection Area
SPD	Supplementary Planning Document
SRO	Strategic Resource Options
SSSI	Site of Special Scientific Interest

Abbreviation	Full Term
STW	Sewage Treatment Works
STEAM	Science, technology, engineering, arts and mathematics
T2AT	Thames to Affinity Transfer
UK	United Kingdom
UK Hab	UK Habitat Classification
UXO	Unexploded Ordnance
WFD	Water Framework Directive
WRMP	Water Resources Management Plan
WRPG	Water Resources Planning Guideline
WRSE	Water Resources South East
WSI	Written Scheme of Investigation

Executive Summary

Introduction

This Terrestrial Environment Assessment Report (EAR) is a technical supporting document prepared to support the Gate 2 submission report to the Regulators' Alliance for Progressing Infrastructure Development (RAPID) for the South East Strategic Reservoir Option (SESRO)

SESRO has been identified as one of the Strategic Resource Options (SROs) in Ofwat's Price Review 2019 (PR19) Final Determination.

SESRO is an 'off-line', fully bunded raw water storage reservoir in the upper catchment of the River Thames.

Water would be abstracted from the River Thames during periods of high flow and stored in a reservoir, to be released back into the River Thames when there is a need to augment the flows in the River Thames. Water released from SESRO could be re-abstracted by existing or new infrastructure further downstream to supply customers of Thames Water and Affinity Water.

The key components or assets required to deliver the scheme are as follows:

- Provision of a fully bunded raw water storage reservoir in Oxfordshire, 5km south-west of Abingdon.
- Pumping station at the toe of the embankment (on the north-east side of the reservoir) including both inflow pumps and outflow energy-recovery turbines.
- Conveyance tunnel to transfer flows via the pumping station to and from the intake / outfall structure on the River Thames near Culham.
- Auxiliary drawdown channel (ADC) linking the reservoir siphons to the River Thames, to allow drawdown of the reservoir in emergency scenarios. This could also form a navigable channel and as plans progress for the SESRO scheme, there is an opportunity to engage with the promoter of any rehabilitation of the Wilts & Berks Canal for an ADC to form part of their scheme.
- Main access road into the site (from A415, Marcham Road) and diversion of the existing East Hanney to Steventon Road.
- Temporary rail siding to facilitate delivery of certain construction materials by freight train.
- Public access, parking and recreation facilities, public education facilities, landscaping and creation of aquatic / grassland habitats.
- Local stream channel diversion to both the east and the west of the reservoir and construction of compensatory floodplain.

Several size variants of the SESRO scheme have been submitted to the Water Resources South East Group (WRSE).

Building on feedback received at Gate 1, this executive summary of the EAR presents the terrestrial environmental appraisal work undertaken to date, an updated environmental feasibility statement that includes potential risks, barriers and mitigation measures of largest SESRO option.

This EAR does not definitively scope potential environmental effects in or out at this stage and the recommendations for further technical work outlined within this EAR are subject to change as further information becomes available at subsequent project stages. Future work will be carried out in conjunction with relevant stakeholders to inform the approach to the Environmental Impact Assessment.

The details set out in this EAR are still at a formative stage and consideration should be given to that when reviewing the proposals. They are for the purposes of making decisions on progress and further funding not seeking permission.

Six other regulatory assessments have been completed for SESRO and form part of the Gate 2 submission:

- B1, Environmental Appraisal Report (aquatic);
- B3, Conservation, Access and Recreation Strategy;
- B4, Habitats Regulations Assessment (HRA);
- B5, Water Framework Directive Assessment;
- B6, Biodiversity Net Gain Report; and
- B7, Inputs into WRSE and WRMP24 Strategic Environmental Assessment (SEA).

Environmental Appraisals

This section summarises the main findings of the desk-based terrestrial environmental appraisals and the suggested mitigation measures for potential effects identified. The approaches to the appraisals are described in detail within each of the topic chapter of the EAR.

Air Quality

The changes in the concentrations of pollutants at sensitive receptors from emissions from road traffic and from plant and machinery is considered to be negligible. Therefore, as per the assessment criteria in the Environmental Protection UK (EPUK)/Institute of Air Quality Management (IAQM) guidance, this would represent a not significant effect on air quality.

For demolition, the proposed activities include the demolition of approximately 50 residential properties plus outbuildings, the former Ministry of Defence depot (including storage units and hard standings), the existing East Hanney Road, access roads and farm tracks, farm silos, out buildings and removal of the Landmead solar farm and Solar power station.

For the largest SESRO option based on the scale and nature of the works and the sensitivity of the area to dust impacts, the likely risk of dust impact for dust soiling is considered a High risk. For human health impacts, there is likely to be a Low to Medium risk.

For earthworks, the proposed activities include site preparation prior to the enabling works, vegetation clearance, excavation of the borrow pit, formation of the reservoir embankments (with a height above natural ground level of between approximately 15m and 25m), excavation for the 3.3km long tunnelling, excavation of the auxiliary drawdown channel (aligned with a proposed alignment of the Wiltshire & Berkshire Canal) and landscaping.

Based on the scale and nature of the works and the sensitivity of the area to dust impacts, the likely risk of dust impact for dust soiling is considered a High risk. For human health impacts, there is likely to be a Low risk.

For main construction, the proposed activities include construction of the river intake / outfall structure (including the shaft); Conveyance Tunnel 1 (3.3km) from the reservoir to the intake / discharge structure at Culham on the River Thames, the conveyance tunnel (0.4km) from the Pumping Station to the Main Intake/Outlet Tower; the Pumping station, the railway sidings and materials handling area; auxiliary drawdown channel, temporary rail sidings and associated materials handling area; main access road from the A415 and diversion of the East Hanney to Steventon Road.

Based on the scale and nature of the works and the sensitivity of the area to dust impacts, the likely risk of dust impact for dust soiling is considered a Medium to High risk. For human health impacts, there is likely to be a Low risk.

Although there are likely to be large number of Heavy Duty Vehicles (HDVs) exiting the indicative location for SESRO on to the A415 (Marcham Road), based on the sensitivity of the area to dust impacts, the likely risk of dust impact for dust soiling is considered a Low risk. For human health impacts, there is also likely to be a Low risk.

Overall, the likely risk of dust impact associated with the construction of SESRO indicates that there is a high risk for dust soiling impacts at sensitive human receptors and a medium risk for human health impacts

Good practice mitigation measures would be needed to reduce the potential for dust emissions to lead to significant impacts in the vicinity of the indicative location for SESRO. The mitigation measures proposed have been obtained from the IAQM guidance and would normally be sufficient to reduce construction dust nuisance and risks to human health to a not significant effect.

Biodiversity

There may be potential for indirect impacts on Barrow Farm Fen Site of Special Scientific Interest (SSSI) due to its location within 0.5km of the indicative location for SESRO. Despite the absence of a downstream hydrological link with Barrow Farm Fen SSSI, there may be potential for impacts during construction, such as changes in air quality, which will need to be considered when more construction details become available.

The indicative location for SESRO falls within the SSSI Impact Risk Zone for the listed SSSIs, with a reservoir falling within the ‘all planning applications’ category. The Local Planning Authority should

consult with Natural England regarding the potential impacts to the SSSIs and whether any bespoke mitigation strategies are required.

SESRO has the potential to significantly impact one non-statutory designated site. The Cuttings and Hutchin's Copse Local Wildlife Site (LWS) falls partly within the indicative location for SESRO. This LWS contains ancient woodland, deciduous woodland Habitat of Principle Importance (HoPI), ponds that potentially qualify as HoPI, notable beetles, badger, potentially protected and notable birds and great crested newt. The species listed may be impacted through the loss of suitable habitat for example waterbodies and woodlands. As far as reasonably practical, SESRO should be designed to avoid or reduce direct impacts to the LWS. Should the LWS be unavoidably impacted by SESRO, appropriate mitigation proposals would be required in compensation.

The current baseline information indicates that the only potential parcel of ancient woodland located within the indicative location for SESRO is The Cuttings and Hutchin's Copse LWS. However, all areas of woodland located within the indicative location for SESRO should be assessed by an arboriculturalist and botanist to determine whether they are ancient or not. An assessment of ancient woodland indicator plant species would also be undertaken. A further desk study would also be undertaken to review county archive material of woodlands dating back to 1600AD.

Due to the irreplaceable nature of ancient and veteran trees, there is no established design for the mitigation or compensation for the loss of this type of habitat. It is therefore recommended that a bespoke mitigation strategy is created to at least compensate for the loss of the ancient crack willow. This is likely to involve additional tree planting, ideally with seeds from the veteran tree, and may also involve translocating the tree or parts of the tree itself as standing or fallen deadwood. Ideally the deadwood habitat would be retained within the indicative location for SESRO.

There is no hydrological connectivity between the indicative location for SESRO and the closest ancient woodland, Hydes Copse. There may be, however, a pathway for air pollution effects. A study of the potential effects to air quality will be performed for the scheme and the results should be analysed for any likely effects to designated sites, and biodiversity in general.

Four HoPI types have been recorded within the indicative location for SESRO; coastal and floodplain grazing marsh, traditional orchard, wood pasture and parkland and deciduous woodland. Where possible, these habitats will be retained, or clearance kept to a minimum. However, due to the nature of SESRO, parcels of these habitats will be lost which will constitute a significant habitat impact.

A masterplan has been produced for SESRO which illustrates the areas of habitat that could be created. The current concept design has been produced to maximise the biodiversity value of SESRO, post-construction. Habitats to be created include HoPI such as hedgerows, rivers, neutral grassland, coastal and floodplain grazing marsh, wet woodland and reedbeds. It is likely that the area of HoPI to be created would be higher in biodiversity value at maturity than the areas lost. However, it is recommended that loss of HoPI is avoided where design allows or reduced as far as reasonably practical.

Additionally, any hedgerows lost should be compensated for prior to construction. New hedgerows should be planted within retained habitats to link up existing linear vegetation so that there is a no-net-loss in connectivity across the landscape.

Potentially significant impacts relating to the likelihood of destruction or disturbance of important habitat types for breeding, commuting or foraging in the absence of mitigation and/or killing or injury and disturbance in the absence of mitigation have been identified for bats, otter, great crested newt, water vole, badger, reptiles and birds.

The outline results of the Biodiversity Net Gain calculation indicate that SESRO will generate a significant gain in habitat units but small loss of hedgerow units. The trading for lowland mixed deciduous woodland has also not been met. Updates to the Biodiversity Net Gain assessment will be made as the project evolves, ensuring that full field data including habitat categorisation and habitat condition assessments are undertaken. As the design for SESRO develops, further hedgerow and tree line habitat creation should be included, and retention of existing linear features should be encouraged. The required 10% net gain may also be achieved through off-site habitat creation or the enhancement of existing hedgerows.

The illustrative masterplan includes a large area of wetland mosaic habitat creation located to the west of the reservoir. This area has huge potential for biodiversity and would likely be higher in value per hectare at maturity than any existing habitat within the indicative location for SESRO. Other habitats of significant value to biodiversity and nature conservation would be created around the perimeter of the reservoir including areas of species-rich grassland, woodland and wildlife ponds.

Historic Environment

The assessment identified the extensive amount of archaeological intervention already carried out within and near the indicative location for SESRO. This has in certain areas confirmed the existence of locally, regionally and nationally important archaeological remains initially identified from aerial photographs. The scale of the archaeological resource in particular highlights the need for further detailed studies to understand the extent to which it exists, its state of preservation and significance.

Mitigation aims to reduce, or even remove the adverse effects of the proposed scheme through the application of standard measures of implementation. Where feasible, mitigation would be incorporated by design to remove the need for erasing or damaging an historic environment asset. This embedded mitigation approach seeks to preserve assets in situ (in place). Where this is not possible, and where the loss of an asset is deemed acceptable, its damage or removal would be mitigated through the creation of an archive through archaeological recording. This is known as preservation by record.

Impacts to the archaeological and palaeoenvironmental remains which are likely to be abundant throughout the indicative location for SESRO would primarily be mitigated through preservation by record. This would entail the creation of an archive from the physical hand excavation and recording of archaeological and paleoenvironmental features. The recording of the resource would be accurately quantified during the design process via investigation. In order to generate a robust

mitigation strategy, the location and extents of archaeological and palaeoenvironmental assets must be robustly defined. Consultation with the Oxfordshire County Council archaeological advisory service has highlighted the need for comprehensive archaeological investigation to ascertain the presence, extent and significance of the buried archaeological resource. Geophysical survey of all the accessible parts of the indicative location for SESRO would need to be carried out to inform subsequent phases of archaeological trial trenching. There are areas within the indicative location for SESRO that have already been subject to archaeological investigation, both geophysics and trial trenching. These have been limited in scale and a more comprehensive approach is required.

Geotechnical ground investigation would also benefit from geoarchaeological coverage in order to assist in developing a deposit model for the site and identifying the presence of relict palaeochannels and other organic remains in the buried environment. Furthermore, early-stage geoarchaeological engagement might target the extent of geoarchaeologically-specific investigations at subsequent project stages.

Landscape and Visual

During construction, the magnitude of effect on local Landscape Character Areas (LCAs) within the setting of the North Wessex Downs Area of Outstanding Natural Beauty (AONB) would likely range from small adverse up to large adverse. There could also potentially be indirect effects on local LCAs within the AONB ranging from negligible adverse up to medium adverse magnitude of effect. The most noticeable effect on the landscape character of the AONB would likely be focussed on the elevated and open scarp of the AONB.

The visual appraisal has found that the magnitude of effect on the representative views from the North Wessex Downs AONB and its northern fringe would vary during construction. The most notable visual effects would likely affect views directly south of the indicative location for SESRO, including elevated views along the Ridgeway National Trail (one of the key landscape characteristics of the distinctive north-facing scarp - a special quality of the AONB), as well as views from the Vale Way Long Distance Path on the northern fringe of the AONB.

Indirect effects on the AONB would potentially result from intervisibility with the largescale construction activities for the reservoir in the landscape of its setting to the north, which would lead to an abrupt change in character within a localised part of the AONB's setting. As such, the landscape character of the AONB would be eroded as the views from and towards the AONB form an important, valued aesthetic component of the AONB.

At night, localised construction lighting could affect the northern extent of the AONB's dark skies (one of the AONB's special qualities). However, the night skies in this northern part of the AONB are generally classed as already affected to some extent by light pollution associated with urban areas. The effect on the night skies of localised construction lighting in the landscape further north would therefore likely be limited.

By winter year 1 of operation, the material handling areas and other temporary construction features would have been removed. While the landscape mitigation planting would generally not have established yet, grass seeding would have established and this would soften the landscape. The

wetland habitat mosaic would be establishing, along with habitat enhancements of the construction settlement ponds.

The landscape appraisal has concluded that during winter year 1 of operation, the magnitude of effect on local LCAs within the setting of the AONB would likely continue to vary. There could potentially also be indirect effects on local LCAs within the AONB. The most noticeable effect on the landscape character of the AONB would likely be focussed on the scarp of the AONB directly south of the indicative location for SESRO.

The visual appraisal has found that the magnitude of effect on the representative views from the North Wessex Downs AONB and its northern fringe would be likely to continue to range from negligible adverse up to medium adverse during winter year 1 of operation. The most notable visual effects would likely affect views directly south of the indicative location for SESRO, including elevated views along the Ridgeway National Trail, as well as views from the Vale Way Long Distance Path on the northern fringe of the AONB.

Indirect effects on the AONB would potentially result from intervisibility with an uncharacteristic and large-scale bunded reservoir and associated traffic and infrastructure, as well as absence of vegetation, within the generally farmed open Vale landscape to the north of the AONB. This would notably alter the character of a localised part of the AONB setting, since landscape mitigation planting would not yet have established.

A new PRoW network would be created, providing new links into the wider landscape. Similarly, new opportunities for views towards the AONB and the Corallian Limestone Ridge would be created, mainly from the reservoir crest. This would help to restore the sense of place within the broad Vale landscape.

At night, localised lighting associated with infrastructure for SESRO could affect the northern extent of the AONB's dark skies. However, as the night skies in this northern part of the AONB are already affected to some extent by light pollution associated with urban areas, the effect on the night skies is likely to be very limited. The darkest skies of the AONB would be unaffected.

By summer year 15 of operation, the landscape mitigation planting would have established. The hedgerows, shrubs, scrub, trees, small woodland blocks and copses would help to integrate the reservoir and associated infrastructure into the landscape. However, the loss of one ancient tree could not be mitigated.

The landscape appraisal has concluded that the effect on local LCAs within the setting of the AONB would have reduced by summer year 15 of operation, when considering the established planting. There would also be positive contributions to the landscape character within the floodplain. However, there would still be some residual adverse effects upon other LCAs due to the permanent effect of the reservoir. Indirect effects on local LCAs within the AONB could potentially continue to vary, with the most noticeable effect on the landscape character of the AONB along the scarp directly south of the indicative location for SESRO.

The effect on the representative views from the North Wessex Downs AONB and its northern fringe would reduce by summer year 15 of operation. The most notable visual effects would likely continue to affect views directly south of the indicative location for SESRO, including elevated views along the Ridgeway National Trail, as well as views from the Vale Way Long Distance Path on the northern fringe of the AONB. In representative views from the Vale looking towards the North Wessex Downs AONB, the magnitude of effect is likely to reduce at the most affected view along the northern fringe of the indicative location for SESRO, looking towards the scarp of the.

The established landscape mitigation would help to integrate and soften the reservoir and associated traffic and infrastructure into the Vale landscape within the setting of the AONB to the north. It is also possible that the reservoir could become an accepted feature of the AONB setting in such views due to the passage of time.

Landscape mitigation is illustrated on an Landscape and environmental design strategy plan, including, but not limited to, replacement floodplain storage, wetland creation and floating islands.

In addition to the mitigation illustrated on the Landscape and environmental design strategy plan, further measures in line with relevant guidance have been proposed. For example, the retention of vegetation, protection of trees, shrubs and hedges and strategic location of lighting during construction and the implementation of a five-year landscape period during operation, to be maintained and managed through the implementation of a long-term Landscape and Ecological Management Plan (LEMP).

Noise

Embedded mitigation, namely the earth screening mounds incorporated into the current concept design for SESRO, have been considered in the noise assessment. The screening mounds vary in height from approximately 2m when located close to sensitive properties, up to approximately 10m where they are positioned between sensitive receptors and the reservoir embankments.

During construction, potentially significant noise effects have been identified at sample receptors selected for the construction assessment in Abingdon, Drayton, Steventon, East Hanney and North and South of East Hanney. These effects are as a result of construction activities throughout the indicative location for SESRO, including the rail sidings.

During construction, potential vibration effects at sample receptors selected for the construction assessment are not anticipated to be significant and no significant construction traffic noise impacts are anticipated.

During operation, road traffic, the water intake/outfall structure and pump station have been identified as potential sources of noise.

No significant noise effects are anticipated as a result of traffic on the proposed new access road based on the forecast uplift in average vehicle movements on Marcham Road and the A34.

In regard to the existing Hanney Road between Steventon and East Hanney Road and the new road proposed directly south of the indicative location for SESRO, no change in traffic is forecast during

operation. It is likely that noise effects during operation as a result would be generally neutral or slightly beneficial for nearby properties.

In regard to the water intake/outfall structure, located approximately 360m from the closest noise sensitive property, noise may be audible due to low existing noise levels. However, with the implementation of noise and vibration control measures within the design of the structure, it is anticipated that significant effects would be avoided.

In regard to the pump station, located over 700m from the nearest noise sensitive receptor, the dominant noise source at sensitive receptors would be the A34. As such, no significant noise effects are anticipated due to the operation of the pump station.

Works would be carried out in accordance with Best Practicable Means as defined in Section 72 of the Control of Pollution Act 1974 and in accordance with the recommendations of BS 5228 part 1 and part 2.

The contractor would undertake a risk assessment prior to commencing works, based on the latest construction methodology and design information, and used to update/supplement the assessments presented in this environmental assessment report.

The contractor would develop and implement a noise and vibration control strategy in order to minimise construction noise and vibration emissions at nearby receptors. Where appropriate, this may include agreeing noise and vibration limits at receptors. This strategy would be agreed with the Local Planning Authority.

Soils, Geology and Land Contamination

During Construction, the areas of permanent land take to construct the largest SESRO option would result in permanent loss of agricultural land. Best and most versatile (BMV) land of ALC grade 2 and 3a land would be lost and therefore this effect is potentially significantly adverse without mitigation. The permanent loss of agricultural land cannot be fully mitigation. However, mitigation measures such as the re-use of topsoil and subsoil to improve the quality of agricultural land elsewhere and the implementation of a Soil Resource Plan (SRP) could result in neutral (no change) or beneficial effects.

The potential to encounter UXO and the subsequent health risks that could result may be potentially significantly adverse without mitigation. Mitigation measures including the clearance of UXO and a remediation strategy that includes UXO to identify and mitigate risks may result in a beneficial effect by removing the risk of UXO to receptors.

Contamination of surface and groundwater and harm to human health through construction activities causing exposure, mobilisation or leaching of potential existing contamination on site and the introduction of new sources of contamination may result in potentially significantly adverse effects without mitigation. Mitigation measures including further assessment of quality of soil, groundwater and surface water to develop a remediation strategy may result in beneficial effects by removing the risk of contamination from these sources to receptors.

Potential sterilisation of mineral resources by construction on or near to (including tunnelling under) the sand and gravel resources towards the eastern end of the indicative location for SESRO where expansion of extraction operations is proposed could result in potentially significant effects without mitigation. To mitigate this, further assessment of the extraction proposals in relation to the water transfer tunnel and pipeline route should be undertaken at subsequent project stages. If unacceptable impacts could result from the extraction works, it may be possible to programme the works so that they are complete before the tunnel is constructed. Alternatively, excavation of the minerals could be undertaken in small zones to reduce the potential impacts.

During operation, the contamination of surface and groundwater and damage to human health from operation activities (e.g. accidental spills and mismanagement of solid and liquid wastes) could result in potentially significant effects without mitigation.

Good industry working practices and procedures should be incorporated into construction and operation, aimed at limiting potential contamination and risk to human health and the environment.

Natural Capital

SESRO demonstrates an overall positive impact on climate regulation, water purification, and recreation ecosystem service provision. Disbenefits are seen for food production, air pollutant removal, and natural hazard regulation services. SESRO has the potential to significantly impact ecosystem service provision, but to varying degrees and in different directions, as highlighted by the valuation exercise.

Though it was not possible to quantify and monetise water regulation benefits for SESRO, it is likely that they would be the most substantial benefits across the board. The next most substantial benefits are likely to come from the recreational value of SESRO.

The results broadly align with those from the Gate 1 assessment, though expected losses were only seen for food production within the earlier assessment. The difference in air pollutant removal and natural hazard regulation between Gate 1 and Gate 2 can be explained by the change in woodland areas. For Gate 1, a net gain in woodland area was expected. However, following updates to both the baseline and future-baseline habitat areas at Gate 2, a net loss is expected. Woodland has a high capacity to deliver these ecosystem services and a shift to a net loss explains some of this disbenefit. Another important factor is that the Gate 2 assessment considers the maturity of newly created woodland, rather than assuming a constant delivery of services. As such, it takes time for the air pollutant removal and natural hazard regulation benefits provided by new woodland to scale up.

Wider Benefits

SESRO would provide a broad range of long term benefits in Oxfordshire, providing opportunities to improve physical health, access to STEAM learning opportunities, provide employment and grow the local economy.

Employment provided by SESRO during the construction and operation would lead to further benefits for the economy through more jobs being created. In addition to the 4,297 employment years created by SESRO's construction a further 2,741 are estimated to be created through further

economic activity. During operation, an estimated 30 SESRO jobs would create an additional 26 within the wider economy for the foreseeable future, therefore 56 jobs created in total due to SESRO's operation. An estimated £252m of GVA over 10 years construction is significant given the size of Berkshire, Buckinghamshire and Oxfordshire's construction sector.

The increased range of physical activities at SESRO would propose significant health benefits to the visiting population locally and in Oxfordshire. Not only would more people use SESRO than the existing site for physical activities but the range of hobbies would create a more inclusive and accessible environment to exercise.

The education value of SESRO has been quantified in terms of the potential annual willingness to pay by educators to visit the facility with school children for STEAM field trips. This value should not be considered solely indicative of the total benefits of education, a much greater economic value would be felt with the long-term economy.

Furthermore, as the area has low levels of deprivation it is likely that only a small proportion of the population would be significantly affected by a change in cost of living. This can be addressed through targeted mitigation.

It is possible that SESRO would generate some disbenefits for local communities including disturbance to local businesses but this impact is limited to 19 businesses and would be short term. Potential long term disbenefit of an increase to customer bills may affect Thames Water customers as part of securing future water supply.

Ultimately, the opportunities created at SESRO should lead to long-term benefits of a far greater magnitude than the short-term disbenefits. There would be significant employment, economic activity, education, and health benefits as a result of SESRO's construction and operation.

Potential In-combination and Cumulative Effects

Project in-combination effects will be examined further when more information is available at subsequent project stages.

Cumulative and in-combination effects have been reviewed at a strategic level as part of the update to the SEA, refer to Supporting Document B7, Inputs into WRSE and WRMP24 Strategic Environmental Assessment (SEA).

Next Steps

This EAR has been informed by desk based assessments using publicly available information in line with the requirements of the Gate 2 submission. The work is at a preliminary stage and establishes an initial appraisal that can be built on during subsequent project stages. In future, this will also be informed by the undertaking of site surveys and collection of additional information and data that will inform an Environmental Impact Assessment likely to be required as part of any future consenting process.

The table below sets out recommendations for future technical work at subsequent project stages.

Topic	Next steps
Air Quality	• Should additional baseline air quality data be required, it may be necessary to undertake air quality monitoring survey(s), the type, monitoring locations and duration of which, would be agreed with the Vale of White Horse District Council and other relevant stakeholders. • As SESRO develops and construction related traffic data is finalised, working with the traffic modellers, it would be necessary to understand the construction vehicle distribution north and south of the A34 interchange as this, in addition to the finalised traffic data, would determine whether there is a need for a more detailed assessment. If a more detailed assessment is required, the scope and methodology would be agreed with the Vale of White Horse District Council prior to commencement. • As more construction related information becomes available, following IAQM guidance, a construction dust risk assessment more specific to the proposals and more accurately reflecting SESRO construction activities, can be undertaken. Appropriate recommendations can then be made as to which good practice mitigation measures should be taken forward into the CEMP or equivalent management plan.
Biodiversity	• Undertake a full Preliminary Ecological Assessment (PEA) for the habitats located within the indicative location for SESRO and within a suitable buffer around SESRO. It is recommended that the three rail siding options are included within the scope of the PEA. The survey would aim to identify all potential ecological constraints within the indicative location for SESRO. • Undertake a full UK Hab survey and habitat condition assessment as part of the PEA to form the baseline of a full Ecological Impact Assessment for SESRO. It is recommended that the three rail siding options are included within the scoped of the UK Hab survey and habitat condition assessment. • Undertake phase 2 surveys for specific species and habitats including an assessment of woodlands for ancient trees and ancient woodland indicator species, and surveys to identify the presence/likely absence of protected species. Depending on the survey results, legal compliance may require mitigation, additional survey, and European Protected Species Mitigation Licence.

Topic	Next steps
Historic Environment	• Specialist historic environment studies covering areas such as the palaeoenvironment, the setting of heritage assets and the level of impact on historic built heritage would be crucial at subsequent project stages. Mitigation would then be informed by these specialist assessments. • The DBA has identified the data gaps which need to be addressed in order to fully inform detailed assessment. Specialist sub-consultant assistance would be required. The detailed assessment would encompass the full array of potential impacts to the historic environment. • Consultation with the Oxfordshire County Council archaeological advisor has highlighted the need to implement archaeological investigation at the earliest opportunity. The scale of SESRO requires a very large amount of geophysical survey and trial trench investigation. • All archaeological work must be carried out in accordance with a method statement (Written Scheme of Investigation) approved by the Oxfordshire County Council archaeological advisory service prior to commencement on site. For a scheme of this scale, a strategic WSI would be required.
Landscape and Visual	• Undertake a comprehensive Landscape and Visual Impact Assessment (LVIA) in conjunction with design development to enable the iterative process of design and assessment to continue. • Undertake a topographical survey, arboricultural survey and Phase 1 habitat survey to inform the LVIA and design development. • Use the high-level landscape mitigation principles to guide any future development of the operational design.

Topic	Next steps
Noise	• Update construction assessment when the design is further developed and when early contractor involvement is available to inform the likely construction strategy. This would include more detailed consideration of construction road and rail impacts during construction and tunnelling. • Baseline sound level monitoring to define noise limits at noise sensitive receptors, this is particularly relevant for the assessment of potential operational noise impacts. • Further consideration of potential impacts arising from the operation of SESRO. • More detailed consideration of noise and vibration mitigation to control construction and operational impacts as the design is developed.
Soils, Geology and Land Contamination	• Consultation with Natural England regarding the loss of agricultural soil resources and the proposed mitigation. An updated Soil Resource Survey should be undertaken where there are gaps in data and a Soil Resource Plan should be developed; • Consultation with the Environment Agency, Vale of White Horse District Council and Oxfordshire County Council to provide any available information on historical environment and land use, landfills, groundwater and surface water abstraction (private, small scale), discharges, contamination. unauthorised burials, unlicensed waste disposal; • Further assessment of the UXO risk and a remediation strategy should be developed to mitigate the risks where necessary. A specialist UXO company should undertake this; • A preliminary contamination risk assessment report should be prepared and a ground investigation should be designed to include collection of environmental samples of soil, groundwater and surface water for chemical testing; • A quantitative assessment of the soil, groundwater and surface water quality and Kimmeridge Clay bituminous content should be undertaken following the ground investigation to better understand potential risks to sensitive receptors and develop appropriate mitigation measures; • Geotechnical assessment should be undertaken to assess the risk to the tunnel at the proposed mineral extraction operations; and • Discussions should be held with the operators of the quarry at the east end of the indicative location for SESRO to determine the timing of their planned mineral extraction works.

Topic	Next steps
Natural Capital	• In line with the ACWG guidance, the NCA should be further refined to better integrate with the EIA process. The NCA should also be further updated to capture developments in the SESRO concept design. • Develop NCA to better quantify and monetise the impact on water regulation services by considering the economic value of water left in the environment for other existing or future users. • The updated NCA would expand on the ecosystem services considered at Gate 2. Consult on the *Gate Two Environmental Appraisal Approach to Wider Benefits* document to support the identification of additional ecosystem services that would be considered for subsequent project stages. Stakeholder consultation would be undertaken as part of the consenting process and would provide a useful means of identifying relevant ecosystem services. • Following the completion of ecological site surveys, integrate asset quality and locational indicators into the NCA. • The findings of the Gate 2 and subsequent NCAs should be considered within the iterative design process. This would help to optimise the delivery of multiple benefits. • Consideration of natural capital value alongside biodiversity would support SESRO to move beyond Biodiversity Net Gain towards environmental net gain.
Wider Benefits	• Develop a more granular methodology for assessing the quantitative and qualitative benefits of SESRO. • If further analysis is produced for Flood Risk and Air Quality then economic analysis of potential wider impacts may be required. • Impacts on customer bills can be further assessed with research into willingness to pay. • A greater assessment of the socio-economic benefits generated by SESRO itself (in terms of its impact upon quality of life) would be suitable. This would encapsulate the different benefits under one term to allow for easier communication upon the opportunities and benefit.

1. Introduction

1.1 Purpose of the report

1.1 The South East Strategic Reservoir Option (SESRO) has been identified as one of the Strategic Resource Options (SROs) in Ofwat's Price Review 2019 (PR19) Final Determination.

1.2 This is an initial Environmental Appraisal Report (EAR) presenting the findings of terrestrial environment desk-based assessments of SESRO for the following topics:

- Air Quality;
- Biodiversity;
- Historic Environment;
- Landscape and Visual;
- Noise;
- Soils, Geology and Contaminated Land;
- Natural Capital; and
- Wider Benefits.

1.2 Water Resource Planning

1.3 All water supply companies in the UK have a statutory duty to consult upon and produce a Water Resources Management Plan (WRMP) every 5 years. The next plan, which would be issued in draft for consultation in November 2022, provides a strategic forecast of the companies' expected requirements and proposed investment to ensure a secure and resilient water supply to their customers from 2025 to 2100.

1.4 The WRMP process is supported by a non-statutory regional water resources management plan, which is produced for each region of the UK and provides the strategic regional context for the WRMP.

1.5 Thames Water and Affinity Water are both part of the Water Resources South East Group (WRSE), along with South East Water, Southern Water, Sutton and East Surrey Water and Portsmouth Water. The WRSE group published their emerging draft regional plan in January 2022, with an updated Draft Regional Management Plan in late summer 2022. In accordance with the Water Resources Planning Guidance the partner companies' Draft WRMPs are consistent with this regional strategy.

1.6 The WRMPs include a set of solutions to meet customers' future water supply needs. A number of these solutions involve strategically important and large-scale new developments that can be lengthy and complex to consent and develop. For this reason, a number of the strategic solutions need further investigation and feasibility studies completed for them to ensure uncertainties associated with them are better

understood and that they are ready to consent and develop within the required timescales identified in the WRMP. The SESRO is one such option.

1.7 The feasibility studies for the different strategic solutions are completed under the RAPID gated process (refer to Section 1.3).

1.3 Context of this report

1.8 The Regulators' Alliance for Progressing Infrastructure Development (RAPID), a joint team made up of the three water regulators (Ofwat, the Environment Agency and the Drinking Water Inspectorate), was set up to support and oversee projects across several water companies. These projects include recycling, desalination, transfers between regions and reservoirs to identify optimal regional solutions that could be started in 2025-2030.

1.9 RAPID has introduced a new regulatory process which sets out the activities that need to be completed to a series of governance 'Gates', enabling key information to be presented and an assessment made on whether the scheme should continue for further feasibility assessment. The gates set out by RAPID are as follows:

- Gate 1 – Initial feasibility, design and multi-solution decision making (July 2021);
- Gate 2 – Detailed feasibility, design and multi-solution decision making (November 2022);
- Gate 3 – Finalised feasibility, pre-planning investigations and planning applications (Summer 2023); and
- Gate 4 – Planning applications, procurement strategy and land purchase (Summer 2024).

1.3.2 Gate 2

1.10 In accordance with the requirements set out by RAPID, this Terrestrial EAR supports the Gate 2 submission, alongside a series of other technical reports including Supporting Document A1: Concept Design Report to be read in conjunction with these reports. The scope of this report has been informed by the Gate 2 guidance document[1] issued by RAPID and the feedback received following the Gate 1 submission.

1.11 This Terrestrial EAR (Supporting Document B2) sits alongside a suite of other environmental reports that form part of the Gate 2 submission:

- B1, Environmental Appraisal Report (aquatic);
- B3, Conservation, Access and Recreation Strategy;
- B4, Habitats Regulations Assessment (HRA);

[1] Regulators' Alliance for Progressing Infrastructure Development (RAPID) (2022). Strategic regional water resource solutions guidance for gate two.

- B5, Water Framework Directive Assessment;
- B6, Biodiversity Net Gain Report; and
- B7, Inputs into WRSE and WRMP24 Strategic Environmental Assessment (SEA).

1.12 Building on feedback received at Gate 1, this EAR presents the environmental appraisal work undertaken to date, an updated environmental feasibility statement that includes potential risks, barriers and mitigation measures of six different size options for the reservoir. See Table 1.1 for an overview of this EAR's compliance with the requirements set in section 6.3 of the RAPID Gate 2 Guidance.

1.13 This EAR has been informed by desk based assessments using publicly available information in line with the requirements of the Gate 2 submission. The work is at a preliminary stage and establishes an initial appraisal that can be built on during subsequent project stages. In future, this will also be informed by the undertaking of site surveys and collection of additional information and data that will inform an Environmental Impact Assessment likely to be required as part of any future consenting process.

1.14 This EAR does not definitively scope potential environmental effects in or out at this stage and the recommendations for further technical work outlined within this EAR are subject to change as further information becomes available at subsequent project stages. Future work will be carried out in conjunction with relevant stakeholders to inform the approach to the Environmental Impact Assessment.

1.15 The details set out in this EAR are still at a formative stage and consideration should be given to that when reviewing the proposals. They are for the purposes of making decisions on progress and further funding not seeking permission.

Table 1.1: Compliance with RAPID requirements for Gate 2 Environmental Appraisal

RAPID guidance for Gate 2 Environmental Appraisal	Compliance with RAPID guidance
An update of the gate one work where relevant	Chapters 3 to 11 of this EAR present environmental appraisals that build on the work undertaken to support the Gate 1 process.
The environmental appraisal work undertaken to date – likely to be at a strategic scale.	Chapters 3 to 11 of this EAR present the environmental appraisal work undertaken to date to support the Gate 2 process. Chapters 3 to 11 include a varying level of detail based on the information available to inform the appraisal of a specific topic. The Gate 1 SEA has been reviewed and updated and has been submitted as Supporting Document B7, Inputs into WRSE and WRMP24 Strategic Environmental Assessment (SEA).
Baseline and analysis – this might include results of monitoring, modelling, environmental surveys, etc.	An understanding of the baseline is presented for each topic in Section X.4 of Chapters 3 to 11.
Options assessment, with sufficient detail to allow comparison of options within the solution and identify potential effects (positive and negative) and opportunities.	Chapters 3 to 11 of this EAR set out assessment of the alternative reservoir size options with sufficient detail to allow comparison of options within the solution and identify potential effects (positive and negative) and opportunities.
Assessment of the effects of the solution, an evaluation of their significance and any cumulative or in-combination effects.	Section X.5 Assessment outcomes of Chapters 3 to 11 outline the potential environmental effects identified for each topic, including an evaluation of significance in line with the relevant topic-specific legislation and/or guidance. Project in-combination effects will be examined further when more information is available at subsequent project stages. Cumulative and in-combination effects have been reviewed at a strategic level as part of the update to the SEA, refer to Supporting Document B7, Inputs into WRSE and WRMP24 Strategic Environmental Assessment (SEA).

RAPID guidance for Gate 2 Environmental Appraisal	Compliance with RAPID guidance
Clear justification as to options within the solution discounted, those taken forward, and the preferred option selected. Where the preferred option is identified, potential environmental effects and opportunities should be discussed.	Narrative provided in the Gate 2 Report.
The appraisal work should include consideration of resilience (e.g. climate change,), biodiversity net gain, climate change and carbon effects.	For consideration of resilience (e.g. climate change), climate change and carbon effects, refer to Supporting Document A3, Carbon Report. For Biodiversity Net Gain, refer to Supporting Document B6, Biodiversity Net Gain Report.
A description of the connection to other assessments (e.g. biodiversity net gain, WFD, natural capital, carbon) and demonstrate how they have been considered within this initial appraisal work.	The following supporting documents have been issued alongside this EAR: • B1, Environmental Appraisal Report (aquatic); • B3, Conservation, Access and Recreation Strategy; • B4, Habitats Regulations Assessment (HRA); • B5, Water Framework Directive Assessment; • B6, Biodiversity Net Gain Report; and • B7, Inputs into WRSE and WRMP24 Strategic Environmental Assessment (SEA). These documents have been referred to throughout this EAR where relevant in line with the above. For example, Chapter 4 Biodiversity and Chapter 9 Natural Capital make reference to Supporting Document B6, Biodiversity Net Gain Report.
Development of mitigation and enhancement opportunities.	Mitigation and enhancement are presented in Section X.6 Mitigation for Chapters 3 to 8 with the exception of Chapter 6 where mitigation and enhancements are presented in Section 6.5.

RAPID guidance for Gate 2 Environmental Appraisal	Compliance with RAPID guidance
Any future monitoring requirements of the identified environmental effects and efficacy of any included mitigation measures.	Where relevant, future monitoring requirements have been referred to within Section X.6 mitigation and/or Section X.7 Next steps of Chapters 3 to 11 for each topic.
A summary of any consultation undertaken.	Captured in Chapters 3 – 10 as appropriate
A clear planning strategy and consenting route, and a plan to gate 3	Refer to Supporting Document G, Planning and Consents Strategy

1.16 The findings of this report have fed into Supporting Documents B3: Conservation, Access and Recreation Strategy, B4: Habitats Regulations Assessment (HRA), B6: Biodiversity Net Gain Report, and B7: Strategic Environmental Assessment (SEA).

1.4 Overview of report content

1.17 Chapter 2 of this EAR provides an overview of the scheme including the site and surroundings and alternative options.

1.18 Chapters 3 to 11 of this EAR present the desk-based assessments for each of the environmental topics including relevant legislation and policy, methodology, baseline, assessment outcomes, mitigation and next steps.

1.19 Chapter 12 of this EAR provides a summary of the main findings for each environmental topic and the next steps proposed. Table 1.2 outlines the chapters of this EAR and the supporting appendices and figures where relevant. Appendices can be found in Supporting Document B2.1 Environmental Appraisal Report (terrestrial) Appendices. Figures can be found in Supporting Document B2.2 Environmental Appraisal Report (terrestrial) Figures.

Table 1.2: Chapters of this EAR and supporting appendices and figures.

Chapter	Supporting Appendices*	Supporting Figures**
Chapter 1: Introduction	n/a	n/a
Chapter 2: Scheme description	n/a	Figure 2.1 Landscape and Environmental Design Strategy Plan
Chapter 3: Air Quality	n/a	Figure 3.1 Monitoring Locations, Air Quality Management Areas and Proposed Construction Traffic Route
Chapter 4: Biodiversity	n/a	n/a
Chapter 5: Historic Environment	Appendix A5.1 Cultural Heritage Desk-Based Assessment	n/a
Chapter 6: Landscape and Visual	Appendix A6.1 Landscape and Visual Appraisal Criteria Appendix A6.2 Consultation and Engagement Feedback Appendix A6.3 Representative Viewpoints Appendix A6.4 Illustrative Viewpoints Appendix A6.5 Published Sources of Landscape Character Appendix A6.6 Landscape and Visual Appraisal Tables	Figure 6.1 Zone of Theoretical Visibility Figure 6.2 Zone of Theoretical Visibility of Scarp of North Wessex Downs AONB - Without SESRO Figure 6.3 Zone of Theoretical Visibility of Scarp of North Wessex Downs AONB - With SESRO Figure 6.4 Topography Figure 6.5 Landscape Context and Planning Constraints Figure 6.6 Published Landscape Character Areas
Chapter 7: Noise	Appendix A7.1 Noise Assessment Criteria Appendix A7.2 Noise Construction Assessment Approach	Figure 7.1 Noise and Vibration Assessment - Sample Receptor Location Plan

Chapter	Supporting Appendices*	Supporting Figures**
	Appendix A7.3 Strategic Noise Mapping Appendix A7.4 Construction Vibration	
Chapter 8: Soils, Geology and Contaminated Land	n/a	Figure 8.1 Bedrock Geology and Aquifer Properties Figure 8.2 Superficial Geology and Aquifer Properties Figure 8.3 SESRO Agricultural Land Classification Figure 8.4 Unexploded Ordnance
Chapter 9: Natural Capital	n/a	n/a
Chapter 10: Wider Benefits	n/a	n/a
Chapter 11: Summary of Main Findings and Next Steps	n/a	n/a

** Appendices can be found in Supporting Document B2.1, Environmental Appraisal Report (terrestrial) Appendices*
** Figures can be found in Supporting Document B2.2, Environmental Appraisal Report (terrestrial) Figures

2. Solution design, options and sub-options

2.1 Solution description

2.1 The South East Strategic Reservoir Option (SESRO) is an 'off-line', fully bunded raw water storage reservoir in the upper catchment of the River Thames.

2.2 Water would be abstracted from the River Thames during periods of high flow and stored in a reservoir, to be released back into the River Thames when there is a need to augment the flows in the River Thames. Water released from SESRO could be re-abstracted by existing or new infrastructure further downstream to supply customers of Thames Water and Affinity Water.

2.3 SESRO also incorporates the future flexibility to abstract water direct from the reservoir, treat it on site and then transfer potable water either to the south to serve Southern Water[2] or else to support TW's Swindon and Oxfordshire supply zone[3]. These elements will continue to be explored as the scheme develops and the timing and magnitude of each is confirmed in the final WRMPs.

2.2 Options considered

2.4 SESRO is one of various raw water storage reservoirs that have been considered for WRMP24 by Thames Water. Alternative options have been passed through an appraisal process[4] and feasible options costed and assessed as part of WRMP24. Analysis completed as part of the options appraisal for WRMP24 confirms that alternative sites for storage reservoirs are available in the Thames Valley, but none considered as suitable as SESRO. Building upon the options appraisal work that was originally undertaken for WRMP09 and has been updated for each subsequent strategic plan to ensure accuracy, the leading alternative sites have been analysed and costed (and made available for selection as feasible options) as part of option selection for WRMP24. Further 'back-checking' of the analysis and screening out of alternative sites has ensured that the list of options is correct and robust. This is all reported in the updated Reservoir Feasibility Report that will be published for consultation by Thames Water as part of WRMP24.

2.5 Several size variants of the SESRO scheme have been included in the Thames Water WRMP24 Constrained List of options and submitted as options to WRSE, as follows:

- 150 Mm3 capacity reservoir;
- 125 Mm3 capacity reservoir;
- 100 Mm3 capacity reservoir;
- 75 Mm3 capacity reservoir;
- 30+100 Mm3 capacity phased reservoir; and

[2] Thames to Southern Transfer, another SRO project, jointly funded by Thames Water and Southern Water

[3] The additional transfers and associated water treatment facilities are not included within the SESRO core scheme, although a provision of land allocation within the scheme is identified for such future use

[4] Thames Water WRMP24, Reservoir Feasibility Report Update.

- 80+42 Mm3 capacity phased reservoir.

2.3 Option configuration and operation

2.6 The combined river intake / outfall Structure would be located on the western bank of the River Thames upstream of Culham. Abstracted water would pass through a tunnel and pumping station and jetted into the reservoir at the base of an inlet tower.

2.7 Water being discharged back into the river would pass through an outlet tower and the same tunnel before flowing over a stepped gravity weir at the outfall, which would maximise aeration whilst avoiding scour to the River Thames.

2.8 The current conceptual design provisionally allows for the inclusion of the outfall for the Severn to Thames Transfer (STT) SRO project within the SESRO outfall, providing a more efficient combined solution should both schemes be implemented.

2.9 The intake for the reservoir would operate under strict conditions imposed by the Environment Agency's future environmental permit for the scheme. This would be sought as part of the scheme's consenting strategy:

- The abstraction into SESRO shall be controlled by a Minimum Residual Flow (MRF) that must be retained in the River Thames at Culham of 1,450Ml/d;
- The maximum pumping capacity at the intake shall not exceed 1,200 Ml/d;
- The maximum 24-hour abstraction shall be < 1,000 Ml/d (and < 150,000 Ml/yr);
- Abstraction will increase progressively at a rate of no more than 300 Ml/d; and
- Water would be discharged at a maximum rate of 600 Ml/d, with typical release rate between ~165 Ml/d and ~320 Ml/d depending on the size of the reservoir.

2.10 The need for water to be released from the reservoir would be triggered by conditions in the lower River Thames, governed by the Lower Thames Operating Agreement[5]. It is expected that the release would primarily be triggered during periods of low flow.

2.4 Key assets required

2.11 The key components or assets required to deliver the scheme are as follows:

- Provision of a fully bunded raw water storage reservoir in Oxfordshire, 5km south-west of Abingdon.
- Pumping station at the toe of the embankment (on the north-east side of the reservoir) including both inflow pumps and outflow energy-recovery turbines.
- Conveyance tunnel to transfer flows via the pumping station to and from the intake / outfall structure on the River Thames near Culham.
- Auxiliary drawdown channel (ADC) linking the reservoir siphons to the River Thames, to allow drawdown of the reservoir in emergency scenarios. This could also form a navigable channel and as plans progress for the SESRO scheme, there is an opportunity

[5] Further information may be found in Supporting Document G: Planning and Consents Strategy

to engage with the promoter of any rehabilitation of the Wilts & Berks Canal for an ADC to form part of their scheme.

- Main access road into the site (from A415, Marcham Road) and diversion of the existing East Hanney to Steventon Road.
- Temporary rail siding to facilitate delivery of certain construction materials by freight train.
- Public access, parking and recreation facilities, public education facilities, landscaping and creation of aquatic / grassland habitats.
- Local stream channel diversion to both the east and the west of the reservoir and construction of compensatory floodplain.

2.12 To provide a first illustration of how the engineering requirements of the scheme may be integrated with the expected environmental mitigation and with possible recreational uses of the site, an indicative landscape and environment led Master Plan for the largest SESRO option has been developed for Gate 2 (see Figure 2.1). This vision will be subject to change and refinement if SESRO progresses through scheme promotion, through future consultation, environmental assessment and associated design iterations, but provides an initial overview of how the largest SESRO option could be conceptualised. We considered this level of detail appropriate for the SESRO Gate 2 submission, which may exceed that available or presented for other SROs, due to the maturity of the scheme (it has been considered in many previous strategic plans and subject to various previous public consultations) and the level of public interest in the scheme, as demonstrated by the consultation on the WRSE emerging regional plan and the SESRO Gate 1 submission (see Section 9 of the Gate 2 Report). As noted in paragraph 2.4 previously, the 150 Mm^3 option, as the largest option for the proposed site, has formed the basis of the design work completed for Gate 2. Although all options were considered feasible and available, this largest scheme contains the most constraints and issues to resolve and hence was considered a better 'starting point' for the Gate 2 design process and for the development of the indicative Gate 2 Master Plan.

2.13 This indicative Gate 2 Master Plan has been informed by the design principles and vision for the scheme and driven by the initial desk-based environmental assessments that have been completed (see Section 6.1 of the Gate 2 Report) and by initial community feedback. These are demonstrated in Table 2.1 below.

2.14 We aim to develop this indicative Gate 2 Master Plan once the size and / or phasing of the preferred scheme is confirmed by WRMP24 and as we progress more local, community engagement on the specific design and use of SESRO.

2.15 The design development undertaken for Gate 2 aligns to the design principles set out by the All Company Working Group Gate 2 methodology on design[6], with further details provided in Supporting Document A1: Concept Design Report. This methodology provides a guiding framework for the design of the SROs to ensure consistency and best-practice.

[6] All Company Working Group (ACWG) Design Principles, Process and Gate 2 Interim Guidance, December 2021, Fereday Pollard

Table 2.1: Summary of key aspects of the Indicative Gate 2 Master Plan

Design Philosophy	Indicative Gate 2 Master Plan 'response'
Provide value to local communities	Provide recreational and access opportunities for local communities. Small scale water-based recreation, under controlled conditions (such as via a sailing club or similar), could be provided in the north-east corner, co-located with the main access routes into and out of the site. This corner, furthest from the local villages, would be a much busier part of the site, dedicated to the more intensive recreational uses. The access and recreational concept for the site is intended to be modest, at this early stage, and to maximise environmental benefit and to minimise disturbance and disruption to the closest villages. The wetland focused western part of the site, adjacent to East Hanney would be designed to be a quieter, less disturbed part of the site, to maximise the environmental benefit. Some local access and parking would be provided on this western side for the benefit of East Hanney. Visitor footfall to the south-east corner of the site, around Steventon, would also be discouraged to minimise disturbance. However, the indicative master plan has been currently developed to allow local access from both villages to the circular footpath and cycle path networks, along with limited local parking.
Manage visitors to the site to minimise local disruption and maximise environmental benefit	'Zoning' of the site into different areas, to implement the habitat creation and mosaic of biodiversity net gain required and also to help manage the flow of visitors into and around the site and to help protect the more sensitive areas. Access into and out of the site is configured to minimise disruption to local traffic networks, as far as possible, making best use of the adjacent trunk main and A-road network. This enables the main access road to come into the site from the north, directing the majority of visitors and operational traffic to the north-east corner of the site, furthest from the existing villages of East Hanney and Steventon. A modest visitor 'hub' could be provided at this location, adjacent to the main parking areas, with a small café on the embankment crest overlooking the views of the Ridgeway towards the south.
Focus on the aquatic environment	The management of water on site, either drainage, stream diversion or floodplain compensation is designed to make best use of the existing topography of the site. This enables the lower lying western areas to be dedicated as a conservation and biodiversity led sector, providing extensive wetland habitat creation. A small education centre is envisaged to the north of this sector, providing educational opportunities for the local school communities. We have suggested the possibility of integrating this wetland creation, with conservation led features along the west and south-west sides of the main reservoir, including lagoons and small floating platforms for wildfowl.
Enable access for all	The network of footpaths and cycle paths across the site is intended to provide enhanced integration with the existing Public Rights of Way network and provide access to all across the site and link up with all surrounding routes and villages. The new paths across the site could include a crest path around the reservoir, various circular routes around the embankment and multiple access points up to the crest. The footpaths around the quieter western sector are designed to integrate into the wetland areas.

Figure 2.1: SESRO 150Mm3 option, Indicative Gate 2 Master Plan

note, the details of this plan are subject to change through future community engagement and consultation, further environmental assessment and associated design development; it will be adjusted, as required, once the size of the preferred scheme is confirmed by WRMP24

2.5 Interactions with existing assets and other SROs

2.16 There are significant potential physical interactions between SESRO and other SROs and local water supply schemes, which may need to be integrated together in the final scheme design, depending on the final timing between schemes. These include:

- **Severn to Thames Transfer (STT) SRO:** to minimise construction disruption and to provide greater refill resilience if SESRO is linked to the Thames to Southern Transfer (T2ST) SRO. Further information on the Deployable Output benefit of combining the schemes is provided in Section 4.2 of the Gate 2 Report. In the WRSE draft Regional plan and draft WRMPs preferred plans, the STT is required by 2050 for the more extreme future scenarios (situations 1 and 4).
- **Thames to Southern Transfer (T2ST) SRO**: to minimise the impacts of the transfer on London's Deployable Output and maximise the resilience of the transfer. In the WRSE draft Regional plan and draft WRMPs preferred plans, this is required by 2040 for the more extreme future scenarios (situations 1, 4 and 7).
- **Thames to Affinity Transfer (T2AT) SRO**: The resources from SESRO could provide supplies to the Thames to Affinity Transfer (T2AT), required by 2040 in the WRSE draft Regional plan and draft WRMPs preferred plans, hence they would need to be integrated in terms of utilisation and control. However, there is no physical interaction between the schemes at the reservoir site.
- **Supply to Thames Water's Swindon and Oxford (SWOX)** water resources zone. In the WRSE draft Regional plan and draft WRMPs preferred plans, this would be utilised for up to 48 Ml/d after 2050 for the more extreme future scenarios (situations 1, 4, 5 and 7).
- **Potential integration with Farmoor Reservoir**: to help manage potential future reductions in abstraction during low flow periods and deliver environmental benefits to the Oxford watercourses, which forms part of Thames Water's medium and high scenario Environmental Destinations[7].

2.17 These interactions and the implications for SESRO are summarised in Table 2.2 below. The exact integration of these different aspects has not yet been decided and will not be until the exact timing between them is finalised in the Final WRMP. However, it is probable that some of the aspects noted above may need to be integrated into the DCO for either SESRO or the STT, in order to deliver the schemes in the most cost efficient and the least environmentally and socially disruptive way.

[7] In the draft WRMP the reductions at Farmoor are within the Medium scenario (15Ml/d reduction in Deployable Output by 2050) and High scenario (35Ml/d reduction in Deployable Output by 2050).

Table 2.2: Interactions of SESRO with other SROs and with other local supplies and sources

Interaction	Implication for SESRO
STT	The route of the STT pipeline passes close to the SESRO site. The two schemes could be joined via a connecting valve chamber west of the A34 crossing, linking the STT pipeline and the SESRO intake pumping station. This means that either scheme could be delivered first, depending on the outcome of the WRMP process. The lower section of the STT pipeline follows the approximate route of the SESRO ADC and discharges to the River Thames at the same location as SESRO. The concept design currently allows for the lower sections of the STT pipeline to be constructed at the same time as the ADC, located in the towpath of the canal. This would minimise construction disruption, avoid the need for multiple road crossings and reduce the land area required for the two schemes. A single outfall structure could accommodate the discharge from both schemes. If STT precedes SESRO, then this configuration will need to be revised, but the current approach reflects the timing of the schemes within the draft WRMP.
T2ST	The proposed site for the water treatment works for the T2ST is currently located on the SESRO site, adjacent to the intake pumping station. The site for this works would either need to be safeguarded within the SESRO site design, to enable future construction when required under separate consent by a third party, or else included within the SESRO scheme, depending on scheme timing. The initial sections of treated water main to Southern Water would pass to the east of the SESRO embankment, before crossing the Great West Railway. It is expected that the initial section of this treated water main would need to be constructed as part of the SESRO scheme, to avoid destroying new habitat that would be created as part of the SESRO scheme. The SESRO indicative Gate 2 Master Plan has been developed to ensure such a pipeline route is available through the site, into which the T2ST SRO could then connect, as required.
SWOX Supply and Farmoor	The proposed site for the water treatment works for the local SWOX supply is currently located on the SESRO site, adjacent to the intake pumping station. The site for this works would either need to be safeguarded within the SESRO site design, to enable future construction when required under separate consent by a third party, or else included within the SESRO scheme, depending on scheme timing. The initial sections of treated / raw water main(s) to SWOX and Farmoor would pass to the north, crossing the River Ock floodplain. The SESRO indicative Gate 2 Master Plan has been developed to ensure a route for these main(s) is available. The optimised option for meeting the SWOX supply and the abstraction reduction at Farmoor Reservoir has yet to be developed. This will be a key aspect of the scheme development in the next phase.

2.6 Scalability

2.18 The SESRO options enable a degree of scalability and future phasing, but this is within the constraints of the main option chosen. For each of the single phase options, once built, these would not enable easy future expansion and no such facility is currently built into the concept design. The two phased options are available, which would enable the assets, and hence the available deployable output, to be phased if that is the best value solution. The phased options do tend to be more expensive (see Section 8.1 of the Gate 2 Report) as they involve more earthworks, overall, for the volume of storage created, and would need to be developed in multiple construction phases thereby extending the time of the construction phase impacts.

2.19 The integration with other schemes would enable scalability in the future. For example, the STT connection could be enabled for future use but not commissioned immediately, which would enable future integration with transfers from the Severn to maximise the potentially available additional DO (see Section 4.2.1 of the Gate 2 Report). Equally, the SWOX supply or the Thames to Southern Transfer WTWs could be developed in a modular fashion, depending on future need for the water. This would enable the supply of water to those subsidiary uses to be scaled if required, to help manage future uncertainty. The design of these aspects of the scheme will be developed during the next design phase, depending on the outcome of the WRMP24 process.

3. Air Quality

3.1 Introduction

3.1 Building on the work undertaken to support the Gate 1 process, this chapter presents an environmental appraisal of the potential air quality impacts associated with SESRO.

3.2 This chapter sets out the key legislation and policy relevant to air quality followed by the methodology and study area used for the environmental appraisal. An analysis of the baseline is presented, followed by an appraisal of the effects of SESRO and an evaluation of their significance. An overview of likely mitigation measures that may be adopted to avoid, reduce or offset any potential effects is provided followed by recommendations for further work.

3.3 This chapter focusses on the largest SESRO option (i.e. 150Mm^3) with narrative provided on the relative performance of the alternative reservoir options (i.e. 125Mm^3, 100Mm^3, 75Mm^3, 30+100Mm^3 and 80+42Mm^3).

3.4 This chapter is supported by Figure 3.1 Monitoring Locations, Air Quality Management Areas and Proposed Construction Traffic Route which can be found in can be found in Supporting Document B2.2, Environmental Appraisal Report (terrestrial) Figures.

3.1.2 Scope of the environmental desktop study

3.5 The scope of this desktop study is to assess the potential air quality effects resulting from SESRO during the construction phase. It is anticipated there would be no significant air quality effects associated with the operation phase of SESRO. Therefore, the operational phase is not considered further from an air quality perspective for this Gate 2 appraisal.

3.6 This desktop study considers local air quality impacts on key sensitive receptors at human exposure locations and designated sites of nature conservation during the construction phase.

3.1.3 Potential sources of air pollutants

3.7 The main pollutants of potential concern for air quality which are relevant to SESRO are those associated with combustion emissions, which, in the United Kingdom (UK), typically arise from road traffic, domestic and commercial combustion and industry. The key pollutants are oxides of nitrogen (NOx), nitrogen dioxide (NO_2) and particulate matter (PM_{10} and $PM_{2.5}$ (particulate matter with an aerodynamic diameter of 10 microns or less and 2.5 microns or less, respectively)). These air pollutants can affect human health and cause damage to sensitive vegetation and ecosystems.

3.8 Also relevant is 'dust' which could affect human health or give rise to annoyance or

damage due to the soiling of surfaces through deposition. The term 'dust' refers to all particulate matter including all solid particles suspended in air or settled and deposited on a surface after having been suspended in air. This includes the smaller-sized particles associated with potential health impacts (i.e. PM_{10} and $PM_{2.5}$) and the larger particles associated with causing annoyance or affecting sensitive vegetation through deposition to surfaces. Dust can be generated during construction activities such as demolition, earthworks or construction vehicles travelling on dusty roads and surfaces.

3.9 The potential sources of air pollutants associated with the construction phase of SESRO that are considered in this chapter are:

- exhaust emissions of pollutants to air from associated vehicles on the local road network;
- exhaust emissions of pollutants from Non-Road Mobile Machinery (NRMM) and plant; and
- dust emissions generated by demolition, earthworks, construction and trackout (i.e. the transport of dust and dirt from the construction/demolition site onto the public road network, where it may be deposited and then re-suspended by vehicles using the network) related activities.

3.10 Emissions from the proposed freight trains transporting bulk material (i.e. sand, gravel and rip rap that are required primarily for embankment slope protection) to the indicative location for SESRO are not considered in this desktop study. The freight trains would travel along the Great Western Main Line (London to Bristol), which runs adjacent to the southern side of the indicative location for SESRO. Although the Great Western Main Line is electrified, diesel powered freight trains would be required to transport the bulk material. It is anticipated a maximum of 2 trains per day would be required for up to a year before construction of the reservoir commences, to enable the stockpiling of raw materials. Due to the low frequency of train journeys, there is likely to be a negligible impact on local air quality and, therefore, emissions from freight trains transporting bulk material are not considered further in this desktop study. However, construction of the temporary rail sidings and associated materials handling area (required to receive the bulk material from the freight trains), is considered in the assessment of dust emissions from construction related activities.

3.2 Legislation and policy

3.11 Table 3.1 presents the relevant legislation, policy and strategies relevant to the assessment of air quality.

Table 3.1: Air Quality Key Legislation and Policy

Legislation / Policy	Description
Environment Protection Act 1990 Part III[8]	Provides statutory nuisance provisions for nuisance dust and details the principal controls over it for local authorities.
Environment Act 1995, Part IV[9]	Introduced a system of Local Air Quality Management (LAQM) in the UK. This requires local authorities to review and assess air quality within their boundaries regularly and systematically against Air Quality Objectives (AQOs), appraise development and transport plans against these assessments and make plans to meet the AQOs where these are exceeded. Where the AQOs are not being met, local authorities must issue an order designating an air quality management area (AQMA) and produce action plans to improve air quality in those areas.
Environment Act 2021[10]	The European Act 2021 acts as the UK's new framework of environmental protection. The legislation will aim to improve air and water quality, tackle waste, increase recycling, halt the decline of species, and improve the natural environment.
The Air Quality (England) Regulations 2000 (UK Government, 2000) and The Air Quality (England) (Amendment) Regulations 2002[11]	Legislates for the AQO's for pollutants set out in the 2000 Air Quality Strategy, which was revised in 2007 (Defra, 2007). AQOs exist for a variety of pollutants including NOx, NO_2, PM_{10} and $PM_{2.5}$. These are established for the protection of human health and of vegetation and ecosystems (see Table 3.2 for the AQOs relevant to this assessment).

[8] United Kingdom (UK) Government (2020). Environmental Protection Act 1990 Part III. [online]. Available at https://www.legislation.gov.uk/ukpga/1990/43/part/III. [Accessed June 2022].
[9] United Kingdom (UK) Government (2015). Environment Act 1995 Part IV Air Quality. [online]. Available at https://www.legislation.gov.uk/ukpga/1995/25/part/IV. [Accessed June 2022].
[10] United Kingdom (UK) Government (2021). Environment Act 2021. [online]. Available at https://www.legislation.gov.uk/ukpga/2021/30/contents/enacted. [Accessed August 2022].
[11] United Kingdom (UK) Government (2002) The Air Quality (England) Amendment Regulations 2002. [online]. Available at: https://www.legislation.gov.uk/uksi/2002/3043/made. [Accessed June 2022].

Legislation / Policy	Description
The Air Quality Standards Regulations 2010/2016 (as amended)[12]	Transposes the air quality limit values set out in the European Union (EU) ambient air quality directive 2008/50/EC[13] to UK law. The UK Government is responsible to the European Commission for ensuring that it complies with the provisions of EU Directives. On the UK Government's behalf, the Department for Transport (DfT) and the Department for Environment, Food and Rural Affairs (Defra) have Public Service Agreements relating to EU limit values.
The Environment (Miscellaneous Amendments) (EU Exit) Regulations 2020[14]	This instrument makes amendments to legislation in the fields of air quality to address failures of EU retained law and to ensure the legislation operates effectively after the end of the implementation period. It also makes necessary amendments to directly applicable retained EU law.
The National Air Quality Strategy (AQS) for England, Scotland, Wales and Northern Ireland, 2007[15]	Updates the 2000 Air Quality Strategy, and sets out how local air quality is managed, through the application of AQOs based on the Air Quality (England) Regulations 2000 and The Air Quality (England) (Amendment) Regulations 2002.
Draft National Policy Statement (NPS) for Water Resources Infrastructure (2018)	The NPS sets out the need and government's policies for, development of nationally significant infrastructure projects (NSIPs) for water resources in England. It provides planning guidance for applicants of NSIPs for water resources, as defined in the Planning Act 2008 ('the Planning Act').

[12] United Kingdom (UK) Government (2016) The Air Quality Standards (Amendment) Regulations 2016. [online]. Available at: https://www.legislation.gov.uk/uksi/2016/1184/contents/made. [Accessed June 2022].
[13] European Union (EU) (2008). Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe. [online]. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0050&from=en. [Accessed June 2022].
[14] United Kingdom (UK) Government (2020). The Environment (Miscellaneous Amendments) (EU Exit) Regulations 2020 [online]. Available at https://www.legislation.gov.uk/uksi/2020/1313/contents/made. [Accessed July 2022].
[15] Department for Environment, Food and Rural Affairs (Defra) and the Devolved Administrations (2007) The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. [online]. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69336/pb12654-air-quality-strategy-vol1-070712.pdf. [Accessed June 2022].

Legislation / Policy	Description
The National Planning Policy Framework (NPPF)[16]	The NPPF sets out the government's planning policies for England and how these are expected to be applied. The NPPF introduces the presumption in favour of sustainable development in England, where there are no relevant development plan policies, or where the policies which are most important for determining the application are out of date.
Vale of White Horse District Council Local Plan, Part 1 2016	The Vale of White Horse Local Plan 2031 Part 1: Strategic Sites and Policies provides a policy framework for the delivery of sustainable development across the district up to 2031. Core Policy 43 incorporates all elements of natural resources, including air quality, to ensure it is protected from decline.
Vale of White Horse District Council Local Plan, Part 2 2019	The Vale of White Horse Local Plan 2031 Part 2: Detailed Policies and Additional Sites sets out detailed development management policies to complement the strategic policies as set out in the Part 1 plan (see above) to ensure all new developments adequately consider air quality.

[16] Ministry of Housing, Communities and Local Government (2021). National Planning Policy Framework. [online] Available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1005759/NPPF_July_2021.pdf. [Accessed June 2022].

3.3 Methodology

3.3.1 Datasets and reports reviewed

3.12 To inform this desktop study, data has been collated from the following sources:

- Defra background map datasets[17] and other representative measurement data[18] have been used to determine ambient background concentrations of air pollutants at the indicative location for SESRO and surrounding area;
- construction related traffic datasets as submitted for Gate 1;
- historical reports such as the Upper Thames Reservoir Construction Method Statement (Draft)[19] and Upper Thames Reservoir Constructability Report (Draft)[20]; and
- more recent SESRO related reports such as the SESRO Engineering Technical Annex A-2: Concept Design Report[21] which supported the Gate 1 submission.

3.3.2 Assessment methodology

3.13 This desktop study was undertaken in accordance with the assessment methodologies set out in the following guidance documents:

- Environmental Protection UK (EPUK) and Institute of Air Quality Management (IAQM): Land Use Planning and Development Control: Planning for Air Quality[22];
- IAQM guidance: A guide to the assessment of air quality impacts on designated nature conservation sites[23]; and
- IAQM: Guidance for assessing dust from demolition and construction[24].

3.3.2.2 Construction phase – emissions from road traffic

3.14 The EPUK/IAQM guidance[22] sets out screening criteria for identifying roads where there is the potential for a significant effect on local air quality and identifying the need for an air quality assessment. The criteria are based on changes in road traffic flows between Do Minimum (DM) (i.e. without SESRO) and Do Something (DS) (i.e. with SESRO) scenarios.

[17] Department for Environment, Food and Rural Affairs (Defra) (2022). UK Air Information Resource. [online] Available at: http://uk-air.defra.gov.uk [Accessed February 2022].
[18] Vale of White Horse District Council (2021). 2021 Air Quality Annual Status Report (ASR). June 2021.
[19] Thames Water (2008). The Upper Thames Major Resource Development. Upper Thames Reservoir Construction Method Statement (DRAFT). Version 1.0, September 2008.
[20] Thames Water (2006). The Upper Thames Major Resource Development. Upper Thames Reservoir Constructability Report (DRAFT). Version 0.1, July 2006.
[21] Mott MacDonald (2021). SESRO Engineering Technical Annex A-2: Concept Design Report. June 2021.
[22] Environmental Protection UK (EPUK) and Institute of Air Quality Management (IAQM): Land Use Planning & Development Control: Planning for Air Quality. Version 1.1. June 2015.
[23] Institute of Air Quality Management (IAQM): A guide to the assessment of air quality impacts on designated nature conservation sites. Version 1. June 2019.
[24] Institute of Air Quality Management (IAQM): Guidance on the assessment of dust from demolition and construction. Version 1.1. June 2016.

3.15 As per the EPUK/IAQM guidance[22], an assessment of traffic emissions would be required where:

- the change in light duty vehicles (LDV) (i.e. cars and small vans less than 3.5 tonne (t) gross vehicle weight) flows of more than 100 annual average daily traffic (AADT) (i.e. the total volume of vehicle traffic on a highway or road for a year divided by 365 days) within or adjacent to an AQMA or more than 500 AADT elsewhere; or
- the change in heavy duty vehicles (HDV) (i.e. goods vehicles and buses greater than 3.5 t gross vehicle weight) flows of more than 25 AADT within or adjacent to an AQMA or more than 100 AADT elsewhere.

3.16 Road links where the change in traffic flows exceed these thresholds are considered to be 'affected' roads. The study area for the assessment of potential air quality effects from road traffic generated by the project would include sensitive receptors within 200m of the 'affected' roads (for example human receptors such as residential properties, or sensitive vegetation or ecosystems such as designated habitats).

3.17 Affected roads in relation to ecological receptors are identified using the IAQM guidance on designated nature conservation sites[23] and based on the following changes in road traffic flows between the DM and DS scenarios:

- change in AADT of greater than 1,000; or
- a change in HDV flows of greater than 200 (as an AADT).

3.18 At this stage of the Concept Design (i.e. Gate 2), anticipated construction related traffic flow data are yet to be finalised. However, preliminary construction related traffic flow data associated with the largest SESRO option has been considered and has been applied in this desktop study accordingly.

3.19 It is anticipated construction vehicles would enter and exit the indicative location for SESRO via the proposed main site entrance situated on the A415 (Marcham Road), before travelling eastwards and joining the A34 at the Marcham interchange. Once at the Marcham interchange, construction vehicles would then either travel northwards or southwards on the A34.

3.20 For the SESRO, the primary construction material to be delivered by road is asphalt. As the majority of potential asphalt suppliers for SESRO (e.g. Hanson Group and Foster Yeoman) are located to the south of the indicative location for SESRO, it is reasonable to assume a greater proportion of the construction vehicles would travel southwards on the A34.

3.21 For the largest SESRO option, the estimated AADT for Year 11 (i.e. the peak year of construction activities), assuming there is no distribution north and south of the A34 interchange, would be 313 LDVs and 58 HDVs, which is below the criteria (see paragraph 3.15) for identifying the need for further assessment.

3.22 Therefore, for the largest and alternative reservoir options, an air quality assessment

to assess the impact of emissions from construction related traffic on sensitive human receptors and ecological receptors is not likely to be required and is not considered further from an air quality perspective. On this basis, changes in the concentrations of pollutants at sensitive receptors would be negligible.

3.3.2.3 Construction phase – emissions from plant and machinery

3.23 IAQM guidance[24] specifies the following in relation to the assessment of emissions to air from construction plant and machinery (i.e. non-road vehicles):

'Experience of assessing the exhaust emissions from on-site plant (also known as Non-road Mobile Machinery or NRMM) and site traffic suggests that they are unlikely to make a significant impact on local air quality, and in the vast majority of cases they will not need to be quantitatively assessed.'

3.24 For the largest and alternative reservoir options, the primary construction activities associated with SESRO are excavation of the borrow pit from where all structural embankment fill and most of the landscape fill would be won. The excavation programme of the borrow pit reflects the embankment construction programme (i.e. March to October for each year of construction) to avoid the risk of poor winter weather affecting construction activities and more specifically, minimising the risk of the Kimmeridge and Gault clay (excavated from the borrow pit) becoming saturated prior to excavation and movement. Plant anticipated to be utilised during construction include 35t articulated dump trucks, 50t dozers, 25t tracked excavators and 25t graders.

3.25 Based on the likely duration and relatively low number of diesel-powered plant and machinery items that are likely to be required to operate simultaneously at the same location, the potential impact on local air quality at sensitive human and ecological locations in the vicinity of the indicative location for SESRO is considered to be negligible. Therefore, an assessment of emissions from construction plant and machinery is not considered further from an air quality perspective.

3.3.2.4 Construction Phase – dust emissions

3.26 Emissions of dust to air can occur from works associated with the preparation of land (e.g. demolition, land clearing or grading, earth moving and excavation) and during construction).

3.27 The desktop study of dust emissions during the construction phase of the largest and alternative reservoir options was carried out using a qualitative risk-based appraisal with reference to the location of construction activities, which takes into account the location and sensitivity of receptors to the works and the planned type and scale of the construction-related activities. This is in line with the process described in the IAQM guidance[24].

3.28 As per the IAQM guidance[24], the assessment at sensitive human receptors focuses on areas up to 350m from the indicative location for SESRO. The effects of trackout are determined up to 50m from the edge of local construction routes up to 500m

from the main construction site exit. In line with the IAQM guidance[24], the assessment also considers ecological receptors up to 50m from the indicative location for SESRO and up to 50m from the edge of the local construction route at a distance of up to 500m from the main construction site exit.

3.29 The key potential construction dust emission sources which are considered in this desktop study are set out below. These have been assigned into the four categories specified in the IAQM guidance[24] of demolition, earthworks, construction and trackout as follows:

- Demolition activities: '*Any activity involved with the removal of an existing structure (or structures). This may also be referred to as de-construction, specifically when a building is to be removed a small part at a time'*.
- Earthworks: *'Covers the processes of soil-stripping, ground-levelling, excavation and landscaping'.*
- Construction activities: *'Any activity involved with the provision of a new structure (or structures), its modification or refurbishment. A structure will include a residential dwelling, office building, retail outlet, road, etc'.*
- Vehicle movement and trackout: *'The transport of dust and dirt from the construction/demolition site onto the public road network, where it may be deposited and then re-suspended by vehicles using the network. This arises when heavy duty vehicles (HDVs) leave the construction/demolition site with dusty materials, which may then spill onto the road, and/or when HDVs transfer dust and dirt onto the road having travelled over muddy ground on site'.*

3.30 The IAQM methodology[24] provides an assessment on three separate dust effects for the four activity types listed above, which are:

- annoyance due to dust soiling;
- the risk of health effects due to a significant increase in exposure to PM_{10}; and
- harm to ecological receptors.

3.31 Although $PM_{2.5}$ is not specifically included as a parameter within the assessment, the risk levels associated with PM_{10} and any subsequent mitigation measures would also apply to $PM_{2.5}$.

3.3.3 Assessment criteria

3.3.3.1 Air Quality Objectives and Target Values

3.32 The AQO's referred to in Table 3.1 which are relevant to this assessment for the protection of human health and vegetation are set out in Table 3.2. Relevant Environmental Assessment Levels (EALs) set out in the Environment Agency guidance are also included in Table 3.2 where these supplement the AQOs.

3.33 For the purposes of reporting, the AQOs and EALs have been collectively termed as Environmental Quality Standards (EQSs).

Table 3.2: Air quality objectives and environmental assessment levels

Pollutant	EQS ($\mu g/m^3$)	Concentration measured as
NO_2	40	Annual mean
	200	1-hour mean, not to be exceeded more than 18 times a year (99.79^{th} percentile)
NOx	30	Annual mean limit value for the protection of vegetation (referred to as the "critical level")
	75	Maximum 24-hour mean for the protection of vegetation (referred to as the "critical level")
PM_{10}	40	Annual mean
	50	24-hour mean, not to be exceeded more than 35 times a year (90.41^{st} percentile)
$PM_{2.5}$	20[1]	Annual mean

Note 1: Amendment to the Air Quality Standards Regulations 2010 as per the Environment (Miscellaneous Amendments) (EU Exit) Regulations 2020[25].

3.3.3.2 *Construction phase – emissions from road traffic and from plant and machinery*

3.34 As discussed previously, the changes in the concentrations of pollutants at sensitive receptors from emissions from road traffic and from plant and machinery is considered to be negligible. Therefore, as per the assessment criteria in the EPUK/IAQM guidance[22], this would represent a not significant effect on air quality.

3.3.3.3 *Construction phase – dust emissions*

3.35 The IAQM guidance[24] uses a consistent approach to define the risks associated with the construction activities (demolition, earthworks, construction and trackout) in order to specify the required level of mitigation required to reduce those risks. The risk is defined from the dust emission magnitude (i.e. the scale of the activities being undertaken) and the sensitivity of the area in the vicinity of the indicative location for SESRO (i.e. the number and proximity of sensitive receptors to the indicative location for SESRO, their sensitivity to dust deposition and PM_{10} concentrations, and existing PM_{10} concentrations). Risks are described in terms of there being a low, medium or high risk of dust impacts for each of the four potentially dust emitting activities (demolition, earthworks, construction and trackout).

3.36 This risk classification would then be used to define the recommended site-specific mitigation to reduce the residual effects of construction dust emissions to a not

[25] UK Government (2020) The Environment (Miscellaneous Amendments) (EU Exit) Regulations 2020. [online]. Available at: https://www.legislation.gov.uk/uksi/2020/1313/contents/made. [Accessed June 2022].

significant effect. These mitigation measures to control dust emissions would be included in the air quality management strategies set out in the Construction Environmental Management Plan (CEMP) or equivalent management plan that would be agreed with the relevant local planning authority and appointed contractor(s) prior to construction commencing.

3.37 A full description of the methodology including further explanation on how the dust emission magnitude and area sensitivity are defined is provided in the IAQM guidance[24].

3.3.4 Assumptions and limitations

3.38 At this stage of the Concept Design, the anticipated number of construction traffic and distribution on the A34 and wider road network is yet to be finalised. However, given that the estimated change in AADTs for the largest SESRO option was below the criteria, it is assumed that the distribution of construction traffic on the A34, once determined, would further reduce the road traffic flows below the relevant EPUK/IAQM criteria[22] as presented in Section 3.3.2.

3.39 The IAQM guidance[24] recommends that the receptor distance is based on the distance from the source rather than the site boundary. This desktop study was undertaken on the basis that all activities (i.e. demolition, earthworks, construction and trackout) take place at the edge of the indicative location for SESRO. This represents a conservative assumption, as in practice most activities would not take place at the edge of the indicative location for SESRO, thus increasing the distance between the source and the receptor.

3.40 This desktop study is based on information available at the time of writing and may be subject to change as the final design details are developed. However, where required, a precautionary approach has been taken and at this stage, it is considered that the information provided is sufficient to identify the likely risks due to dust emissions from activities associated with construction of the largest SESRO option and alternative reservoir options.

3.4 Understanding of the baseline

3.4.1 Identification of key air quality receptors

3.4.1.1 *Human receptors*

3.41 For human exposure, sensitive receptors (termed 'human receptors') include locations where members of the public could be present over short or long periods of time, for example residential properties, schools, hospitals, doctor's surgeries, places of worship, busy streets, shops, playing fields or parks and Public Rights of Way (PRoW).

3.42 For the assessment of emissions of dust, a desktop review of relevant human receptors has identified between 10 - 100 'High' sensitive receptors (e.g. residential properties) within or adjacent to the indicative location for SESRO. These receptors represent isolated residential properties and also residential properties on the

outskirts of the villages of Steventon and East Hanney. Some of the identified human receptors are approximately 20m – 50m from the screening mounds that are anticipated near the southern and western extents of the indicative location for SESRO. In addition, there are between 1 - 10 'High' sensitive receptors within 200m of the works associated with the auxiliary drawdown channel, the closest residential property being approximately 100m away. Furthermore, there are between 1 - 10 'High' sensitive within 100m of the East Hanney to Steventon Road diversion works. There are no 'High' sensitive receptors within 50m of the route(s) used by construction vehicles on the local road network, up to 500m from the main site exit. However, the shared use footway and cycleway (considered a 'Low' sensitivity receptor as per IAQM guidance[24] that runs alongside the A415 (Marcham Road) is considered for the assessment of trackout.

3.4.1.2 *Ecological receptors*

3.43 The term 'ecological receptors' refers to European designated sites (i.e. Special Area of Conservation (SAC), Special Protection Area (SPA) and Ramsar sites), Site of Special Scientific Interest (SSSI) and local nature sites including ancient woodlands, local wildlife sites (LWS) and national and local nature reserves (NNR and LNR).

3.44 A desktop review of relevant ecological receptors in the vicinity of the indicative location for SESRO has identified Hyde's Copse ancient woodland (approximately 550m north of the indicative location for SESRO) and Barrow Farm Fen SSSI (approximately 470m north of the indicative location for SESRO) as the closest relevant ecological receptors. As per IAQM guidance[24], the absence of any relevant ecological sites within 50m of the indicative location for SESRO or relevant ecological sites within 50m of the route(s) used by construction vehicles up to 500m from the main site exit, means the potential effects of construction dust on ecological sites is not required to be considered further.

3.4.2 Background pollutant concentrations

3.45 A desktop review was carried out to determine the availability of baseline air quality data recorded in the vicinity of the indicative location for SESRO and also if data from other regional or national sources such as the UK Air Information Resource (UK-AIR)[17] website could be used to represent background concentrations of the relevant pollutants in the vicinity of the indicative location for SESRO.

3.46 As part of the LAQM process, the Vale of White Horse District Council has declared three AQMAs across its administrative borough. The closest AQMA to the indicative location for SESRO is termed 'Marcham AQMA' and was declared for exceedances of the annual mean AQO for NO_2 in 2015. This AQMA comprises an area along the A415 and includes part of Abingdon Road, Packhorse Lane and Frilford Road within the village of Marcham. This AQMA is approximately 480m west of the proposed main site entrance at its closest point. The next closest AQMA is 'Abingdon AQMA', which was declared for exceedances of the annual mean AQO for NO_2 in 2006. This AQMA encompasses an area along the main road system in the centre of Abingdon and is approximately 1.7km north of the indicative location for SESRO at its closest point

and approximately 1.5km east of the A34 Marcham interchange. The nearest AQMA's to the indicative location for SESRO are presented in Figure 3.1 in Technical Supporting Document B2.2, Environmental Appraisal Report (terrestrial) Figures.

3.47 The Vale of White Horse District Council carries out regular assessments and monitoring of air quality within its administrative boundary as part of the LAQM process. The most recent Air Quality Annual Status Report[18] was reviewed to determine concentrations of NO_2 within the vicinity of the indicative location for SESRO. The nearest monitoring locations to the indicative location for SESRO are presented in Table 3.3 and Figure 3.1 in Technical Supporting Document B2.2, Environmental Appraisal Report (terrestrial) Figures. It should be noted that the Vale of White Horse District Council does not currently monitor PM_{10} and $PM_{2.5}$ concentrations.

3.48 Table 3.3 presents the 2019 monitored annual mean NO_2 concentrations as this dataset is the latest available representative data not affected by the Covid pandemic and related travel restrictions.

Table 3.3: Nearest monitoring locations to the indicative location for SESRO

Site ID	Description	Site type	2019 Annual mean concentration µg/m^3)
Masons	Stert Street, Abingdon	Roadside	22.0
S15	S15: Mill Road, Marcham	Urban background	10.6
S16	S16: Packhorse Lane, Marcham	Kerbside	41.4
S17	S17: Frilford Road, Marcham	Roadside	35.6
S18	S18: Packhorse Lane, Marcham	Kerbside	26.3
S19	S19: Packhorse Lane, Marcham	Roadside	33.3
S20	S20: Abingdon Road, Marcham	Kerbside	28.9
S45	S45: Henry Liddon House, Abingdon	Roadside	35.8
S11	S11: Marcham Road Abingdon	Roadside	38.9
S14	S14: Spring Road, Abingdon	Kerbside	29.7
S10	S10: Ock Street Drama Club, Abingdon	Roadside	32.6
S13	S13: Drayton Road, Abingdon	Roadside	32.6
S09	S09: Drayton Road, Abingdon	Roadside	30.8
S08	S08: Turner Road, Abingdon	Urban Background	14.4
S12	S12: 9 Ock Street, Abingdon	Roadside	29.4
S05	S05: Ock Street Baptist Church, Abingdon	Roadside	29.9
S04	S04: High Street, Abingdon	Roadside	36.5

Site ID	Description	Site type	2019 Annual mean concentration µg/m^3)
S38	S38: Market Square / Central Wantage, Wantage	Kerbside	25.6
S39	S39: Hampden Road, Wantage	Urban Background	10.5
S35	S35: Sutton Courtenay Mill	Kerbside	24.5
S34	S34: Sutton Courtenay Junction, Sutton Courtenay	Kerbside	25.6
S43	Steventon Milton Lane	Urban Background	10.2
S42	Steventon Co-op	Kerbside	20
S37	S37: Copenhagen Drive, Abingdon	Kerbside	29.1

3.49 The nearest automatic monitoring location to the indicative location for SESRO is Site ID: Masons at National Grid Reference (NGR) which is approximately 1.8km from the indicative location for SESRO. In 2019, this monitoring location recorded an annual mean NO_2 concentration of 22.0µg/m^3 which is well within the relevant NO_2 AQO (i.e. 40µg/m^3).

3.50 Analysis of the diffusion tube monitoring data shows one exceedance of the annual mean NO_2 AQO in 2019 at Site ID: 16 NGR. This diffusion tube is situated adjacent to the A415 (Abingdon Road) and within 'Marcham AQMA'. Table 3.3 indicates that the highest annual mean NO_2 concentrations are recorded at roadside locations adjacent to the A415, both east and west of the A34 Marcham Interchange (see Figure 3.1 in Technical Supporting Document B2.2, Environmental Appraisal Report (terrestrial) Figures) but not adjacent to the construction traffic route on the A415 between the site entrance and A34 Marcham interchange.

3.51 It should be noted that Site ID S15 NGR E, which is an urban background site type[26] and approximately 150m south of the A415 at Marcham, recorded an annual mean NO_2 concentration of 10.6µg/m^3 in 2019. This diffusion tube monitoring location (approximately 1.1km from the indicative location for SESRO) is likely to be more representative of the baseline conditions in the vicinity of the indicative location for SESRO, away from a busy roadside location. The remaining diffusion urban background site types presented in Table 3.3 recorded an annual mean NO_2 concentration of between 10.2µg/m^3 – 14.4µg/m^3, which are well within the relevant NO_2 AQO (i.e. 40µg/m^3).

3.52 For the assessed pollutants, information on background air quality in the vicinity of the indicative location for SESRO was also obtained from Defra background map datasets[17]. The 2018-based background maps by Defra are estimates based upon the principal local and regional sources of emissions and ambient monitoring data. These background concentrations are presented in Table 3.4.

Table 3.4: Background concentrations in the vicinity of the indicative location for SESRO

Pollutant	Annual mean concentration (µg/m^3)	EQS (µg/m^3)	Concentration measured as
NO_2	7.8 – 12.1	40	Defra 1km x 1km background map values in the vicinity of the indicative location for SESRO, 2022 map concentration
PM_{10}	13.3 – 17.5	40	Defra 1km x 1km background map values in the vicinity of the indicative location for SESRO, 2022 map concentration

[26] Located at distances of more than 50 m from a busy road.

Pollutant	Annual mean concentration (µg/m^3)	EQS (µg/m^3)	Concentration measured as
$PM_{2.5}$	8.5 – 10.4	20	Defra 1km x 1km background map values in the vicinity of the indicative location for SESRO, 2022 map concentration

3.53 Table 3.4 indicates that the background map NO_2 concentrations in the vicinity of indicative location for SESRO are fairly consistent with the urban background diffusion tube measurements presented in Table 3.3. Therefore, it is considered likely that the background NO_2 concentrations in the vicinity of the indicative location for SESRO (and away from busy roadside locations), would be relatively low and well below the relevant AQO. For those receptors located closer to the roadside, NO_2 concentrations are likely to be higher.

3.54 Table 3.4 indicates that the background map PM_{10} and $PM_{2.5}$ concentrations in the vicinity of the indicative location for SESRO are well below the relevant AQO.

3.55 A review of existing air quality conditions in the vicinity of the indicative location for SESRO has also been undertaken using Pollution Climate Mapping (PCM) model outputs[27]. The PCM model (modelled by Ricardo Energy & Environment (on behalf of Defra)) is a collection of air dispersion models that have been created to report ambient concentrations of certain pollutants across the UK to assess Limit Value compliance. The nearest PCM links to the indicative location for SESRO encompass a section of the A34 Marcham interchange and A415 (Marcham Road) east of the A34 Marcham interchange. The modelled PCM 2022 annual mean NO_2 concentration at these links is 22.5 µg/m^3, which is well below the NO_2 AQO (i.e. 40 µg/m^3).

3.4.3 Local climatic conditions

3.56 Analysis of the local climatic conditions was also undertaken to provide additional context to this environmental desktop study and assist in the determination of the sensitivity of the area.

3.57 Local climatic conditions such as wind speed and precipitation (rainfall) would affect the probability of airborne dust occurring from potentially dust emitting activities, or from open areas and stockpiles, and can also affect the dispersion of dust in the air. The wind direction is a useful parameter to understand the likelihood of effects occurring at sensitive locations if dust is emitted or becomes airborne and how severe its effects could potentially be.

3.58 Meteorological data covering the period 1 January 2016 to 31 December 2020 were

[27] Department for Environment, Food and Rural Affairs (Defra) and the Devolved Administrations (2022). 2020 NO_2 and PM projections data (2018 reference year). [online]. Available at: https://uk-air.defra.gov.uk/library//no2ten/2020-no2-pm-projections-from-2018-data. [Accessed August 2022].

obtained from ADM Ltd[28] for the Royal Air Force (RAF) Benson meteorological station which is approximately 17.5km east-southeast of the indicative location for SESRO. This meteorological station is considered the closest and most representative of the climatic conditions experienced at the indicative location for SESRO and surrounding area.

3.59 A wind rose for the RAF Benson metrological station is presented in Plate 3.1 for the period 1 January 2016 to 31 December 2020. The wind rose plot shows the direction the wind blows from, in five wind speed categories and the number of hours that it blows in each direction.

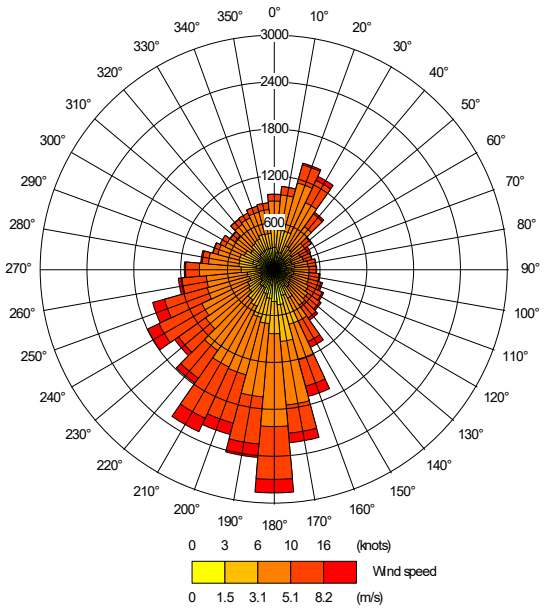


Plate 3.1: RAF Benson meteorological station windrose (2016 - 2020)

3.60 Plate 3.1 indicates that the prevailing wind direction[29] is from the south and south-southwest. Therefore, receptors to the north and north-northeast of any construction related activity which may generate dust emissions, would have the highest probability of experiencing potential increases in dust deposition or PM_{10} and $PM_{2.5}$ concentrations.

3.5 Assessment outcomes

3.5.1 Construction phase – emissions from road traffic and from plant and machinery

3.61 As discussed previously, the changes in the concentrations of pollutants at sensitive receptors from emissions from road traffic and from plant and machinery is considered to be negligible. Therefore, as per the assessment criteria in the

[28] ADM Ltd (2022). Hourly sequential meteorological data for RAF Benson meteorological station 2016-2020. [online] Further information available at: http://www.aboutair.com/met-data.htm.
[29] wind direction most frequently observed during a given period.

EPUK/IAQM guidance[22], this would represent a not significant effect on air quality.

3.5.2 Construction phase – emissions from dust

3.62 The likely risks of dust impact associated with the construction phase of SESRO are presented below.

3.5.2.2 Demolition

3.63 Proposed activities include the demolition of approximately 50 residential properties plus outbuildings, the former Ministry of Defence depot (including storage units and hard standings), the existing East Hanney Road, access roads and farm tracks, farm silos, out buildings and removal of the Landmead solar farm and Solar power station.

3.64 For the largest SESRO option and all alternative reservoir options, based on the scale and nature of the works and the sensitivity of the area to dust impacts, the likely risk of dust impact for dust soiling is considered a High risk. For human health impacts, there is likely to be a Low to Medium risk.

3.5.2.3 *Earthworks*

3.65 Earthworks activities include site preparation prior to the enabling works, vegetation clearance, excavation of the borrow pit, formation of the reservoir embankments (with a height above natural ground level of between approximately 15m and 25m), excavation for the 3.3km long tunnelling, excavation of the auxiliary drawdown channel (aligned with a proposed alignment of the Wiltshire & Berkshire Canal) and landscaping.

3.66 For the largest SESRO option and all alternative reservoir options, based on the scale and nature of the works and the sensitivity of the area to dust impacts, the likely risk of dust impact for dust soiling is considered a High risk. For human health impacts, there is likely to be a Low risk.

3.5.2.4 *Construction*

3.67 Activities include construction of the river intake / outfall structure (including the shaft); Conveyance Tunnel 1 (3.3km) from the reservoir to the intake / discharge structure at Culham on the River Thames, the conveyance tunnel (0.4km) from the Pumping Station to the Main Intake/Outlet Tower; the Pumping station, the railway sidings and materials handling area; auxiliary drawdown channel, temporary rail sidings and associated materials handling area; main access road from the A415 and diversion of the East Hanney to Steventon Road.

3.68 For the largest SESRO option and all alternative reservoir options, based on the scale and nature of the works and the sensitivity of the area to dust impacts, the likely risk of dust impact for dust soiling is considered a Medium to High risk. For human health impacts, there is likely to be a Low risk.

3.5.2.5 *Trackout*

3.69 Although there are likely to be large number of HDV's exiting the indicative location for SESRO on to the A415 (Marcham Road), for the largest SESRO option and all alternative reservoir options, based on the sensitivity of the area to dust impacts, the likely risk of dust impact for dust soiling is considered a Low risk. For human health impacts, there is also likely to be a Low risk.

3.5.3 Summary

3.70 The likely risk of dust impact associated with the construction of the largest SESRO option and all alternative reservoir options, indicates that there is a high risk for dust soiling impacts at sensitive human receptors and a medium risk for human health impacts

3.71 Good practice mitigation measures would be needed to reduce the potential for dust emissions to lead to significant impacts in the vicinity of the indicative location for SESRO. The mitigation measures presented in Section 3.6 have been obtained from the IAQM guidance[24] and would normally be sufficient to reduce construction dust nuisance and risks to human health to a not significant effect.

3.72 For emissions from road traffic and from plant and machinery, the likely changes in concentrations of pollutants at sensitive receptors associated with the largest SESRO option, is considered to be negligible.

3.73 As fewer construction vehicles and plant and machinery are likely to be required for the construction of the alternative reservoir options (with lower reservoir capacity), the likely changes in concentrations of pollutants at sensitive receptors for all alternative reservoir options is also considered to be negligible. Therefore, as per the assessment criteria in the EPUK/IAQM guidance[22], this would represent a not significant effect on air quality.

3.6 Mitigation

3.74 As discussed previously, good practice mitigation measures would be needed to reduce to reduce construction dust nuisance and risks to human health to a not significant effect in the vicinity of the indicative location for SESRO. The measures to control dust emissions would be included in the air quality management strategies set out in the CEMP or equivalent management plan.

3.75 The full list of general and activity-specific good practice mitigation measures are provided in the IAQM guidance[24]. Examples of the measures that may be taken forward and included in the CEMP or equivalent management plan are presented below.

3.6.2 Communications

- Develop and implement a stakeholder communications plan that includes community engagement before work commences.

- Develop dust mitigation and control measures as part of the air quality management strategies as set out in the CEMP or equivalent management plan. This may also include measures to control other pollutant emissions. The level of detail would depend on the risk and should include as a minimum the highly recommended measures in this assessment.

3.6.3 Monitoring

- Undertake daily on-site and off-site inspection, where receptors (including roads) are nearby, to monitor dust, record inspection results, and make the log available to the local authority when asked. This should include regular dust soiling checks of surfaces such as street furniture, cars and window sills within 100m of site boundary, with cleaning to be provided if necessary.
- Carry out regular site inspections to monitor compliance with the DMP, record inspection results, and make an inspection log available to the local authority when asked.
- Agree dust deposition, dust flux, or real-time PM_{10} continuous monitoring locations with the Local Authority. Where possible commence baseline monitoring at least three months before work commences on site or, if it a large site, before work on a phase commences. Further guidance is provided by IAQM on monitoring during demolition, earthworks and construction[30].

3.6.4 Site Management

- Record all dust and air quality complaints, identify cause(s), take appropriate measures to reduce emissions in a timely manner and record the measures taken.
- Make the complaints log available to the local authority when asked.
- Record any exceptional incidents that cause dust and/or air emissions, either on-site or off-site, and the action taken to resolve the situation in the logbook.

3.6.5 Preparing and maintaining the site

- Plan site layout so that machinery and dust-causing activities are located away from receptors, as far as is possible.
- No discharge of site runoff to ditches, watercourses, drains, sewers or soakaways without consultation of the appropriate authorities.
- Cover, seed or fence stockpiles to prevent wind-whipping as soon as is reasonably practicable following completion of earthworks.

3.6.6 Operations

- Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays or local extraction, e.g. suitable local exhaust ventilation systems.

[30] Institute of Air Quality Management (IAQM). Guidance on Monitoring in the Vicinity of Demolition and Construction Sites. Version 1.1, October 2018.

- Ensure an adequate water supply on the site for effective dust/particulate matter suppression/mitigation, using non-potable water where possible and appropriate.
- Avoid dry sweeping of large areas.
- Inspect on-site haul routes for integrity and instigate any necessary repairs to the surface as soon as reasonably practicable.
- Record all inspections of haul routes and any subsequent action in a site logbook.
- Install hard surfaced haul routes, which are regularly damped down with fixed or mobile sprinkler systems, or mobile water bowsers, and regularly cleaned.

3.6.7 Demolition

- Soft-strip inside buildings before demolition (retaining walls and windows in the rest of the building where possible, to provide a screen against dust).
- Ensure effective water suppression is used during demolition operations. Hand-held spays are more effective than hoses attached to equipment as the water can be directed to where it is needed. In addition, high-volume water suppression systems, manually controlled, can produce fine water droplets that effectively bring the dust particles to the ground.
- Avoid explosive blasting, using appropriate manual or mechanical alternatives.
- Bag and remove any biological debris or damp down such material before demolition.

3.6.8 Earthworks

- Re-vegetate earthworks and exposed areas/soil stockpiles to stabilise surfaces as soon as practicable.
- Use hessian fabric, mulches or tackifiers where it is not possible to re-vegetate or cover with topsoil, as soon as practicable.
- Only remove the cover in small areas during work and not all at once.

3.6.9 Construction

- Avoid scabbling (roughening of concrete surfaces) if possible.
- Ensure sand and other aggregates are stored in bunded areas and are not allowed to dry out unless this is required for a particular process, in which case ensure that appropriate additional control measures are in place.
- Ensure bulk cement and other fine powder materials are delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery.
- For smaller supplies of fine powder materials, ensure bags are sealed after use and stored appropriately to prevent dust.

3.6.10 Trackout

- Use water-assisted dust sweeper(s) on the access and local roads to remove, as necessary, any material tracked out of the site. This may require the sweeper being continuously in use.
- Ensure vehicles entering and leaving the site are covered to prevent escape of materials during transport.
- Implement a wheel washing system (with rumble grids to dislodge accumulated dust and mud prior to leaving the site where reasonably practicable).
- Ensure there is an adequate area of hard surfaced road between the wheel wash facility and the site exit, wherever site size and layout permits.

3.7 Next Steps

3.76 At this stage of the Concept Design, the baseline data collated thus far is considered appropriate to inform further assessment. However, should additional baseline air quality data be required, it may be necessary to undertake air quality monitoring survey(s), the type, monitoring locations and duration of which, would be agreed with the Vale of White Horse District Council and other relevant stakeholders.

3.77 For emissions from road traffic, the change in AADT is likely to fall below the EPUK/IAQM criteria[22] threshold that requires the need for an air quality assessment. As SESRO develops and construction related traffic data is finalised, working with the traffic modellers, it would be necessary to understand the construction vehicle distribution north and south of the A34 interchange as this, in addition to the finalised traffic data, would determine whether there is a need for a more detailed assessment at the next stage of the RAPID Gated process. If a more detailed assessment is required, the scope and methodology would be agreed with the Vale of White Horse District Council prior to commencement.

3.78 As more construction related information becomes available, following IAQM guidance[24], a construction dust risk assessment more specific to the proposals and more accurately reflecting SESRO construction activities, can be undertaken. Appropriate recommendations can then be made as to whether the good practice mitigation measures discussed in Section 3.6 should be taken forward into the CEMP or equivalent management plan.

4. Biodiversity

4.1 Introduction

4.1 Building on the work undertaken to support the Gate 1 process, this chapter presents an environmental appraisal of the potential terrestrial biodiversity impacts associated with SESRO. This includes potential impacts on sites designated for nature conservation, ancient woodland, Habitats of Principal Importance (HoPI) and protected and notable species and the potential impacts of SESRO on the spread of invasive and non-native species.

4.2 This chapter sets out the key legislation and policy relevant to terrestrial biodiversity followed by the methodology and study area used for the environmental appraisal. An analysis of the baseline is presented, followed by an appraisal of the effects of SESRO and an evaluation of their significance. An overview of likely mitigation measures that may be adopted to avoid, reduce or offset any potential effects is provided followed by recommendations for further work.

4.3 This chapter focusses on the largest SESRO option (i.e. 150Mm^3) with narrative provided on the relative performance of the alternative reservoir options (i.e. 125Mm^3, 100Mm^3, 75Mm^3, 30+100Mm^3 and 80+42Mm^3). The ecological assessment is based on the largest reservoir option as it is considered to have the most likely impact on terrestrial biodiversity due to its size and location. This option has also been used for the assessment as it encompasses each of the other five options, so is precautionary for the smaller reservoir designs.

4.4 A summary of the Biodiversity Net Gain requirements for SESRO are also discussed. The detailed Biodiversity Net Gain report is provided in Supporting Document B6.

4.2 Legislation and policy

4.5 This section is organised by ecological receptors. The legislation, and the protection provided by it, is then stated for each receptor. This format has been used to align with the approach to biodiversity in this chapter.

4.2.2 Statutory designated Sites

4.6 Sites of nature conservation importance that have 'statutory protection' receive protection by means of legislation in recognition of their biodiversity or geological value[31].

4.2.2.2 Special Area of Conservation

4.7 A Special Area of Conservation (SAC) is a site designated under the European Union's *Habitats Directive 1992* to protect habitats and species listed in Annex I and Annex II of the Directive which are of European interest and most in need of conservation

[31] The Wildlife Trusts, undated. [Online] Protected wildlife sites. [Online] Available at: https://www.surreywildlifetrust.org/what-we-dorestoring-surreys-nature/protected-wildlife-sites

(excluding birds). They, and their qualifying features, are fully protected under the *Conservation of Habitats and Species Regulations* 2017 (as amended) in the UK.

4.2.2.3 Special Protection Area

4.8 A Special Protection Area (SPA) is a site designated under the European Union's *Birds Directive 2009* to protect birds listed in Annexe 1 of the Directive and certain migratory species. They, and their qualifying species, are fully protected under the *Conservation of Habitats and Species Regulations* 2017 (as amended) with additional protection under the *Wildlife and Countryside Act 1981* (as amended).

4.2.2.4 Sites of Special Scientific Interest

4.9 Sites of Special Scientific Interest (SSSI) are afforded statutory protection under the *Wildlife and Countryside Act 1981* (as amended) and the *Countryside and Rights of Way Act 2000* for their flora, fauna, or geological or physiographical features.

4.2.2.5 Ramsar Sites

4.10 Ramsar sites are wetland areas of international importance that have been designated under the criteria of the *Ramsar Convention on Wetlands 1971* for containing representative, rare or unique wetland habitat types or for their importance in conserving biological diversity. The designation of UK Ramsar sites has generally been underpinned through prior notification of these areas as Sites of Special Scientific Interest. These receive statutory protection under the *Wildlife and Countryside Act 1981* (as amended).

4.2.2.6 National Nature Reserves

4.11 National Nature Reserves (NNR) are designated and protected under Section 35 of the *Wildlife and Countryside Act 1981* (as amended) for their habitats, species and geology. They are owned by or managed through agreements with Natural England.

4.2.2.7 Local Nature Reserves

4.12 Local Nature Reserves (LNR) are designated by local authorities for their importance to wildlife, geology, education or public enjoyment. They are protected under the *National Parks and Access to the Countryside Act 1949*.

4.2.3 Non-statutory designated sites

4.13 Non-statutory designated sites are designated by local authorities, which afford them some protection through local planning policy. Several different terms are used for these sites including Local Wildlife Sites (LWS), Sites of Importance for Nature Conservation (SINC), Sites of Nature Conservation Importance (SNCI) and County Wildlife Sites (CWS).

4.2.3.2 Local Wildlife Sites

4.14 LWS are wildlife-rich sites selected for their local nature conservation value. They vary in shape and size and can contain important, distinctive and threatened habitat and species.

4.2.4 Habitats

4.2.4.1 Ancient woodland, veteran trees and Habitats of Principal Importance

4.15 Ancient woodlands, veteran trees and HoPI are protected by the local planning authority, The Vale of White Horse District, in the planning process.

4.16 The Vale of White Horse District Local Plan[32] Core Policy 46 relates to Conservation and Improvement of Biodiversity. The Core Policy 46 states that:

'Development that will conserve, restore and enhance biodiversity in the district will be permitted. Opportunities for biodiversity gain, including the connection of sites, large-scale habitat restoration, enhancement and habitat re-creation will be actively sought, with a primary focus on delivery in the Conservation Target Areas. A net loss of biodiversity will be avoided.

The highest level of protection will be given to sites and species of international nature conservation importance (SAC and European Protected Species). Development that is likely to result in significant effect, either alone or in combination, on such sites and species will need to satisfy the requirements of the Habitat Regulations.

Development likely to result in the loss, deterioration of harm to habitats or species of importance to biodiversity or of importance for geological conservation interests, either directly or indirectly, will not be permitted unless:

I. The need for, and benefits of, the development in the proposed location outweighs the adverse effect on the relevant biodiversity interest.

II. It can be demonstrated that it could not reasonably be located on an alternative site that would result in less or no harm to the biodiversity interests; and

III. Measures can be provided (and are secured through planning conditions or legal agreements), that would avoid, mitigate against or, as a last resort, compensate for, the adverse effects likely to result from development.

The habitats and species of importance to biodiversity and sites of geological interest considered in relation to points I) to III) comprise:

- *Sites of Special Scientific Interest*
- *Local Wildlife Sites*
- *Local Nature Reserves*

[32] Vale of White Horse District Council (2016). Local Plan 2031 Part 1 Strategic Sites and Policies

- *Priority Habitats and species listed in the national and local Biodiversity Action Plan*
- *Ancient Woodland and veteran trees*
- *Legally Protected Species*
- *Locally Important Geological Sites*

The level of protection and mitigation should be proportionate to the status of the habitat or species and its importance individually and as part of a wider network.

It is recognised that habitats/ areas not considered above (I.e. Nationally or Locally designated and not priority habitats) can still have a significant biodiversity value within their local context, particularly where they are situated within a Conservation Target Area and/or they have good potential to be restored to priority habitat status or form/have good potential to form links between priority habitats or act as corridors for priority species. These habitats will be given due weight in the consideration of planning applications. If significant harm to these sites cannot be avoided (through locating on an alternative site with less harmful impacts) it will be expected that mitigation will be provided to avoid a net loss in biodiversity or, as a last resort, compensation will be required to offset the impacts and achieve a net gain in biodiversity.'

4.17 In addition, Section 41 of the *Natural Environment and Rural Communities (NERC) Act 2006* affords protection to HoPI through the planning process. Local authorities must consider areas of HoPI in development proposals. These habitats have been identified as the habitats and species most in need of conservation.

4.2.5 Species

4.18 The key pieces of legislation relating to protected, notable and invasive species in the UK are detailed below.

4.2.5.2 Conservation of Habitats and Species Regulations 2017

4.19 Species listed on Schedule 2 of the *Conservation of Habitats and Species Regulations 2017 (*as amended), are strictly protected in the UK. A person is guilty of an offence if they:

- deliberately capture, injure or kill any wild animal listed;
- deliberately disturb wild animals of any such species in such a way as to be likely to impair their ability:
  - to survive, to breed or reproduce, or to rear or nurture their young;
  - to hibernate or migrate;
  - affect significantly the local distribution or abundance of the species to which they belong;
- deliberately take or destroy the eggs of such an animal; or

- damage or destroy a breeding site or resting place of such an animal.

4.2.5.3 Wildlife and Countryside Act 1981

4.20 All wild nesting birds, their nests and eggs are protected by the *Wildlife and Countryside Act 1981* (as amended) and it is an offence to:

- Intentionally kill, injure or take any wild bird;
- Intentionally take, damage or destroy the nest of any wild bird while it is in use or being built; and
- Intentionally take or destroy the egg of any wild bird.

4.21 Bird species listed on Schedule 1 of the *Wildlife and Countryside Act 1981* (as amended) receive additional protection from disturbance during the breeding season. It is therefore an offence to:

- Intentionally or recklessly disturb any wild bird listed on Schedule 1 while it is nest building or is in, on or near a nest with eggs or young; or disturb the dependent young of such a bird.

4.22 Animals listed on Schedule 5 of the *Wildlife and Countryside Act 1981* (as amended) receive varying levels of legal protection. Concerning fully protected animals, a person is guilty of an offence if they:

- intentionally kill, injure or take certain animals listed on Schedule 5,
- intentionally or recklessly damage or destroy any structure or place used for shelter or protection,
- intentionally or recklessly disturb any such animal while it is occupying a structure or place which it uses for shelter or protection; or
- intentionally or recklessly obstruct access to any structure or place which any such animal uses for shelter or protection.

4.23 Plants listed on Schedule 8 of the *Wildlife and Countryside Act 1981* (as amended) are protected from the intentional picking, uprooting, destruction, and sale.

4.24 Animals and plants listed on Schedule 9 of the *Wildlife and Countryside Act 1981* (as amended) are invasive non-native species to which legal controls apply. A person is guilty of an offence if they release any animal or cause to grow in the wild any plant listed under Schedule 9.

4.2.5.4 Protection of Badgers Act

4.25 Badgers are protected under the *Protection of Badgers Act 1992* (as amended), which makes it an offence to:

- wilfully kill, injure, take, possess or cruelly ill-treat a badger, or to attempt to do so;

- intentionally or recklessly damage, destroy or obstruct access to a badger sett; or
- disturb a badger while it is occupying a sett.

4.2.5.5 Wild Mammals Protection Act

4.26 The *Wild Mammals (Protection) Act 1996* makes it an offence for any person to cause undue suffering to any wild mammal. The *Wild Mammals (Protection) Act 1996* also makes it an offence for wild mammals to die by certain inhumane methods such as by crushing or asphyxiation.

4.2.5.0 Natural Environment and Rural Communities Act

4.27 As outlined in Section 4.2.4.1, Section 41 of the *NERC Act 2006* affords protection to priority habitats through the planning process, but it also applies to priority species. Local authorities must consider the populations of Species of Principal Importance (SoPI) and areas of HoPI in development proposals. These lists are derived from the previous UK Biodiversity Action Plan lists and have been identified as the habitats and species most in need of conservation. These priority species and habitats are hereby referred to as SoPI and HoPI, respectively.

4.3 Methodology

4.3.1 General approach

4.28 The SESRO Gate 2 terrestrial biodiversity assessment has predominantly been a desk-based exercise, reviewing previous survey reports for SESRO and undertaking a local biodiversity records centre data search. It has only been possible to undertake a high-level UK Habitat Classification (UK Hab) field survey to date due to limited access to the indicative location for SESRO being available at the time of survey. The majority of the UK Hab assessment was completed by analysis of aerial imagery and other desk-based resources. Field survey was undertaken to validate the desk-based data, as far as reasonably possible with limited access to the indicative location for SESRO (field surveys have been undertaken from Public Rights of Way (PRoW) only). No updates to the species-specific surveys from Gate 1 have been performed for Gate 2. This high-level approach, coupled with stakeholder workshops and meetings, has aimed to inform the landscape and environmental masterplan, including habitat creation design and has also informed the Biodiversity Net Gain calculations.

4.29 The recommendations from the Other Habitats and Species and Biodiversity Net Gain chapters of the SESRO Gate 1 EAR have informed the approach to the Gate 2 assessment. A summary of the recommendations made in the Gate 1 report are listed below. As stated above, the recommendations relating to field survey work have not been completed for Gate 2 due to access constraints on site. These additional surveys would be undertaken to inform subsequent project stages. The field surveys are likely to commence in Autumn 2022 and would continue through the spring and summer of 2023. Additional field survey work may be required in 2024, depending on program constraints.

- Undertake a full desk study, including a data request from TVERC covering both protected and notable species and invasive non-native species. The desk study should also include an analysis of ancient and veteran trees from the Woodland Trust Ancient Tree Inventory.
- Consult with the LPA regarding the removal of important hedgerows (if present). The LPA may also wish to consult with Natural England regarding potential impacts on SSSIs as the Scheme falls within the Impact Risk Zone of a number of SSSIs.
- Complete a Phase 1 Habitat survey/ UK Hab survey of all the land within and up to at least 50 m from the Scheme boundary, in order to update the currently available information.
- Following the completion of the Phase Habitat survey/ UK Hab survey, further targeted Phase 2 surveys would be required in order to complete the Ecological Impact Assessment (EcIA) to inform the detailed design and support any subsequent DCO or planning application for the proposed Scheme.
- During early 2021, Natural England are due to issue a revised version of the Biodiversity Metric (3.0). Once published, this would be reviewed to see how it could influence the predicted results for SESRO.
- Field surveys would be essential to provide revised and refined information on the types and condition of the habitats on site. This would involve recording the habitat types and their condition, following the most up to date Natural England guidance at the time of the survey.
- Further desk study and field survey would also be undertaken to check that the woodland on site is correctly identified as not being ancient. Field surveys would also be undertaken to confirm whether any of the mature trees on site constitute ancient or other veteran trees.
- The BNG metric would be run for linear terrestrial features (hedgerows and tree lines). If field surveys are not possible, hedgerows and tree lines would be mapped based on available data and aerial imagery and the metric would be run based on this information, with assumptions about condition.

4.3.2 Assessment of alternative reservoir options

4.30 This chapter focusses on the largest SESRO option (i.e. 150Mm^3) with a high-level narrative provided on the relative performance of the alternative reservoir options (i.e. 125Mm^3, 100Mm^3, 75Mm^3, 30+100Mm^3 and 80+42Mm^3). The footprint of the largest option also encompasses each of the other five options, so individual assessments for each alternative are not required at this stage of the investigation.

4.3.3 Review of the current data

4.31 Previous ecological reports produced for SESRO during the earlier stages of project development (between 2005 and 2018) have been reviewed alongside various online and historical datasets.

4.3.4 Stakeholder consultation

4.32 Engaging with stakeholders and holding workshops to discuss scheme design, mitigation proposals and Biodiversity Net Gain (amongst other things) has been an important part of the Gate 2 process (as recommended in the Gate 1 EAR). Stakeholders invited to comment on SESRO and attend workshops has included representatives from Natural England, Environment Agency, Oxfordshire County Council, Vale of White Horse District Council and the North Wessex Downs AONB.

4.33 The focus of discussions with stakeholders was largely regarding Biodiversity Net Gain and how a 10% gain could be achieved through the creation of habitats on site such as wetland areas, woodlands and species-rich grasslands, to compensate for habitats lost to the scheme.

4.3.5 Desk study

4.34 A request for environmental records was sent to the Thames Valley Environmental Record Centre (TVERC) in February 2022. Records of protected and notable species and habitats as well as designated sites information was requested. Information was also collected from open-source websites including the Multi-Agency Geographic Information for the Countryside (MAGIC) website, Ancient Woodland Inventory and Ancient Tree Inventory.

4.35 The search area for the desk study was defined by the zone of influence around SESRO for each ecological receptor type. The size of the zone of influence for each ecological receptor type is determined by the nature and scale of SESRO and the sensitivity of the receptor. The zones of influence for identified ecological receptor types are outlined in Table 4.1 below.

Table 4.1: Zone of influence search areas for ecological features in the desk study

Receptor	Zone of influence buffer (km)
Internationally designated statutory sites with bats as a qualifying feature (SAC)	30
Internationally designated sites (SAC, SPA, Ramsar)	10
Nationally and locally designated statutory sites (SSSI, NNR, LNR)	5
Locally designated non-statutory sites (LWS, SINC, SNCI)	2
Protected, notable and invasives species	2
European Protected Species Mitigation Licences (EPSML)	2
HoPI and ancient woodland	1
Waterbodies suitable for breeding great crested newt (*Triturus cristatus*)	0.5

4.3.6 UK Habitat Classification Survey

4.36 UK Hab[33] is a relatively recent technique for rapidly obtaining baseline habitat information over a large area of land. It classifies areas of land based on the vegetation present, using a hierarchical system that contains five levels which are set out below. Levels two to five are coded with alternative letters and numbers such as 'g3a5' which stands for lowland hay meadows.

- Level 1 – Major ecosystems such as terrestrial, freshwater or marine
- Level 2 – Ecosystem types
- Level 3 – Broad habitats
- Level 4 – UK Biodiversity Action Plan Priority Habitats
- Level 5 – EU Directive Annex 1 habitats

4.37 All habitats located within the indicative location for SESRO were identified to Level 3 at a minimum on the habitat hierarchy. Secondary habitat codes allow for the recording of additional information linked to a primary habitat. For example, 10 (scattered scrub) can be linked with 'g' (grassland) or 'h' (heathland). Plant species identification followed *The New Flora of the British Isles*[34].

4.38 Plant species identified from each habitat type within the survey area were recorded and their abundance was assessed on the DAFOR scale:

D Dominant

A Abundant

F Frequent

O Occasional

R Rare

4.39 The UK Hab survey was undertaken for the land located within the indicative location for SESRO in January 2022, using both desk-based and field-based surveys. Land parcels were mapped in GIS and UK Habitat classification categories were allocated to each habitat feature using aerial imagery and Ordnance Survey (OS) maps. The habitat types and condition assessment for each habitat type have been documented within Supporting Document B6, Biodiversity Net Gain report.

4.40 As access to the indicative location for SESRO was limited to PRoW, only the habitats the surveyors could access could be validated during the field survey. Less than 50% of the indicative location for SESRO could be accurately ground-truthed during the

[33] UK Habitat Classification Working Group (2020). UK Habitat Classification User Manual. Available Online: http://ecountability.co.uk/ukhabworkinggroup-ukhab/.
[34] Stace (2019). New flora of the British Isles. C&M Floristics.

field survey and therefore significant assumptions have been made with regards to the habitats present within the indicative location for SESRO, as well as the condition of the habitats.

4.3.7 Biodiversity Net Gain

4.41 As recommended in the Gate 1 EAR, an outline Biodiversity Net Gain assessment has been conducted for Gate 2 using the data collected during the UK Hab field survey and desk study. This assessment was conducted for all six SESRO Reservoir Options, however the focus of the report was on the 150Mm^3 Option. The Biodiversity Net Gain assessment was a feasibility assessment conducted to compare the possible net gains for each Option. A summary of the Biodiversity Net Gain methodology and results is provided in this EAR and the full report is provided in Supporting Document B6, Biodiversity Net Gain report.

4.42 The DEFRA Biodiversity Metric 3.0[35] provides a value measured in units for a site pre-intervention ('baseline value') and post-intervention, allowing the difference (positive or negative) to be measured as a net loss or net gain. The calculation is based on the size of a parcel of habitat and its quality. For each habitat parcel, a biodiversity value is generated based on four factors as detailed below:

- **Area:** the area in hectares that the habitat occupies or the length of hedgerow.
- **Distinctiveness:** the relative scarcity of the habitat and its importance for nature conservation. This is scored between 0 (very low distinctiveness) and 8 (very high distinctiveness).
- **Condition:** a measure of the quality of a habitat. This is scored between 1 (poor condition or N/A) and 3 (good condition).
- **Strategic significance:** gives extra value to habitats that are located in optimal locations to meet biodiversity and other environmental objectives. This can include areas identified as suitable for protected species compensation. This is scored between 1 (low strategic significance) and 1.15 (high strategic significance).

4.43 The UK Hab habitat types, areas, habitat conditions, habitat distinctiveness and strategic significance are entered into the DEFRA Biodiversity Metric 3.0 calculation tool to quantify the baseline quantity of habitat units.

4.44 The post-intervention quantity of habitat units is then calculated using the habitat types and areas from the masterplan for SESRO, as illustrated on Figure 2.1 Landscape and environmental design strategy plan in Technical Supporting Document B2.2, Environmental Appraisal Report (terrestrial) Figures, with the condition of the habitats estimated to be achievable based on the current baseline and the management required.

4.45 A habitat condition assessment was undertaken for the habitat features viewable

[35] Natural England (2021). The Biodiversity Metric 3.0.

from PRoW following the DEFRA Biodiversity Metric 3.0 during the UK Hab field survey. Conditions were recorded as 'Good', 'Moderate', 'Poor' or 'N/A' using the criteria contained in the condition assessment form appropriate to the habitat. Not all habitats were viewable from PRoW and therefore not all were able to be condition assessed. For the purposes of Gate 2, the conditions of each habitat type have been standardised based on the information collected on the condition of the habitats that could be assessed during the field survey. For example, all hedgerows have been categorised as having the same condition assessment. Where assumptions were made regarding habitat condition, a precautionary approach was adopted, and a higher condition score was allocated to each habitat.

4.4 Understanding of the baseline

4.4.1 Assessment of alternative options

4.46 The baseline information for this assessment is based on the 150Mm^3 reservoir option which is the largest of all the six reservoir options. The 150Mm^3 option also encompasses all of the other reservoir options. The ecological assessment has been conducted on this option, but the same assessment has been applied to all other options. The assessment is therefore precautionary for the smaller five options, due to the largest reservoir option having the greatest likely impacts on terrestrial biodiversity.

4.4.2 Desk study

4.47 One of the recommendations of the Gate 1 EAR report was to obtain baseline desk study information. Contained in this section are the records received from the Thames Valley Environmental Record Centre, MAGIC website, Ancient Woodland Inventory website and Ancient Tree Inventory website as part of the 2022 desk study.

4.4.2.2 Statutory designated sites

4.48 Table below details the statutory designated sites identified within the search area. No SAC designated for bats were identified within the 30km search area.

Table 4.2: Statutory designated sites identified during the desk study

Site name	Area (ha)	Approximate distance and direction	Qualifying features
Special Areas of Conservation (SAC) within 10km			
Cothill Fen	43.26	2.7km north	Annex I habitats that are a primary reason for selection of this site 7230 Alkaline fens Annex I habitats present as a qualifying feature, but not a primary reason for selection of this site

Site name	Area (ha)	Approximate distance and direction	Qualifying features
			91E0 Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*) * Priority feature
Little Wittenham	68.92	7.1km east	Annex II species that are a primary reason for selection of this site 1166 great crested newt (*Triturus cristatus*)
Hackpen Hill	35.81	8.9km southwest	Annex I habitats present as a qualifying feature, but not a primary reason for selection of this site 6210 Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) (* important orchid sites) Annex II species that are a primary reason for selection of this site 1654 Early gentian *Gentianella anglica*
Sites of Special Scientific Interest (SSSI) within 5km			
Barrow Farm Fen	6.72	0.5km north	This site is primarily of interest for its remnants of calcareous fen vegetation which are found within a matrix of dense wet and dry carr woodland. This type of fen community has declined considerably within Oxfordshire and the only sizeable area now remaining is the nearby Cothill Fen.
Frilford Heath, Ponds and Fens	108.84	1.9km north	The acid grassland, heathland and associated valley fens at Frilford Heath are unique in southern England. The site has an exceptionally diverse flora and fauna, with over 400 species of vascular plants recorded, including many national rarities, together with rare beetles, flies, bees and other insects.
Culham Brake	1.48	1.7km northwest	Site is unmanaged willow carr, subject to flooding. Dominated by mature crack willow (*Salix fragilis*), occasional mature oak (*Quercus robur*) and ash.
Dry Sandford Pit	4.21	2.4km north	Abandoned quarry with calcareous vegetation, including fen, grassland, scrub and lichen-rich heath. Associated with the pools and their inflow and exit streams is a rich calcareous fen which differs from the neighbouring fen at Cothill in some aspects of its vegetation, particularly the bryophyte flora. Such fens

Site name	Area (ha)	Approximate distance and direction	Qualifying features
			are rare and confined to the Corallian beds of Oxfordshire.
Cothill Fen	43.26	2.7km north	Large species rich lowland calcareous fen, grass snake *(Natrix helvetica),* common lizard *(Zootoca vivipara)* and a large number of scarce invertebrates have been recorded including southern damselfly *(Coenagrion mercuriale)* and Desmoulin's whorl snail *(Vertigo moulinsiana).* Several uncommon plants including alkaline fens, including narrow-leaved marsh orchid *(Dactylorhiza traunsteineri),* marsh helleborine *(Epipactis palustris)*, bog pimpernel *(Anagallis Tenella),* black bog rush *(Schoenus nigricans)* and marsh valerian *(Valerian dioica).* Part of Cothill Fen SAC.
National Nature Reserves (NNR) within 5km			
Cothill	1.51	2.8km north	Cothill NNR is known for its fens and their rich invertebrate life, but in addition the site also has open water, reedbeds and oak and alder woodland. Part of Cothill Fen SSSI and SAC.
Local Nature Reserves (LNR) within 5km			
Abbey Fishponds	5.62	3.0km north	Wetlands, wet woodland, reedbed, fen and meadow.

4.4.2.3 Non-statutory designated sites

4.49 Table below details the non-statutory LWS located within 2km of the indicative location for SESRO.

Table 4.3: Non statutory sites identified during the desk study

Site name	Area (ha)	Approximate distance and direction	Qualifying features
Local Wildlife Sites (LWS) within 2km			
The Cuttings and Hutchin's Copse	17.86	Within the indicative location for SESRO	The Cuttings are a series of ponds alongside the railway and Hutchin's Copse is ancient woodland. The site supports ancient woodland flora, a good

Site name	Area (ha)	Approximate distance and direction	Qualifying features
			range of birds, nationally notable beetles and great crested newt.
Cowslip Meadow	12.55	0.4km west	The meadows have a good range of plant species which are typically associated with meadows which have been traditionally managed for many years without re-seeding or the use of artificial fertilisers.
Marcham Salt Spring	1.47	0.9km north	Only site in the county that supports wild celery *(Apium graveolens)* with a rich and interesting flora.
Gozzards Ford Fen	1.57	1.8km north	Gozzards Ford Fen is largely wet woodland with small open areas of calcareous fen dominated by greater tussock sedge. The site has been noted for its invertebrate interest with previous records for numerous rare and notable species of moth, fly, bee, and wasp.

4.4.2.4 Ancient woodland and veteran trees

4.50 The description of The Cuttings and Hutchin's Copse LWS above states that the woodland within the designated site is ancient, although this does not show on the Ancient Woodland Inventory. The closest ancient woodland outside of the indicative location for SESRO is Hydes Copse, located approximately 0.5km to the north of the indicative location for SESRO.

4.51 There is one ancient tree located within the indicative location for SESRO, according to the Ancient Tree Inventory[36]. It is a crack willow *(Salix fragilis)* with a 4.5 metre diameter at breast height. There are 16 additional veteran trees along the River Ock to the north of SESRO that would be retained and protected from damage.

4.52 Neither the Ancient Woodland Inventory or the Ancient Tree Inventory are definitive, and the indicative location for SESRO has not been thoroughly surveyed, so unregistered ancient woodlands and veteran trees could be present within the indicative location for SESRO.

4.4.2.5 Habitats of Principal Importance

4.53 Table below details the HoPI identified within 1km of the indicative location for SESRO during the desk study.

[36] Woodland Trust (2022). [Online] Ancient Tree Inventory. Available at: https://www.woodlandtrust.org.uk/visiting-woods/things-to-do/ancient-tree-inventory/.

Table 4.4: HoPI identified during the desk study

Habitat type	Locations of closest parcel	Number of parcels	Within indicative location for SESRO
Coastal and floodplain grazing marsh	Within the northern extent and eastern extent of the indicative location for SESRO, primarily in the fields alongside the River Ock.	87	**Yes**
Deciduous woodland	A number of parcels within the indicative location for SESRO, including Drayton Copse towards the centre of the indicative location for SESRO and parcels associated with the Old Canal, the railway line and Steventon Storage Facility, off Hanney Road. Areas of woodland listed on the National Forest Inventory are present within the indicative location for SESRO mostly associated with deciduous woodland HoPI.	260	**Yes**
Wood-pasture and parkland	Within the southern extent of the indicative location for SESRO (Hutchins's Marsh).	5	**Yes**
Traditional orchards	Within the south-eastern extent of the indicative location for SESRO.	79	**Yes**
Open mosaic habitat	5m to the west of the indicative location for SESRO.	4	No
Lowland dry acid grassland	370m to the north of the indicative location for SESRO.	1	No
Lowland meadows	415m to the west of the indicative location for SESRO.	5	No
Good quality semi-improved grassland (non-priority)	505m to the west of the indicative location for SESRO.	6	No
Lowland fens	615m to the north of the indicative location for SESRO.	1	No

4.54 There is the potential for other habitats within the indicative location for SESRO to also qualify as HoPI. This would be determined once targeted field surveys have been completed.

4.4.2.6 Protected and notable species

4.55 Table below details the records of species located within 2km of the indicative location for SESRO within the last 10 years, returned by Thames Valley Environmental Record Centre in the 2022 desk study. These records give an indication of the threatened species which could be impacted by the scheme. Consideration to protected and notable species must be given to avoid committing an offence under the aforementioned legislation.

Table 4.5: Records of protected and notable species identified during the desk study

Common name	Latin Name	Habitat Regs	Wildlife and Countryside Act	SoPI	BOCC	Badgers Act	Number of records	Distance from indicative location for SESRO (m)
Amphibians								
Common toad	*Bufo bufo*		Schedule 5 (sale only)	✓			21	Within
Great crested newt	*Triturus cristatus*	Schedule 2	Schedule 5	✓			60	494
Natterjack toad	*Epidalea calamita*	Schedule 2	Schedule 5	✓			158	1241
Birds								
Black-headed gull	*Chroicocephalus ridibundus*				Amber		120	Within
Brambling	*Fringilla montifringilla*		Schedule 1				1	1647
Cetti's warbler	*Cettia cetti*		Schedule 1				234	Within
Common gull	*Larus canus*				Amber		23	109
House martin	*Delichon urbicum*				Amber		24	109
Reed bunting	*Emberiza schoeniclus*			✓	Amber		116	Within
Common sandpiper	*Actitis hypoleucos*				Amber		4	109
Common tern	*Sterna hirundo*				Amber		42	109

Common name	Latin Name	Habitat Regs	Wildlife and Countryside Act	SoPI	BOCC	Badgers Act	Number of records	Distance from indicative location for SESRO (m)
Corn bunting	*Emberiza calandra*			✓	Red		3	79
Cuckoo	*Cuculus canorus*			✓	Red		25	109
Curlew	*Numenius arquata*			✓	Red		3	Within
Dunlin	*Calidris alpina*				Amber		1	Within
Dunnock	*Prunella modularis*			✓	Amber		176	Within
Eurasian bullfinch	*Pyrrhula pyrrhula*				Amber		54	109
Skylark	*Alauda arvensis*			✓	Red		32	Within
Herring gull	*Larus argentatus*			✓	Red		36	109
Fieldfare	*Turdus pilaris*				Red		26	109
Gadwall	*Anas strepera*				Amber		89	109
Goldeneye	*Bucephala clangula*		Schedule 1		Amber		4	109
Grasshopper warbler	*Locustella naevia*			✓	Red		4	109
Green sandpiper	*Tringa ochropus*		Schedule 1		Amber		7	Within
Greenshank	*Tringa nebularia*		Schedule 1		Amber		4	109
Grey partridge	*Perdix perdix*			✓	Red		17	Within
Grey wagtail	*Motacilla cinerea*				Red		45	109

Common name	Latin Name	Habitat Regs	Wildlife and Countryside Act	SoPI	BOCC	Badgers Act	Number of records	Distance from indicative location for SESRO (m)
Greylag goose	*Anser anser*				Amber		55	109
Hen harrier	*Circus cyaneus*		Schedule 1	✓			1	Within
Hobby	*Falco subbuteo*		Schedule 1				6	109
House sparrow	*Passer domesticus*			✓	Red		30	109
Kestrel	*Falco tinnunculus*				Amber		35	Within
Kingfisher	*Alcedo atthis*		Schedule 1		Amber		82	109
Lapwing	*Vanellus vanellus*			✓	Red		22	Within
Lesser black-backed gull	*Larus fuscus*				Amber		21	109
Lesser redpoll	*Acanthis cabaret*			✓	Red		3	109
Linnet	*Linaria cannabina*				Red		80	Within
Mallard	*Anas platyrhynchos*				Amber		220	Within
Meadow pipit	*Anthus pratensis*				Amber		13	Within
Merlin	*Falco columbarius*		Schedule 1		Red		1	79
Mistle thrush	*Turdus viscivorus*				Red		15	109
Mute swan	*Cygnus olor*				Amber		176	109
Oystercatcher	*Haematopus ostralegus*				Amber		11	109

Common name	Latin Name	Habitat Regs	Wildlife and Countryside Act	SoPI	BOCC	Badgers Act	Number of records	Distance from indicative location for SESRO (m)
Peregrine	*Falco peregrinus*		Schedule 1				3	Within
Pochard	*Aythya ferina*				Red		69	109
Red kite	*Milvus milvus*		Schedule 1				83	Within
Redwing	*Turdus iliacus*		Schedule 1		Red		31	109
Ruff	*Calidris pugnax*		Schedule 1		Red		2	Within
Short-eared owl	*Asio flammeus*				Amber		3	340
Shoveler	*Anas clypeata*				Amber		15	109
Snipe	*Gallinago gallinago*				Amber		12	Within
Song thrush	*Turdus philomelos*			✓	Red		121	109
Spoonbill	*Platalea leucorodia*		Schedule 1		Amber		1	794
Spotted flycatcher	*Muscicapa striata*			✓	Red		1	1513
Starling	*Sturnus vulgaris*			✓	Red		47	109
Stock dove	*Columba oenas*				Amber		28	Within
Swift	*Apus apus*				Amber		53	Within
Tawny owl	*Strix aluco*				Amber		18	Within
Teal	*Anas crecca*				Amber		28	Within
Tree sparrow	*Passer montanus*			✓	Red		2	340

Common name	Latin Name	Habitat Regs	Wildlife and Countryside Act	SoPI	BOCC	Badgers Act	Number of records	Distance from indicative location for SESRO (m)
Turtle dove	*Streptopelia turtur*			✓	Red		2	340
Barn owl	*Tyto alba*		Schedule 1				23	26
Wigeon	*Anas penelope*				Amber		36	109
Willow warbler	*Phylloscopus trochilus*				Amber		35	Within
Woodcock	*Scolopax rusticola*				Red		3	604
Yellow wagtail	*Motacilla flava*			✓	Red		2	1626
Yellowhammer	*Emberiza citrinella*			✓	Red		13	Within
Plants								
Juniper	*Juniperus communis*			✓			1	896
Bluebell	*Hyacinthoides non-scripta*		Schedule 8 (sale only)				9	598
Chamomile	*Chamaemelum nobile*			✓			1	1038
Grape-hyacinth	*Muscari neglectum*			✓			2	1151
Red hemp-nettle	*Galeopsis angustifolia*			✓			2	494
Invertebrates								

Common name	Latin Name	Habitat Regs	Wildlife and Countryside Act	SoPI	BOCC	Badgers Act	Number of records	Distance from indicative location for SESRO (m)
Stag beetle	*Lucanus cervus*		Schedule 5 (sale only)	✓			3	Within
Marsh fritillary	*Euphydryas aurinia*		Schedule 5 (killing or injuring)	✓			2	654
Small blue	*Cupido minimus*		Schedule 5 (sale only)	✓			9	1644
Small heath	*Coenonympha pamphilus*			✓			11	121
Autumnal rustic	*Eugnorisma glareosa*			✓			7	1031
Beaded chestnut	*Agrochola lychnidis*			✓			43	1031
Blood-vein	*Timandra comae*			✓			3	1031
Brindled beauty	*Lycia hirtaria*			✓			1	1031
Brown-spot pinion	*Agrochola litura*			✓			14	1031
Buff ermine	*Spilosoma lutea*			✓			61	1031
Centre-barred sallow	*Atethmia centrago*			✓			12	1031
Cinnabar moth	*Tyria jacobaeae*			✓			26	Within
Dark spinach	*Pelurga comitata*			✓			2	1031
Deep-brown dart	*Aporophyla lutulenta*			✓			8	1031

Common name	Latin Name	Habitat Regs	Wildlife and Countryside Act	SoPI	BOCC	Badgers Act	Number of records	Distance from indicative location for SESRO (m)
Dot moth	*Melanchra persicariae*			✓			8	1010
Dusky brocade	*Apamea remissa*			✓			4	1031
Dusky thorn	*Ennomos fuscantaria*			✓			4	1031
Dusky-lemon sallow	*Cirrhia gilvago*			✓			1	1031
Feathered gothic	*Tholera decimalis*			✓			1	1031
Garden tiger	*Arctia caja*			✓			1	545
Ghost moth	*Hepialus humuli*			✓			1	1031
Green-brindled crescent	*Allophyes oxyacanthae*			✓			38	1031
Grey dagger	*Acronicta psi*			✓			1	1053
Large wainscot	*Rhizedra lutosa*			✓			8	1031
Latticed heath	*Chiasmia clathrata*			✓			1	1241
Mottled rustic	*Caradrina morpheus*			✓			4	1031
Mouse moth	*Amphipyra tragopoginis*			✓			15	1031
Mullein wave	*Scopula marginepunctata*			✓			6	1031

Common name	Latin Name	Habitat Regs	Wildlife and Countryside Act	SoPI	BOCC	Badgers Act	Number of records	Distance from indicative location for SESRO (m)
Oak hook-tip	*Watsonalla binaria*			✓			1	1031
Powdered quaker	*Orthosia gracilis*			✓			2	1031
Rosy minor	*Litoligia literosa*			✓			2	1031
Rosy rustic	*Hydraecia micacea*			✓			24	1031
The rustic	*Hoplodrina blanda*			✓			39	1031
The sallow	*Cirrhia icteritia*			✓			23	1031
September thorn	*Ennomos erosaria*			✓			9	1031
Shaded broad-bar	*Scotopteryx chenopodiata*			✓			10	200
Small phoenix	*Ecliptopera silaceata*			✓			1	1031
The spinach	*Eulithis mellinata*			✓			3	1031
White ermine	*Spilosoma lubricipeda*			✓			14	1017
A leafhopper	*Erotettix cyane*			✓			5	494
Mammals								
Brown long-eared bat	*Plecotus auritus*	Schedule 2	Schedule 5	✓			35	Within

Common name	Latin Name	Habitat Regs	Wildlife and Countryside Act	SoPI	BOCC	Badgers Act	Number of records	Distance from indicative location for SESRO (m)
Common pipistrelle bat	*Pipistrellus pipistrellus*	Schedule 2	Schedule 5				62	Within
Daubenton's bat	*Myotis daubentonii*	Schedule 2	Schedule 5				7	Within
Leisler's bat	*Nyctalus leisleri*	Schedule 2	Schedule 5				5	237
Nathusius's pipistrelle bat	*Pipistrellus nathusii*	Schedule 2	Schedule 5				7	49
Natterer's bat	*Myotis nattereri*	Schedule 2	Schedule 5				5	92
Noctule bat	*Nyctalus noctula*	Schedule 2	Schedule 5	✓			29	Within
Serotine bat	*Eptesicus serotinus*	Schedule 2	Schedule 5				7	49
Soprano pipistrelle bat	*Pipistrellus pygmaeus*	Schedule 2	Schedule 5	✓			45	Within
Barbastelle bat	*Barbastella barbastellus*	Schedule 2	Schedule 5	✓			12	49
Whiskered bat	*Myotis mystacinus*	Schedule 2	Schedule 5				1	864
Brown hare	*Lepus europaeus*			✓			39	Within

Common name	Latin Name	Habitat Regs	Wildlife and Countryside Act	SoPI	BOCC	Badgers Act	Number of records	Distance from indicative location for SESRO (m)
Badger	*Meles meles*					✓	42	Within
Otter	*Lutra lutra*	Schedule 2	Schedule 5	✓			185	Within
Water vole	*Arvicola amphibius*		Schedule 5	✓			182	Within
Harvest mouse	*Micromys minutus*			✓			4	Within
Polecat	*Mustela putorius*	Schedule 4		✓			2	238
European hedgehog	*Erinaceus europaeus*			✓			79	101
Reptiles								
Common lizard	*Zootoca vivipara*		Schedule 5 (killing or injuring)	✓			12	Within
Grass snake	*Natrix helvetica*		Schedule 5 (killing or injuring)	✓			23	144

4.56 The desk study returned records of many species already considered during the Gate 1 assessment. However, the desk study also returned records of species not considered previously and which may therefore require further investigation and survey work. Of particular importance are the following:

- natterjack toad (*Epidalea calamita*) is fully protected under the *Conservation of Habitats and Species Regulations* 2017 (as amended) making it a European Protected Species;
- marsh fritillary (*Euphydryas aurinia*) butterfly is protected from killing or injuring under Schedule 5 of the *Wildlife and Countryside Act 1981* (as amended);
- polecat (*Mustela putorius*) is listed as a SoPI;
- European hedgehog (*Erinaceus europaeus*) is listed as a SoPI; and
- four plant species listed as SoPI, chamomile (*Chamaemelum nobile*), grape-hyacinth (*Muscari neglectum*), juniper (*Juniperus communis*) and red hemp-nettle (*Galeopsis angustifolia*).

4.4.2.7 Invasive non-native species

4.57 Table 4.6 details the invasive non-native terrestrial species identified within 2km of the indicative location for SESRO during the desk study.

Table 4.6: Invasive non-native species recorded during the desk study

Common Name	Latin Name	Number of records	Distance from the indicative location for SESRO (m)
Rhododendron	*Rhododendron ponticum*	2	943

4.58 No invasive non-native species were recorded during the UK Hab survey. However, it should be noted that a full survey of the site could not be conducted due to access constraints. Therefore, there is a possibility that invasive non-native species are present on site but were not recorded during the field survey.

4.4.3 Gate 1 Species Data

4.59 No species-specific field surveys have been conducted to inform the Gate 2 assessment due to access restrictions. Survey data were collected between 2005 and 2009 but the survey area did not include the habitat to the north of the River Ock or to the east of the A34. The survey area for all species below focussed on the reservoir footprint itself. The data are now out of date and the surveys would require updating as part of subsequent project stages. It is however considered unlikely that the habitats present within the indicative location for SESRO have changed significantly since the original field surveys were undertaken. Consequently, the field data collected between 2005 and 2009 is provided below for context.

4.4.3.2 Bats

4.60 Bat survey work undertaken in 2005 and 2009 identified at least ten, and possibly up to twelve species of bat either have roosts within the main study area or use the main study area for foraging and commuting[37]. The species recorded were noctule (*Nyctalus noctula)*, Leisler's bat (*Nyctalus leisleri)*, common pipistrelle (*Pipistrellus pipistrellus)*, soprano pipistrelle (*Pipistrellus pygmaeus)*, serotine (*Eptesicus serotinus)*, brown long-eared (*Plecotus auritus)*, barbastelle *(Barbastella barbastellus)* and up to five species of the genus *Myotis* (i.e. Daubenton's bat (*Myotis daubentonii)*, Natterer's bat *(Myotis nattereri*), whiskered bat (*Myotis mystacinus)*, Bechstein's *bat (Myotis bechsteinii)* and Brandt's bat *(Myotis brandtii)).* Pipistrelle species, noctule and Leisler's bats were the most recorded across the main study area. Species of note are the barbastelle and Bechstein's bat, which are rare and listed as 'Near Threatened' on the IUCN Red List. The serotine, whiskered and Brandt's bats, are restricted in range and categorised as vulnerable.

4.61 Preliminary bat roost assessments were carried out as part of previous work undertaken in 2006. A total of 27 trees were found to have high potential to support roosting bats, particularly around Hutchins's Copse CWS, Drayton Copse and the route of the Old Canal. Ten trees with moderate potential to support bat roosts were recorded within the water transfer system study area, mainly concentrated along the right bank of Culham Reach. A maternity colony of soprano pipistrelle bats was reported to roost in Willow Bank Farm by the occupiers in 2006. It was also considered probable that a maternity colony of noctules occupied trees in Drayton Copse in July and August.

4.62 Dusk surveys carried out in 2007 and 2008 assessed the size of the bat colonies using Willow Bank Farm and Drayton Copse. No bats were recorded at Willow Bank Farm. Noctule and soprano pipistrelle bats were recorded at Drayton Copse.

4.63 A search for EPS licences on MAGIC[38] recorded eight licences within the last 10 years, with six of these still active. These are for brown long-eared bat, common pipistrelle, soprano pipistrelle, natterers, barbastelle and serotine.

4.4.3.3 Otter

4.64 Otter *(Lutra lutra)* monitoring surveys were conducted between 2006 and 2009. The survey area provides plentiful suitable terrestrial habitat for otters, with woodland and scrub close to the watercourses within the survey area. The surveys carried out in 2006 found eleven potential holt sites recorded along the River Ock and Childrey Brook, all of which were associated with ash *(Fraxinus excelsior)* trees.

4.65 During 2006, otter activity was recorded on the River Ock and Cow Common Brook, which both had fairly fresh spraints, and Childrey Brook, where footprints were

[37] Cascade Consulting, Bat Pro Ltd and Applied Ecology Ltd (2009) 2005–2009 Bat Survey. Version 1.3 (Draft).
[38] DEFRA (2022). [Online] Multi-Agency Geographic Information for the Countryside Map. [Online] Available at: https://magic.defra.gov.uk/MagicMap.aspx

identified. During the 2008 and 2009 surveys, significant levels of otter activity were recorded along the River Ock, including spraints, feeding remains and tar. Spraints were also recorded on Childrey Brook and Hollywell Brook. Potential holts were recorded at two locations in the boughs of willow trees near Childrey Brook and Mere Dyke West.

4.4.3.4 Amphibians

4.66 Amphibian surveys were carried out between 2005 and 2008. Great crested newt were recorded within seven ponds, six of which were located within The Cuttings and Hutchin's Copse LWS and the seventh in the northwest of the main study area near Venn Mill. The survey results confirmed the presence of three separate breeding populations of great crested newts, located in The Cuttings and Hutchin's Copse LWS along the southern boundary of the main study area. Only a single newt was recorded at Venn Mill, the habitat at the pond is considered sub-optimal for breeding great crested newts.

4.67 Low numbers of stickleback *(Gasterosteus sp)* were recorded in ponds across The Cuttings and Hutchin's Copse LWS, one of which is a confirmed great crested newt breeding pond. Therefore, it is possible that great crested newt populations have declined over the last decade. Fish presence at high enough densities can completely decimate a great crested newt population from ponds due to egg predation.

4.68 Other common species of amphibian (smooth newt *(Lissotriton vulgaris),* common frog *(Rana temporaria),* and common toad *(Bufo bufo)*) are widespread across the main study area in ponds and ditches.

4.69 A search for EPS licences within 2km of the indicative location for SESRO within the last 10 years identified seven for great crested newts, with all the licence periods ending in 2019.

4.4.3.5 Water vole

4.70 The water vole *(Arvicola amphibius)* baseline survey was conducted between 2006 and 2008. Water vole field signs (such as droppings, latrines, feedings stations, footprints and burrows) were searched for along the entire length of each watercourse within the indicative location for SESRO. The results of the assessment identified that small and fragmented populations of water vole are present within the indicative location for SESRO.

4.71 Signs of water vole activity (burrows and latrines) were identified along Childrey Brook, Mere Dyke West, Cow Common Brook and the old River Ock during the survey. No signs of water vole were identified along Ginge Brook during the October 2006 survey (likely due to high water levels), but incidental records of latrines and droppings were made along Ginge Brook during other surveys conducted earlier in 2006. These findings indicate that in 2006 Ginge Brook was considered to be a stronghold for water vole in the local area. However, it should be noted that over recent years (2012 and 2015) the Bucks, Berks and Oxon (BBO) Water Vole Recovery

project has monitored this population of water vole and have concluded that the species is now likely absent or has at least significantly declined.

4.72 No signs of water vole activity were recorded along Hanney Ditch or Orchard Farm Ditch during the 2006 survey, these watercourses were dry or drying at the time of survey. The fluctuating water level makes these ditches sub-optimal for water vole.

4.73 Water vole droppings, runs and feedings signs were identified along Cow Common Brook. However, only the northern section of Cow Common Brook, at its confluence with the River Ock, was found to support permanent standing water. Given the lack of water vole burrows along the Brook, it is likely that water voles are only present here in a transitory capacity.

4.74 During the 2008 and 2009 otter surveys, mink *(Neovision vision)* scats were recorded on the River Ock, Childrey Brook and Cow Common Brook. Mink is known to predate water vole, so it is possible the mink population in the area has negatively impacted the water vole population since these surveys were carried out. However, these surveys were undertaken approximately 13 years ago and assumptions regarding the impact of American mink on the local water vole population should be assessed with caution. This is because the presence of otter may deter mink and in turn positively impact the local water vole population.

4.4.3.6 Badger

4.75 The indicative location for SESRO was surveyed for badger *(Meles meles)* field signs including setts, latrine sites, prints and hairs between February and May 2006, with a re-survey conducted in 2008[39]. The surveys included bait-marking studies carried out between February and April 2006 and in February 2008. The purpose of the bait marking surveys was to confirm the status of the main and potential main setts within the study area and to determine the extent of badger territorial ranges.

4.76 A total of 72 setts were identified across the study area. The survey in 2008 identified 49 active setts within the study area, of which eight were categorised as main setts. Following bait-marking surveys and observations of activity levels associated with each of the main setts, a total of eight social groups of badgers were identified within the indicative location for SESRO.

4.4.3.7 White-clawed crayfish

4.77 A white-clawed crayfish *(Austropotamobius pallipes)* survey was conducted between 2006 and 2008 of the River Ock, Nor Brook, Childrey Brook, Cow Common Brook, Portobello Ditch, Marcham Brook and the Ginge Brook[40]. There are historic records of white-clawed crayfish in Childrey Brook.

4.78 Portobello Ditch, Cow Common Brook and Nor Brook were found to be dry at the time of the 2006 crayfish survey, this renders them unsuitable habitat for crayfish on

[39] (Applied Ecology, 2008a) Applied Ecology Ltd (2008a) Badger Baseline Survey.
[40] Applied Ecology Ltd (2009d) Native Crayfish Baseline Survey 2006–2008.

the assumption they are subject to regular drying.

4.79 During the surveys, no white-clawed crayfish were recorded in the River Ock, Childrey Brook, Ginge Brook or Marcham Brook. Signal crayfish (*Pacifastacus leniusculus*), a non-native invasive species, were recorded in the River Ock and Ginge Brook in 2006. As no white-clawed crayfish were identified and signal crayfish were present in some of the watercourses, it is now considered likely that white-clawed crayfish are absent from the study area. This is because signal crayfish carry a disease that is lethal to our native species.

4.4.3.8 Hazel dormouse

4.80 Surveys for hazel dormouse *(Muscardinus avellanarius)* were conducted between March and November 2006. Fifty dormouse nest tubes were installed within suitable dormouse habitat at six survey locations within the indicative location for SESRO (totalling 300 tubes). No dormouse nests or other evidence of recent dormouse activity such as chewed hazel nuts, were found within the study area. In addition, it was considered that the study area provides poor quality habitat for the species due to the heavily managed nature of the hedgerows and isolated woodland parcels.

4.4.3.9 Reptiles

4.81 Reptile surveys were carried out between 2005 and 2008. Four breeding populations of grass snake were identified in rank grassland habitat adjoining Hutchins's Copse CWS, Steventon Depot, Childrey Brook and Mere Dyke West. Juvenile or sub-adult individuals were recorded at all four locations. The maximum number of individuals recorded in one survey was seven animals.

4.82 Common lizards were recorded at Steventon Depot, The Cuttings and Hutchins's Copse LWS and near Cow Common Brook. The most recorded in a single survey was 27 adults and 13 juveniles.

4.83 During the previous surveys, a single slow worm *(Anguis fragilis)* was recorded in the main study area.

4.4.3.10 Birds

4.84 Baseline surveys for breeding and wintering birds were carried out between 2005 and 2008. Survey data for breeding and wintering bird species diversity, density and distribution across the main study area was collected between May 2005 and February 2006. Further work was carried out between May and July 2008 to confirm barn owl nest locations.

4.85 The most important habitat area for breeding birds within the study area consisted of the adjoining habitats within The Cuttings and Hutchins's Copse LWS and Hutchins's Marsh, which supported a total of 18 breeding species of Birds of Conservation Concern (BoCC) in 2006. Species recorded across the survey area included marsh tit, reed bunting, yellowhammer and turtle dove. In addition, kingfisher *(Alcedo atthis)* was recorded along Childrey Brook and a nesting tunnel

was recorded on the River Ock. Tawny owl *(Strix aluco)* and long-eared owl *(Asio otus)* were also found to be using habitats in the study area for nesting.

4.86 Barn owl *(Tyto alba)* have been recorded breeding in the study area. In 2005 an occupied nesting site was identified within a black poplar tree *(Populus sp)* on the left bank of Cow Common Brook to the north of Steventon Road Bridge. In 2008, breeding barn owls were confirmed at three sites, two in barns and another in a barn owl box. A pair of nesting red kites *(Milvus milvus)* were recorded during the 2008 surveys in a poplar plantation in the north-west of the study area.

4.87 A total of 103 bird species were recorded in the main study area over both the breeding and wintering bird surveys and of these, 79 species were breeding. Most species are classed as common or very common; however, approximately 17% of the records are classed as uncommon, rare or very rare for Oxfordshire. A number of bird species recorded, including barn owl and kingfisher, were listed as Schedule 1 species and are afforded additional protection from disturbance during the breeding season.

4.4.3.11 Terrestrial invertebrates

4.88 The terrestrial invertebrate surveys focussed on significant landscape features and habitats, including woodlands and wetlands which could provide optimal habitat for a range of invertebrate species. A variety of sampling techniques were used, including flight interception trapping, pitfall trapping and light trapping.

4.89 During the 2005–2006 surveys of the study area, a total of 1,665 species of terrestrial invertebrates were identified, bringing the total number of species from this and previous surveys to 2,154. This does not include any species protected by the *Wildlife and Countryside Act 1981* (as amended) or any Biodiversity Action Plan species. A total of 18 species were recorded as 'Potentially Threatened' in the UK (Red Data Book species) and 162 species were classed as 'Nationally Scarce'.

4.90 Assemblages of decaying wood-associated invertebrates (present in Drayton Copse and Hutchin's Copse CWS) were indicated by the invertebrate report to be of moderate to high conservation interest.

4.91 Wetland habitats (especially near Hutchins's Copse CWS in the south and the River Ock in the north and northwest) harbour invertebrate assemblages exhibiting remnant fen characteristics that were indicated by the invertebrate report to be of moderately high conservation interest. Scarlet tiger moth (*Callimorpha dominula*), an Oxfordshire County Biodiversity Action Plan species, was observed in a damp meadow to the east of Hutchins Copse CWS.

4.92 Grassland invertebrate assemblages associated with Steventon Depot, Cow Common and the older and least disturbed green lanes, bridleways and hedgerows were also considered to be of some conservation interest.

4.4.3.12 Brown hare

4.93 Surveys for brown hare *(Lepus europaeus)* were carried out between April 2005 and January 2006. The initial walkover survey found that brown hare was widely distributed across the study area. Transect surveys undertaken between November 2005 and January 2006 identified a total of 18 hares.

4.4.3.13 Water shrew

4.94 Surveys to determine the presence or likely absence of water shrew *(Neomys fodiens)* were carried out in 2006[41]. The surveys used tubes baited with larvae, which attract water shrews for foraging. Evidence of water shrew presence is identified if individuals leave faecal droppings in the tube. Water shrews were detected at nine of the 19 sites surveyed along ditches and watercourse within the survey area. Four of the positive sites were dry when the tubes were collected, indicating that water shrews would use waterways that are not permanently wet.

4.95 Overall, the survey identified water shrews across much of the survey area, at northern and southern boundaries as well as within the centre. Water shrew evidence was found along the River Ock and a number of small ditches across the survey area.

4.4.3.14 Harvest mouse

4.96 Harvest mouse *(Micromys minutus)* surveys were carried out in 2006. Nest searches were carried out in the autumn, focusing on areas of suitable habitat within grassland, hedgerows, field margins and woodland edges. In total, four harvest mouse nests were identified, all of which were close to rivers. Two nests were found near Cow Common Brook, one near the River Ock and another near Childrey Brook. An additional nest was found near Cow Common Brook, but it was not possible to confirm confidently that it was a harvest mouse nest.

4.97 Barn owl pellet analysis identified that harvest mouse was the second most abundant species predated upon within the survey area.

4.98 Overall, the surveys show that harvest mice are widespread in the area to the north of the Hanney-Steventon Road.

4.4.4 UK Habitat Classification Survey

4.99 The UK Hab survey identified 13 habitat types. These are listed below in Table with their condition, which is based on field survey data and aerial imagery, and the corresponding habitat code as per the UK Hab User Manual. The location of each habitat is shown on the figures within Supporting Document B6, Biodiversity Net Gain report.

[41] Chanin (2008) Water Shrew Baseline Survey 2006–2008.

Table 4.7: UK Hab habitats and conditions recorded during the UK Hab survey

Habitat type	Habitat code	Condition
Other neutral grassland	g3c	Poor
Modified grassland	g4	Moderate
Lowland mixed deciduous woodland	w1f	Good
Line of trees	w1g6	Moderate
Other woodland mixed	w1h	Moderate
Hedgerow (priority habitat)	h2a	Moderate
Mixed scrub	h3h	Moderate
Arable and horticulture	c1	N/A
Built-up areas and gardens	u1	N/A
Buildings	u1b5	N/A
Built linear features	u1e	N/A
Other inland rock and scree	s1d	Moderate
Other eutrophic standing waters	r1a6	Moderate

4.4.5 Biodiversity Net Gain

4.100 Table below contains the results summary of the high-level terrestrial biodiversity net gain calculation for SESRO.

Table 4.8: Summary results of the Biodiversity Net Gain calculations

Biodiversity Units	Onsite Baseline	Onsite Post Development	Total Net Unit Change	Total % Change
Habitat Units	4923.57	6552.91	1629.34	33.09
Hedgerow Units	440.24	343.79	-96.45	-21.91

4.4.6 Rail siding

4.101 Under the current proposals, reservoir construction materials would be transported to SESRO via rail. To facilitate this, a new railway siding would be constructed along the existing railway line to the south of the indicative location for SESRO. There are currently three options being assessed for the proposed location of the railway siding. A figure showing the location of each of the options and the assessment in

terms of biodiversity are provided in Section 4.5.7 below.

4.5 Assessment outcomes

4.102 This section details the assessment of the current baseline, based on the previously collected data, the desk study, and the UK Hab field survey undertaken in 2022.

4.5.2 Designated sites

4.5.2.1 Statutory designated sites

4.103 There are three SACs located within 10km of the indicative location for SESRO, none of which are located within the indicative location for SESRO or directly adjacent. Due to the distance of the three SACs from the indicative location for SESRO (over 2km), direct nor significant impacts as a result of construction and operation of the reservoir are not anticipated. A Habitats Regulations Assessment (HRA) has been produced for SESRO and is included in Supporting Document B4. The purpose of the HRA is to determine whether construction of the reservoir would lead to any likely significant effects on the SACs.

4.104 There may be potential for indirect impacts on Barrow Farm Fen SSSI due to its location within 0.5km of the indicative location for SESRO. Despite the absence of a downstream hydrological link with Barrow Farm Fen SSSI, there may be potential for impacts during construction, such as changes in air quality, which would need to be considered when more construction details become available. Impacts on all other SSSIs, and the NNR and LNR are not anticipated due to distance and absence of downstream hydrological links. However, all options fall within the SSSI Impact Risk Zone for the listed SSSIs, with a reservoir falling within the 'all planning applications' category.

4.5.2.2 Non-statutory designated sites

4.105 SESRO has the potential to significantly impact one non-statutory designated site. The Cuttings and Hutchin's Copse LWS falls partly within the indicative location for SESRO. This LWS contains ancient woodland, deciduous woodland HoPI, ponds that potentially qualify as HoPI, notable beetles, badger, potentially protected and notable birds and great crested newt. The species listed may be impacted through the loss of suitable habitat for example waterbodies and woodlands.

4.5.3 Ancient woodland and veteran trees

4.106 The current baseline information indicates that the only potential parcel of ancient woodland located within the indicative location for SESRO is The Cuttings and Hutchin's Copse LWS. However, further arboricultural surveys are required to confirm this conclusion.

4.107 There is no hydrological connectivity between the indicative location for SESRO and the closest ancient woodland, Hydes Copse. There may be, however, a pathway for air pollution effects. A study of the potential effects to air quality would be

performed for the scheme and the results should be analysed for any likely effects to designated sites, and biodiversity in general.

4.108 The ancient crack willow tree located within the indicative location for SESRO would be lost. Retention is not feasible due to it being located within the indicative footprint of the reservoir. Current plans have been designed in order to retain all of the veteran trees along the River Ock. Tree protection measures are outlined in Section 4.6 should construction work be located within proximity of the retained trees.

4.5.4 Habitats of Principal Importance

4.109 Four HoPI types have been recorded within the indicative location for SESRO; coastal and floodplain grazing marsh, traditional orchard, wood pasture and parkland and deciduous woodland. Where possible, these habitats would be retained, or clearance kept to a minimum. However, due to the nature of SESRO, parcels of these habitats would be lost which would constitute a significant habitat impact. Recommendations for impacts to HoPI are provided in Section 4.6.

4.5.5 Protected and notable species

4.110 Based on the current available data, SESRO has the potential to significantly impact numerous protected and notable species. The likely impacts to these species are detailed in Table 4.9 below. As there are no historical records for white-clawed crayfish and hazel dormouse within 2km of the indicative location for SESRO, it is considered likely that these species are absent from the indicative location for SESRO and surrounding zone of influence. However, it is recommended that a species habitat assessment be undertaken as a minimum to inform future stages of the project.

Table 4.9: Likely effects on protected and notable species

Species or species group	Legislation and implications	Appraisal of likely effects
Bats	**All species protected under Conservation of Habitats and Species Regulations 2017 (as amended) and Wildlife and Countryside Act 1981 (as amended) with seven species also listed under Natural Environment and Rural Communities Act 2006** Strictly protected from killing, injuring and disturbance Places of rest or shelter protected even when animals are absent	***Potentially significant impacts** Losses of multiple roost sites in buildings and trees Loss of foraging and commuting habitat Disturbance of roosts
Otter	**Conservation of Habitats and Species Regulations 2017 (as amended), Wildlife and Countryside Act 1981 (as amended) and Natural Environment and Rural Communities Act 2006** Strictly protected from killing, injuring and disturbance Places of rest or shelter protected even when animals are absent	***Potentially significant impacts** Potential loss of or disturbance of holts Potential loss of foraging grounds Potential severing of commuting routes
Common toad	**Natural Environment and Rural Communities Act 2006** Same or larger population post-development	Loss of foraging and breeding habitat Direct mortality

Species or species group	Legislation and implications	Appraisal of likely effects
Great crested newt	**Conservation of Habitats and Species Regulations 2017 (as amended), Wildlife and Countryside Act 1981 (as amended) and Natural Environment and Rural Communities Act 2006** Strictly protected from killing, injuring and disturbance Places of rest or shelter protected even when animals are absent	***Potentially significant impacts** Loss of breeding habitat Loss of terrestrial habitat Direct mortality Disturbance impacts
Natterjack toad	**Conservation of Habitats and Species Regulations 2017 (as amended), Wildlife and Countryside Act 1981 (as amended) and Natural Environment and Rural Communities Act 2006** Strictly protected from killing, injuring and disturbance Places of rest or shelter protected even when animals are absent	Loss of breeding habitat Loss of terrestrial habitat Direct mortality Disturbance impacts
Water vole	**Wildlife and Countryside Act 1981 (as amended) and Natural Environment and Rural Communities Act 2006** Protected from killing, injuring and disturbance Protected from disturbance when occupying a place of rest or shelter	***Potentially significant impacts** Loss of breeding habitat Loss of terrestrial habitat Direct mortality Disturbance impacts
Badger	**Protection of Badgers Act 1992** Protected from intentional killing and injuring Setts protected from intentional or reckless damage Protected from disturbance when in setts	***Potentially significant impacts** Loss of multiple setts Loss of foraging habitat

Species or species group	Legislation and implications	Appraisal of likely effects
		Disturbance impacts
White-clawed crayfish	**Conservation of Habitats and Species Regulations 2017 (as amended), Wildlife and Countryside Act 1981 (as amended) and Natural Environment and Rural Communities Act 2006** Strictly protected from killing, injuring and disturbance Places of rest or shelter protected even when animals are absent	Likely absent
Hazel dormouse	**Conservation of Habitats and Species Regulations 2017 (as amended), Wildlife and Countryside Act 1981 (as amended) and Natural Environment and Rural Communities Act 2006** Strictly protected from killing, injuring and disturbance Places of rest or shelter protected even when animals are absent	Likely absent
Reptiles	**Wildlife and Countryside Act 1981 (as amended) and Natural Environment and Rural Communities Act 2006** No intentional killing or injuring	***Potentially significant impacts** Loss of habitat Direct mortality
Birds	**All protected under Wildlife and Countryside Act 1981 (as amended) with some listed under Natural Environment and Rural Communities Act 2006** No intentional killing or injuring of nesting birds or damage to active nests Additional protection from disturbance of Schedule 1 listed birds when actively nesting	***Potentially significant impacts** Loss of nesting habitat Loss of foraging habitat
Marsh fritillary	**Wildlife and Countryside Act 1981 (as amended) and Natural Environment and Rural Communities Act 2006**	Loss of habitat Direct mortality

Species or species group	Legislation and implications	Appraisal of likely effects
	No intentional killing or injuring	
Invertebrates listed as SoPI	**Natural Environment and Rural Communities Act 2006** Same or larger population post-development	Loss of habitat Direct mortality
Polecat, European hedgehog, harvest mouse and brown hare	**Natural Environment and Rural Communities Act 2006** Same or larger population post-development	Loss of habitat Direct mortality
Chamomile, grape-hyacinth, juniper and red hemp-nettle	**Natural Environment and Rural Communities Act 2006** Same or larger population post-development	Direct losses

*Potentially significant impacts relate to the likelihood of destruction or disturbance of important habitat types for breeding, commuting or foraging in the absence of mitigation. Potentially significant impacts also include killing or injury and disturbance in the absence of mitigation.

4.111 Based on the current data, it is considered that SESRO, in the absence of mitigation, would have an adverse impact on non-statutory designated sites, HoPI, a single ancient tree and protected and priority species. However, the implementation of appropriate mitigation measures (including European Protected Species Mitigation Licences (EPSML), where required) and compensation for losses, would avoid and reduce potentially adverse impacts on these ecological features.

4.112 The mitigation or further survey recommended to comply with the legislation and policy relevant to the protected and priority species above is detailed in Section 4.6.

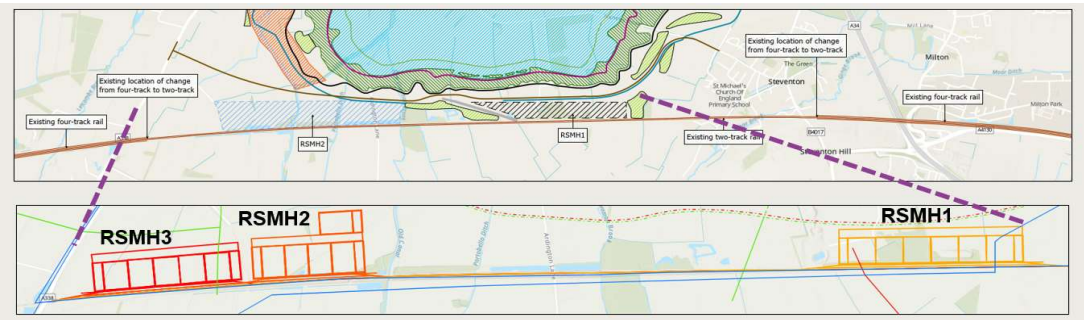
4.5.6 Biodiversity Net Gain

4.113 The outline results of the Biodiversity Net Gain calculation indicate that SESRO would generate a significant gain in habitat units but small loss of hedgerow units. The trading for lowland mixed deciduous woodland has also not been met. As previously stated, the Gate 2 assessment, including the UK Hab assessment for Biodiversity Net Gain is high level and further field work needs to be conducted to accurately map habitats. Updates to the Biodiversity Net Gain assessment would be made as the project evolves, ensuring that full field data including habitat categorisation and habitat condition assessments are undertaken.

4.5.7 Rail siding

4.114 Based on the proposed siding locations shown below in Plate 4.1, a desk-based assessment of the potential ecological constraints associated with each Option, has been undertaken. RSMH1 appears to impact woodland, scrub, grassland, and ditches. RSMH2 is partially located within The Cuttings and Hutchin's Copse LWS and is likely to impact woodland (including potentially ancient woodland), waterbodies, ditches, cropland, hedgerows, scrub, and grassland. RSMH3 appears to impact a much smaller amount of woodland and scrub, and grassland. All three options have the potential to impact protected species including breeding birds, great crested newts, badgers and bats.

Plate 4.1: Potential railway siding locations



4.6 Recommendations and mitigation

4.6.1 Preliminary Ecological Appraisal (PEA) and UK Hab Survey

4.115 For subsequent project stages, it is recommended that a full Preliminary Ecological Assessment (PEA), following best practice and methodologies[42], be conducted for the habitats located within the indicative location for SESRO and a suitable buffer around SESRO (minimum required to capture potential impacts on sensitive species and habitat features). The survey area buffer would be determined following an approach that considers potential pathways to impact. The survey would aim to identify all potential ecological constraints within the indicative location for SESRO. A full UK Hab survey and habitat condition assessment would be conducted during the PEA. The survey should be undertaken by a suitably experienced ecologist following current best practice guidelines. The survey would form the baseline of a full Ecological Impact Assessment for SESRO with up-to-date recommendations for legal compliance with relevant biodiversity legislation.

4.6.2 Designated sites

4.6.2.1 Statutory designated sites

4.116 The indicative location for SESRO is within the Impact Risk Zone of five SSSIs. Although it is considered SESRO is unlikely to have any direct impacts on these designated sites, an assessment would need to be undertaken to determine the potential indirect impacts on the SSSIs. Indirect impacts as a result of SESRO could include air pollution and hydrological changes. The Local Planning Authority should consult with Natural England regarding the potential impacts to the SSSIs and whether any bespoke mitigation strategies are required.

4.6.2.2 Non-statutory designated sites

4.117 The Cuttings and Hutchin's Copse LWS is located within the indicative location for SESRO and is an important site for nature conservation. Not only does the indicative location for SESRO contain parcels of ancient woodland but it also provides habitat for protected species including great crested newts, breeding birds, badgers and likely bats. As far as reasonably practical, SESRO should be designed to avoid or reduce direct impacts to the LWS. This would include siting the new railway siding outside of the LWS. Should the LWS be unavoidably impacted by SESRO, appropriate mitigation proposals would be required in compensation.

4.6.3 Ancient woodland and veteran trees

4.118 All areas of woodland located within the indicative location for SESRO should be assessed by an arboriculturalist and botanist to determine whether they are ancient or not. The assessment would include The Cuttings and Hutchin's Copse woodland located to the south of the scheme. In addition to the tree assessment, an

[42] CIEEM (2017). Guidelines for Preliminary Ecological Appraisal, 2nd Edition. Chartered Institute of Ecology and Environmental Management, Winchester.

assessment of ancient woodland indicator plant species would also be undertaken. A further desk study would also be undertaken to review county archive material of woodlands dating back to 1600AD.

4.119 Due to the irreplaceable nature of ancient and veteran trees, there is no established design for the mitigation or compensation for the loss of this type of habitat. It is therefore recommended that a bespoke mitigation strategy is created to at least compensate for the loss of the ancient crack willow. This is likely to involve additional tree planting, ideally with seeds from the veteran tree, and may also involve translocating the tree or parts of the tree itself as standing or fallen deadwood. Ideally the deadwood habitat would be retained within the indicative location for SESRO. Refer to section 4.2 in the Biodiversity Net Gain Report for further clarification on how the loss of irreplaceable habitat would impact the net gain calculations for the scheme[43].

4.6.4 Habitats of Principal Importance

4.120 A masterplan has been produced for SESRO, as illustrated on Figure 2.1 Landscape and environmental design strategy plan in Technical Supporting Document B2.2, Environmental Appraisal Report (terrestrial) Figures, which depicts the indicative reservoir location and the areas of habitat to be created. The current concept design has been produced to maximise the biodiversity value of SESRO, post-construction. Habitats to be created include HoPI such as hedgerows, rivers, neutral grassland, coastal and floodplain grazing marsh, wet woodland and reedbeds. It is likely that the area of HoPI to be created would be higher in biodiversity value at maturity than the areas lost. However, it is recommended that loss of HoPI is avoided where design allows or reduced as far as reasonably practical. Any losses of deciduous woodland, hedgerows, traditional orchards, wood pasture and parkland, or coastal and floodplain grazing marsh HoPI should be equally compensated for in created habitat.

4.121 Additionally, any hedgerows lost should be compensated for prior to construction. New hedgerows should be planted within retained habitats to link up existing linear vegetation so that there is a no-net-loss in connectivity across the landscape. This would ensure there is no fragmentation of habitats and wildlife are able to continue commuting through the landscape throughout the construction and operational phases of SESRO.

4.6.5 Protected and notable species

4.122 The baseline assessment has identified suitable habitat is present either within the indicative location for SESRO or near SESRO for numerous protected and notable species. In order to determine the presence or likely absence of these species and potential mitigation and habitat enhancement proposals, further field surveys should be undertaken. Where necessary, a habitat appraisal for each species would be undertaken prior to the commencement of any targeted species surveys. For example, should the scheme boundary provide no suitable habitat for natterjack

[43] Jacobs, 2022. South East Strategic Resource Option. *Technical Appendix B6, Biodiversity Net Gain Report.*

toads, targeted surveys would not be required. Following current best practice guidelines, surveys for bats, otter, common toad, great crested newt, natterjack toad, water vole, badger, reptiles, breeding and wintering birds, protected and priority invertebrates, polecat, European hedgehog, priority plant species, brown hare, water shrew and harvest mouse should be conducted (as required). These surveys should be undertaken by a suitably experienced ecologist.

4.123 Hazel dormouse and white clawed crayfish have previously been assessed as likely absent from the indicative location for SESRO. However, the data collected for these species are no longer valid due to their age. Therefore, as a minimum, it is recommended that a habitat assessment for these two species be conducted as the scheme evolves.

4.124 Depending on the survey results, legal compliance may require mitigation, additional survey, and EPSML. Based on the current available data, Table 4.10 below details the likely required mitigation for protected and notable species.

Table 4.10: Outline mitigation based on the current data

Species or species group	Likely impacts	Outline mitigation
Bats	***Potentially significant impacts** Losses of multiple roost sites in buildings and trees Loss of foraging and commuting habitat Disturbance of roosts	EPSML likely required Avoidance of impacts to roosts Diversion of linear features prior to vegetation clearance Foraging habitat creation Roost creation and translocation Lighting regimes and restrictions
Otter	***Potentially significant impacts** Potential loss of or disturbance of holts Potential loss of foraging grounds Potential severing of commuting routes	EPSML likely required Holt replacement with artificial holts Foraging and commuting habitat retained on site where feasible. Additional habitat to be created through wetland creation (wet ditches, ponds and canal diversion)
Common toad	Loss of foraging and breeding habitat Direct mortality	Aquatic and terrestrial habitat creation Ecological clerk of works
Great crested newt	***Potentially significant impacts** Loss of breeding habitat Loss of terrestrial habitat Direct mortality Disturbance impacts	EPSML likely required Breeding pond creation Terrestrial habitat creation
Natterjack toad	Loss of breeding habitat Loss of terrestrial habitat	Likelihood of presence unknown – considered likely to be low due to the specific habitat requirements required by the species.

Species or species group	Likely impacts	Outline mitigation
	Direct mortality Disturbance impacts	EPSML would be required if present Breeding pond creation Terrestrial habitat creation
Water vole	***Potentially significant impacts** Loss of breeding habitat Loss of terrestrial habitat Direct mortality Disturbance impacts	CL31 licence likely required Aquatic habitat creation
Badger	***Potentially significant impacts** Loss of multiple setts Loss of foraging habitat Disturbance impacts	Main sett replacement with artificial setts Foraging habitat creation
Reptiles	***Potentially significant impacts** Loss of habitat Direct mortality	Trapping and translocation Habitat creation Ecological clerk of works
Birds	***Potentially significant impacts** Loss of nesting habitat Loss of foraging habitat	Avoidance of breeding bird season (March to August inclusive) Nesting habitat creation Bespoke mitigation possibly required for SoPI Ecological clerk of works
Marsh fritillary butterfly	Loss of habitat Direct mortality	Avoidance of suitable habitats where possible

Species or species group	Likely impacts	Outline mitigation
		Vegetation clearance between mid-May and mid-July in habitat suitable for marsh fritillary Ecological clerk of works Planting or seeding of food plant – devil's-bit scabious *(Succisa partensis)*
Invertebrates listed as SoPI	Loss of habitat Direct mortality	Habitat creation Planting or seeding of food plants Avoiding sensitive life stages
Polecat, European hedgehog, harvest mouse and brown hare	Loss of habitat Direct mortality	Habitat creation Planting of hedgerows prior to vegetation clearance Ecological clerk of works
Chamomile, grape-hyacinth, juniper and red hemp-nettle)	Direct losses	Taking of turfs or replanting Sewing locally collected seed

**Potentially significant impacts relate to the likelihood of destruction or disturbance of important habitat types for breeding, commuting or foraging in the absence of mitigation. Potentially significant impacts also include killing or injury and disturbance in the absence of mitigation.*

4.125 The habitats depicted in the masterplan for SESRO, as illustrated on Figure 2.1 Landscape and environmental design strategy plan in Technical Supporting Document B2.2, Environmental Appraisal Report (terrestrial) Figures, can support mitigation for many of the protected species impacted by SESRO. The created habitats may be suitable for displacement of species or translocations under licence. For example, newly constructed waterbodies may be suitable for water voles or great crested newts, and the created grasslands may be suitable receptor areas for reptile translocations. Should any licence require bespoke mitigation not already included in the masterplan, then this would be formulated in a mitigation plan following the collection of up-to-date survey data.

4.6.6 Biodiversity Net Gain

4.126 The Biodiversity Net Gain calculations would need to be updated as construction and landscape designs are developed. The recommended PEA survey would include mapping the habitats within the whole indicative location for SESRO with UK Hab habitat types, with accurate condition assessments. This would provide a more accurate baseline assessment for future Biodiversity Net Gain calculations.

4.127 The data collected through the Gate 2 Biodiversity Net Gain process has highlighted that a minimum of 10% Biodiversity Net Gain can be achieved for habitats. However, habitats which have a high distinctiveness value, such as lowland mixed deciduous woodland, must be retained and enhanced on site where possible. These habitats are difficult to replace due to the time it takes for the habitat to become established and therefore the habitat 'trading' element to the metric has not currently been achieved. Following further field surveys and updates to the Scheme design to account for additional woodland planting, retention and enhancement, these trading rules for habitats of high distinctiveness should be achieved.

4.128 The Biodiversity Net Gain calculations currently show that there is a loss of linear features on site and a gain of 10% has not been achieved. As the design for SESRO develops, further hedgerow and tree line habitat creation should be included, and retention of existing linear features should be encouraged. The required 10% net gain may also be achieved through off-site habitat creation or the enhancement of existing hedgerows.

4.6.7 Habitat creation

4.129 The current proposals for mitigation include a large area of wetland mosaic habitat creation located to the west of the reservoir. The wetland mosaic would include reedbeds, wet woodland, sheep-grazed neutral grassland, scrub, and wildlife ponds. This area has huge potential for biodiversity and would likely be higher in value per hectare at maturity than any existing habitat within the indicative location for SESRO. Other habitats of significant value to biodiversity and nature conservation would be created around the perimeter of the reservoir including areas of species-rich grassland, woodland and wildlife ponds.

4.130 The wetland habitat and the reservoir itself, have the potential to support species not currently found within the indicative location for SESRO such as aquatic invertebrates and waterfowl. These newly created habitats may also be suitable to receive translocated protected species as part of any mitigation licences such as great crested newts and reptiles.

4.6.8 Railway siding

4.131 Based on desk-based information only, RSMH3 is the preferred option for the location of the new railway siding. RSMH3 is located within an area of agricultural land and no woodland habitat would be impacted by its construction. The preferred siding option would therefore have the least potential impact on ecological receptors such as bats, badgers, birds, great crested newts and the ancient woodland. RSMH2 is the least preferred option due to its location within the LWS. It is recommended that the three railway siding options are included within the scope of the PEA and UK Hab survey to map the habitats present and record potential for protected and notable species.

4.7 Next steps

4.132 The next steps for subsequent project stages in terms of biodiversity would be to undertake the PEA and UK Hab survey, followed by phase 2 surveys for specific species and habitats including an assessment of the woodlands for ancient trees and ancient woodland indicator species. Table 4.11 provides the likely surveys required and associated seasonal constraints. Surveys for brown hare, water shrew, polecat and harvest mouse may also be required.

Table 4.11: Next steps for SESRO Gate 3

Survey	Timeframe
Preliminary Ecological Appraisal with UK Habitat Categorisation and Condition Assessment	May to September inclusive
Bats	Ground based bat roost assessments of trees and man-made structures at any time of year. Emergence and return to roost surveys, climbing surveys, static detectors and activity transects from May to September inclusive. Hibernation surveys of trees and structures from November to February inclusive.
Otter	Surveys not seasonally constrained but can be conducted in conjunction with water vole surveys.

Survey	Timeframe
Great crested newt	Habitat Suitability Index (HSI) assessments can be undertaken at any time of year. Survey season limited to spring, mid-March to mid-June for presence/absence (four survey visits) and population size class assessment (additional two survey visits). eDNA sampling to determine presence/ likely absence of great crested newts within ponds can be undertaken 15 April to 30 June.
Natterjack toad	Habitat appraisal performed at any time of year. Survey season between start of spring and end of autumn with some survey methods limited to between April and June.
Water vole	Spring (April–June) and autumn (September and October) surveys required, with two survey visits undertaken.
Badger	No specific time constraints to survey but November to April is considered the optimum.
White-clawed crayfish	Activity surveys, torch only April to June, trap and torch mid-July to mid-September.
Hazel dormouse	Surveys run from April to November in one year.
Reptiles	Surveys spring (March–June) or autumn (September).
Breeding birds	Surveys undertaken April to July.
Wintering birds	Surveys undertaken in winter (monthly visits between November and March), if required.
Terrestrial invertebrates	Surveys are undertaken between April and September, with adjustment for local weather conditions and latitudes, and may target the flight times of key species like marsh fritillary. The need for invertebrate scoping surveys would be identified by the PEA.
National Vegetation Classification (NVC)	Surveys may be required May to July, depending on the type of habitat.
Hedgerow Regulations survey	Surveys to identify hedgerows classified as important under the *Hedgerow Regulations 1997* can be undertaken between April and October, with June and July being the optimum months.
Veteran tree survey and arboricultural survey	No specific time constraints.
Ancient woodland survey	Ancient woodland surveys are best done in April or May when short-lived vernal species can be recorded.

5. Historic Environment

5.1 Introduction

5.1 Building on the work undertaken to support the Gate 1 process, this chapter presents an environmental appraisal of the potential historic environment impacts associated with SESRO, based on the information within Appendix A5.1 Cultural Heritage Desk-Based Assessment (DBA) which can be found in Supporting Document B2.1, Environmental Appraisal Report (terrestrial) Appendices.

5.2 This chapter sets out the key legislation and policy relevant to the historic environment followed by the methodology and study area used for the environmental appraisal. An analysis of the baseline is presented, followed by an appraisal of the effects of SESRO and an evaluation of their significance. An overview of likely mitigation measures that may be adopted to avoid, reduce or offset any potential effects is provided followed by recommendations for further work.

5.3 The DBA and this chapter focusses on the largest SESRO option (i.e. 150Mm^3) with narrative provided on the relative performance of the alternative reservoir options (i.e. 125Mm^3, 100Mm^3, 75Mm^3, 30+100Mm^3 and 80+42Mm^3).

5.2 Legislation and policy

5.4 Table 5.1 below lists the legislation and planning context relevant to SESRO in terms of the types of historic environment assets affected.

Table 5.1 Historic environment key legislation and policy

Legislation / Policy	Description
Ancient Monuments and Archaeological Areas Act 1979	This Act (amended by the National Heritage Acts of 1983 and 2002) provides for the protection of Scheduled Monuments but does not afford any protection to their setting
Planning (Listed Buildings and Conservation Areas) Act 1990	The Town and Country Planning Act (1971) as amended by the Planning (Listed Buildings and Conservation Areas) Act 1990 details the statutory protection afforded to Listed Buildings. The relevant legislation in this case extends from Section 66 (1) of the 1990 Act, which states that in considering planning applications the Local Planning Authority (LPA) shall have special regard to the desirability of preserving the Listed Building or its setting, or any features of special architectural or historic interest that it possesses In addition, Section 72 of the 1990 Act states that in exercising all planning functions, LPAs must have special regard to the desirability of preserving or enhancing Conservation Areas

Legislation / Policy	Description
Enterprise and Regulatory Reform Act 2013	This deregulatory legislation allows greater authority to LPAs in respect of Listed Building Consent. It also allows greater definition of a Listed Building by allowing the exclusion of attached buildings and structures and those within the curtilage of the principal Listed Building from protection. It states that a certificate of immunity from listing may be applied for at any time and it replaced Conservation Area Consent with planning permission
Environment Act 1995 (Hedgerow Regulations 1997)	In determining the 'importance' of a hedgerow in historic environment terms, the regulations of Section 97 of the above Act states that this would be determined through the following criteria: *'Archaeology and history* *1. The hedgerow marks the boundary, or part of the boundary, of at least one historic parish or township; and for this purpose "historic" means existing before 1850.* *2. The hedgerow incorporates an archaeological feature which is—* *(a) included in the schedule of monuments compiled by the Secretary of State under section 1 (schedule of monuments) of the Ancient Monuments and Archaeological Areas Act 1979(35); or* *(b) recorded at the relevant date in a Sites and Monuments Record.* *3. The hedgerow—* *(a) is situated wholly or partly within an archaeological site included or recorded as mentioned in paragraph 2 or on land adjacent to and associated with such a site; and* *(b) is associated with any monument or feature on that site.* *4. The hedgerow—* *(a) marks the boundary of a pre-1600 AD estate or manor recorded at the relevant date in a Sites and Monuments Record or in a document held at that date at a Record Office; or* *(b) is visibly related to any building or other feature of such an estate or manor.* *5. The hedgerow—* *(a) is recorded in a document held at the relevant date at a Record Office as an integral part of a field system pre-dating the Inclosure Acts (36); or* *(b) is part of, or visibly related to, any building or other feature associated with such a system, and that system—* *(i) is substantially complete; or* *(ii) is of a pattern which is recorded in a document prepared before the relevant date by a local planning authority, within the meaning of the*

Legislation / Policy	Description
	1990 Act (37), for the purposes of development control within the authority's area, as a key landscape characteristic.'
National Policy Statement for Water Resources Infrastructure (Draft, 2018)	The National Policy Statement (NPS) for nationally strategic water infrastructure projects has not yet been adopted but it is assumed it would be and therefore would set the planning framework at subsequent project stages. The draft NPS reflects that of the National Networks NPS (**) in so far as the determination of asset values and the way in which the historic environment shall be treated as part of a Nationally Significant Infrastructure Projects. Where a scheme is deemed to be of public interest in so far as it outweighs the need for the physical preservation of an asset, preservation by record is acceptable in mitigation: '*4.7.27 Where the loss of the whole or part of a heritage asset's significance is justified, the Secretary of State will require the applicant to record and advance understanding of the significance of the heritage asset before it is lost (wholly or in part). The extent of the requirement should be proportionate to the asset's importance and significance and the impact. The applicant should be required to publish this evidence and to deposit copies of the reports with the relevant Historic Environmental Record. They should also be required to deposit the archive generated in a local museum or other public repository willing to receive it.* *4.7.28. Where appropriate, the Secretary of State will impose requirements on the development consent order to ensure that the work is undertaken in a timely manner, in accordance with a written scheme of investigation (WSI) that complies with the policy in this NPS and which has been agreed in writing with the relevant local authority, and to ensure that the completion of the exercise is properly secured.* *4.7.29. Where there is a high probability that a development site may include as yet undiscovered heritage assets with archaeological interest, the Secretary of State will consider requirements to ensure appropriate procedures are in place for the identification and treatment of such assets discovered during construction.*'
Draft Oxfordshire Plan 2050	This document is still subject to public consultation, but cultural heritage features within a consultation paper (Topic Paper 7: Heritage). This paper sets out the objective of future county-wide policies to manage change to the historic environment. '*The broad objectives include:* *The need for addressing impacts to historic environment assets* *The long term need to protect, repair and enhance Oxfordshire's exceptional historic stock/'at risk' structures*

Legislation / Policy	Description
	Securing long term storage of artefacts that are being produced in volume as a result of the pace of development *The need to foster and support the maintenance of a skills base in the heritage sector to meet the needs created* *To secure more effective networking and harnessing synergies of disparate heritage bodies across city and county* *The need to foster and support a long-term strategic vision in terms of sustaining key heritage values across the county*'

5.3 Methodology

5.5 The DBA this chapter is drawn from was prepared in line with a Written Scheme of Investigation (WSI) which is a detailed method statement (DBA, Appendix B). This was approved in advance of report preparation by the archaeological advisory service of Oxfordshire County Council after a consultation exercise.

5.6 The WSI stipulated the limited nature of the assessment which was an approach more befitting a feasibility study. It set out the approach to use up-to-date historic environment datasets, previous assessments and the summaries of previous archaeological activity within the indicative location for SESRO and a 2km study area extending outwards from it (hereafter referred to as the 'wider study area').

5.7 In part, the DBA was to be used as a GAP analysis to identify data and information that was missing and that should be used at subsequent project stages.

5.8 The DBA was based on the current concept design. It provides a summary of the likely impacts of SESRO on aspects of the historic environment. The DBA makes general recommendations on the need for assessment and archaeological intervention at subsequent project stages.

5.4 Understanding of the baseline

5.9 The historic environment resource was split into three main areas for study: archaeological remains, built heritage (historic buildings and structures) and historic landscape (designed landscapes and historic landscape character).

5.10 The baseline section of the DBA contains a summary of the known baseline broken down by time period. These have been summarised in the following sections. The data utilised was primarily derived from the Oxfordshire County Council Historic Environment Record (HER), and the reference numbers of these assets as proscribed in the HER are reproduced after the assets names and descriptions below.

5.4.2 Archaeology

5.11 There are no scheduled monuments within the indicative location for SESRO. There are 12 scheduled monuments in the wider study area, which are detailed in the DBA gazetteer (DBA, Appendix A). Five are within the urban limits of Abingdon with most of the remainder to the east of the A34.

5.12 Within the indicative location for SESRO there are:

- 24 prehistoric assets recorded chiefly from aerial photographic interpretation and trial trenching;
- 14 Romano-British assets, some of which continue from the Iron Age period and are also included in the prehistoric total above;
- One early medieval (Anglo-Saxon) feature;
- Nine medieval assets;
- Three post-medieval and modern assets; and
- 13 undated assets.

5.13 The HER data records the following within the wider study area:

- 262 prehistoric assets, many of which are artefacts recovered from the topsoil from organised fieldwalking. Many assets also represent one phase of multi-period settlements or areas of activity reflected by cropmarks. These are also represented in the asset totals given for other periods below.
- 135 Romano-British assets, approximately half of which are findspots, most of which were located on the ground surface and found during fieldwalking exercises. These were often located alongside artefacts from other periods. Many coincided with the locations of the cropmark complexes reproduced on the supporting figures (DBA, Appendix A).
- 55 early medieval assets, which include settlement evidence, cemeteries and assorted artefact findspots.
- 93 medieval assets, over half of which are artefacts in the form of pottery or small finds. Medieval fields systems such as ditches and ridge and furrow are also well represented, as are the urban remains of villages within existing settlements and deserted ones.
- 87 post-medieval and modern assets. Broadly grouped, these comprise the remains of RAF Abingdon and a host of other Defence of Britain sites such as former pill boxes and anti-tank locations, which are concentrated alongside roads.
- 71 undated archaeological assets.

5.14 Further to the HER ‘monument’ data listed above, there have been 50 recorded archaeological interventions (archaeological discoveries through formal planning-related archaeological work or by accident, such as chance discoveries by the public)

within the indicative location for SESRO and 261 in the wider study area. The majority of the archaeological events recorded within the indicative location for SESRO are results from previous investigations associated with previous studies undertaken for the reservoir project. These have included analysis and interpretation of aerial photographs, geophysical surveys and archaeological trial trenching.

5.4.3 Built heritage

5.15 There are two listed buildings within the indicative location for SESRO. These comprise Marcham Mill (1199505) a Grade II listed mill building and a bridge (1048362) 50m south-east of the mill on the Childrey Brook, which runs parallel to the River Ock which is also Grade II listed.

5.16 There are 530 listed buildings in the wider study area. Of these, 14 are listed at Grade I, 39 at Grade II* and 477 at Grade II.

5.17 The majority of these designations are concentrated within the following historic settlements within the study area:

- Marcham - 33 listed buildings and structures;
- Drayton - 31 listed buildings and structures;
- West Hanney - 25 listed buildings and structures;
- East Hanney - 27 listed buildings and structures;
- Grove - 7 listed buildings and structures;
- Steventon - 43 listed buildings and structures;
- Milton - 19 listed buildings and structures;
- Abingdon - 251 listed buildings and structures;
- St. Helen Without – 13 listed buildings and structures;
- Garford – 4 listed buildings and structures;
- Sutton Courtenay – 63 listed buildings and structures;
- Culham – 13 listed buildings and structures; and
- Ardington – 1 listed building.

5.18 The canal locks along the redundant line of the Berkshire-Wiltshire Canal (8896) which runs through the middle of the proposed reservoir on a north-east to south-west axis. The locks are recorded as surviving built heritage on the HER and comprise the locks at Drayton (12656) and Steventon (7127) which lie near to the central part of the proposed reservoir. At the southern end of the proposed reservoir's footprint is the Ardington Marsh lock (7145). A short distance to the south-west of the Ardington Marsh lock is an undated stone (7144) which might have been a distance marker along the canal.

5.19 There are two other non-designated structures on the HER within the indicative location for SESRO: a brick kiln (12282) and Pinmarsh Farmhouse (4942) on Grove Park Drive.

5.20 There are 134 historic buildings on the HER dataset in the wider study area which are not explicitly described as listed, but it is clear from the supporting figures (DBA, Appendix A) that many listed buildings have been attributed HER reference numbers so listed structures clearly make up most of the built heritage resource in this area relative to the indicative location for SESRO. Naturally the majority of these are focussed within the historic villages surrounding it. Outliers include some Defence of Britain features, which include RAF Abingdon (28771) is a former training barracks set up in the 1930's as an airfield for bombers. Together with the concentrations of surviving pill boxes that are located along local roads the mid-20th century wartime preparedness is well represented.

5.4.4 Historic landscapes

5.21 There are no registered historic parks and gardens within the indicative location for SESRO.

5.22 There are two registered historic parks and gardens in the wider study area; Sutton Courtenay Manor Garden (29361) which is a Grade II listed modern formal and wild gardens around two hectares in area, created in the 1920s by Norah Lindsay. The other lies in Abingdon, the Grade II listed Albert Park.

5.23 There are 75 historic landscape character (HLC) units within the indicative location for SESRO. These comprise an array of historic landscapes interpreted from the archaeological record, historic mapping and the existing field patterns. In the wider study area, there are 437 further HLC units. These are numbered in the supporting gazetteer (DBA, Appendix B).

5.5 Assessment outcomes

5.24 The assessment identified the extensive amount of archaeological intervention already carried out within and near the indicative location for SESRO. This has in certain areas confirmed the existence of locally, regionally and nationally important archaeological remains initially located from aerial photographs. The scale of the archaeological resource in particular highlights the need for further detailed studies to understand the extent to which it exists, its state of preservation and significance.

5.6 Mitigation

5.25 Mitigation aims to reduce, or even remove the adverse effects of the proposed scheme through the application of standard measures of implementation. Where feasible, mitigation would be incorporated by design to remove the need for erasing or damaging an historic environment asset. This embedded mitigation approach seeks to preserve assets in situ (in place). Where this is not possible, and where the loss of an asset is deemed acceptable, its damage or removal would be mitigated

through the creation of an archive through archaeological recording. This is known as preservation by record.

5.26 Impacts to the archaeological and palaeoenvironmental remains which are likely to be abundant throughout the indicative location for SESRO would primarily be mitigated through preservation by record. This would entail the creation of an archive from the physical hand excavation and recording of archaeological and paleoenvironmental features. The recording of the resource would be accurately quantified during the design process via investigation. In order to generate a robust mitigation strategy, the location and extents of archaeological and palaeoenvironmental assets must be robustly defined. Consultation with the Oxfordshire County Council archaeological advisory service has highlighted the need for comprehensive archaeological investigation to ascertain the presence, extent and significance of the buried archaeological resource. Geophysical survey of all the accessible parts of the indicative location for SESRO would need to be carried out to inform subsequent phases of archaeological trial trenching. There are areas within the indicative location for SESRO that have already been subject to archaeological investigation, both geophysics and trial trenching. These have been limited in scale and a more comprehensive approach is required.

5.27 Geotechnical ground investigation would also benefit from geoarchaeological coverage in order to assist in developing a deposit model for the site and identifying the presence of relict palaeochannels and other organic remains in the buried environment. Furthermore, early-stage geoarchaeological engagement might target the extent of geoarchaeologically-specific investigations at subsequent project stages.

5.7 Next steps

5.28 Given the scale of the SESRO options and the varied impacts arising from them on different aspects of the historic environment, specialist studies covering areas such as the palaeoenvironment, the setting of heritage assets and the level of impact on historic built heritage would be crucial at subsequent project stages. With discipline specialists focussing on their particular sub-discipline, the changes to the resources can be more accurately determined and the appropriate level of attention given to managing the respective changes. Mitigation would then be informed by these specialist assessments.

5.29 The DBA has identified the data gaps which need to be addressed in order to fully inform detailed assessment for the assorted SESRO options. These underline the need for focussed specialist assessments on the various different elements of the historic environment, from the palaeoenvironmental resource to archaeology, historic landscape and built heritage. In the case of the palaeoenvironment, and possibly other sub-disciplines, specialist sub-consultant assistance would be required. These requirements are common to all the SESRO reservoir options.

5.30 The detailed assessments would encompass the full array of potential impacts to the historic environment. These would include, but not be exclusive of the various

sources associated with enabling works, construction and operation. The removal of soil horizons, loading of materials on to surfaces for storage, the change in hydrological regimes, both temporary and permanent and the temporary and permanent changes to setting and temporary and permanent access routes would be included.

5.31 Consultation with the Oxfordshire County Council archaeological advisor has highlighted the need to implement archaeological investigation at the earliest opportunity. The scale of SESRO requires a very large amount of geophysical survey and trial trench investigation. Although much investigation has taken place already, chiefly focussed on the cropmark concentrations, this has been limited in scale. The geophysical survey data from the 1990's is relatively obsolete in terms of interpretation and therefore further geophysical surveys should be undertaken.

5.32 All archaeological work must be carried out in accordance with a method statement (WSI) approved by the Oxfordshire County Council archaeological advisory service prior to commencement on site. For a scheme of this scale, a strategic WSI would be required.

6. Landscape and Visual

6.1 Introduction

6.1 Building on the work undertaken to support the Gate 1 process, this chapter presents a Landscape and Visual Appraisal (LVA) of the potential landscape and visual effects associated with SESRO.

6.2 This chapter sets out the key legislation and policy relevant to landscape and visual appraisal followed by the methodology and study area used for the environmental appraisal. An analysis of the baseline is presented, followed by an appraisal of the potential effects of SESRO and a broad evaluation of whether the potential effects on the North Wessex Downs Area of Outstanding Natural Beauty (AONB) are likely to be significant. An overview of likely mitigation measures that may be adopted to avoid, reduce or offset any potential effects is provided with an overview of suggested work for subsequent project stages.

6.3 This chapter focusses on the largest SESRO option (i.e. 150Mm^3) with narrative provided on the relative performance of the alternative reservoir options (i.e. 125Mm^3, 100Mm^3, 75Mm^3, 30+100Mm^3 and 80+42Mm^3).

6.4 The LVA addresses two separate but related issues, namely:

- Effects on the landscape as a resource; and
- Effects on people's views and visual amenity.

6.5 Landscape effects relate to changes in aesthetic and perceptual aspects of landscape character, including any physical changes to landscape elements that contribute to landscape character. Visual effects relate to changes in people's views and to their general visual amenity.

6.6 In line with the assessment framework for Gate 2 set out in Section 2.6 of the EAR prepared for the Gate 1 submission[44], this LVA has been undertaken as an initial high-level appraisal in accordance with Guidelines for Landscape and Visual Impact Assessment (3rd edition)[45] (GLVIA3). This LVA will be used as the basis to inform subsequent project stages. In accordance with the Gate 1 EAR assessment framework for Gate 2[44], this LVA considers SESRO in relation to the North Wessex Downs AONB but does not set out to provide a review and appraisal of effects on all potential landscape and visual receptors, nor a full landscape and visual impact assessment (LVIA) of all landscape and visual effects that may arise.

[44] Atkins (2021). South East Strategic Reservoir Option Gate 1 submission – Technical Annex B1 Environmental Assessment Report. Thames Water Utilities Ltd.

[45] The Landscape Institute and the Institute of Environmental Management and Assessment (2013). Guidelines for Landscape and Visual Impact Assessment (3rd edition).

6.7 This chapter is supported by the following appendices which can be found in Supporting Document B2.1, Environmental Appraisal Report (terrestrial) Appendices:

- Appendix A6.1 Landscape and Visual Appraisal Criteria;
- Appendix A6.2 Landscape and Visual Engagement Feedback;
- Appendix A6.3 Representative Viewpoints;
- Appendix A6.4 Illustrative Viewpoints;
- Appendix A6.5 Published Sources of Landscape Character; and
- Appendix A6.6 Landscape and Visual Appraisal Tables.

6.8 This chapter is supported by the following figures which can be found in Supporting Document B2.2, Environmental Appraisal Report (terrestrial) Figures:

- Figure 6.1 Zone of Theoretical Visibility;
- Figure 6.2 Zone of Theoretical Visibility of Scarp of North Wessex Downs AONB - Without SESRO;
- Figure 6.3 Zone of Theoretical Visibility of Scarp of North Wessex Downs AONB - With SESRO;
- Figure 6.4 Topography;
- Figure 6.5 Landscape Context and Planning Constraints; and
- Figure 6.6 Published Landscape Character Areas.

6.2 Legislation and policy

6.9 Table 6.1 presents the relevant legislation, policy, strategies and guidance relevant to the landscape and visual appraisal.

Table 6.1 Landscape and visual key legislation and policy.

Legislation / Policy	Description
European Landscape Convention[46]	Promotes *'the protection, management and planning of the landscapes…'.*
Countryside and Rights of Way Act 2000 (CROW Act)	The Act clarifies the purpose of designating AONBs and consolidates the provisions of previous legislation. It requires local authorities to produce management plans for each AONB and to have regard to the purpose of conserving and enhancing the natural beauty of AONBs when performing their functions. It also provides for better management of AONBs.
Draft National Policy Statement for Water Resources Infrastructure[47]	National Policy Statements (NPS) set out the need for and government's policies to deliver Nationally Significant Infrastructure Projects (NSIPs) in England. The Draft National Policy Statement for Water Resources Infrastructure sets out the overarching national policy for delivery of major water resources infrastructure projects. Section 3.6 of the Draft NPS for Water Resources Infrastructure sets out the criteria for 'good design' for water resources infrastructure. These include effective engagement with local communities and planning authorities, as well as establishing design principles to guide the development in order to achieve a good site layout design that responds to the *'existing landscape … character and function, landscape permeability, landform and vegetation…'*. Section 4.9 of the Draft NPS for Water Resources Infrastructure sets out the requirements in relation to landscape and visual impacts. Key requirements relevant to this LVA include: • assessment of 'likely significant landscape and visual impacts' during construction and operation, to 'include tranquillity effects' and consideration of 'noise and light pollution effects…'; • 'Any application for development consent within, or to affect land in … an Area of Outstanding Natural Beauty would need to comply with the … duties in … the Countryside and Rights of Way Act 2000';

[46] Council of Europe (2000). European Landscape Convention and reference documents. Online. Available at: https://www.coe.int/en/web/landscape. Accessed April 2022.
[47] Department for Environment Food & Rural Affairs (2018). Draft National Policy Statement for Water Resources Infrastructure. Online. Available at: https://consult.defra.gov.uk/water/draft-national-policy-statement/supporting_documents/draftnpswaterresourcesinfrastructure.pdf. Accessed April 2022.

Legislation / Policy	Description
	• '….the aim should be to avoid or minimise harm to the landscape, providing reasonable mitigation or enhancement measures where possible and appropriate'; • 'The duty to have regard to the purposes of nationally designated areas also applies when considering applications for projects outside the boundaries of these areas which may have impacts within them. The development should aim to avoid compromising the purposes of designation, and such projects should be designed sensitively given the various siting, operational, and other relevant constraints.' • potential mitigation to be considered to include: ▪ *'Construction activity could be screened where possible to avoid or minimise adverse landscape and visual impacts.* ▪ *Site layout and infrastructure design [including choice of materials] could minimise landscape and visual impacts including utilising existing, and providing new, landscape features.* ▪ *Opportunities could be sought to enhance landscape character through, for example, green infrastructure provision.* ▪ *Opportunities could be sought to improve public access to the countryside.'* • '… it may be appropriate to undertake landscaping off site … For example, filling in gaps in existing tree and hedge lines may help to mitigate the impact when viewed from a more distant vista.'
National Planning Policy Framework 2021[48] (NPPF)	The NPPF includes the following chapters relevant to the LVA: • Chapter 12 – Achieving well-designed places • Chapter 15 – Conserving and enhancing the natural environment These chapters seek to encourage good design, protect and enhance valued landscapes, and recognise the character of the countryside.

[48] Ministry of Housing, Communities & Local Government (2021). National Planning Policy Framework. Online. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1005759/NPPF_July_2021.pdf. Accessed April 2022.

Legislation / Policy	Description
	With regards to statutory landscape designations, paragraph 176 states that: *'Great weight should be given to conserving and enhancing landscape and scenic beauty in ... Areas of Outstanding Natural Beauty, which have the highest status of protection in relation to these issues. The conservation and enhancement of wildlife and cultural heritage are also important considerations in these areas… development within their setting should be sensitively located and designed to avoid or minimise adverse impacts on the designated areas'.*
Vale of White Horse Local Plan 2031[49] (Part 1 adopted 2016 and Part 2 adopted 2019)	Core Policy 14: Strategic Water Storage Reservoirs *'Any proposal for a reservoir must:* *i. mitigate the impact of construction on local people, the environment and roads* *ii. minimise the effects on the landscape of an embankment reservoir through its design, general configuration and the use of hard and soft landscaping* *iii. promote the recreational uses of the reservoir consistent with the landscape … values of the proposal …* *vii. include measures to avoid or mitigate any other significant adverse effects identified through the environmental impact assessment of the proposal…'* Core Policy 44: Landscape This policy aims to protect and where possible enhance the key landscape features and elements that *'contribute to the nature and quality of the Vale of White Horse District's landscape'*. In addition to physical landscape features, these are suggested to include perceptual qualities such as *'important views and visually sensitive skylines'* and tranquillity. It is also stated that landscape proposals for new development are expected to *'incorporate appropriate landscape proposals that reflect the character of the area through appropriate design and management'* and *'preserve and promote local distinctiveness and diversity and, where practical, enhance damaged landscape areas'*.

[49] Vale of the White Horse District Council (2016 to 2019). Local Plan 2031 Part 1 Strategic Sites and Policies; and Part 2 Detailed Policies and Additional Sites. Online. Available at: https://www.whitehorsedc.gov.uk/vale-of-white-horse-district-council/planning-and-development/local-plan-and-planning-policies/local-plan-2031/. Accessed April 2022.

Legislation / Policy	Description
	The following part of the policy is of particular relevance to this LVA: '*High priority will be given to conservation and enhancement of the natural beauty of the North Wessex Downs AONB and planning decisions will have regard to its setting. Proposals that support the economy and social wellbeing of communities located in the AONB, including affordable housing schemes, will be encouraged, provided they do not conflict with the aims of conservation and enhancement.'* Core Policy 45: Green Infrastructure *'Proposals for new development must provide adequate Green Infrastructure in line with the Green Infrastructure Strategy. All major applications must be accompanied by a statement demonstrating that they have taken into account the relationship of the proposed development to existing Green Infrastructure and how this will be retained and enhanced. Proposals will be required to contribute to the delivery of new Green Infrastructure ...'* More detailed development policies of relevance include: • Development Policy 21: External Lighting, which seeks to avoid adverse effect of lighting; • Development Policy 23: Impact of Development on Amenity, which seeks to avoid significant adverse impacts on amenity; • Development Policy 31: Protection of Public Rights of Way, National Trails and Open Access Areas, which seeks to protect and improve the PRoW network, including the national trails; • Development Policy 32: Wilts and Berks Canal, which seeks to safeguard a corridor for the canal restoration, and that potential impacts on the environment, including the landscape, are assessed; and • Development Policy 35: New Countryside Recreation Facilities, which seeks to ensure that new countryside recreational facilities do not harm the North Wessex AONB and its setting, and 'respects the settlement character, locality and intrinsic beauty'.

Legislation / Policy	Description
South & Vale Green Infrastructure Strategy[50]	South Oxfordshire and Vale of White Horse District Councils have jointly published a green infrastructure strategy that identifies the main green infrastructure assets within the Vale. It also includes an assessment of the provision of green infrastructure against an adapted version of nationally accepted standards. The northern portion of the indicative location of SESRO lies within the Ock Valley Blue Corridor, while the far eastern fringe near the River Thames lies within the Thames Valley Blue Corridor. These are two of eight priority landscape scale strategic green and blue corridors identified in the strategy, where there are seen to be key opportunities for strategic green infrastructure enhancements, linkages and creation. It is noted that the Ock Valley Strategic Blue Corridor: *'running through the Vale of White Horse includes the River Ock valley floodplain and its tributaries, and provides a strategic connection to the Thames Valley Blue Corridor. Opportunities include Conservation Target Areas for habitat management, restoration and creation; and the provision of accessible natural greenspace to address identified deficiencies in … Marcham, Drayton and Abingdon. Opportunities also arise for connectivity and provision of larger areas of accessible natural greenspace for settlements such as … Wantage.'* It is stated that The Thames Valley Blue Corridor: *'extending largely through South Oxfordshire includes the valley floodplain and tributaries of the River Thames between Reading and Oxford, and provides a major strategic connection to [green infrastructure] in adjoining areas ... Opportunities include Conservation Target Areas for habitat management, restoration and creation; strategic access route improvements (The Thames Path); and the provision of accessible natural greenspace to address identified deficiencies in … Abingdon...'*
Vale of White Horse District Council Design Guide 2015[51]	The Vale of White Horse District Council Design Guide 2015 is a Supplementary Planning Document (SPD) which is referred to within the Vale of White Horse Local Plan 2031[49]. It seeks to encourage high quality design standards that are locally appropriate. While the SPD applies to all development, the focus of the document is on housing

[50] Chris Blandford Associated on behalf of South Oxfordshire & Vale of White Horse District Councils (2017). South & Vale Green Infrastructure Strategy Online. Available at: https://data.whitehorsedc.gov.uk/java/support/dynamic_serve.jsp?ID=1019020450&CODE=6FC84D5697E564DA1F77A5D61D3F14CC Accessed April 2022.
[51] Vale of White Horse District Council (2015). Vale of White Horse District Council Design Guide (2015). Online. Available at: https://www.whitehorsedc.gov.uk/wp-content/uploads/sites/3/2020/08/Vale-of-White-Horse-Design-Guide-2015.pdf. Accessed April 2022.

Legislation / Policy	Description
	development. However, some general principles are of relevance to SESRO, including Section 2 Responding to the site and setting, which sets out *'how applicants should assess the context and character of their site to ensure that new development will respect, respond to and enhance the unique characteristics of the Vale.'* Principle DG2: AONB states that: *'Applicants with sites within and/ or abutting the North Wessex Downs AONB must accord with relevant criteria set out in the AONB Management Plan and Paragraphs 115-116 of the NPPF* [updated in 2021 to paragraph 176]. *Proposals outside the AONB should not adversely affect its setting.'* The design guide also includes a landscape character assessment in Appendix E Vale of White Horse Settlement and Landscape Character. The indicative location for SESRO is within Geology Zone 2B - Central Clay Vale, and Landscape and Settlement Character Zone 2B - Central Alluvial Island Villages. The North Wessex Downs AONB corresponds to Landscape and Settlement Character Zones 2B Rolling Farmland Villages and Zone 5 Upper Chalk Downs.
Drayton Neighbourhood Development Plan 2015-2031 (Adopted 2015)[52]	The Drayton Neighbourhood Development Plan 2015-2031 forms part of the Vale of White Horse District Council's development plan and sets out guidance and policy for development within Drayton. Policy P-LF6: Additional Greenery – New Developments, seeks to ensure that reduce impact of built development through local appropriate tree and shrub planting.
East Hanney Draft Neighbourhood Plan 2021 to 2031[53]	The East Hanney Draft Neighbourhood Plan 2021 to 2031 sets out draft proposals for how local people would like development to be shaped in East Hanney. However, it has not yet been adopted. In relation to SESRO it is noted that:

[52] Drayton 2020 (2015). Drayton Neighbourhood Development Plan 2015-2031. https://www.whitehorsedc.gov.uk/wp-content/uploads/sites/3/2019/07/DRAYTON-NEIGHBOURHOOD-DEVELOPMENT-PLAN-Referendum-Copy-_0.pdf. Accessed April 2022.
[53] East Hanney Neighbourhood Plan Steering Committee (2022). East Hanney Neighbourhood Plan 2021 to 2031, Pre-Submission Version. Online. Available at: https://www.easthanneyparishcouncil.org.uk/uploads/east-hanney-draft-neighbourhood-plan-december-2021.pdf. Accessed April 2022.

Legislation / Policy	Description
	'Should the reservoir be approved by the government it is important that the village is protected from the works and that the opportunity is taken for a green environmental and recreational area be provided for ensuring an environmentally beneficial buffer between the village and the reservoirs infrastructure that protects the nature and character of the village.' Relevant draft policy themes include Policy theme 1 – village character and Policy theme 2 - Green Space and Environment.
North Wessex Downs AONB Management Plan 2019-2024[54]	The North Wessex Downs AONB Management Plan 2019-2024, sets out the *'vision and long-term ambitions for the North Wessex Downs and the legal and policy framework for the Plan'.* It also describes and explains the special qualities of the AONB. The management plan is set out in thematic chapters which describe and explain the special qualities that make this landscape unique. At the end of each chapter are summaries of the special qualities, key issues, objectives and policies relating to the theme. The landscape and development chapters are the most relevant to this LVA and extracts of relevant guidance and policy from these chapters are included below. Chapter 2: Theme 1 Landscape This chapter refers to the landscape character types identified in the North Wessex Downs AONB Integrated Landscape Character Assessment[55] (refer to section 6.4.6), which are referenced as forming the special qualities of the landscape. The special landscape quality most relevant to this LVA is: *'The distinctive northern Downs Plain and Scarp [which] plunges down from the chalk plain to the Vale of White Horse, creating a dramatic recognisable horizon.'*

[54] North Wessex Downs Area of Outstanding Natural Beauty (2019). North Wessex Downs Area of Outstanding Natural Beauty Management Plan 2019-2024. Online. Available at: https://www.northwessexdowns.org.uk/our-work/management-plan/. Accessed April 2022.
[55] Land Use Consultants (2002). North Wessex Downs Area of Outstanding Natural Beauty Integrated Landscape Character Assessment. Online. Available at: https://www.northwessexdowns.org.uk/downloadable-resources/. Accessed April 2022.

Legislation / Policy	Description
	It is suggested that the following key issues, have the *'potential to have significant influence on the AONB's Landscape Special Qualities'*. • 'The potential for development beyond the AONB boundary to visually damage or undermine the scale and critical qualities of landscape character areas.' • 'The need to conserve and enhance the remoteness and expansive open scale of the downland landscape.' • 'Intense pressure for development throughout the AONB and its setting that threatens the character and quality of its landscape…' • 'The need to protect and enhance historic sites, buildings and landscapes and their setting.' Landscape policies of relevance are: • LA 03: 'Use the North Wessex Downs Integrated Landscape Character Assessment to inform policy and decision making across the AONB and its setting.' • LA 06: 'Ensure that all development in or affecting the setting of the AONB conserves and enhances the character, qualities and heritage of the North Wessex Downs landscape.' Chapter 7: Theme 6 Development It is noted that 'When preparing planning applications, those responsible should refer to: • the North Wessex Downs AONB Management Plan; • relevant AONB Position Statements and Guidance Notes; • the North Wessex Downs Integrated Landscape Character Assessment; and • the Historic Landscape Character Assessment.' The relevant special qualities include: • 'remoteness and tranquillity' associated with the landscape character types;

Legislation / Policy	Description
	• 'distinctive architectural styles'; • 'sparse road network'; and • 'traditional land based and rural economy'. The following key issues are noted for their 'potential to have significant influence on the AONB's Special Qualities'. • 'Impact on dark skies and tranquillity of high-powered external lighting, especially where poorly directed or in an exposed location (not usually subject to planning control).' • 'Potential for certain forms of development to intrude on the wider landscape, including masts, pylons, wind turbine developments, photovoltaic schemes, and minerals and waste schemes, threatening the landscape quality, heritage assets, and the sense of remoteness and tranquillity.' • 'Development that results in a material loss of tranquillity and/ or impact on the dark night skies within the North Wessex Downs or its setting.' Development policies of relevance are: • DE 01: 'Encourage all proposals for new development, redevelopment and re-use to conserve and enhance the natural beauty of the North Wessex Downs. Oppose forms of development that fail to conserve and enhance the character and quality of the AONB and its setting and to make reference to the AONB's published guidance.' • DE 08: 'Avoid and reduce light pollution, including control of lighting schemes or other developments that threaten the integrity of dark night skies over the North Wessex Downs.' • DE 12: 'Encourage the retention of existing and provision of new 'Green Infrastructure. Ensure that Green Infrastructure is incorporated within the area of all 'major developments', both within and in the setting of the AONB.'

Legislation / Policy	Description
North Wessex Downs AONB Position Statement on Setting (2019)[56]	The geographical extent of the setting for the North Wessex Downs AONB is not formally defined on a map. It is defined as: *'the area within which development and land management proposals, by virtue of their nature, size, scale, siting, materials or design can be considered to have an impact, either positive or negative, on the natural beauty and special qualities of the North Wessex Downs AONB.'* The position statement highlights example development which could cause adverse impacts on the setting of the North Wessex Downs AONB. These are: • 'development which would have a significant visual impact on views in or out of the AONB; • breaking the skyline, particularly when this is associated with developments that have a vertical emphasis and / movement (chimneys, plumes or blades for example); • loss of tranquillity through the introduction or increase of lighting, noise, or traffic movement or other environmental impact like dust, vibration, spatial associations and historic relationships; • introduction of abrupt change of landscape character; • loss of biodiversity, particularly if of habitats or species of importance to the AONB; • loss of features of historic and natural landscape interest, particularly if these are contiguous with the AONB; • change of use of land such that to cause harm to landscape character; • development individually or cumulatively giving rise to significantly increased traffic flows to and from the AONB, resulting in loss of tranquillity and erosion of the character of rural roads and lanes…' It is also noted that *'adverse impacts might not be visual, as listed above tranquillity, a special quality of the North Wessex Downs AONB can be affected by a development which for example is noisy, even if not visible from the AONB'*.

[56] North Wessex Downs Area of Outstanding Natural Beauty (2019). North Wessex Downs AONB Position Statement, Setting. Online. Available at: https://www.northwessexdowns.org.uk/wp-content/uploads/2021/11/Setting_Position_Statement_2019_Final.pdf Accessed March 2022.

Legislation / Policy	Description
	The following expectations for development within the setting are set out in the position statement: • 'measures to consider impact on the setting of the AONB, including where required through Landscape and Visual Impact Assessments; • care over orientation, site layout, height and scale of structures and buildings; • consideration not just of the site but also the landscape and land uses around and beyond it; • careful use of colours, materials and non-reflective surfaces; • restraint and care over the installation and use of street lighting, floodlighting and other external lighting to prevent harm to the dark night skies of the AONB; • the grouping of new structures and buildings close to existing structures and buildings to avoid new expanses of development that are visible and out of context …; and • detailed mitigation measures, for example including native landscaping …, and noise reduction (landscaping in certain contexts can be damaging to historic features/deposits/landscape/character so will require careful consideration).'
North Wessex Downs AONB Position Statement Dark Skies & Artificial Light (2021)[57]	This position statement notes that *'artificial external lighting within the AONB or its setting should be kept to a minimum to conserve and enhance dark skies… The surroundings of the North Wessex Downs AONB and the protected landscape of the AONB add value to each other as the landscape and skies are linked. Lighting proposals in the setting should, therefore, have regard to their impact on the landscape character and special qualities of the AONB'.* When considering lighting proposals within or in the setting of the AONB, the AONB Partnership suggests application of the guidance in Dark Skies of the North Wessex Downs AONB: A Guide to Good External Lighting (see below).

[57] North Wessex Downs Area of Outstanding Natural Beauty (2021). North Wessex Downs AONB Position Statement Dark Skies & Artificial Light. Online. Available at: https://www.northwessexdowns.org.uk/wp-content/uploads/2021/11/Position-Statement-on-Dark-Skies-and-Artificial-Light-Final.pdf. Accessed May 2022.

Legislation / Policy	Description
Dark Skies of the North Wessex Downs a Guide to Good External Lighting (2021)[58]	Dark skies are one of the defining characteristics of the AONB. As such, the North Wessex Downs AONB Management Plan[54] includes protection for dark skies and policies to reduce light pollution. Refer to Section 6.4.5 below for further detail about mapping of the night skies of the AONB.
North Wessex Downs AONB; Guidance on the selection and use of colour in development (2020)[59]	This document primarily provides *'direction and guidance on the selection and use of colour for building development within the AONB'*, but also makes reference to the potential for harm to arise from proposals within the setting of the AONB. Key points of relevance to this LVA are listed below. • 'The topography of the AONB … has implications for development that sits outside the AONB boundaries but which has a major impact upon views from the top of the scarp slopes. Roof colours in particular can become very dominant unless carefully considered from higher ground. Assessing the major viewpoints within the AONB, all roof materials require a tonality not less than NCS [Natural Colour System[60]] S 5500N – S 6500N, if they are to integrate into the surrounding landscape and therefore minimise their visual impact upon the views.' • 'The choice of building materials and finishes as well as colour needs to be informed by the background texture of the landscape setting.' • Consideration should be given to textures, materiality, and reflectiveness.

[58] North Wessex Downs Area of Outstanding Natural Beauty (2021). Dark Skies of the North Wessex Downs AONB: A Guide to Good External Lighting. Online. Available at: https://www.northwessexdowns.org.uk/our-work/our-current-projects/dark-skies/. Accessed April 2022.
[59] Waygood Colour for North Wessex Downs Area of Outstanding Natural Beauty (2020). Guidance on the selection and use of colour in development. Online. Available at: https://www.northwessexdowns.org.uk/wp-content/uploads/2021/11/WD_guidance_screen.pdf. Accessed April 2022.
[60] https://ncscolour.com/ncs/.

6.3 Methodology

6.3.1 Datasets/reports reviewed

6.10 The LVA baseline has been established using the following sources of information:

- Aerial photography (Esri/Google Earth/Google Maps) and Google Maps 'Street View';
- Ancient Tree Inventory[61] (Checked on 26 January 2022);
- Ancient Woodland Inventory;[62]
- EAR prepared for the Gate 1 submission[44];
- England's Light Pollution and Dark Skies;[63]
- Environment Agency 2m Composite LiDAR delivered Digital Terrain Model and other Lidar topography survey data (2020);
- GIS data sets for statutory and non-statutory designations, public rights of way and cycle routes;
- National Character Area (NCA) Profiles 108, 109 and 116;[64]
- North Wessex Downs AONB Integrated Landscape Character Assessment[55];
- Ordnance Survey Explorer Mapping (1:25,000 scale);
- South & Vale Green Infrastructure Strategy[50]
- The Oxfordshire Wildlife and Landscape Study;[65]
- Tree Preservation Order (TPO) dataset;[66]
- Tranquillity Map: England. National map with 2001 district boundaries[67]; and

[61] Woodland Trust (2020). Ancient Tree Inventory. Online. Available at: https://ati.woodlandtrust.org.uk/tree-search/?v=2051486&ml=map&z=12&nwLat=51.703411551270804&nwLng=-1.5950046062469414&seLat=51.59860845884042&seLng=-1.0676608562469414. Accessed April 2022.
[62] Natural England (2020) Ancient Woodland Inventory. Online. Available at: https://data.gov.uk/dataset/9461f463-c363-4309-ae77-fdcd7e9df7d3/ancient-woodland-england. Accessed April 2022.
[63] Campaign to Protect Rural England (2019) England's Light Pollution and Dark Skies. Online. Available at: https://www.nightblight.cpre.org.uk/maps/. Accessed April 2022.
[64] Natural England (2013 to 2014). National Character Area profiles. Online. Available at: https://www.gov.uk/government/publications/national-character-area-profiles-data-for-local-decision-making/national-character-area-profiles#ncas-in-south-east-england-and-london. Accessed April 2022.
[65] Oxfordshire County Council, Natural England and The Earth Trust (2004). The Oxfordshire Wildlife and Landscape Study. Online. Available at: https://owls.oxfordshire.gov.uk/wps/wcm/connect/occ/OWLS/Home/ Accessed May 2022.
[66] South Oxfordshire District Council (2022). Tree Preservation Orders. Online. Available at: http://maps.southoxon.gov.uk/gis/. Accessed January 2022.
[67] Campaign to Protect Rural England (2007) Tranquillity Map: England. National map with 2001 district boundaries. Online. Available at: https://www.cpre.org.uk/resources/tranquility-map-england/. Accessed April 2022.

- Vale of White Horse District Landscape Character Assessment.[68]

6.11 The LVA baseline has also utilised the information within the baseline sections of Chapter 4 Biodiversity and Chapter 5 Historic Environment of this EAR.

6.3.2 Approach to assessment

6.12 The EAR prepared for the Gate 1 submission[44] established that a high-level LVA should be undertaken for this Gate 2 submission, focussing on the *'potential scale of impact on the landscape, and the visual impact of the proposed location of SESRO in relation to the setting of the North Wessex Downs AONB'.* This is the aim of this high-level LVA, which mainly considers the potential magnitude of effect of the largest SESRO option (i.e. 150Mm3) on the AONB and its setting, informed by consideration of potential effects on local landscape character areas, as well as views to and from the AONB.

6.13 Paragraph 3.2 of GLVIA3 sets out the requirements for a standalone LVA, compared with LVIA. It states that 'As a standalone 'appraisal' the process is informal and there is more flexibility, but the essence of the approach - specifying the nature of the proposed change or development; describing the existing landscape and the views and visual amenity in the area that may be affected; predicting the effects, although not their likely significance; and considering how those effects might be mitigated - still applies.' This is the approach that has been followed for this high-level LVA.

6.14 The LVA has been informed by a desktop review of background documentation, mapping and relevant national and local policy combined with fieldwork and photography carried out from public areas on roads and public rights of way (PRoW) in January and March 2022.

6.15 The methodology for this LVA is based on the GLVIA3 and associated technical guidance notes, as referenced where relevant below. It should be noted that GLVIA3 is not prescriptive and relies on tailoring the methodology to suit the particular project circumstances. It also emphasises the importance of professional judgement.

6.16 The changes to the constituent landscape features and elements/components of the landscape character areas (LCAs), such as trees, woods, hedgerows, hedgerow trees, landform, field patterns and heritage assets, have been considered in combination as part of the effects on landscape character and not as individual receptors. This proportionate approach is in line with GLVIA3.

6.17 In accordance with GLVIA3, the LVA provides a proportionate appraisal, with the appraisal of visual effects based upon representative viewpoints. The visual impact appraisal, therefore, does not identify effects on every individual receptor. However,

[68] Hankinson Duckett Associates (HDA), on behalf of Vale of White Horse District Council (2017). Vale of White Horse District Landscape Character Assessment. Online. Available at: https://data.whitehorsedc.gov.uk/java/support/Main.jsp?MODULE=FolderView&ID=789122104&CODE=498F5A0A897C751630F233DEB1E72432&NAME=19.+Landscape+Character+Assessment&REF=Local%20Plan%202031%20Part%202:%20Publication%20Version%20Publicity%20Period

the number and locations of representative viewpoints are considered proportionate to the scope of this LVA. A small number of illustrative viewpoints have also been included to provide supplementary information, to illustrate particular effects and specific issues. Both the representative and illustrative viewpoints have been tailored to address the comments received from relevant stakeholders, as set out in Section 6.3.3 below.

6.3.2.2 Identification of the Study Area

6.18 The extent of the study area for the appraisal has been determined through desktop study, Zone of Theoretical Visibility (ZTV) modelling and site visits.

6.19 The most elevated operational features of SESRO have been used to define the target points for the ZTV illustrated on Figure 6.1 Zone of theoretical visibility in Technical Supporting Document B2.2, Environmental Appraisal Report (terrestrial) Figures. That is the crest of the reservoir embankments and the towers within the reservoir. Refer to paragraph 6.61 for the worst-case heights assumed for these features.

6.20 Two further ZTVs have been modelled to indicate the areas of theoretical visibility between the scarp of the AONB and the surrounding landscape, with and without the indicative changes to the topography as a result of SESRO. Figure 6.2 Zone of Theoretical Visibility of Scarp of North Wessex Downs AONB - Without SESRO and Figure 6.3 Zone of Theoretical Visibility of Scarp of North Wessex Downs AONB - With SESRO illustrates the results of this modelling. For this modelling, target points at existing ground level along the Ridgeway National Trail (which roughly follows the crest of the AONB) have been used to indicate the theoretical visibility of the scarp.

6.21 All of the ZTVs are based on a bare earth scenario, which only takes account of the visual screening provided by the existing topography. The ZTVs do not take account of surface features, such as buildings and vegetation, which could also provide screening. The ZTVs are therefore an indication only of the areas within which visual effects may be expected to occur and the actual extent of visibility is likely to be considerably less than what is illustrated on the figures. For further information regarding the software, data and methodology used to generate the ZTVs, reference should be made to the notes on the ZTVs figures.

6.22 Based upon the ZTV modelling and site visits, a proportionate study area for the LVA has been defined in accordance with paragraph 5.2 of GLVIA3 which advises that the study area should *'cover the site itself and its wider context, within which the Proposed Development may influence it in a significant manner'*[45]. In line with this, the study area incorporates an offset of up to approximately 10km from the indicative location of the reservoir footprint for SESRO, as illustrated on Figure 6.1 Zone of theoretical visibility in Technical Supporting Document B2.2, Environmental Appraisal Report (terrestrial) Figures. This is the area where potential significant effects are considered to be likely due to the scale of the project, and nature of long distance and elevated views available. Whilst there may be more distant views available towards SESRO, this would likely affect a small part of the overall views due the distance and intervening vegetation. Landscape and visual effects beyond 10km

are therefore not likely to be significant due to distance and the assumed scale of the proposals.

6.3.2.3 Identification of baseline conditions and receptors

6.23 The level of detail set out in the baseline has been tailored to determine and assess the likely high-level magnitude of effect on the North Wessex Downs AONB and its setting.

6.24 The key receptors on which to base the LVA were identified following baseline studies, ZTV modelling and a review of the potential changes likely to arise from SESRO. For a landscape or visual effect to occur, there must be a link between the cause of the effect and the receptor. This would result from a direct physical effect on the landscape, or intervisibility between the receptor and the construction activities or the operational scheme that would result in a direct visual effect, or an indirect effect on landscape character or a designation, due to direct effects within its setting. Intervisibility has been established by ZTV modelling and by site appraisal. Landscape or visual receptors within the study area with no theoretical intervisibility with construction or operation of SESRO, or which are not relevant to the consideration of potential effects on the North Wessex Downs AONB and its setting, have not been included as potential receptors.

6.25 Photographs from representative and illustrative viewpoints have been taken in the winter, to represent maximum visibility without leaf cover, in accordance with the Technical Guidance Note 06/19 Visual Representation of Development Proposals[69].

6.3.2.4 Timescales for the appraisal

6.26 The timescale over which the potential effects of SESRO would occur varies according to the nature of the change.

6.27 The varying nature of landscape and visual effects throughout the indicative timeline of SESRO has been considered in this assessment in line with the timescales set out below:

- Construction: Considers construction activities, temporary works and construction traffic during the construction period (approximately 10 years for the largest SESRO option). Assessments for each landscape and visual receptor have been made at a time during construction when effects are likely to be most significant for the individual receptor.
- Winter year 1 of operation: Considers effects on a winter's day during year 1 following completion of all construction, when planting mitigation would not yet be fully effective. Both the completed scheme and the likely activities associated with it, such as traffic on site access and diversion roads, are considered.

[69] Landscape Institute (2019). Visual Representation of Development Proposals Technical Guidance Note 06/19. Online. Available at: https://landscapewpstorage01.blob.core.windows.net/www-landscapeinstitute-org/2019/09/LI_TGN-06-19_Visual_Representation.pdf. Accessed April 2022.

- Summer year 15 of operation: Considers the effects on a summer's day in the fifteenth year after opening when planting mitigation would have taken effect. Both the completed scheme and the likely activities associated with it, such as traffic on site access and diversion roads, are considered.

6.28 Both day and night-time changes for landscape and visual receptors are considered and a judgement on the likely overall magnitude of such effects is reported for each receptor.

6.29 The assessment of effects during construction and year 1 of operation has assumed the worst-case during winter, when existing vegetation is not in leaf.

6.3.2.5 Assessment of effects

6.30 The overarching guidance in GLVIA3 is not prescriptive on the criteria to be used for assessing landscape and visual effects. The criteria for assessing sensitivity and magnitude of effect have therefore been developed based on professional judgement by competent specialists with experience gained from the assessment of other major infrastructure projects in the UK. The criteria are set out in Appendix A6.1 Landscape and Visual Appraisal Criteria in Technical Supporting Document B2.1, Environmental Appraisal Report (terrestrial) Appendices. Criteria for assessing the significance of effect are not provided in that appendix, as this is not a requirement for LVA, in line with paragraph 3.2, table 3.1 and figure 3.1 of GLVIA3.

Sensitivity

6.31 Landscape and visual sensitivity is established by assessing the value attached to a receptor and its susceptibility to the particular form of change likely to result from the individual development.

6.32 GLVIA3 defines landscape value as '*The relative value that is attached to different landscapes by society*'[45]. A review of existing designations is the starting point in understanding the value of landscape receptors and views experienced by visual receptors, however GLVIA3 recognises that landscape value is not always signified by designation. Other areas of landscape, or individual elements or features of the landscape contributing to its character, or views may not be recognised by formal designation, but may nevertheless have value. The range of factors provided within the Technical Guidance Note TGN 02/21 Assessing landscape value outside national designations[70] have been considered in the identification of landscape value in this LVA.

6.33 For the purposes of this assessment, susceptibility to change has been defined, in keeping with GLVIA3, as the ability of the landscape or visual receptor to accommodate a development without undue, adverse consequences. Judgements

[70] Landscape Institute (2021). Assessing landscape value outside national designations Technical Guidance Note 02/21. Online. Available at: https://landscapewpstorage01.blob.core.windows.net/www-landscapeinstitute-org/2021/05/tgn-02-21-assessing-landscape-value-outside-national-designations.pdf. Accessed April 2022.

on susceptibility have taken the nature of SESRO into account.

6.34 Sensitivity has been assessed on a five-point scale of very high, high, medium, low or negligible. Tables 1.1 and 1.2 of Appendix A6.1 Landscape and Visual Appraisal Criteria in Technical Supporting Document B2.1, Environmental Appraisal Report (terrestrial) Appendices summarise the key criteria for landscape and visual value and susceptibility to change used to inform the assessment of sensitivity.

6.35 The application of these criteria is not a formulaic process and the tables only indicate general categories of sensitivity. A receptor may be considered to be of high value, but it does not necessarily follow that the same receptor is automatically of high susceptibility to the nature of the proposed change and therefore of high sensitivity. For example, an AONB, though of high value, may be able to accommodate appropriate forms of development without undue effects and therefore not be considered to be of high sensitivity to all changes. Conversely, landscapes considered to be of lower landscape value may be highly susceptible to the nature of the proposed change. Judgements are therefore made about each receptor, with the criteria serving as a guide and balanced accordingly. A receptor of high value and low susceptibility (or vice versa) may for instance be considered to be of overall medium sensitivity.

Magnitude of effect

6.36 The magnitude of effect is the degree of change that would occur during the construction and operation of the SESRO. The assessment takes the concept design stage mitigation into account. Magnitude of landscape and visual effect is determined by an assessment of the nature (whether beneficial or adverse), size and scale of the change likely to result from SESRO, in conjunction with the geographical extent of those changes. Duration and reversibility are considered in conjunction with the magnitude of effect as closely related but separate dimensions and in accordance with the timescales set out above. The overall magnitude of effect for each receptor is judged on individual merit rather than by a formulaic process.

6.37 The size and scale of change in the landscape is mainly a reflection of the extent or proportion of landscape elements lost or added and/or the degree to which aesthetic or perceptual aspects or key characteristics are altered, both of which may result in erosion or enhancement of landscape character.

6.38 Geographical extent of landscape change is assessed by determining the area over which the change would influence the landscape. This could be very localised, within the immediate setting of each development, or affect the wider landscape character and a large proportion of a character area.

6.39 The criteria used to assess the size and scale of visual change have been based upon the amount of change likely to occur as a result of SESRO. The size and/or scale of change in views and visual amenity at representative (or other selected) viewpoints takes into consideration the following:

- the scale of the change in the view with respect to the loss or addition of features in the view, changes in its composition, including the proportion of the view occupied by change and distance of view;
- the degree of contrast or integration of any new features or changes in the landscape with the existing or remaining landscape elements and characteristics in terms of factors such as form, scale and mass, line, height, colour and texture; and
- the nature of the view of SESRO, for example whether views would be full, partial or glimpses or sequential views while passing through the landscape.

6.40 For each representative (or other selected) viewpoint, judgements about the geographical extent of change reflect:

- the angle of view in relation to the main activity of the viewer, for example whether direct or oblique.
- the distance of the viewpoint from the proposed development; and
- the extent of the area over which the changes would be visible.

6.41 As such, the geographical extent of visual change can vary according to the type of viewer. For example, a representative view may be available from only a small proportion of a specific location of open access land, or from most of a specific location. Similarly, users of PRoWs might be able to view a development from most of a particular route (high extent) or there may be only a small section, or intermittent sections, of the route where users may be able to view a development (low extent). A worst-case assessment has been made for each key visual receptor at each representative viewpoint. However, in practice, the level of visual change would vary along each route or within adjacent settlements, in some cases ranging from no change or negligible, to a medium magnitude of effect.

6.42 Magnitude of effect has been assessed on a five-point scale of large, medium, small, negligible or no change. The criteria used as guidance to assess the magnitude of landscape and visual effect, using professional judgement, are set out in Tables 2.1 and 2.2 of Appendix A6.1 Landscape and Visual Appraisal Criteria in Technical Supporting Document B2.1, Environmental Appraisal Report (terrestrial) Appendices. The size and scale of change is considered in relation to the geographical extent of that change to arrive at an overall assessment of the magnitude of effect. A large size and scale of change and a small geographical extent, or vice versa, may therefore be considered to be a medium magnitude of effect.

6.43 The nature of landscape and visual effects has also been assessed. This can be beneficial (positive) or adverse (negative) unless receptors would experience no change. Beneficial effects are those that enhance and/or reinforce characteristics that are valued. Adverse effects are those that remove and/or undermine characteristics that are valued.

Significance of effect

6.44 In line with the assessment framework for Gate 2 set out in Section 2.6 of the EAR prepared for the Gate 1 submission[44] and the requirements for LVA in GLVIA3, this LVA does not identify the significance of effect on landscape and visual receptors. However, professional judgement has been used to indicate broadly whether effects on the North Wessex Downs AONB and its setting could potentially be significant or not. Significant effects are those that could be considered material in the decision-making process.

6.3.2.6 Appraisal of alternative options

6.45 The relative performance of the alternative reservoir options (i.e. 125Mm^3, 100 Mm^3, 75 Mm^3, 30+100 Mm^3 and 80+42 Mm^3), compared with the largest SESRO option (i.e. 150 Mm^3), has been appraised at the end of this LVA. A high-level qualitative appraisal of the effect of the alternative options upon the AONB and its setting has been set out in the narrative, based upon professional judgement.

6.3.3 Engagement feedback

6.46 The following stakeholders have been engaged with in relation to this high level LVA:

- Principal Landscape and Planning Officer at North Wessex Downs Area of Outstanding Natural Beauty;
- Senior Landscape Officer, Planning Services, at Vale of White Horse District Council;
- Landscape Specialist at Oxfordshire County Council; and
- Landscape Senior Specialist, Specialist Services and Programmes Team, at Natural England.

6.47 Engagement with these stakeholders in relation to the representative viewpoints to be used for the LVA have been undertaken by email. In addition, a meeting was held on 16 February 2022 to discuss the approach to the LVA, including the assessment criteria and the mitigation strategy. The meeting was attended by all of the officers listed above, except a representative from Natural England.

6.48 A summary of the key comments received from the stakeholders during winter 2022 and how these have been addressed is set out in Appendix A6.2 Landscape and Visual Engagement Feedback in Technical Supporting Document B2.1, Environmental Appraisal Report (terrestrial) Appendices. From this appendix, it can be seen that:

- all of the stakeholders relevant to this LVA have been engaged with regarding the selection of viewpoints and that the selection of representative and illustrative viewpoints have been tailored to address the comments received during winter 2022, prior to the site visits taking place; and

- the criteria used for this LVA have been updated to take on board the comments received from stakeholders.

6.3.4 Assumptions and limitations

6.49 The assessment provided within this chapter is based on information available at the time of writing.

6.3.4.2 Landscape and visual baseline and assessment

6.50 The landscape and visual baseline information included in this report is focused on informing the assessment of the magnitude of effect on the AONB and its setting. The review of local planning policy has therefore mainly been focussed on this scope and does not detail all policy of relevance to landscape and visual issues.

6.51 The mapping of England's light pollution and dark skies is based upon satellite data of sky glow during the year 2015 and will, therefore, not necessarily fully reflect the current situation.

6.52 Access to receptors and viewpoints assessed has been restricted to publicly accessible areas. Changes to views from private residential and/or inaccessible viewpoints have not been assessed in the high-level LVA, as views from and towards the AONB are generally considered to be most open from PRoW and other publicly accessible areas and therefore represent the worst case. However, where relevant, reference has been made to similar views from an adjacent community/settlement edge located near a representative viewpoint on a public right of way, using professional judgement.

6.53 In accordance with paragraph 7.13 of GLVIA3[45], 'existing schemes and those which are under construction should be included in the baseline for both landscape and visual effects assessment…' As such, development which has been observed to be under construction during the fieldwork for this LVA in January and March 2022, have been included in the future baseline. However, the views from potential future visual receptors have not been considered in this high-level LVA.

6.54 Every effort has been made to ensure that the viewpoint photographs in Appendix A6.3 Representative Viewpoints and Appendix A6.4 Illustrative Viewpoints in Technical Supporting Document B2.1, Environmental Appraisal Report (terrestrial) Appendices represent the most open views at each location towards the indicative SESRO location. However, due to the large scale of the study area and the high-level nature of this LVA, a proportionate approach has been taken to the LVA fieldwork, focussing on the locations considered most likely to be affected based on desktop assessment. It should also be noted that while fieldwork has been scheduled during periods with good visibility forecast, actual weather conditions and seasonal factors have influenced the photographic record of the site. It is therefore recognised that conditions, such as haze, have affected the visibility in the viewpoint photography and this has been taken into account in the LVA. If SESRO is taken forward to subsequent project stages, further photography would be collated at that point, to include both winter and summer photography, ensuring better visibility.

6.55 Representative Viewpoint 11 from Wittenham Clumps has not been visited as conditions during the site visits in March 2022 were not favourable for visibility or photography from this area, looking towards the indicative location for SESRO. In addition, desktop studies indicate that effects on this distant viewpoint, which is located approximately 10km from the indicative reservoir footprint for SESRO, are not likely to be significant. Refer to the visual appraisal for this viewpoint in Appendix A6.6 Landscape and Visual Appraisal Tables in Technical Supporting Document B2.1, Environmental Appraisal Report (terrestrial) Appendices. If SESRO is taken forward to subsequent project stages, this could be verified on site.

6.56 The following broad distance categories have been used to describe viewing distances:

- Local: Up 1km;
- Middle-distance: 1km to 5km;
- Distant: 5k to 10km; and
- Very distant: Over 10km.

6.57 This LVA indicates the magnitude of effect in relation to key landscape and visual receptor groups to inform the assessment of the potential magnitude of effect on the North Wessex AONB and its setting but does not indicate the significance of effect. This is in line with the assessment framework set out in the EAR prepared for the Gate 1 submission[44] and the requirements for LVA in GLVIA3 (paragraph 3.2, table 3.1 and figure 3.1).

6.58 The screening or filtering effect of existing vegetation beyond the indicative SESRO location has been taken into account within the LVA in its current condition. Growth or other changes to this vegetation or planting as part of other development could potentially affect the potential effects caused by SESRO, but the management and retention of such vegetation is outside the control of SESRO and has therefore not been considered in this LVA.

6.3.4.3 Assumptions related to SESRO

6.59 This section sets out the assumptions made regarding construction and operation of SESRO for the purposes of the LVA.

Construction

6.60 For the purposes of this LVA, the following high-level assumptions have been made regarding the construction of SESRO:

- The majority of the construction activities for SESRO would be undertaken within approximately nine years, followed by an additional year to complete the filling of the reservoir.
- The construction site would be enclosed by various types of fencing that would range from 1.2m up to 3m height.

- While two options are under consideration for the rail sidings and materials handling area, this appraisal has assumed that it would be at the RSMH2 location, which is indicated as the current preference. Material stockpiles would be up to 10m high.
- The main construction compound would be located in the area of the indicative operational car park near the visitor centre, as indicated on Figure 2.1 Landscape and environmental design strategy plan in Technical Supporting Document B2.2, Environmental Appraisal Report (terrestrial) Figures. Other smaller satellite compounds would also be likely to be required, but the locations of these have not been determined at this early stage.
- The locations of haul roads have not been determined at this early stage, but it is assumed that the following would be required:
  - an internal reservoir perimeter haul road (between the inner toe of the reservoir embankment and the top of the borrow pit);
  - an outer reservoir perimeter haul road (around the outer toe of the reservoir embankment);
  - haul roads across the borrow pit excavation area;
  - haul roads to connect with the rail sidings; and
  - a haul road along the auxiliary drawdown channel excavation.
- With the exception of the underground construction works for the pumping station to river intake tunnel which are expected to progress 24hours a day, construction activities would generally be undertaken during daylight hours (7am to 6pm weekdays and 7am to 1pm on Saturdays). However, it is likely that some lighting would be required for temporary construction features, key infrastructure features or occasional night-time working.
- The sequencing of the construction works would commence with setting up of materials handling areas, site fencing, compounds and haul roads; followed by the stripping of soil and creation of noise bunding, and subsequently the excavation of the replacement floodplain storage area and reservoir earthworks.
- The type of plant used for construction would generally be earthworks plant such as excavators, dumper trucks and bulldozers. However, for some construction activities cranes of up to 60m height would be required.
- Vegetation along the edge of the indicative location for SESRO would be retained and protected in general, except where specific infrastructure is indicated, such as utility connections or road junctions, as illustrated on the Figure 2.1 Landscape and environmental design strategy plan in Technical Supporting Document B2.2, Environmental Appraisal Report (terrestrial) Figures.
- All vegetation would be cleared within the indicative location for SESRO, except where vegetation is indicated as retained on Figure 2.1 Landscape and environmental design strategy plan in Technical Supporting Document B2.2, Environmental Appraisal Report (terrestrial) Figures.

- The implementation of the Landscape mitigation illustrated on Figure 2.1 Landscape and environmental design strategy plan in Technical Supporting Document B2.2, Environmental Appraisal Report (terrestrial) Figures would generally be carried out at the end of construction. The exceptions would be where mitigation planting is proposed along the edge of the indicative location for SESRO in the vicinity of sensitive local visual receptors, such as those listed below. In these areas the planting would be implemented sooner.
    - residents near the indicative location for SESRO, including in East Hanney and Steventon; and
    - visitors to the South Oxfordshire Crematorium and Memorial Park.

Operation

6.61 For the purposes of this LVA, the following high-level assumptions have been made regarding the operation of SESRO:

- No renewable energy proposals form part of the options assessed in this LVA.
- It is assumed that the operational buildings and structures would comprise those illustrated on Figure 2.1 Landscape and environmental design strategy plan in Technical Supporting Document B2.2, Environmental Appraisal Report (terrestrial) Figures.
- It is assumed that the recreational buildings indicated on Figure 2.1 Landscape and environmental design strategy plan in Technical Supporting Document B2.2, Environmental Appraisal Report (terrestrial) Figures would be single storey.
- The operational reservoir embankments and bunding is assumed to comprise what is illustrated on Figure 2.1 Landscape and environmental design strategy plan in Technical Supporting Document B2.2, Environmental Appraisal Report (terrestrial) Figures. It is assumed that the reservoir embankment crest generally would be at an elevation of 80m AOD, but up to a maximum elevation of 85m AOD at high points along the crest. It is assumed that all other construction noise bunding would have been removed by operation.
- It is assumed that there would be three towers within the reservoir, comprising one main tower up to 98m AOD and two secondary towers up to 88m AOD.
- Some lighting would be likely to be required for the operational scheme. While the locations and type of lighting is not known at this stage, it is assumed that any required lighting would be associated with key infrastructure features, such as possible lighting of road junctions, carparks or buildings for safety reasons.
- Landscape mitigation is illustrated on Figure 2.1 Landscape and environmental design strategy plan in Technical Supporting Document B2.2, Environmental Appraisal Report (terrestrial) Figures.
- Actual heights of established mitigation planting would vary depending on the individual species. For the purposes of the assessment, the heights of established planting during summer year 15 of operation are assumed to be approximately:
    - Woodland and trees: 6-8 m;

- Shrubs and scrub: 3 m; and
- Managed hedgerows: 2 m.

6.4 Understanding of the baseline

6.4.1 Designations

6.62 This section sets out designations and local plan allocations relevant to landscape, as identified through a desktop study. The designations within the study area referred to below, are illustrated on Figure 6.5 Landscape context and planning constraints in Technical Supporting Document B2.2, Environmental Appraisal Report (terrestrial) Figures.

6.4.1.2 North Wessex Downs Area of Outstanding Natural Beauty

6.63 The North Wessex Downs AONB is the third largest AONB in England and is located more than 2km south of the indicative location for SESRO. It is a visibly ancient landscape marked with the impact of thousands of years of human use and settlement. As noted in the North Wessex Downs AONB Management Plan[54], *'the depth of history can still be seen in today's landscape, including … the Ridgeway – the oldest road in England'*.

6.64 The North Wessex Downs forms a 'remote, expansive and tranquil landscape in the heart of Southern England', with 'high, open arable sweeps of chalk downs and dramatic scarp slopes with their prehistoric monuments and beech knolls'[54]. The long scarp and elevated downs of the AONB landscape form a distinctive feature on the horizon to the south of the indicative location for SESRO. It is the relationship and intervisibility between the AONB and indicative location for SESRO which this LVA is focussed on.

6.4.1.3 Oxford Green Belt

6.65 Oxford is surrounded by the Oxford Green Belt, as illustrated on Figure 6.5 Landscape context and planning constraints in Technical Supporting Document B2.2, Environmental Appraisal Report (terrestrial) Figures. The green belt effectively prevents urban sprawl from Oxford and other local urban settlements into the surrounding countryside in accordance with national planning policy.

6.66 The Oxford Green Belt is located immediately to the north of the indicative location for SESRO to the north of Marcham Road and also abuts the far eastern extent of the indicative location for SESRO at the Thames.

6.67 Whilst not strictly a landscape designation, the 'openness' of the landscape within the green belt can be relevant to landscape assessment. However, as the green belt would not be directly impacted by SESRO, there would not be an effect on openness, and the green belt is therefore not considered further in this LVA.

6.4.1.4 Ancient woodlands, ancient and veteran trees, and tree preservation orders

6.68 Ancient woodland, ancient trees and veteran trees are irreplaceable habitats. While there are a number of ancient woodlands within the wider study area, there are no ancient woodlands recorded in the Ancient Woodland Inventory[62] within the indicative location for SESRO. It should, however, be noted that the inventory only records ancient woodlands of more than 2 ha in area and it is therefore possible that there are smaller blocks of ancient woodland that have not been identified at this stage. The closest recorded ancient woodland to the indicative location for SESRO, Hyde's Copse, lies approximately 0.5km to the north-west, near Marcham. Other ancient woodlands are located more than 1.5km from the indicative location for SESRO. These ancient woodlands are located too far away to be affected by SESRO.

6.69 The Woodland Trust Ancient Tree Inventory[61] (checked 26 January 2022) identifies a number of ancient and veteran trees within approximately 15m of the indicative location for SESRO, including a cluster of 5 veteran crack willow trees along Cow Common Brook, to the south of Marcham, and an ancient crack willow tree adjacent to the bridleway 192/5/20 along the Mere Dike. Only a small proportion of ancient or veteran trees are recorded on this inventory.

6.70 If SESRO is taken forward to subsequent project stages, further survey work would be required to identify the possible presence of any additional ancient woodlands and ancient or veteran trees that are not listed on the inventories. This would include a site specific arboricultural survey to understand the tree and vegetation baseline to a greater level of detail.

6.71 While there are a number of trees with TPOs within the wider study area, including within the nearby villages of Steventon, East Hanney, Marcham and Drayton, there are no TPOs within 15m of the indicative location for SESRO[66].

6.4.1.5 Cultural heritage designations

6.72 Cultural heritage designations and assessment of effects on these are set out in detail within Chapter 5: Historic Environment. However, as the landscape setting of heritage features is relevant to the landscape assessment, a brief summary is provided in this section and the designations are included on Figure 6.5 Landscape context and planning constraints in Technical Supporting Document B2.2, Environmental Appraisal Report (terrestrial) Figures.

6.73 There are a number of scheduled monuments within the study area. The nearest is Sutton Wick Settlement Site, adjoining Drayton Road and located within close proximity to the indicative location for SESRO near Abingdon. Within the North Wessex Downs AONB, there are several scheduled monuments, including along the Ridgeway, notably Segsbury Camp / Letcombe Castle Hillfort approximately 1.5km south of Letcombe Regis and more than 7km from the indicative location for SESRO.

6.74 There are numerous conservation areas within the study area. East Hanney is the closest, which lies within approximately 50m to the west of the indicative location

for SESRO. The conservation areas of Letcombe Regis, Ardington and East Lockinge, West Hendred, East Hendred, Blewbury, South Moreton, North Moreton and Little Wittenham lie within the AONB boundary. There are also a number of listed buildings within the study area, which are predominantly associated with the conservation areas and mainly are grade II and II*. However, within Steventon Conservation Area the Church of St Michael and All Angels is grade I listed, located approximately 550m to the south-east of the site. Within the AONB conservation areas there are also some further grade I listed buildings, including amongst other the Church of the Holy Trinity in West Hendred and the Jesus Chapel and Attached House in East Hendred.

6.75 There are five registered parks and gardens within the study area. The closest is Sutton Courtenay Manor (grade II) located approximately 0.6km to the south-east of the indicative location for SESRO. The others are located more than 2km from the site; Hinton Manor and Pusey House to the north-west (both grade II), Albert Park, Abingdon to the north (grade II) and Nuneham Courtenay to the north-east (grade I).

6.76 Previous cultural heritage studies undertaken suggests that a large proportion of the hedgerows within the indicative location for SESRO are deemed as important hedgerows under the archaeology and history criteria of the Hedgerows Regulations 1997, as they form an integral part of a field system pre-dating 1845. Refer to Figure 5 of Appendix A5.1 Cultural Heritage Desk-Based Assessment in Technical Supporting Document B2.1, Environmental Appraisal Report (terrestrial) Appendices.

6.4.1.6 Biodiversity designations

6.77 For biodiversity designations and assessment of effects on these, reference should be made to Chapter 4: Biodiversity. However, the following biodiversity designations have been noted as part of the landscape baseline.

6.78 There are three special area of conservation (SAC) within the study area. Approximately 2.6km to the north, lies Cothilll Fen SAC, part of which is also a National Nature Reserve. Within the North Wessex Downs AONB, Hackpen Hill SAC is located at Devils Punchbowl, more than 8km to the south-west of the indicative location for SESRO, and Little Wittenham SAC is located approximately 9km to the east. All of these sites also form part of a larger number of sites of special scientific interest (SSSIs) within the study area.

6.4.2 Land cover and landscape features locally

6.79 The indicative location for SESRO is within an area of the relatively flat and open clay vale lowland farmland, interspersed by small woodland blocks, hedgerows and tree belts which are often associated with other linear features such as watercourses, PRoWs, roads and the Great Western Rail (GWR) Main Line. The landscape is sparsely settled, with just a few scattered properties that are generally located along the Steventon Road and Hanney Road, between East Hanney village to the west and Steventon village to the east. The road bisects the indicative location for SESRO. To the north of the road, there are three large solar farms located within the farmland;

Landmead, Goose Willow and Steventon Solar Farms. To the south, an industrial estate, including storage units, is located between Hanney Road and the GWR Main Line, the latter which generally forms the southern fringe of the indicative location for SESRO. To the west, East Hanney and the A338 abut the indicative location for SESRO, while the Childrey Brook, Cow Common Brook and River Brook generally forms the northern fringe, except at the far north-eastern corner, which extends up to Marcham Road to the east of Marcham village. The eastern fringe generally abuts the A34 and Steventon, except for the far eastern extent to the east of the A34, which reaches all the way to the River Thames to the south of Abingdon market town and north of Drayton village.

6.4.3 Topography and Geology

6.80 As illustrated on Figure 6.4 Topography in Technical Supporting Document B2.2, Environmental Appraisal Report (terrestrial) Figures, to the north of the broad clay vale, the land rises gently to the Midvale Ridge, which comprises Corallian limestone. To the south, the lower chalk foot-slopes of the North Wessex Downs AONB separates the broad clay vale from the more steeply rising high chalk downs that form the scarp of the AONB.

6.4.4 Tranquillity

6.81 The Campaign to Protect Rural England (CPRE) has undertaken a study of tranquillity in England and has mapped and published the results (2007). The Tranquillity Map for England[67] identifies tranquillity zones based on sources of noise and visual intrusion and the zones over which intrusion may be felt. The indicative location for SESRO falls within an area indicated as moderately tranquil, with lower levels of tranquillity associated with the surrounding main roads and settlements. The highest levels of tranquillity within the study area are associated within the generally undeveloped North Wessex AONB to the south, although the levels of tranquillity in this area are also affected to some extent by roads and settlements.

6.4.5 Night skies

6.82 The CPRE Countryside Charity, have created a night blight map showing the relative darkness of the night sky across England. This mapping is based on satellite images showing light pollution from the sky[71]. CPRE's aim is to protect and improve existing dark skies. Light pollution reduces the visibility of starry skies, as well as interrupting the natural behaviour of wildlife. Generally, urban areas are most affected by light pollution, with darker skies present in rural areas.

6.83 The map of England's Light Pollution and Dark Skies shows that the indicative location for SESRO is mainly affected by light pollution along the eastern extent near the A34 and urban areas like Abingdon, Drayton and Steventon where lighting levels are brighter. Elsewhere, the lighting levels generally fall within the second to third

[71] The Countryside Charity (CPRE) (2016). *Night Blight, Reclaiming our dark skies.* Online. Available at: https://www.nightblight.cpre.org.uk/. Accessed April 2022.

darkest categories, except for the industrial area to the south of Hanney Road where some associated light pollution is indicated. Although East Hanney is a 'dark sky village', as set out in the East Hanney Draft Neighbourhood Plan 2021 to 2031[53] and has limited street lighting to reduce light pollution, the night skies within this village are mapped as falling within the third and fourth darkest categories.

6.84 The North Wessex Downs AONB to the south is affected by light pollution from the surrounding urban areas in the AONB setting. Despite this *'almost 15 per cent of the sky over the AONB is as dark as any in the country, and another 57.9 per cent falls into the next darkest category'*[58].

6.85 Light control zones have been mapped by the AONB Partnership informed by a combination of the CPRE mapping and the Institution of Lighting Professionals (ILP) recommendations in Guidance Note 01/21 The Reduction of Obtrusive Light[72]. The darkest part of the AONB is defined as E0 – Dark Sky Zone, while the remaining AONB away from rural settlements and economic hubs is defined as E1 – Rest of the AONB. The AONB Partnership have not mapped the light control zones of the setting of the AONB but suggests that this *'should be whatever the adjacent zone is within the AONB'*[58].

6.4.6 Landscape character

6.86 The published LCAs referred to in this section are illustrated on Figure 6.6 Published landscape character types and areas in Technical Supporting Document B2.2, Environmental Appraisal Report (terrestrial) Figures, where it has been possible to obtain the datasets from the publishers.

6.4.6.2 National character areas

6.87 At a national scale, Natural England has divided England into 159 National Character Areas (NCA)[64].

6.88 The following NCAs are relevant to the indicative location for SESRO and the North Wessex Downs AONB, as illustrated on Figure 6.6 Published landscape character types and areas in Technical Supporting Document B2.2, Environmental Appraisal Report (terrestrial) Figures:

- NCA 108 Upper Thames Clay Vales (which encompasses the whole of the indicative location for SESRO, as well as the far north-eastern extent of the North Wessex Downs AONB);
- NCA 109 Midvale Ridge (located the north of the indicative location for SESRO); and

[72] Institution of Lighting Professionals (2001). Guidance Note 01/21 The Reduction of Obtrusive Light. Online. Available at: https://theilp.org.uk/publication/guidance-note-1-for-the-reduction-of-obtrusive-light-2021/. Accessed April 2022.

- NCA 116 Berkshire and Marlborough Downs (located to the south of the indicative location for SESRO and covers most of the North Wessex Downs AONB within the study area).

6.89 A key characteristic of NCA 116 that is of particular relevance to the focus of this LVA, is that *'Settlement is sparse on the high Downs, offering experiences of tranquillity, dark skies and far-reaching views'*[64]. Further extracts of the relevant key characteristics of the NCAs within the study area are set out in Table 1.1 of Appendix A6.5 Published Sources of Landscape Character in Technical Supporting Document B2.1, Environmental Appraisal Report (terrestrial) Appendices.

6.4.6.3 Regional and local landscape character areas

6.90 At a regional scale, landscape character has been assessed within The Oxfordshire Wildlife and Landscape Study[66] (OWLS). There are 24 broad landscape character types (LCTs) within the county. The LCTs are then further subdivided into constituent LCAs.

6.91 The OWLS LCTs and LCAs relevant to the indicative location for SESRO and the North Wessex Downs AONB include:

- LCTs/LCAs that overlaps with the indicative location for SESRO:
  - LCT River Meadowlands:
    - LCA River Ock (WH/19); and
    - LCA Lower River Thames (WH/1).
  - LCT Alluvial Lowlands:
    - LCA East and West Hanney (WH/27).
  - LCT Lowland Village Farmlands:
    - LCA Marcham (CR/5).
- LCTs/LCAs that overlap with the parts of the North Wessex Downs AONB that are most likely to be affected by SESRO:
  - LCT Rolling Farmland:
    - LCA Blewbury (WD/6); and
    - LCA Brightwell-cum-Sotwell (WH/9).
  - LCT Farmland Hills:
    - LCA (WH/10) Whittenham Clumps.
  - LCT Chalk Downland and Slopes:
    - LCA North Wessex Downs Escarpment (WD/1).

6.92 A key characteristic of the LCA WD/1, which is of particular relevance to the focus of this LVA, is the *'…very visible and distinctive north-facing escarpment of the North Wessex Downs'*[65].

6.93 It is suggested that the OWLS 'should be used in conjunction with landscape character assessments available at a district level'[65].

6.94 At a local scale (district level), the landscape of the study area is characterised in the Vale of White Horse District Landscape Character Assessment[68] (VoWH-LCA), the North Wessex Downs AONB Integrated Landscape Character Assessment[55] (AONB-LCA) and the South Oxfordshire Landscape Character Assessment[73]. All of these character assessments identify broad LCTs which are further sub divided into smaller LCAs.

6.95 The AONB-LCA includes the northern part of the AONB that lies within the Vale of White Horse District to the west and South Oxfordshire District to the east. As such, there is an overlap between these assessments. In this high level LVA, the LCAs listed in the AONB-LCA have been referred to for the characteristics of the landscape within the AONB boundary, in line with the requirements contained within the local policies and AONB management plan (refer to Table 6.1). The VoWH-LCA have been referred to for the key characteristics of the potentially directly affected local LCAs. As the South Oxfordshire LCTs and LCAs are not likely to be affected directly by SESRO, they have not been considered further as part of the baseline for this LVA.

6.96 The majority of the indicative location for SESRO lies within the LCT VL: Lower Vale Farmland, with the northern extents belonging to the LCT RF: River Floodplain and LCT LM Coraline Limestone Ridge with Woodland, as described in the VoWH-LCA. Key characteristics of the potentially directly affected LCAs within these LCTs and which are of particular relevance to the focus of this LVA, include views towards the elevated scarp of the North Wessex Downs AONB. Such views are described as being visible through gaps in vegetation or from more open areas from LCAs VL2 Grove to Steventon Lower Vale Farmland, VL3 East Hanney to Abingdon Lower Vale Farmland, RF15 Childrey Brook and Letcombe Brook River Floodplain, and LCA LM15 Marcham Corallian Limestone Ridge with Woodland.

6.97 In addition, some wider views towards the Downs are noted as being a key characteristic of the LCA RF11 Garford to Abingdon Ock River Floodplain. In relation to LCA VL2 Grove to Steventon Lower Vale Farmland it is also noted that the solar farms are noticeable in views from areas to the south, including the foot-slopes of the Downs, while the LCA LM15 Marcham Corallian Limestone Ridge with Woodland is noted as being visible from the AONB in distant views. It is therefore recommended in the management requirements for LCAs 5F Liddington – Letcombe Open Scarp and 5D Moreton Plain within the AONB, that development proposals outside the AONB boundary should be considered in terms of impacts on character and views. Impacts of tall structures are also noted as a particular vulnerability for LCA 5C Hendred Plain, which is also located in the AONB.

6.98 Extracts of the relevant key characteristics of the regional and local LCAs within the

[73] South Oxfordshire District Council (2017). South Oxfordshire Landscape Character Assessment. Online. Available at: https://data.southoxon.gov.uk/ccm/support/dynamic_serve.jsp?ID=788092192&CODE=4650A3652852911819269B1BB795E501. Accessed May 2022.

study area are set out in further detail in Table 1.2 of Appendix A6.5 Published Sources of Landscape Character in Technical Supporting Document B2.1, Environmental Appraisal Report (terrestrial) Appendices, with most emphasis on those LCAs that would potentially be directly affected. Relevant published guidance for these areas is also included. Relevant key characteristics are also listed for the LCAs within the North Wessex Downs AONB whose landscape character could be indirectly affected due to intervisibility with SESRO. Figure 6.1 Zone of theoretical visibility in Technical Supporting Document B2.2, Environmental Appraisal Report (terrestrial) Figures indicates the potential for some limited theoretical intervisibility between SESRO and LCAs 1B Lambourne Downs, 1D Blewbury Downs and 2A Brightwalton Downs. These LCAs have not, however, been included in this LVA because the extent of any such intervisibility would be very limited and their character would not be likely to be materially affected by SESRO.

6.4.6.4 Historic landscape character

6.99 The historic landscape character for the indicative location for SESRO and assessment of effects on these are set out in detail within Appendix A5.1 Cultural Heritage Desk-Based Assessment in Technical Supporting Document B2.1, Environmental Appraisal Report (terrestrial) Appendices.

6.100 It is noted that '…The current landscape seems to be heavily influenced by 19th and 20th century reorganisation, with larger prairie-type fields predominating on one side (Frilford side) of the Wiltshire-Berkshire Canal and smaller units on the other (Steventon).'

6.4.7 Sensitivity of landscape receptors

6.101 For this high-level LVA, the landscape receptors have been limited to the AONB and its setting within the study area, the constituent LCAs of the AONB that are most likely to be affected by SESRO, as well as the LCAs that potentially would be directly affected by SESRO and which are also located within the setting of the AONB. In line with the criteria set out in Table 1.1 of Appendix A6.1 Landscape and Visual Appraisal Criteria in Technical Supporting Document B2.1, Environmental Appraisal Report (terrestrial) Appendices, the value of the AONB and its constituent LCAs has been assessed as high, while the value of the LCAs outside the AONB but within its setting have been assessed as medium.

6.102 The constituent LCAs of the AONB are considered to have very limited ability to accommodate a development like SESRO without some undue effects. This is because the large-scale nature of change to the landscape would inevitably affect the character of the views from the AONB towards the Midvale Ridge and these views are an important characteristic of the LCAs. As such, the susceptibility of the LCAs within the AONB is high. Locally, the LCAs that potentially would be directly affected within the setting of the AONB are considered to have limited ability to accommodate a development like SESRO without undue effects, due to the potentially large scale change to the characteristic farmland nature of the landscape and its relatively flat landform, although the low-lying nature of the landscape could

to some extent help to absorb some elements of development into the landscape. As such, the potentially directly affected LCAs are considered to have medium susceptibility.

6.103 In considering the value of the AONB and LCAs referred to above, and their ability to accommodate change, that is their susceptibility, the overall sensitivity of the LCAs within the AONB is considered to be high, while the overall sensitivity of the LCAs within the setting of the AONB is considered to be medium. A summary of the overall sensitivity of each of the landscape receptors is set out in Table 6.*2*.

Table 6.2 Sensitivity of landscape receptors.

Sensitivity	Landscape Receptor
High	North Wessex Downs AONB and its setting (within the study area only)
	LCA 5F Liddington – Letcombe Open Scarp
	LCA 5C Hendred Plain
	LCA 5D Moreton Plain
Medium	LCA LM15 Marcham Corallian Limestone Ridge with Woodland
	LCA RF8 Abingdon to Sutton Courtenay Thames River Floodplain
	LCA RF11 Garford to Abingdon Ock River Floodplain
	LCA RF15 Childrey Brook and Letcombe Brook River Floodplain
	LCA VL2 Grove to Steventon Lower Vale Farmland
	LCA VL3 East Hanney to Abingdon Lower Vale Farmland

6.4.8 Visibility and potential visual receptors

6.104 The landscape within the indicative location for SESRO and the wider vale landscape is generally flat and low lying, with higher ground to the north and south associated with the Midvale Ridge and North Wessex Downs AONB respectively. While hedgerows, tree belts and smaller blocks of woodland limit the distance of views within the Vale to some extent, there are middle-distance to distant views available towards the scarp of the AONB and also views from the AONB towards the Vale.

6.105 The Midvale Ridge is also visible in views from the Vale and from the AONB, looking across the Vale. However, due to more extensive tree cover on the Midvale Ridge compared with the scarp of the AONB which is often more open, local middle-distance views towards the low-lying landscape of the Vale tend to be generally filtered or screened when looking from the Midvale Ridge, although the higher ground of the AONB is visible in the distance.

6.106 The focus of the visual appraisal in this high-level LVA is to inform the consideration of effects on the North Wessex Downs AONB and its setting. Therefore, the visual receptors identified represent groups of people who are either located within the AONB or who have views across the indicative location for SESRO looking towards the AONB. As such, there are other visual receptors in the wider ZTV study area that would be likely to be affected by SESRO which have not been included in this high-level LVA. Examples of such visual receptors include, but are not limited to, residents within the adjacent local communities of East Hanney, Steventon and Drayton, as views towards the indicative location for SESRO from these settlements are not also directly focussed towards the AONB. However, if SESRO is taken forward to subsequent project stages, assessment of representative views from all such receptors would be considered at that stage.

6.107 The visual receptors included in the appraisal fall into four broad categories: users of PRoWs, users of cycle routes, users of open access land and communities.

6.108 Users of PRoWs include users of the Vale Way Long Distance Path and the Ridgeway National Trail, which are important long-distance paths which pass through the AONB within the study area. While the Thames Path National Trail is also located within the study area, views from this path are not considered of particular relevance to the focus of this LVA on the AONB and have therefore not been included.

6.109 Views from the cycle network were also considered as part of the baseline studies, including the National Cycle Network (NCN) Route 5 which passes through the eastern extent of the indicative location for SESRO near the River Thames and NCN Route 544 which is located almost 4km to the south of the indicative location for SESRO, within the AONB. Both of these routes form part of the local Science Vale Cycle Network (SVCN)[74] which is promoted by Oxfordshire County Council. However, fieldwork confirmed that views towards the indicative location for SESRO from the NCN Route 544 within the AONB would not be likely to be significantly affected – refer to paragraph 6.112 below.

6.110 A number of representative and illustrative viewpoints have been selected to represent these receptor groups. The relevant statutory consultees have been engaged with regarding the viewpoints, as set out in Section 6.3.3 above. The locations of the viewpoints are shown on Figure 6.1 Zone of theoretical visibility in Technical Supporting Document B2.2, Environmental Appraisal Report (terrestrial) Figures, with corresponding numbers referenced below.

6.111 The representative viewpoints, which form the basis for the visual appraisal, are listed in Table 6.3 and the viewpoint photography is provided in Appendix A6.3 Representative viewpoints in Technical Supporting Document B2.1, Environmental Appraisal Report (terrestrial) Appendices.

[74] Oxfordshire County Council (2021). Science Vale Cycle Network (SVCN), Strategic Route Map – Oct 2021. Online. Available at: https://www.oxfordshire.gov.uk/sites/default/files/file/roads-and-transport-major-projects/science_vale_cycle_network_0.pdf. Accessed May 2022.

Table 6.3: Representative viewpoints.

Viewpoint Number	Representative Viewpoint Title	Relevant Visual Receptor Groups		
		Users of PRoWs	Users of Open Access Land	Communities
Views from the North Wessex Downs AONB and its northern fringe, to the south of the indicative location for SESRO				
1	Representative view from Devils Punchbowl Open Access Land.		✓	
2	Representative view from the Ridgeway National Trail West of Gramps Hill.	✓		
3	Representative view from PRoW 275/11/10 at Segsbury Camp.	✓		
4	Representative view from the Ridgeway National Trail at Lord Wantage Monument.	✓		
5	Representative view from the Ridgeway National Trail at East Ginge Down.	✓		
6	Representative view from PRoW 285/8/10 South of Ardington.	✓		
7	Representative view from Vale Way Long Distance Path at West Hendred.	✓		✓
Views looking towards the North Wessex Downs AONB				
8	Representative view from South Oxfordshire Crematorium and Memorial Park.			✓
9	Representative view from PROW 222/6/10 southeast of Garford.	✓		
10	Representative view from PRoW 192/3/10 near Marcham Mill.	✓		
View from the North Wessex Downs AONB, to the east of the indicative location for SESRO				
11	Representative view from PRoW at Wittenham Clumps.	✓		

6.112 Photography of the illustrative viewpoints is presented in Appendix A6.4 Illustrative viewpoints in Technical Supporting Document B2.1, Environmental Appraisal Report (terrestrial) Appendices, to illustrate the following particular effects and specific issues:

- Illustrative Viewpoint A: Photography from NCN Route 544 to the east of Wantage which illustrates those views from the NCN 544 within the AONB generally are restricted by landform, intervening vegetation or buildings since the route is located in the foot-slopes of the AONB. While there is a limited gap in the screening features at this viewpoint which allows a restricted view towards the indicative location for SESRO, the 'Yellow Fields' phase of the Kingsgrove Residential Development is currently under construction and this would screen views in the future. This view is therefore included to demonstrate that there would not be likely to be a significant effect on views from NCN 544 within the AONB.
- Illustrative Viewpoints B and C: Photography from two PRoWs on the Midvale Ridge, one to the south of Fyfield and one at Gozzards Ford as suggested by the Landscape Specialist at Oxfordshire County Council. These viewpoints illustrate that the indicative location of SESRO is generally screened by intervening vegetation or buildings in views from the Midvale Ridge looking across the Vale towards the scarp of the AONB. This view is therefore included to demonstrate that there would not be likely to be a significant effect on views from the Midvale Ridge towards the AONB.
- Illustrative Viewpoint D: Photography from a PRoW within the indicative location for SESRO, looking towards the AONB. This view is included to illustrate an example of the views towards the AONB that would potentially be lost due to SESRO. As there would not be a future view for comparison since PRoWs within the reservoir footprint would be diverted, such views are not included in the representative viewpoint assessment in this LVA. However, this has been used to inform the considerations of effects on the AONB and its setting.

6.113 The nature of existing views that are experienced by visual receptors at the representative viewpoints are summarised below.

6.114 From high ground within the North Wessex AONB at Viewpoints 1 to 5, including the Ridgeway National Trail and nearby PRoWs (such as at Segsbury Camp) and open access land at Devils Punch Bowl near Letcombe Bassett, wide-reaching, open and distant views are available looking across the rolling chalk downland of the scarp and towards the Vale to the north. The visibility of the indicative location for SESRO varies depending on the presence of intervening vegetation and settlements, as well as distance. The most open view is available from Viewpoint 5 at East Ginge Down, where the three solar farms, silos at Robertson Envirosystems and pylons on the northern edge of Steventon are visible beyond the GWR Main Line, within the indicative location for SESRO. A further elevated view from the AONB is available from Wittenham Clumps, looking towards the indicative location for SESRO in the distance beyond Sutton Courtney and Drayton. In all of these available views from the AONB, the visible parts of the indicative location for SESRO forms a limited part

of the wider views available from the scarp.

6.115 From lower ground within the AONB, the views are generally contained more locally due to landform and vegetation which limit the distance of the views that are available. Viewpoint 6 provides an example of a view from a PRoW south of Ardington, where there are restricted views towards the indicative location for SESRO, with the silos at Robertson Envirosystems visible between gaps in intervening vegetation, seen against the backdrop of the Midvale Ridge. Viewpoint 7 is located on the Vale Way Long Distance Path near a public house and residential properties on the northern edge of West Hendred and the northern fringe of the AONB. This viewpoint provides an example of the slightly more open views available from the AONB boundary directly north of the indicative location for SESRO. While such views are relatively open, intervening vegetation partially filters or screens views of site features such as the solar farms, pylons and the GWR Main Line. Views from the adjacent public house and residential properties are similar to those from the PRoW, although slightly more restricted due to intervening boundary vegetation and fencing.

6.116 When looking towards the indicative location for SESRO from the low-lying landscape of the Vale, views of the scarp of the AONB in the distance is generally filtered to some degree by intervening vegetation within the valley floor. Viewpoints 8 and 9 provide examples of such views from the South Oxfordshire Crematorium and Memorial Park and a PRoW south of Garford, both of which are located to the north-west of the indicative location for SESRO and where some site features are visible although intervening vegetation partially filters and screens views to varying degrees. It is also noted that there would be similar views to those from Viewpoint 8 from the nearby A338. In addition, Viewpoint 10 provides an example of an open view from a PRoW on the northern fringe of the indicative location for SESRO, where the scarp of the AONB is visible as a backdrop in the distance.

6.4.9 Sensitivity of visual receptors

6.117 In line with the criteria set out in Table 1.2 of Appendix A6.1 Landscape and Visual Appraisal Criteria in Technical Supporting Document B2.1, Environmental Appraisal Report (terrestrial) Appendices, the value of the views from the North Wessex Downs AONB have been assessed as high. The value of views looking towards the AONB are also considered to be high, where the scarp of the AONB forms a noticeable feature in the view. However, in views looking towards the AONB, where the scarp of the AONB is only perceptible in the background, the value of the views is considered to be medium.

6.118 For users of PRoWs, including the Vale Way Long Distance Path, and open access land, the nature of views is considered to form an important part of their experience of using these routes and their susceptibility is therefore assessed as high. However, users of the Ridgeway National Trail are considered to have very high susceptibility, as their attention is likely to be very focussed on the views from this route as an essential part of the experience of the route. When considered alongside the value of views, all users of PRoWs and open access land are considered to have overall high

sensitivity, while users of the Ridgeway National Trail have very high sensitivity.

6.119 People at community facilities, such as the Oxfordshire Crematorium and Memorial Park, are considered to have medium susceptibility, as views are likely to be appreciated even if they are not the focus of their attention. When combined with the medium value of their views, the overall susceptibility is considered to be medium.

6.120 A summary of the overall sensitivity of the visual receptors at each of the representative viewpoints is set out in Table 6.4. Where there is more than one receptor group associated with a viewpoint, the sensitivity of the most sensitive visual receptor group is stated.

Table 6.4: Sensitivity of visual receptors.

Sensitivity of Visual Receptor at Viewpoint	Viewpoint Number	Representative Viewpoint Title
Views from the North Wessex Downs AONB and its northern fringe, to the south of the indicative location for SESRO		
	1	Representative view from Devils Punchbowl Open Access Land, within the North Wessex Downs AONB.
Very high	2	Representative view from the Ridgeway National Trail West of Gramps Hill, within the North Wessex Downs AONB.
	3	Representative view from PRoW 275/11/10 at Segsbury Camp, within the North Wessex Downs AONB.
Very high	4	Representative view from the Ridgeway National Trail at Lord Wantage Monument, within the North Wessex Downs AONB.
Very high	5	Representative view from the Ridgeway National Trail at East Ginge Down, within the North Wessex Downs AONB.
High	6	Representative view from PRoW 285/8/10 South of Ardington within the North Wessex Downs AONB.
High	7	Representative view from Vale Way Long Distance Path at West Hendred, on the North Wessex Downs AONB Boundary.
Views looking towards the North Wessex Downs AONB		
Medium	8	Representative view from South Oxfordshire Crematorium and Memorial Park, looking towards the North Wessex Downs AONB.
High	9	Representative view from PRoW 222/6/10 southeast of Garford, looking towards the North Wessex Downs AONB.

Sensitivity of Visual Receptor at Viewpoint	Viewpoint Number	Representative Viewpoint Title
High	10	Representative view from PRoW 192/3/10 near Marcham Mill, looking towards the North Wessex Downs AONB.
View from the North Wessex Downs AONB, to the east of the indicative location for SESRO		
High	11	Representative view from PRoW at Wittenham Clumps, within the North Wessex Downs AONB.

6.5 Assessment outcomes

6.121 This section is focused upon identifying the potential magnitude of effect upon the part of the North Wessex Downs AONB and its setting, that lies within the study area for this LVA. The appraisal does not set out to provide a full LVIA of all landscape and visual effects that may arise from implementation of SESRO.

6.122 Table 6.5 and Table 6.6 provide a summary of the potential landscape and visual effects of the largest SESRO option, upon the landscape and visual receptors identified within this study. For the full high-level appraisal refer to Appendix A6.6 Landscape and Visual Appraisal Tables in Technical Supporting Document B2.1, Environmental Appraisal Report (terrestrial) Appendices.

6.5.2 Summary of potential landscape effects

Table 6.5: Summary of potential landscape effects associated with the largest SESRO option.

Landscape Receptor	Sensitivity	Magnitude of Effect during Construction	Magnitude of Effect, Year 1 of Operation	Magnitude of Effect, Year 15 of Operation
North Wessex Downs AONB (including its component LCAs) and its setting (within the study area only)	High	Small adverse	Small adverse	Negligible adverse
Potentially indirectly affected LCAs – North Wessex Downs AONB Landscape Character Assessment				
LCA 5F Liddington – Letcombe Open Scarp	High	Medium adverse	Small adverse	Small adverse
LCA 5C Hendred Plain	High	Small adverse	Negligible adverse	Negligible adverse

Landscape Receptor	Sensitivity	Magnitude of Effect during Construction	Magnitude of Effect, Year 1 of Operation	Magnitude of Effect, Year 15 of Operation
LCA 5D Moreton Plain	High	Negligible adverse	No change	No change
Potentially directly affected LCAs - Vale of White Horse District Landscape Character Assessment				
LCA LM15 Marcham Corallian Limestone Ridge with Woodland	Medium	Small adverse	Small adverse	Small adverse
LCA RF 8 Abingdon to Sutton Courtenay Thames River Floodplain	Medium	Medium adverse	Small adverse	Small beneficial
LCA RF11 Garford to Abingdon Ock River Floodplain	Medium	Medium adverse	Small adverse	Negligible adverse
LCA RF15 Childrey Brook and Letcombe Brook River Floodplain	Medium	Medium adverse	Medium adverse	Negligible beneficial
LCA VL2 Grove to Steventon Lower Vale Farmland	Medium	Large adverse	Large adverse	Large adverse
LCA VL3 East Hanney to Abingdon Lower Vale Farmland	Medium	Large adverse	Large adverse	Large adverse

6.5.3 Summary of potential visual effects

Table 6.6: Summary of potential visual effects associated with the largest SESRO option.

Viewpoint Number	Representative Viewpoint Title	Sensitivity of Receptor Group	Magnitude of Effect during Construction	Magnitude of Effect, Year 1 of Operation	Magnitude of Effect, Year 15 of Operation
Views from the North Wessex Downs AONB and its northern fringe, to the south of the indicative location for SESRO					
1	Representative view from Devils Punchbowl Open Access Land.	Very high	Small adverse	Negligible adverse	Negligible adverse

Viewpoint Number	Representative Viewpoint Title	Sensitivity of Receptor Group	Magnitude of Effect during Construction	Magnitude of Effect, Year 1 of Operation	Magnitude of Effect, Year 15 of Operation
2	Representative view from the Ridgeway National Trail West of Gramps Hill.	Very high	Small adverse	Negligible adverse	Negligible adverse
3	Representative view from PRoW 275/11/10 at Segsbury Camp.	High	Small adverse	Negligible adverse	Negligible adverse
4	Representative view from the Ridgeway National Trail at Lord Wantage Monument.	Very high	Medium adverse	Small adverse	Small adverse
5	Representative view from the Ridgeway National Trail at East Ginge Down.	Very high	Medium adverse	Medium adverse	Small adverse
6	Representative view from PRoW 285/8/10 South of Ardington.	High	Small adverse	Negligible adverse	Negligible adverse
7	Representative view from Vale Way Long Distance Path at West Hendred.	High	Medium adverse	Medium adverse	Small adverse
Views looking towards the North Wessex Downs AONB					
8	Representative view from South Oxfordshire Crematorium and Memorial Park.	Medium	Large adverse	Medium adverse	Small adverse
9	Representative view from PROW 222/6/10 southeast of Garford.	High	Small adverse	Small adverse	Negligible adverse

Viewpoint Number	Representative Viewpoint Title	Sensitivity of Receptor Group	Magnitude of Effect during Construction	Magnitude of Effect, Year 1 of Operation	Magnitude of Effect, Year 15 of Operation
10	Representative view from PRoW 192/3/10 near Marcham Mill.	High	Large adverse	Large adverse	Medium adverse
View from the North Wessex Downs AONB, to the east of the indicative location for SESRO					
11	Representative view from PRoW at Wittenham Clumps	High	Negligible adverse	No change	No change

6.5.4 Potential effect of the largest SESRO option on the North Wessex Downs AONB and its setting

6.123 The LVA has considered the potential indirect effect that the largest SESRO option could have on the part of the North Wessex Downs AONB that falls within the study area, as a result of the direct changes that would likely occur within its setting.

6.124 To inform this, the appraisal has considered direct effects on local LCAs within the setting of the AONB, as well as the indirect effects on the constituent LCAs of the AONB that are most likely to be affected by SESRO. Effects on representative views looking both from and towards the AONB have also been considered.

6.5.4.2 Construction

6.125 During construction, the main landscape and visual effects would be associated with the large-scale construction activities in the landscape, including widespread earthworks for the formation of the reservoir and replacement floodplain storage, as well as the auxiliary drawdown channel and temporary noise bunding. The diversion of the East Hanney to Steventon Road would shift traffic slightly further south, while the new main access road would introduce construction traffic within the rural landscape to the west of the A34. Construction compounds and haul routes between the material handling area at the rail sidings along the GWR Main Line and to the reservoir footprint would also be formed. Movements of plant and construction traffic would affect landscape character and views. There would also be vegetation removal, such as hedgerows and trees along field boundaries, as well as some woodland. One ancient tree would be removed, though its deadwood and cuttings would be incorporated as part of the landscape and environmental mitigation design.

Local landscape character

6.126 The landscape appraisal has concluded that during construction, the magnitude of effect on local LCAs within the setting of the AONB would likely range from small adverse up to large adverse. The construction activities would have the most notable effect on LCA VL3 East Hanney to Abingdon Lower Vale Farmland and LCA VL2 Grove to Steventon Lower Vale Farmland. There could also potentially be indirect effects on local LCAs within the AONB ranging from negligible adverse up to medium adverse magnitude of effect. The most noticeable effect on the landscape character of the AONB would likely be focussed on the elevated and open scarp of the AONB (LCA 5F Liddington – Letcombe Open Scarp).

Views

6.127 The visual appraisal has found that the magnitude of effect on the representative views from the North Wessex Downs AONB and its northern fringe would be likely to range from negligible adverse up to medium adverse during construction. The most notable visual effects would likely affect views directly south of the indicative location for SESRO, including elevated views along the Ridgeway National Trail (Representative Viewpoints 4 and 5), as well as views from the Vale Way Long Distance Path on the northern fringe of the AONB (Representative Viewpoint 7). In representative views from the Vale looking towards the North Wessex Downs AONB, the magnitude of effect is likely to range from small adverse up to large adverse. The most affected views are located along the northern fringe of the indicative location for SESRO and its immediate vicinity, looking towards the scarp of the AONB (Representative Viewpoints 8 and 10).

North Wessex Downs AONB

6.128 The appraisal of effects on landscape character and views has been used to draw conclusions about the potential overall effects on the AONB and its setting during the construction of SESRO. The key findings of this are presented below.

6.129 Indirect effects on the AONB would potentially result from intervisibility with the largescale construction activities for the reservoir in the landscape of its setting to the north. Activity which would include widespread earthworks, which would lead to an abrupt change in character within a localised part of the AONB's setting. Amongst others, this would affect elevated views from the Ridgeway National Trail (refer to Representative Viewpoints 2, 4 and 5) which is one of the key landscape characteristics of the distinctive north-facing scarp (a special quality) of this part of the AONB. Characteristic views towards the scarp of the AONB from its setting would also be affected, such as views from Representative Viewpoint 10 on a PRoW on the northern edge of the indicative location for SESRO. As such, the landscape character of the AONB would be eroded as the views from and towards the AONB form an important, valued aesthetic component of the AONB.

6.130 At night, localised construction lighting could affect the northern extent of the AONB's dark skies, which is one of the AONB's special qualities. However, the night

skies in this northern part of the AONB are generally classed as environmental zone E1, reflecting that it is already affected to some extent by light pollution associated with urban areas. The effect on the night skies of localised construction lighting in the landscape further north would therefore likely be limited. The darkest skies of the AONB, classed as E0 – Dark Sky Zones, are generally found to the south of the scarp of the AONB or located to the south-west of the urban area of Wantage. As such, the construction lighting would not be likely to have a discernible effect on these areas.

6.131 Overall, the construction activities within the setting of the AONB would temporarily erode some of the key characteristics of the AONBs component LCAs, as well as the special qualities of the AONB, including its sense of remoteness and tranquillity (also affected by construction noise). However, this effect would be relativity localised (primarily affecting LCAs 5F and 5C indirectly, as set out below), limited to the north facing part of the escarpment that overlooks the indicative location for SESRO, which forms only a relatively small part of the extensive North Wessex Downs AONB. As such, during the construction, there would likely be a small adverse magnitude of effect on the AONB and its setting within the study area. When considering the high sensitivity of the AONB, the effect on the part of the AONB that falls within the study area could potentially be significant during construction. However, the effect on the AONB considered as a whole is unlikely to be significant.

6.5.4.3 Winter year 1 of operation

6.132 By winter year 1 of operation, the material handling areas and other temporary construction features, including compounds and temporary noise bunding would have been removed. While the landscape mitigation planting would generally not have established yet, grass seeding of the earthworks incrementally during construction, including the reservoir embankments, would have established and this would soften the landscape. The wetland habitat mosaic associated with watercourse diversions and realignments, would include reeds, species rich wet grassland and floodplain marsh, which would be establishing, along with habitat enhancements of the construction settlement ponds.

Local landscape character

6.133 The landscape appraisal has concluded that during winter year 1 of operation, the magnitude of effect on local LCAs within the setting of the AONB would likely continue to range from small adverse up to large adverse. The reservoir would have the most notable effect on LCA VL3 East Hanney to Abingdon Lower Vale Farmland and LCA VL2 Grove to Steventon Lower Vale Farmland. There could potentially also be indirect effects on local LCAs within the AONB ranging from no change up to a small adverse magnitude of effect. The most noticeable effect on the landscape character of the AONB would likely be focussed on the scarp of the AONB directly south of the indicative location for SESRO (within LCA 5F Liddington – Letcombe Open Scarp).

Views

6.134 The visual appraisal has found that the magnitude of effect on the representative views from the North Wessex Downs AONB and its northern fringe would be likely to continue to range from negligible adverse up to medium adverse during winter year 1 of operation. The most notable visual effects would likely affect views directly south of the indicative location for SESRO, including elevated views along the Ridgeway National Trail (Representative Viewpoint 5), as well as views from the Vale Way Long Distance Path on the northern fringe of the AONB (Representative Viewpoint 7). In representative views from the Vale looking towards the North Wessex Downs AONB, the magnitude of effect is likely to remain within a range from small adverse up to large adverse. The most affected view is located along the northern fringe of the indicative location for SESRO, looking towards the scarp of the AONB (Representative Viewpoint 10).

North Wessex Downs AONB

6.135 The appraisal of effects on landscape character and views during winter year 1 of operation has been used to draw conclusions about the potential overall effect on the AONB and its setting. The key findings of this are presented below.

6.136 Indirect effects on the AONB would potentially result from intervisibility with an uncharacteristic and large-scale bunded reservoir and associated traffic and infrastructure, as well as absence of vegetation, within the generally farmed open Vale landscape to the north of the AONB. This would notably alter the character of a localised part of the AONB setting, since landscape mitigation planting would not yet have established. It would also affect elevated views from the Ridgeway National Trail (refer to Representative Viewpoints 2, 4 and 5) which is one of the key landscape characteristics of the distinctive north-facing scarp (a special quality) of this part of the AONB.

6.137 The visibility of the reservoir is likely to vary within the AONB depending on precise location and the extent of reflections from the water's surface which is likely to vary depending on weather and light conditions. In some areas within the AONB setting to the north, the characteristic views towards the scarp of the AONB would be lost, such as views from Representative Viewpoint 10 on a PRoW on the northern edge of the indicative location for SESRO, or interrupted, such as from Representative Viewpoints 8 and 9 to the north-west of the indicative location for SESRO. As such, the landscape character of the AONB would be eroded as the views from and towards the AONB form an important, valued aesthetical component of the AONB.

6.138 However, while the PRoW network within the reservoir footprint would be lost, a new PRoW network would be created, providing new links into the wider landscape in keeping with the aims of the landscape guidelines for the local LCTs within the setting of the AONB. Similarly, while characteristic views towards the AONB and the Corallian Limestone Ridge would be lost, new opportunities for views towards these areas would be created, mainly from the reservoir crest. This would help to restore the sense of place within the broad Vale landscape.

6.139 At night, localised lighting associated with infrastructure for SESRO could affect the northern extent of the AONB's dark skies, which is one of the AONB's special qualities. However, as the night skies in this northern part of the AONB are already affected to some extent by light pollution associated with urban areas, the effect on the night skies is likely to be very limited. The darkest skies of the AONB, which are not found directly south of the indicative location for SESRO, would be unaffected.

6.140 Overall, the presence of the reservoir and associated traffic and infrastructure within the setting of the AONB would erode some of the key characteristics and special qualities of the AONB, including its sense of remoteness and tranquillity (also affected by construction noise). However, this effect would be localised (primarily affecting LCA 5F indirectly, as set out below), limited to the north-facing part of the escarpment that overlooks the indicative location for SESRO, which forms only a relatively small part of the extensive North Wessex Downs AONB. As such, during winter year 1 of operation, there would only be a small adverse magnitude of effect on the AONB and its setting within the study area. When considering the high sensitivity of the AONB, the effect on the part of the AONB that falls within the study area could potentially be significant during winter year 1 of operation. However, the effect on the AONB as a whole is unlikely to be significant.

6.5.4.4 Summer year 15 of operation

6.141 By summer year 15 of operation, the landscape mitigation planting would have established. The hedgerows, shrubs, scrub, trees, small woodland blocks and copses would help to integrate the reservoir and associated infrastructure into the landscape. However, the loss of one ancient tree could not be mitigated.

Local landscape character

6.142 The landscape appraisal has concluded that the effect on local LCAs within the setting of the AONB would have reduced by summer year 15 of operation, when considering the established planting. There would be negligible and small beneficial magnitudes of effect within some LCAs where there would be positive contributions to the landscape character within the floodplain. However, there would still be some residual adverse effects upon other LCAs, ranging from negligible adverse up to large adverse. This would be due to the permanent effect of the reservoir, particularly on LCA VL3 East Hanney to Abingdon Lower Vale Farmland and LCA VL2 Grove to Steventon Lower Vale Farmland. Indirect effects on local LCAs within the AONB could potentially continue to range from no change up to small adverse magnitude of effect, with the most noticeable effect on the landscape character of the AONB along the scarp directly south of the indicative location for SESRO (within LCA 5F Liddington – Letcombe Open Scarp).

Views

6.143 The effect on the representative views from the North Wessex Downs AONB and its northern fringe would reduce by summer year 15 of operation. While the magnitude of effect would be negligible adverse on most views, some small adverse effects

would remain. The most notable visual effects would likely continue to affect views directly south of the indicative location for SESRO, including elevated views along the Ridgeway National Trail (Representative Viewpoints 4 and 5), as well as views from the Vale Way Long Distance Path on the northern fringe of the AONB (Representative Viewpoint 7). In representative views from the Vale looking towards the North Wessex Downs AONB, the magnitude of effect is likely to reduce to range from negligible adverse up to medium adverse at the most affected view along the northern fringe of the indicative location for SESRO, looking towards the scarp of the AONB (Representative Viewpoint 10).

North Wessex Downs AONB

6.144 The appraisal of effects on landscape character and views during summer year 15 of operation has been used to draw conclusions about the potential overall effects on the AONB and its setting. The key findings of this are presented below.

6.145 The established landscape mitigation would help to integrate and soften the reservoir and associated traffic and infrastructure into the Vale landscape within the setting of the AONB to the north. The effect on elevated valued views from the AONB would therefore have reduced, mainly affecting views from a limited section of the Ridgeway National Trail, directly south of the indicative location for SESRO (refer to Representative Viewpoints 4 and 5). It is also possible that the reservoir could become an accepted feature of the AONB setting in such views due to the passage of time.

6.146 Overall, the indirect effect on the key characteristics and special qualities of the AONB would have reduced compared with the effect at winter year 1 of operation, due to the establishment of the landscape mitigation. This would include a reduction in the indirect effect on the AONBs sense of remoteness and tranquillity. SESRO would therefore only affect a very limited part of the AONB within the study area. As such, during summer year 15 of operation there would likely be a negligible adverse magnitude of effect on the AONB and its setting within the study area. Therefore, despite the high sensitivity of the AONB, it is unlikely that the effect on the part of the AONB that falls within the study area, as well as the AONB as a whole, would be significant.

6.5.5 Alternative SESRO options

6.147 The relative performance of the SESRO options are considered below, compared with the largest SESRO option which has been appraised within this LVA.

6.148 The 125Mm^3, 100Mm^3 and 75Mm^3 capacity reservoirs are all single-phase reservoirs with respectively reducing reservoir surface areas. All of these variants would include a large-scale body of water and embankments and a comparatively long construction period similar to the largest SESRO option. It is therefore likely that the effect upon the AONB and its setting would be similar during construction and operation, when compared to the largest SESRO option. The effect on the intervisibility between the Vale and the scarp of the AONB to the north of the reservoir may reduce slightly with

the smaller variants, as the smaller reservoir embankment footprints would potentially reduce the extent of screening of the scarp within views when compared to the largest SESRO option.

6.149 The 30+100Mm^3 and 80+42Mm^3 capacity reservoirs are both dual-phase reservoirs with a dividing embankment, proposed to be built in progressive phases. This phasing could potentially slightly reduce the effect upon the AONB and its setting during construction due to the separate phases and smaller individual construction sites. However, the overall construction period of the two phases would likely be comparatively similar to the largest SESRO option. Once completed, there would be two adjacent but relatively large-scale bodies of water, of a similar scale to the largest SESRO option. However, the dividing embankment between the two waterbodies would visually reduce the scale of the waterbodies. As such the large scale of the water bodies may be marginally reduced, this could possibly help with visual integration into the landscape within the setting of the AONB. Despite this, it is likely that the overall level of effect upon the AONB and its setting would be similar during operation, when compared to the largest SESRO option.

6.6 Mitigation

6.150 In addition to the mitigation illustrated on the Figure 2.1 Landscape and environmental design strategy plan in Technical Supporting Document B2.2, Environmental Appraisal Report (terrestrial) Figures, further measures that could mitigate potential landscape and visual effects during construction and operation are set out below.

6.6.2 Construction phase mitigation

6.151 It is assumed that good practice mitigation during construction would include the following measures listed below.

- The implementation of a Construction Environment Management Plan (CEMP). The CEMP would be implemented in advance of construction commencing and enforced and monitored throughout the construction period by a qualified a suitably qualified environmental clerk of works, supported by an arboricultural clerk of works and Chartered Landscape Architect as required.
- Topsoil to be stripped from temporary works areas such as sites proposed for construction compounds and material storage areas. Topsoil would be stored in stockpiles up to 2m high. Where topsoil is to be stored for more than 60 days, it would be seeded with an appropriate low-maintenance seed mix to protect soil quality.
- Disturbance to, or removal of, key landscape features or amenity features that are distinctive, rare and/or are characteristic of the area, would be avoided by appropriate siting and routing of temporary and permanent works.

- Stockpiling of materials or delivery of materials to be used in construction would be avoided in areas with key landscape features or where visual amenity may be affected.
- As much of the existing vegetation as is practicable would be retained within the indicative location for SESRO, including within temporary works areas. Particular attention would be given to the retention of mature vegetation including specimen trees, woodlands and, important or dense hedgerows.
- All existing trees, shrubs, hedges and other landscape elements to be retained would be protected in accordance with the CEMP. This would include the preparation of a tree protection plan showing the root protection areas of trees that are close to construction activities.
- Prior to construction, a suitably qualified environmental clerk of works would confirm vegetation to be protected during the construction works based on the approved tree protection plans.
- All trees, shrubs and hedges to be retained would be protected throughout the construction period in accordance with BS 5837:2012 Trees in relation to design, demolition and construction – Recommendations[75] and in line with the arboricultural method statement and tree protection plans.
- In accordance with standing advice prepared by Natural England and the Forestry Commission[76], the following measures would be developed to protect veteran trees and ancient trees to be retained:
  - Screening barriers would be provided to protect retained ancient trees, ancient woodland and veteran trees from dust and pollution from nearby works.
  - A buffer zone would be defined to avoid impact on root zones. This buffer would be a minimum of 15 times the diameter of the tree trunk or five metres beyond the canopy, whichever is the greater up to a maximum of 15m.
- The supply, storage, handling, planting and maintenance of proposed planting would be undertaken in accordance with relevant British Standards, including BS 4428:1989 Code of practice for general landscape operations (excluding hard surfaces)[77].
- Land take for construction would be kept to the minimum necessary, to limit landscape and visual impact and subsequent extent of areas to be reinstated.

[75] British Standards Institution (2012) BS 5837: 2012 Trees in Relation to Design, Demolition and Construction – Recommendations.

[76] Natural England and Forestry Commission (2022). Ancient woodland, ancient trees and veteran trees: advice for making planning decisions. Online. Available at: https://www.gov.uk/guidance/ancient-woodland-ancient-trees-and-veteran-trees-advice-for-making-planning-decisions#:~:text=Buffer%20zone%20recommendations&text=For%20ancient%20or%20veteran%20trees,15%20times%20the%20tree's%20diameter. Accessed May 2022.

[77] British Standards Institution (1989) BS 4428:1989 Code of practice for general landscape operations (excluding hard surfaces).

- Construction compounds and material storage areas would be reinstated and returned to agricultural use where there is not a requirement for planting mitigation for landscape integration, enhancement or visual screening.
- Construction traffic, deliveries and construction operations would be controlled and organised to reduce visual effects and disturbance to visual amenity; for example, by avoiding weekend working.
- Temporary lighting required for safety and security during construction would be strategically located and selected to provide the optimum light distribution for each location while reducing light spill as far as practicable.
- During construction, hoarding and fencing around the working area would be kept well maintained throughout, in order to ensure hoarding provides temporary screening and that a continuous boundary is retained.

6.152 The following additional mitigation listed below is also recommended to be implemented during construction.

- Siting temporary and permanent compounds, cabins, and car parks away from sensitive receptors such as residential areas and PRoWs.
- Where practicable, maintaining existing views to minimise disturbance to visual amenity through appropriate siting of compounds and haul routes.
- Exploring opportunities for advance planting and phased planting prior to and during construction, including on permanent bunding, to establish mitigation planting as early as practicable.
- Softening temporary noise bunding with advance planting located between sensitive visual receptors and the bunding.
- Where practicable, storing stripped soil in bunds around the perimeter of the construction areas to provide temporary screening.
- Selecting hoarding for site security fencing capable of providing an additional temporary screening function at key locations near sensitive visual receptors in close proximity to the indicative location for SESRO, such as near Representative Viewpoint 8 which is located at the South Oxfordshire Crematorium and Memorial Park.
- Scheduling the reservoir embankment construction so that the outer parts are constructed first, thereby screening inner parts of the site during subsequent construction operations.
- Specifying back light shields and cowls at detailed design such that the potential adverse effects of lighting are reduced.

6.6.3 Operational phase mitigation

6.153 It is assumed that good practice mitigation during operation would include the following measures listed below.

- A five-year landscape establishment period for all planting and seeding mitigation, would be included as part of the construction contract requirements. The appointed contractor would be required submit a programme for undertaking all forms of landscape works, including regular inspections of the soft estate.
- Following the five-year landscape establishment period, the soft estate would be maintained and managed in the long term by way of development and implementation of a long-term Landscape and Ecological Management Plan (LEMP). This would be a flexible document that can be updated if conditions or proposals for the site change.
- All light sources would be light-emitting diodes (LEDs) selected to provide the optimum light distribution for each location and reduce light spill. The number of columns and lanterns, and the height of columns would be kept to a minimum, with column spacings set as far apart as practicable. Any proposed lighting should also be controlled by a central management system that would allow dimming of individual lanterns to respond to different safety factors.

6.7 Next steps

6.154 If SESRO is taken forward, further assessment, surveys and design development would be undertaken during subsequent project stages. These next steps are set out below.

6.7.2 Further assessment

6.155 A comprehensive LVIA should be undertaken in conjunction with design development to enable the iterative process of design and assessment to continue, as it is considered that there could be potentially significant effects on landscape and visual receptors as a result of SESRO. The scope of the LVIA should be agreed with the key stakeholders listed in Section 6.3.3. This should:

- be prepared in accordance with:
  - GLVIA3[45];
  - Technical Guidance Note TGN 02/21 Assessing landscape value outside national designations[70]; and
  - Visual Representation of Development Proposals Technical Guidance Note 06/19[69];
- set out a detailed policy review and the complete landscape and visual baseline for a proportionate study area to be identified, as opposed to the baseline in this LVA which is focussed on informing assessment of effects on the AONB and its setting;

- be focussed on identifying the significance of effect on landscape and visual receptors that are likely to experience significant effects;
- include a detailed assessment of effects on landscape character;
- include a detailed assessment of visual effects at representative viewpoint locations to be agreed with the key stakeholders listed in Section 6.3.3. This should be focussed on the most sensitive visual receptors that are likely to experience significant visual effects locally and at key locations within the AONB;
- include type 1 visualisations (annotated baseline photography) for the agreed representative viewpoints;
- include night-time type 1 visualisations (annotated baseline photography) for a small number of agreed representative viewpoints, to inform assessment of effects on the night skies of the AONB and inform design decision on lighting going forward;
- include type 1 visualisations (annotated baseline photography) at illustrative viewpoint locations, to provide supplementary information, to illustrate particular effects and specific issues;
- include type 3 visualisations (photomontages) at a smaller number of representative viewpoint locations to be agreed with the key stakeholders listed in Section 6.3.3, in order to inform the assessment of visual effects; and
- include the development of further mitigation to be incorporated into the design proposals (refer below), as well as refining proposals for good practice and additional mitigation in relation to specific sensitive landscape and visual receptors.

6.7.3 Further surveys

6.156 In addition to undertaking further landscape and visual fieldwork for the LVIA, it is recommended that more detailed surveys are undertaken to inform the LVIA and design development. These should include:

- topographical survey;
- arboricultural survey in accordance with BS 5837:2012 Trees in relation to design, demolition and construction – Recommendations, to include identification of ancient trees, veteran trees and notable trees as a minimum; and
- Phase 1 habitat survey to add to the baseline understanding and identify if there are any further ancient trees, veteran trees or ancient woodlands (in conjunction with further cultural heritage studies), ecologically important hedgerows or other habitats of high value within the indicative location for SESRO.

6.7.4 Further design development

6.157 The Figure 2.1 Landscape and environmental design strategy plan in Technical Supporting Document B2.2, Environmental Appraisal Report (terrestrial) Figures, has been developed in line with the following high-level landscape mitigation principles.

These should be used to guide any future development of the operational design at subsequent project stages:

- Avoid features that break the skyline and other visually dominant elements within the open landscape, and, where it is not possible, establish strategically placed screen planting.
- Avoid features that introduce lighting (including floodlighting), noise and traffic movement, which would affect Dark Skies and tranquillity of AONB.
- Use 'soft' engineering solutions in preference to 'hard', including the shaping and re-grading of embankment slopes and river channels to blend into the existing contours and provide slopes with a natural appearance by using surplus spoil to create more relaxed gradients and natural contouring to blend into the existing topography.
- Use surplus spoil to vary the height of the reservoir embankment crest, in order to soften its contours.
- Explore opportunities for planting on areas of deeper landscape fill above the engineering earthworks for the reservoir embankment, where this would comply with safety and security requirements for the reservoir.
- Sensitive design of buildings and structures, including through careful use of colours, materials and non-reflective surfaces.
- Allow views out over open water and countryside from the existing and proposed PRoW and cycle path network, including views and new vantage points towards the scarp of the North Wessex Downs AONB to the south, as well as the Midvale Ridge to the north.
- Consider advanced planting to intercept views from sensitive visual receptors, including from the AONB and to promote early habitat restoration.
- Consider use of natural regeneration with strategic planting, including as a strategy for 'advance planting' to establish new woodland.
- Retain Ancient and Veteran trees. Where there is the unavoidable removal of one ancient tree (crack willow), the intact dead wood hulks of the tree would be relocated in close proximity to a nearby woodland area in accordance with standing advice prepared by Natural England and the Forestry Commission[76]. Dead wood would be placed in log piles and left to decompose naturally. The exact location for the placement of the hulks would be identified following liaison with the relevant local planning authorities and be supervised by a qualified arboriculturist. Cuttings would also be taken from the ancient tree and planted within the mitigating design. In addition, a number of individual specimen trees would be planted as compensation for the lost tree. The location, stock size and species selection would be determined following consultation with the relevant local planning authority. The location should allow sufficient open space for establishment of an open crown, whilst being close to other existing retained veteran trees.

- Retain and restore field patterns with hedges and trees along filed boundaries, making reference to the Oxfordshire Historic Landscape Characterisation[78].
- Enhance existing hedgerows to be retained that are in poor condition, by gapping up.
- Planting of new hedgerows, hedgerow trees and trees in fields and small blocks of wet woodland along watercourses, including native willows and black poplar, to reflect the landscape character of NCA 108: Upper Thames Clay Vales, drawing on best practice developed in Aylesbury Vale and Cotswold Water Park.
- Development of new wetland habitats surrounding reservoir and along watercourses, along with waterside access and waterborne recreation, which are characteristic of the River Floodplain LCT which is found within the northern and eastern extent of the indicative location for SESRO.
- Incorporate opportunities for informal natural play spaces alongside new PRoW.

[78] Oxfordshire County Council. Oxfordshire Historic Landscape Characterisation project. Online. Available at: https://www.oxfordshire.gov.uk/residents/environment-and-planning/archaeology/landscape-characterisation. Accessed May 2022.

7. Noise

7.1 Introduction

7.1 Building on the work undertaken to support the Gate 1 process, this chapter presents an environmental appraisal of the potential noise impacts associated with the South East Strategic Reservoir Option (SESRO).

7.2 This chapter sets out the key legislation and policy relevant to noise followed by the methodology and study area used for the environmental appraisal. An analysis of the baseline is presented, followed by an appraisal of the effects of SESRO and an evaluation of their significance. An overview of likely mitigation measures that may be adopted to avoid, reduce or offset any potential effects is provided followed by recommendations for further work.

7.3 This chapter focusses on the largest SESRO option (i.e. 150Mm^3) with narrative provided on the relative performance of the alternative reservoir options (i.e. 125Mm^3, 100Mm^3, 75Mm^3, 30+100Mm^3 and 80+42Mm^3).

7.4 This chapter is supported by the following appendices which can be found in Supporting Document B2.1, Environmental Appraisal Report (terrestrial) Appendices:

- Appendix A7.1 Noise Assessment Criteria;
- Appendix A7.2 Noise Construction Assessment Approach;
- Appendix A7.3 Strategic Noise Mapping; and
- Appendix A7.4 Construction Vibration.

7.5 This chapter is supported by Figure 7.1 Noise and Vibration Assessment - Sample Receptor Location Plan which can be found in Supporting Document B2.2, Environmental Appraisal Report (terrestrial) Figures.

7.2 Legislation and policy

7.6 Table 7.1 presents the legislation and policy relevant to the assessment of noise and vibration.

Table 7.1: Noise and Vibration - Key Legislation and Policy

Applicable Legislation/Policy	Description
The National Planning Policy Framework (NPPF) 2021[79]	This sets out the Government's planning policies for England and how these are expected to be applied. For what constitutes a significant adverse impact, the NPPF refers to the Noise Policy Statement for England.
Environmental Protection Act 1990 Part III[80]	Part III defines statutory nuisance and provides the principal controls over it for local authorities. Under the Act, local authorities have a duty to inspect their areas to detect nuisances, and when satisfied that a statutory nuisance exists or is likely to occur or recur, to serve an abatement notice on the responsible party. They also have a duty to investigate any complaint made by a person living within their area. Though businesses have a defence of best practicable means, failure to comply with a valid notice is a criminal offence.
Control of Pollution Act 1974[81]	This Act contains powers for local authorities to deal with noise and vibration from construction and demolition sites.
The Noise Policy Statement for England (NPSE) 2010[82]	This provides explanation of the term 'significant adverse impact' from the NPPF. The document also defines the meanings of the terms No Observed Effect Level (NOEL), Lowest Observed Adverse Effect Level (LOAEL) and Significant Observed Adverse Effect Level (SOAEL).
Planning Practice Guidance – Noise[83]	Provides additional guidance to the NPPF and sets out how planning can manage potential noise impacts in new development. It advises that planning authorities should take account of the acoustic environment and in doing so consider: • whether or not a significant adverse effect is occurring or likely to occur • whether or not an adverse effect is occurring or likely to occur • whether or not a good standard of amenity can be achieved.

[79] MHCLG (2021). National Planning Policy Framework (NPPF). London, the Ministry of Housing, Communities and Local Government
[80] Environmental Protection Act 1990, Part III. London. The Stationery Office
[81] Control of Pollution Act 1974. London. The Stationery Office
[82] DEFRA (March 2010). The Noise Policy Statement for England (NPSE). London, the Department for Environment, Food and Rural Affairs
[83] MHCLG (22 July 2019). Planning Practice Guidance – Noise. The Ministry of Housing, Communities and Local Government

Applicable Legislation/Policy	Description
	Planning Practice Guidance - Noise states that these potential effects should be evaluated by comparison with the SOAEL and the LOAEL for the given situation.
Draft National Policy Statement for Water Resources Infrastructure November 2018[84]	The National Policy Statement for water resources infrastructure sets out the need and government's policies for, development of nationally significant infrastructure projects (NSIPs) for water resources in England. It provides planning guidance for applicants of NSIPs for water resources, as defined in the Planning Act 2008.
Vale of White Horse District Council Local Plan, Part 1 2016[85]	The Vale of White Horse District Council Local Plan, Part 1 adopted in 2016 includes Core Policy 44 that is designed to protect the landscape of the district with the requirement to respect, retain and enhance the local character and distinctiveness of the landscape of the Vale. Landscape policy CP44 states: '*The key features that contribute to the nature and quality of the Vale of White Horse District's landscape will be protected from harmful development and where possible enhanced, in particular:* *…* • *tranquillity and the need to protect against intrusion from light pollution, noise, and motion*'.
Vale of White Horse District Council Local Plan, Part 2 2016[86]	Part 2 of the Vale of White Horse District Council Local Plan was adopted in 2019 and includes Development Policy 25 that is designed to protect against noise pollution. Development Policy 25 states: '*Noise-generating development that would have an impact on environmental amenity or biodiversity will be expected to provide an appropriate scheme of mitigation that should take account of:* *i. the location, design and layout of the proposed development* *ii. existing levels of background noise* *iii. measures to reduce or contain generated noise, and* *iv. hours of operation and servicing.*

[84] Defra (November 2018). Draft National Policy Statement for Water Resources Infrastructure. London, the Department for Environment, Food and Rural Affairs

[85] Vale of White Horse District Council (December 2016). Local Plan 2031, Part 1, Strategic Sites and Policies. Vale of White Horse District Council

[86] Vale of White Horse District Council (October 2019). Local Plan 2031, Part 2, Detailed Policies and Additional Sites. Vale of White Horse District Council

Applicable Legislation/Policy	Description
	Development will not be permitted if mitigation cannot be provided within an appropriate design or standard'.
North Wessex Down AONB Management Plan 2019-2024[87]	The AONB Management Plant states the following: '*The North Wessex Downs AONB landscape faces a range of challenges which this Plan will address through the implementation of the key objectives and policies…j)… the dominance of roads, in particular the impact of traffic noise, external lighting, road signs, insensitive materials and clutter on landscape character and people's experience of the landscape as they travel through it.*' '*Remoteness and Tranquillity* *…7.15… In some parts of the area there is already an ambient level of noise associated with transport networks and machinery.* *…7.16 … Concerns raised by local residents and users of the landscape over loss of these special perceptual qualities will inform decisions on particular development proposals. New uses or new developments that individually or cumulatively result in a material increase in lighting, noise and or activity into the countryside is likely to be opposed.*'

7.7 Table 7.2 presents guidance relevant to the assessment of noise and vibration.

Table 7.2: Noise and Vibration - Key Guidance

Guidance	Description
British Standards	
BS 5228-1:2009+ A1:2014 Code of practice for noise and vibration control on construction and open sites. Noise[88]	This code of practice provides guidance on the assessment and control of noise on construction sites, along with guidance on acceptable noise levels.
BS 5228-2:2009+ A1:2014 Code of practice for noise and vibration control on	This code of practice provides guidance on the assessment and control of vibration on construction sites, along with guidance on acceptable vibration levels.

[87] Defra (2019). North Wessex Downs Area of Outstanding Natural Beauty, Management Plan 2019-2024. London, the Department for Environment, Food and Rural Affairs

[88] British Standards Institution (2014). BS5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites. Noise. London, BSI

Guidance	Description
construction and open sites. Vibration[89]	
BS 6472:2008 Guide to evaluation of human exposure to vibration in buildings[90]	Sets out guidelines for assessing blast-induced and non-blast-induced vibrations in two separate parts.
BS 7445:2003 Description and measurement of environmental noise[91]	Contains guidance of relevance to the description and measurement of environmental noise.
BS 8233:2014 Guidance on sound insulation and noise reduction for buildings[92]	Includes guideline values for noise levels within domestic homes and other building uses.
Other guidance documents	
Acoustic design of schools: performance standards. Building Bulletin 93[93]	These standards define suitable indoor ambient noise levels for a number of different educational activities and environments.
Acoustics of Schools: a design guide[94]	Accompanies Building Bulletin 93 and provides professional guidance and recommendations on achieving suitable indoor and external ambient noise levels.
Calculation of Road Traffic Noise[95]	The Calculation of Road Traffic Noise (CRTN) document presents a methodology for the prediction of road traffic noise from road traffic flow and other data.
Calculation of Railway Noise[96]	The Calculation of Railway Traffic Noise (CRN) document presents a methodology through which to determine the acoustic energy associated with each railway pass-by event

[89] British Standards Institution (2014). BS5228-2:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites. Vibration. London, BSI
[90] British Standards Institution (2008). BS6472:2008 Guide to evaluation of human exposure to vibration in buildings. London, BSI
[91] British Standards Institution (2003). BS7445:2003 Description and measurement of environmental noise. London, BSI
[92] British Standards Institution (2014). BS8233:2014 Guidance on sound insulation and noise reduction for buildings. London, BSI
[93] Department for Education and Education Funding Agency (2015). Acoustic design of schools: performance standards. Building bulletin 93. London: The Stationery Office
[94] Institute of Acoustics and the Association of Noise Consultants (2014). Acoustics of Schools: a design guide. St Albans
[95] Department for Transport and the Welsh Office (1988). Calculation of Road Traffic Noise. Cardiff: National Assembly for Wales
[96] Department of Transport (1995). Calculation of Railway Noise. London, Her Majesty's Stationery Office (HMSO)

Guidance	Description
	and the resultant continuous equivalent sound level over daytime and night-time periods.
Additional Railway Noise Source Terms for Calculation of Railway Noise 1995[97]	Defra published an addendum to CRN in 2007. The purpose of the addendum report was to provide additional source terms for CRN and includes additional information about more current freight vehicles.
Sustainability & Environment Appraisal DMRB LA 111 - Noise and Vibration[98]	Contains advice on the assessment of noise and vibration from road traffic, particularly that from new/altered roads, and guidance on the assessment of construction noise and vibration impacts.
Guidelines for Community Noise[99]	This guidance provides guideline noise levels for community noise in specific environments, e.g., outdoor living areas and outside bedrooms.
Night Noise Guidelines for Europe[100]	Review's health effects associated with exposure to night-time noise and recommends noise guideline values.
A Guide to Measurement and Prediction of the Equivalent Continuous Sound Level, Leq[101]	The Noise Advisory Council (NAC) set up a working group to prepare a report for practitioners with the appropriate technical background who need to measure or predict environmental noise. The report provides a method for calculating the Leq noise level from the combined effect of a number of events (e.g. vehicle pass-bys) with their own single event noise exposure level (LAX, commonly referred to as the SEL). In addition, the report presents a method for determining the LAX at a distance of 10m from the nearside edge, for heavy and light vehicles travelling at different speeds.
BS 4142:2014+A1:2019 Methods for rating and assessing industrial and commercial sound[102]	This British Standard is the primary guidance used in rating and assessing sound of an industrial nature. The Standard defines specific sound levels and rating levels for an industrial source, and ambient, background and residual sound levels in the vicinity of the source under investigation.

[97] Defra (2007), Additional Railway Noise Source Terms for 'Calculation of Railway Noise 1995'
[98] Highways England (2020). DMRB LA 111 Noise and vibration, Rev. 2
[99] Berglund, B., Lindvall, T. and Schwela, D.H. (on behalf World Health Organization) (1999). Guidelines for Community Noise. World Health Organization Regional Publications, European Series
[100] World Health Organization (2009). Night Noise Guidelines for Europe, WHO
[101] Noise Advisory Council (1978). A Guide to Measurement and Prediction of the Equivalent Continuous Sound Level, Leq. London, Her Majesty's Stationery Office
[102] British Standards Institute (2019). BS4142:2014+A1:2019 Methods for rating and assessing industrial and commercial sound. London, BSI

Guidance	Description
	A quantitative assessment of industrial noise source during operation of SESRO, as per the method detailed in this Standard, has not been possible at this time, but would be undertaken during/following detailed design when more details regarding the design and operation of the industrial noise sources are known.

7.3 Methodology

7.8 A desk-based study has been undertaken to assess potential noise and vibration impacts resulting from the construction and operation of SESRO.

7.3.2 Consultation

7.9 The approach to the assessment outlined below was presented to the Environmental Health Department of the Vale of White Horse District Council and the Transport Planning Department of Oxfordshire County Council. Consultation took place via email in February and March 2022, with a further call arranged with the Environmental Health Officer at Vale of White Horse District Council on 02 March 2022, where the approach was agreed and no changes to the assessment or baseline data gathering approaches were proposed.

7.10 The consultation document presented the proposed assessment approach and assessment criteria for the Gate 2 noise and vibration desk-based study, including the approach to collecting baseline data.

7.3.3 Baseline Sources

7.11 A baseline sound level monitoring survey has not been undertaken at this time. Instead, where available, online noise map data has been used to determine indicative existing baseline sound levels (arising from road and rail noise sources) at sensitive receptors in the vicinity of the indicative location for SESRO. As a precautionary approach to assessing potential noise impacts, where noise mapping is unavailable at nearby sensitive receptors, the lower thresholds for construction noise presented within BS 5228-1[88] have been adopted.

7.12 It is assumed that existing vibration levels are below the assessment threshold for the onset of a potential significant effect, as set out in Section 7.3.7.

7.13 The following baseline data sources have been used:

- England Noise Map Viewer[103], to identify indicative baseline sound levels in the vicinity of sensitive receptors; and

[103] Extrium Noise and Air Quality Viewer. *Extrium.co.uk/noiseviewer.html* [accessed 25 April 2022]

- Google Maps[104], Ordnance Survey mapping available through emapsite[105], and Ordnance Survey AddressBase Plus data to identify sensitive receptors.

7.3.4 Geographical scope

7.14 Separate study areas are defined below for each element of the noise and vibration assessment. The study areas have been kept under review during the assessment to ensure that all potentially significant effects have been identified.

7.3.4.2 Construction Noise and Vibration

7.15 The initial study area for the construction noise assessment was 300m, as recommended in DMRB LA 111[98], from the indicative location for SESRO. However, with the use of more stringent construction noise impact criteria for earthmoving operations (as described in Section 7.3.7), this was extended to 500m. The noise model extends beyond 500m from the scheme and was kept under review throughout the assessment and extended to include additional receptors where necessary.

7.16 The study area for the construction vibration assessment is 100m from the indicative location for SESRO as effects are commonly experienced over much shorter distances than noise effects.

7.3.4.3 Construction Traffic Noise

7.17 DMRB LA 111 recommends that the construction traffic noise study area is defined as 50m from the carriageway edge of public roads with the potential for an increase in Basic Noise Level (BNL) of 1dB(A) or more. The procedure for calculating a BNL is set out by the Calculation of Road Traffic Noise (CRTN)[95] and DMRB LA 111 and relates to a noise level at a reference location 10m from the carriageway edge.

7.3.4.4 Operational Noise

7.18 There is no current authoritative guidance on how far a noise study area should extend from the operational noise sources proposed as part of a project. It is anticipated that the most common receptor type with the potential to be affected by operational noise from the indicative location of SESRO is residential. The study area is therefore defined to extend to the nearest residential receptors.

7.3.5 General Approach

7.19 The assessment of potential construction noise and vibration impacts has considered the indicative schedule of construction plant proposed for SESRO and the indicative construction programme for works, based on the information within studies previously undertaken. With the exception of tunnelling works (which would take place for 24-hours) and material handling at the rail sidings (which may occur from

[104] Google Maps. *Google.co.uk/maps/* [accessed Jan-Apr 2022]
[105] Emapsite. *Emapsite.com* [accessed Jan-Apr 2022]

06:00 in the morning and finish as late as 21:00 in the evening), it is assumed that all works would take place during general site working hours (07:00 to 18:00 weekdays and 07:00 to 13:00 on Saturday).

7.20 Appendix A7.1 Assessment Criteria in Technical Supporting Document B2.1, Environmental Appraisal Report (terrestrial) Appendices presents the assessment criteria used in the noise and vibration appraisal.

7.21 Appendix A7.2 Construction Assessment Approach in Technical Supporting Document B2.1, Environmental Appraisal Report (terrestrial) Appendices presents the construction scenarios considered in the appraisal, including a list of plant and equipment assumed to be operating during various phases of construction along with descriptions of the construction activities.

7.22 Noise and vibration mitigation is presented in this chapter to provide examples of construction control measures that represent Best Practicable Means for mitigating noise and vibration. At the current concept design stage, it is not possible for detailed construction mitigation measures to be identified. Due to the qualitative nature of the operational assessment and current concept design for SESRO, operational noise and vibration controls are discussed at a high level.

7.3.6 Assessment Method

7.3.6.1 Construction Noise and Vibration

7.23 The noise and vibration assessment considers the following sensitive human receptors in the vicinity of the indicative location for SESRO:

- residential properties;
- schools (and other educational establishments);
- hospitals (and other healthcare facilities);
- places of worship;
- recreational areas; and
- public open spaces.

7.24 A description of the closest noise and vibration sensitive receptors in the vicinity of the indicative location for SESRO is presented in Section 7.4.

7.25 A computer noise model has been developed to allow construction noise impacts to be predicted at sensitive properties in the vicinity of the indicative location of SESRO. The model is based on the current concept design for the largest SESRO option. Construction vibration impacts have been predicted using the empirical calculations for piling, ground compaction and tunnelling presented in table E.1 of BS 5228-2[89], including Groundborne Noise and Vibration impacts associated with the tunnelling works to the east of SESRO to the River Thames (Drayton area). Due to the currently available design information, concurrent noise impacts, e.g., as a result of two or more works activities taking place at the same time in relatively close proximity to

receptors, have not been considered. Concurrent working does have the potential to result in higher noise levels than those presented in the assessment below. However, it should be noted that a precautionary approach to the assessment has been made, such as the selection of higher noise emitting plant (when several options are being considered) and in the placement of noise sources within the model. The potential for concurrent noise impacts from multiple activities would be considered at subsequent project stages, when the construction methods and programme are sufficiently well developed to allow a robust assessment of such impacts to be considered.

7.26 Vibration resulting from heavy vehicles on temporary access roads (haul roads within the works site and between the works site and public highways) have been assessed using indicative levels of vibration from heavy vehicle movements[106].

7.27 It is anticipated that construction noise and vibration impacts arising from the largest SESRO option would represent a worst-case situation for noise and vibration impacts. As such, a review of the smaller reservoir capacity alternative options has been undertaken via semi-quantitative methods, namely through consideration of the impacts assessed for the largest SESRO option and how those may alter for each option based on, for example, the location of the proposed work sites to receptors.

7.3.6.2 Operational Noise

7.28 A qualitative assessment of potential operational noise impacts has been undertaken. This includes consideration of potential operational noise impacts associated with the proposed pumping station and the impact on the local road network due to the introduction of the reservoir, which is anticipated to attract additional visitors to the area.

7.3.7 Assessment Criteria

7.29 As stated earlier, Appendix A7.1 Assessment Criteria in Technical Supporting Document B2.1, Environmental Appraisal Report (terrestrial) Appendices presents the assessment criteria used in the noise and vibration appraisal. A summary of the noise and vibration thresholds is presented below.

7.30 For all aspects of construction noise and vibration, a significant effect would be identified where it is determined that the relevant noise/vibration threshold would occur for a duration exceeding either:

- 10 or more days or nights in any 15 consecutive days or nights; and
- A total number of days exceeding 40 in any 6 consecutive months.

7.31 For the purposes of this assessment, it is generally assumed that all works would occur for a duration of at least that presented above.

[106] British Steel (1986). Legislation and Practice on Noise and Vibration Control with particular relevance to Piling

7.32 The noise and vibration thresholds presented below are expressed as Lowest Observed Adverse Effect Level (LOAEL) and Significant Observed Adverse Effect Level (SOAEL). The SOAEL shall be considered the level at which a potential significant adverse effect may occur and is discussed in Appendix A7.1 Noise Assessment Criteria in Technical Supporting Document B2.1, Environmental Appraisal Report (terrestrial) Appendices.

7.3.7.2 Airborne Noise

Residential properties

7.33 The SOAEL for construction activities at residential properties would be either the threshold level determined as per BS 5228-1 annex E.3 (Table E.1) or Annex E.5 of BS 5228-1. The SOAEL relates to the site noise level, which is the noise from construction activities alone.

7.34 Table 7.3 reproduces the example threshold of potential significant effect at dwellings presented in Table E.1 of BS 5228-1[88] and also includes the additional guidance presented within Annex E.5 of BS 5228-1 pertaining to long-term substantial earth moving activities. These noise thresholds have been adopted as the SOAEL values for the assessment of construction noise and residential properties.

Table 7.3: Noise Effect Levels for Residential Receptors - Based on Table E.1 and Annex E.5 in BS 5228-1:2009+A1:2014

Reference period	SOAEL threshold value $L_{Aeq,T}$ dB (façade)			
	All construction activities (excluding embankment formation)			Embankment formation
	Category A (1)	Category B (2)	Category C (3)	Annex E.5
Weekday daytime (07:00-19:00) **Saturdays (07:00-13:00)**	65	70	75	58
Weekday evenings (19:00-23:00) **Saturdays (13:00-23:00)** **Sundays (07:00-23:00)**	55	60	65	Highest of a) $L_{A90,T}$ +10, or b) 45
Night-time (23:00-07:00)	45	50	55	45

(1) Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are less than these values.
(2) Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are the same as category A values.
(3) Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are higher than category A values.
Note: A potential significant effect is indicated if the $L_{Aeq,T}$ noise level arising from the site exceeds the threshold level for the category appropriate to the ambient noise level.

Non-residential properties / community assets

7.35 The SOAEL values for non-residential receptors are presented in Table 7.4.

Table 7.4: Construction Noise Impact Criteria for Non-Residential Properties and Community Assets

Receptor Type	Impact Criteria		Sources
	Day 07:00-23:00	Night 23:00-07:00	
Schools and colleges(1)	50dB(2) $L_{Aeq,T}$ or a change of >3dB	-	BS 8233[92], EFA Acoustics Performance Standards[107], HTM 08-01[108], WHO Guidelines[99], Acoustics of Schools[109]
Outdoor teaching spaces	55dB $L_{Aeq,T}$, with at least one area suitable for outdoor teaching where noise levels are below 50dB $L_{Aeq,T}$(3)	-	
Hospitals(1)	50dB(2) $L_{Aeq,T}$ or a change of >3dB	45dB(4) $L_{Aeq,T}$ or a change of >3dB	
Hotels, care homes, nursing homes, places of worship and community facilities	As per the approach adopted for residential properties(5)		BS 5228-1[88]
Public open spaces	Total noise exceeds existing ambient ($L_{Aeq,T}$) by 5dB or more(6)	-	BS 5228-1

(1) Assessment criteria presented within HS2 London – West Midlands Environmental Statement, Volume 5 Technical Appendices, SV-001-000.
(2) Based on an internal level of 35dB $L_{Aeq,T}$ consistent with Education Funding Agency (EFA) and BS 8233. Equivalent external level assuming 15dB reduction for a partially open window.
(3) Based on the LAeq,30min noise criteria presented in the IOA/ANC Acoustics of Schools design guide.
(4) Based on an internal level of 30dB $L_{Aeq,T}$ consistent with BS 8233, WHO guidelines. Equivalent external level assuming 15dB reduction for a partially open window.
(5) BS 5228-1 states that the evaluation criteria are generally applicable to residential properties, hotels and hostels, buildings in religious use, schools and health or community facilities.
(6) BS 5228-1 advises that for public open space, the impact might be deemed to cause significant effects if the total noise exceeds the ambient noise ($L_{Aeq,T}$) by 5dB or more for a period of one-month or more. However, the extent of the area impacted relative to the total available area also needs to be

[107] Education Funding Agency (2012), Acoustics Performance Standards for the Priority Schools Building Programme. Department for Education. The Stationery Office Limited.
[108] DoH (2013), Specialist services, Health Technical Memorandum 08-01: Acoustics. Department of Health, Richmond.
[109] IOA/ANC (2015), Acoustics of Schools: a design guide. The Institute of Acoustics and the Association of Noise Consultants.

taken into account in determining whether the impact causes a significant effect.

7.3.7.3 Groundborne Noise and Vibration – human response

7.36 The vibration impact criteria (human response), reproduced from BS 5228-2[89] is presented in Table 7.5. Human response in occupied non-residential receptors, such as hotels, hospital wards, education dormitories, offices, schools and places of worship would also be assessed using the criteria presented in Table 7.5.

Table 7.5: Vibration Impact Criteria (Human Response)

Vibration level, PPV (mm/s)	Effect
10	10mm/s: Vibration is likely to be intolerable for any more than a very brief exposure to this level.
1.0 (SOAEL)	1.0mm/s: It is likely that vibration of this level in residential environments would cause complaint but can be tolerated if prior warning and explanation has been given to residents.
0.3	0.3mm/s: Vibration might just be perceptible in residential environments.
0.14	0.14mm/s: Vibration might just be perceptible on the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.
<0.14	Vibration is below levels of perception.

7.37 The criteria set out in Table 7.6 would be adopted in the assessment of potential groundborne noise at buildings in the vicinity of the proposed tunnel.

Table 7.6: Groundborne Noise Impact Criteria for Residential Properties, Non-Residential Properties and Community Assets

Category of Building	Groundborne noise effect levels dB L_{ASmax}
Residential properties(1)	45 (SOAEL)
Schools, colleges, and hospitals(2)	35 (SOAEL)

(1) applies to hotels, care homes, nursing homes, places of worship and community facilities.
(2) threshold is based on those established for educational establishments and hospitals in Table 7.4.

7.3.7.4 Vibration - buildings

7.38 Table 7.7 defines the impact criteria for groundborne vibration with regard to risk of building damage, below which there is no risk of cosmetic damage.

Table 7.7: Groundborne Noise Impact Criteria for Residential Properties, Non-Residential Properties and Community Assets

Category of building	Peak Particle Velocity, PPV mm/s - at building foundation	
	Transient[(1)] vibration	Continuous [(2)] vibration
Potentially vulnerable buildings[(3)]	6	3
Structurally sound buildings	12	6

Thresholds are based on those used for HS2 vibration impact criteria for buildings (HS2 2013[110])
(1) Transient vibration relative to building response such as impulsive vibration from percussive piling.
(2) Continuous vibration relative to building response such as vibrating rollers.
(3) BS 7385 highlights that the criteria for aged buildings may need to be lower if the buildings are structurally unsound. The standard also notes that criteria should not be set lower simply because a building is important or historic (listed). Properties shall be considered structurally sound, unless stated otherwise.

7.3.7.5 Construction Traffic – Public Highways

7.39 The SOAEL for residential properties shall be consistent with the thresholds presented in Table 7.3, while a LOAEL of 55dBA at the façade of the property shall apply at residential properties. The SOAEL for non-residential receptors shall be as per the thresholds presented in Table 7.4. In addition to the absolute noise thresholds for construction traffic, the noise change thresholds presented in Table 7.8, which are applicable to all receptors considered by the assessment, shall apply.

Table 7.8: Onset of significant effect - construction road traffic noise

Change in Basic Noise Level (BNL) resulting from construction traffic noise	
Where BNL is between LOAEL and SOAEL	**Where BNL is at or above SOAEL**
Greater than or equal to 5.0	Greater than or equal to 3.0

7.3.7.6 Construction rail movements

7.40 The approach to the assessment of construction noise resulting from rail movements would consider the same assessment thresholds and noise change criteria as presented for construction road traffic.

7.3.7.7 Operational Traffic – Public Highways

7.41 A potential significant effect from operational road traffic would be considered possible where the daytime noise levels are predicted to be at or above 55dB $L_{A10,18hr}$

[110] HS2 (November 2013) London – West Midlands Environmental Statement, Volume 5, Technical Appendices. Methodology, assumptions and assessment (route-wide). Sound, noise and vibration. High Speed 2.

and a noise change of at least 1.0dB is predicted to occur.

7.42 As per DMRB LA 111[98], potential significant vibration effects due to road traffic are scoped out of this assessment. DMRB LA 111 states: *'operational vibration is scoped out of the assessment methodology as a maintained road surface will be free of irregularities as part of project design and under general maintenance, so operational vibration will not have the potential to lead to significant adverse effects'.*

7.43 The principal guidance for the assessment of industrial noise impact (e.g. that arising from the pumping station) in mixed residential areas in the UK is BS 4142[102]. This method involves the determination of a specific noise level due to the source in question at the nearest noise sensitive location (NNSL), thence a rating level. The difference between the rating level and background level at the NNSL is calculated. According to BS 4142:

- a difference of around +10dB or more indicates that complaints are likely;
- a difference of around +5dB is of marginal significance; and
- if the rating level is lower than 10dB below the background level (< -10dB) then this is a positive indication that complaints are unlikely.

7.44 It may be considered that for broadband noise sources, a level of 10dB below the background is generally indiscernible above the background noise, hence the above assessment of BS 4142.

7.45 A single penalty of 5dB may be added to the specific level if the noise:

- contains a distinguishable, discrete, continuous note (whine, hiss, screech, hum, etc.);
- contains distinct impulses (bangs, clicks, clatters, or thumps); or
- is irregular enough to attract attention.

7.46 BS 4142[102] also indicates that where background levels are below 30dB(A), and rating levels below 35dB(A), these levels are below the scope of the assessment according to that standard. There is no other formal guidance for the assessment in these cases.

7.47 The pumping station is located at more than 600m from the nearest receptor. operational impacts due to the pumping station are scoped out of this assessment.

7.48 DMRB LA 111[98] states the following regarding vibration from road traffic: '*operational vibration is scoped out of the assessment methodology as a maintained road surface will be free of irregularities as part of project design and under general maintenance, so operational vibration will not have the potential to lead to significant adverse effect*'. As such, operational vibration impacts are not considered in this assessment.

7.4 Understanding of the baseline

7.49 The existing noise climate in the vicinity of SESRO is likely to be dominated by road traffic noise, predominantly from:

- A34, to the east and north-east of the indicative location for SESRO;
- A338, to the west of the indicative location for SESRO; and
- A415 (Marcham Road) to the north of the indicative location for SESRO.

7.50 In addition, noise from the Great Western Main Line (GWML) is likely to dominate at some locations and contribute in general to the local noise climate to the south of the indicative location for SESRO. Other noise sources would include road traffic noise from local roads and noise associated with rural and some urban activities.

7.51 Sensitive residential receptors and community assets are located in East Hanney, Steventon, Drayton, Abingdon and Marcham.

7.52 There are a number of schools within the 500m study area, these include St Michael's Church of England Primary School in Steventon (370m from the indicative location for SESRO), Drayton Community Primary School (440m) and Marcham Church of England Primary School (500m). There are also several schools outside of the 500m study area including St James Church of England School in East Hanney (660m) and Thameside Primary School in Abingdon (690m).

7.53 There are four Noise Action Planning Important Areas in or in close proximity to the study area, three for roads (13238 and 13239, both for the A338 in and north of East Hanney, and 13240, the A415 west of Marcham) and one for rail (RI_1342, the GWML south of Steventon). These are presented in Appendix A7.3 Strategic Noise Mapping in Technical Supporting Document B2.1, Environmental Appraisal Report (terrestrial) Appendices.

7.54 Abingdon Hospital is located approximately 800m from the indicative location for SESRO (access road, west of A34/A415 roundabout) and separated by the A34.

7.55 Appendix A7.3 Strategic Noise Mapping in Technical Supporting Document B2.1, Environmental Appraisal Report (terrestrial) Appendices presents the prevailing day and night noise levels in the vicinity of the indicative location for SESRO due to major road and rail noise sources (namely the GWML, the A34, the A338 and the A415), and shows that noise levels at receptors in close proximity to these sources would be in excess of 55dB $L_{Aeq,16hr}$ during the daytime period and 50dB L_{night}.

7.5 Assessment outcomes

7.56 The assessment of potential construction and operational noise and vibration effects are presented below.

7.5.2 Construction

7.5.2.1 Construction noise

7.57 The construction noise assessment considers potential noise impacts at approximately 2,500 receptors within the vicinity of the indicative location of SESRO. Potential construction noise levels are presented at the locations and sample receptors shown in Table 7.9 which also includes the sample receptors selected for the construction vibration assessment.

Table 7.9: Locations and sample receptors presented in construction noise and vibration assessment

Area	Sample Receptor	
	ID	Address
Marcham (146 receptors)	M1	Primary School, Marcham
	M2	Anson Close, Marcham
	M3	Mill Road, Marcham
	M4	Mill Road (2), Marcham (located ~1km south of Marcham village)
	M5	Preschool, Marcham
Abingdon (548 receptors)	A1	Primary School, Abingdon
	A2	Hospital
	A3	Oday Hill, Drayton, Abingdon
	A4	Stonehill, Drayton, Abingdon
	A5	Public park, Abingdon (free field)
	A6	The Green, Culham, Abingdon
	A7	Riding School, Abingdon (free field)
Drayton (749 receptors)	D1	Primary School, Drayton
	D2	Village Hall [(1)]
	D2a	Village Hall playing field (free field)
	D2b	Village Hall playground (free field)
	D3	Playing field, Sutton Wick
	D4	Willow Way, Drayton
	D5	Steventon Road, Drayton
Steventon	S1	Primary School

Area	Sample Receptor	
	ID	Address
(608 receptors)	S2	Hanney Road, Steventon
	S3	Hanney Road (2), Steventon
	S4	Prior Crescent, Steventon
	S5	Hanney Road(3), Steventon
East Hanney (456 receptors)	EH1	Primary School, East Hanney
	EH2	Steventon Road, East Hanney
	EH3	Oxford Road, East Hanney
	EH4	Dandridge Close, East Hanney
	EH5	Franklin Gardens, East Hanney
	EH6	Lamble Walk, East Hanney
North/south of East Hanney (nr Oxford Rd) (5 receptors)	NS-EH1	Old Mans Lane, Grove
	NS-EH2	Station Road (1)
	NS-EH3	Near Grove Park Drive
	NS-EH4	Oxford Road

NOTES
(1) Appears to be unoccupied farm building but this could not be confirmed during desktop study so included as possible sensitive receptor at this time.

7.58 The assessment of potential construction noise impacts has considered the construction activities presented in Section 7.3.5 and Appendix A7.2 Construction Assessment Approach in Technical Supporting Document B2.1, Environmental Appraisal Report (terrestrial) Appendices, and includes the mitigation afforded by the screening mounds. All noise levels are predicted at 1.5m above ground height to represent daytime construction noise levels unless stated otherwise.

7.59 Tables 7.10 to 7.15 present the predicted construction noise levels at sample receptors in the vicinity of the indicative location for SESRO and provides a count of receptors predicted to experience an exceedance of the construction noise SOAEL values presented in Section 7.3.

Table 7.10: Potential construction noise impacts – Marcham

Construction Activity	Predicted construction noise level ($L_{Aeq,T}$, dB) & number of properties predicted to exceeded SOAEL					
	No. >SOAEL	Sample Receptor				
		M1	M2	M3	M4	M5
1.Site Clearance and Vegetation Removal	0	39	52	48	60	39
2.Borrow Pit Operations	0	<20	<20	30	40	<20
3.Earthworks - Embankments (1)	0	<20	<20	45	53	<20
4.Earthworks - Screening Mounds	0	<20	<20	46	49	<20
5.Service Diversion	0	30	33	42	49	29
6.Rail Sidings and Material Handling Area Operation	0 (d) 0 (e) 0 (n)	<20	<20	<20	<20	<20
7.Bridge Piling	0	34	44	47	52	36
8.Access Road	0	39	52	49	45	38
9.Replacement Flood Plain Storage	0	<20	<20	<20	<20	<20
10.Reservoirs Towers - Tower Construction Slip forming	0	<20	<20	<20	35	<20
11.Sheet Piling (river intake/outfall towers)	0	<20	<20	<20	<20	<20
12.River Intake (Excavation behind diaphragm walls and dewatering)	0	<20	<20	<20	<20	<20
13.Rail Sidings (ballast excavation/installation)	0	<20	<20	<20	<20	<20
14.Auxiliary Drawdown Channel (ADC) Excavation and Fill	0	34	42	47	57	28

NOTES
(1) 55dB $L_{Aeq,T}$ construction noise limit for embankment formation works.
(d), (e) and (n) denote potential daytime, evening and night-time impacts during material handling activities at rail sidings.

7.60 Table 7.10 shows that construction activities 1 and 14 (site clearance and vegetation removal, and Auxiliary Drawdown Channel (ADC) excavation and fill) are predicted to result in the highest noise levels at receptors in/near to Marcham (namely sample receptor M4). These activities are located towards the north and north-east of the indicative location for SESRO.

7.61 The construction noise levels at sensitive receptors in/near the village of Marcham are predicted to remain below the SOAEL and no significant impacts are anticipated.

Abingdon

Table 7.11: Potential construction noise impacts – Abingdon

Construction Activity	Predicted construction noise level ($L_{Aeq,T}$, dB) & number of properties predicted to exceeded SOAEL						
		Sample Receptor					
	No. >SOAEL	A1	A2	A3	A4	A5	A7 (1)
1.Site Clearance and Vegetation Removal	**3**	44	39	57	***65***	50	***69***
2.Borrow Pit Operations (excavation of Kimmerige clay)	0	<20	<20	<20	<20	<20	<20
3.Earthworks - Embankments (2)	0	<20	<20	<20	<20	<20	<20
4.Earthworks Screening Mounds	0	<20	<20	29	40	<20	37
5.Service Diversion	0	41	40	60	49	53	47
6.Rail Sidings and Material Handling Area Operation	0 (d) 0 (e) 0 (n)	<20	<20	<20	<20	<20	<20
7.Bridge Piling	**1**	46	44	***65***	57	48	56
8.Access Road	0	34	35	38	39	31	40
9.Replacement Flood Plain Storage	0	<20	<20	<20	<20	<20	<20

Construction Activity	Predicted construction noise level ($L_{Aeq,T}$, dB) & number of properties predicted to exceeded SOAEL						
		Sample Receptor					
	No. >SOAEL	A1	A2	A3	A4	A5	A7 (1)
10.Reservoirs Towers-Tower Construction Slip forming	0	<20	<20	<20	<20	<20	<20
11.Sheet Piling (river intake/outfall towers)	0	40	<20	49	46	50	43
12.River Intake (Excavation behind diaphragm walls and dewatering)	0	43	<20	52	48	53	46
13.Rail Sidings (ballast excavation/installation)	0	<20	<20	<20	<20	<20	<20
14.Auxiliary Drawdown Channel Excavation and Fill	**7**	45	40	***65***	***68***	52	***71***

NOTES
(1) Free-field construction noise levels presented for sample receptor A7 (riding school).
(2) 55dB $L_{Aeq,T}$ construction noise limit for embankment formation works.
(d), (e) and (n) denote potential daytime, evening and night-time impacts during material handling activities at rail sidings.

7.62 Table 7.11 shows that construction activities 1, 7 and 14 (site clearance and vegetation removal, bridge piling and ADC excavation and fill) are predicted to result in the highest noise levels at receptors in/near to Abingdon. These activities are located towards the north-east of the indicative location for SESRO.

7.63 The indicative construction programme for SESRO[111] identifies site clearance and the installation of perimeter fencing (activity 1) as taking approximately 12-months, the excavation and fill of the ADC (activity 14) as taking approximately 7-months, and bridge piling (activity 7) as taking approximately 20-months. These durations are for the works phase over the entire SESRO; however, would be anticipated to take place for shorter durations in the vicinity of receptors in Abingdon, in the order of one to two months for activity 1, and one to four months for activities 7 and 14 in the vicinity of nearby receptors.

[111] Supporting Document A1 Concept Design Report prepared to support the RAPID Gate 2 submission.

7.64 Based on the construction noise levels presented in Table 7.11 and the anticipated duration of works, potentially significant construction noise effects during site clearance, piling at bridge locations, and excavation and fill of the ADC are predicted.

7.65 Section 7.6 presents a detailed list of noise (and vibration) control strategies that would be considered and adopted (where practicable) during construction.

Drayton

Table 7.12: Potential construction noise impacts – Drayton

Construction Activity	Predicted construction noise level ($L_{Aeq,T}$, dB) & number of properties predicted to exceeded SOAEL							
	Sample Receptor							
	No. >SOAEL	D1	D2	D2 a [1]	D2 b [1]	D3	D4	D5
1.Site Clearance and Vegetation Removal	0	41	53	50	46	55	51	50
2.Borrow Pit Operations (excavation of Kimmerige clay)	0	35	39	36	35	26	31	38
3.Earthworks – Embankments [2]	0	47	52	49	46	46	46	50
4.Earthworks Screening Mounds	**48**	55	***65***	61	57	50	49	***78***
5.Service Diversion	0	40	54	51	49	51	52	35
6.Rail Sidings and Material Handling Area Operation	0 (d) 0 (e) 0 (n)	<20	<20	<20	<20	<20	<20	<20
7.Bridge Piling	0	49	46	43	34	54	54	32
8.Access Road	0	47	45	42	35	48	49	41
9.Replacement Flood Plain Storage	0	<20	<20	<20	<20	<20	<20	<20
10.Reservoirs Towers-Tower Construction Slip forming	0	<20	35	33	29	<20	<20	33
11.Sheet Piling (river intake/outfall towers)	0	<20	<20	<20	<20	41	<20	<20

Construction Activity	Predicted construction noise level ($L_{Aeq,T}$, dB) & number of properties predicted to exceeded SOAEL							
	Sample Receptor							
	No. >SOAEL	D1	D2	D2 a (1)	D2 b (1)	D3	D4	D5
12.River Intake (Excavation behind diaphragm walls and dewatering)	0	<20	<20	<20	<20	43	<20	<20
13.Rail Sidings (ballast excavation/installation)	0	<20	<20	<20	<20	<20	<20	<20
14.Auxiliary Drawdown Channel Excavation and Fill	0	44	38	35	29	64	60	<20

NOTES
(1) Free-field construction noise levels presented for sample receptor D2a (playing field) and D2b (playground).
(2) 55dB $L_{Aeq,T}$ construction noise limit for embankment formation works.
(d), (e) and (n) denote potential daytime, evening and night-time impacts during material handling activities at rail sidings.

7.66 Table 7.12 shows that construction activity 4, earthworks phase for the formation of the screening mounds, is predicted to result in the highest noise levels at receptors in/near to Drayton. These activities are located towards the east of the indicative location for SESRO.

7.67 Prevailing ambient noise levels at the sensitive receptors in Drayton village would be dominated by noise from the A34, see Appendix A7.3 Strategic Noise Mapping (Figure A7.3.13) in Technical Supporting Document B2.1, Environmental Appraisal Report (terrestrial) Appendices, and from viewing the strategic mapping, prevailing ambient noise levels for some receptors in Drayton are likely to be in the order of 65dB $L_{Aeq,16hr}$ (including at sample receptor D5). As such, the 65dB $L_{Aeq,16hr}$ SOAEL used in assessing all residential receptors (on a precautionary basis) may need to be increased during later more detailed assessment. As such, the assessment presented here is likely to result in an overestimation of adverse impacts at some receptors.

7.68 The indicative construction programme for SESRO[112] identifies earth screening mounds (activity 4), which are included in the SESRO design specifically to provide noise mitigation during construction at nearby noise sensitive receptors, as taking approximately 15-months. This duration would be for the entire SESRO; however,

[112] Supporting Document A1 Concept Design Report prepared to support the RAPID Gate 2 submission.

this activity would be anticipated to take place for no more the approximately one to three months in the vicinity of the receptors in Drayton.

7.69 Based on the construction noise levels presented in Table 7.12 and the anticipated duration of works, potential significant construction noise effects during the earthworks associated with the earth screening mounds in the vicinity of sensitive receptors in Drayton are predicted.

7.70 Section 7.6 presents a detailed list of noise (and vibration) control strategies that would be considered and adopted (where practicable) during construction.

Steventon

Table 7.13: Potential construction noise impacts – Steventon

Construction Activity	Predicted construction noise level ($L_{Aeq,T}$, dB) & number of properties predicted to exceeded SOAEL					
		Sample Receptor				
	No. >SOAEL	S1	S2	S3	S4	S5
1.Site Clearance and Vegetations Removal	0	38	51	52	47	49
2.Borrow Pit Operations (excavation of Kimmerige clay)	0	39	44	44	42	42
3.Earthworks - Embankments [(1)]	**1**	46	***55***	54	53	53
4.Earthworks Screening Mounds	**10**	53	***77***	***74***	***67***	***66***
5.Service Diversion	**2**	39	***80***	***71***	58	63
6.Rail Sidings and Material Handling Area Operation	0 (d) 0 (e) **38 (n)**	37	42	***45***	44	***46***
7.Bridge Piling	0	<20	<20	<20	<20	<20
8.Access Road	**2**	44	***84***	***70***	55	58
9.Replacement Flood Plain Storage	0	<20	<20	<20	<20	<20
10.Reservoirs Towers- Tower Construction Slip forming	0	<20	40	39	36	36

Construction Activity	Predicted construction noise level ($L_{Aeq,T}$, dB) & number of properties predicted to exceeded SOAEL					
		Sample Receptor				
	No. >SOAEL	S1	S2	S3	S4	S5
11.Sheet Piling (river intake/outfall towers)	0	<20	<20	<20	<20	<20
12.River Intake (Excavation behind diaphragm walls and dewatering)	0	<20	<20	<20	<20	<20
13.Rail Sidings (ballast excavation/installation)	0	39	44	50	49	51
14.Auxiliary Drawdown Channel Excavation and Fill	0	<20	<20	<20	<20	<20

NOTES
(1) 55dB $L_{Aeq,T}$ construction noise limit for embankment formation works.
(d), (e) and (n) denote potential daytime, evening and night-time impacts during material handling activities at rail sidings.

7.71 Table 7.13 shows that construction activities 3, 4, 5 and 8 (earthworks for the main embankment formation, earthworks for the screening mounds, service diversions, and the construction of the access road) are predicted to result in the highest noise levels at receptors in/near to Steventon. These activities are located towards the south-east of the indicative location for SESRO.

7.72 The indicative construction programme for SESRO[113] identifies main earthworks for the embankment (activity 3) as taking approximately 32-months, the formation of earth screening mounds (activity 4) as taking approximately 15-months, electricity/gas diversion (activity 5) as taking approximately 10-months, and the East Hanney road diversion (activity 8) as taking place over approximately 17-months. These durations are for the works phase over the entire SESRO; however, would be anticipated to take place for shorter durations in the vicinity of receptors in Steventon, in the order of 6-months for activity 3, one to three months for activity 4, one to three months for activity 5 and two to four months for activity 8.

7.73 The unloading of materials at the proposed rail sidings, while not generating noise levels as high as those for the activities listed above, are predicted to be at or in excess of 45dB $L_{Aeq,T}$. Therefore, this would result in potential significant noise effects should unloading of material be undertaken between 06:00 and 07:00, which is included within the BS 5228 night-time period.

[113] Supporting Document A1 Concept Design Report prepared to support the RAPID Gate 2 submission.

7.74 Based on the construction noise levels presented in Table 7.13 and the anticipated duration of works, potential significant construction noise effects during earthworks, service diversion works, access road construction, and material handling/unloading (before 07:00) in the vicinity of sensitive receptors in Steventon are predicted.

7.75 Section 7.6 presents a detailed list of noise (and vibration) control strategies that would be considered and adopted (where practicable) during construction.

East Hanney

Table 7.14: Potential construction noise impacts – East Hanney

Construction Activity	Predicted construction noise level ($L_{Aeq,T}$, dB) & number of properties predicted to exceeded SOAEL						
		Sample Receptor					
	No. >SOAEL	EH1	EH2	EH3	EH4	EH5	EH6
1.Site Clearance and Vegetation Removal	**9**	44	***68***	***77***	***70***	57	64
2.Borrow Pit Operations (excavation of Kimmerige clay)	0	<20	43	41	42	36	43
3.Earthworks - Embankments [(1)]	**3**	36	***56***	52	53	49	55
4.Earthworks Screening Mounds	**70**	51	***81***	***73***	***72***	58	***73***
5.Service Diversion	**17**	33	58	49	50	48	***75***
6.Rail Sidings and Material Handling Area Operation	0 (d) 0 (e) **72 (n)**	37	***47***	38	44	***48***	28
7.Bridge Piling	**1**	30	***71***	47	46	43	60
8.Access Road	0	39	40	31	30	56	23
9.Replacement Flood Plain Storage	**72**	50	***78***	***68***	***69***	62	***73***
10.Reservoirs Towers- Tower Construction Slip forming	0	<20	37	<20	31	<20	36
11.Sheet Piling (river intake/outfall towers)	0	<20	<20	<20	<20	<20	<20

Construction Activity	Predicted construction noise level ($L_{Aeq,T}$, dB) & number of properties predicted to exceeded SOAEL						
		Sample Receptor					
	No. >SOAEL	EH1	EH2	EH3	EH4	EH5	EH6
12.River Intake (Excavation behind diaphragm walls and dewatering)	0	<20	<20	<20	<20	<20	<20
13.Rail Sidings (ballast excavation/installation)	0	39	54	40	50	53	30
14.Auxiliary Drawdown Channel Excavation and Fill	0	<20	<20	<20	<20	<20	<20

NOTES
(1) 55dB $L_{Aeq,T}$ construction noise limit for embankment formation works.
(d), (e) and (n) denote potential daytime, evening and night-time impacts during material handling activities at rail sidings.

7.76 Table 7.14 shows that construction activities 1, 3, 4, 5, 7 and 9 (site clearance and vegetation removal, earthworks for the main embankment formation, earthworks for the screening mounds, service diversions, bridge piling, and replacement flood plain storage) are predicted to result in the highest noise levels at receptors in to East Hanney. These activities are located towards the west of the indicative location for SESRO.

7.77 The indicative construction programme for SESRO[114] identifies site clearance and the installation of perimeter fencing (activity 1) as taking approximately 12-months, main earthworks for the embankment (activity 3) as taking approximately 32-months (4 seasons), the formation of earth screening mounds (activity 4) as taking approximately 15-months, electricity/gas diversion (activity 5) as taking approximately 10-months, and flood plain storage area construction (activity 9) as taking approximatively 12-months. These durations are for the works phase over the entire SESRO; however, would be anticipated to take place for shorter durations in the vicinity of receptors in East Hanney, in the order of one to two months for activity 1, six months for activity 3, two to four months for activity 4, one to three months for activity 5, and two to four months for activity 9.

7.78 The unloading of materials at the proposed rail sidings, while not generating noise levels as high as those for the activities listed above, are predicted to be at or in excess of 45dB $L_{Aeq,T}$. Therefore, this would result in potential significant noise effects should unloading of material be undertaken between 06:00 and 07:00, which is

[114] Supporting Document A1 Concept Design Report prepared to support the RAPID Gate 2 submission.

included within the BS 5228 night-time period.

7.79 Based on the construction noise levels presented in Table 7.14 and the anticipated duration of works, potential significant construction noise effects during site clearance and vegetation removal, earthworks for main embankments and screening mounds, service diversions, bridge piling, replacement flood plain storage, and material handling/unloading (before 07:00) are predicted.

7.80 Section 7.6 presents a detailed list of noise (and vibration) control strategies that would be considered and adopted (where practicable) during construction.

North and South of East Hanney

Table 7.15: Potential construction noise impacts – North and South of East Hanney

Construction Activity	Predicted construction noise level ($L_{Aeq,T}$, dB) & number of properties predicted to exceeded SOAEL				
		Sample Receptor			
	No. >SOAEL	NS-EH1	NS-EH2	NS-EH3	NS-EH4
1.Site Clearance and Vegetation Removal	0	61	52	43	62
2.Borrow Pit Operations (excavation of Kimmerige clay)	0	36	32	34	40
3.Earthworks - Embankments [(1)]	0	48	46	44	53
4.Earthworks Screening Mounds	0	61	60	60	53
5.Service Diversion	0	48	41	32	45
6.Rail Sidings and Material Handling Area Operation	0 (d) 0 (e) **3 (n)**	***52***	***46***	***45***	<20
7.Bridge Piling	0	44	35	35	38
8.Access Road	0	54	49	32	<20
9.Replacement Flood Plain Storage	**2**	56	50	43	***74***
10.Reservoirs Towers- Tower Construction Slip forming	0	<20	<20	<20	<20
11.Sheet Piling (river intake/outfall towers)	0	<20	<20	<20	<20

Construction Activity	Predicted construction noise level ($L_{Aeq,T}$, dB) & number of properties predicted to exceeded SOAEL				
		Sample Receptor			
	No. >SOAEL	NS-EH1	NS-EH2	NS-EH3	NS-EH4
12.River Intake (Excavation behind diaphragm walls and dewatering)	0	<20	<20	<20	<20
13.Rail Sidings (ballast excavation/installation)	0	57	48	48	<20
14.Auxiliary Drawdown Channel Excavation and Fill	0	<20	<20	<20	<20

NOTES
(1) 55dB $L_{Aeq,T}$ construction noise limit for embankment formation works.
(d), (e) and (n) denote potential daytime, evening and night-time impacts during material handling activities at rail sidings.

7.81 Table 7.15 shows that construction activity 9, replacement flood plain storage area construction, is predicted to result in the highest noise levels at receptors north and south of East Hanney. This activity is located towards the north-west of the indicative location for SESRO.

7.82 The indicative construction programme for SESRO[115] identifies flood plain storage area construction (activity 9) as taking approximatively 12-months This duration would be for the entire SESRO; however, this activity would be anticipated to take place for no more the approximately two to four months in the vicinity of the receptors considered in this assessment.

7.83 The unloading of materials at the proposed rail sidings, while not generating noise levels as high as those for construction works at the flood plain storage area, are predicted to be at or in excess of 45dB $L_{Aeq,T}$. Therefore, this would result in potential significant noise effects should unloading of material be undertaken between 06:00 and 07:00, which is included within the BS 5228 night-time period.

7.84 Based on the construction noise levels presented in Table 7.15 and the anticipated duration of works, potential significant construction noise effects during the construction of the flood plain storage area and material handling/unloading (before 07:00) are predicted.

[115] Supporting Document A1 Concept Design Report prepared to support the RAPID Gate 2 submission.

7.85 Section 7.6 presents a detailed list of noise (and vibration) control strategies that would be considered and adopted (where practicable) during construction.

7.5.2.2 Construction vibration

7.86 There is the potential for significant vibration impacts during the construction phase for SESRO, both in terms of human response and building damage. It is considered that the most likely sources of construction vibration would arise from:

- ground compaction;
- vibratory piling;
- tunnelling; and
- heavy vehicle movements.

7.87 Appendix A7.4 Construction Vibration in Technical Supporting Document B2.1, Environmental Appraisal Report (terrestrial) Appendices presents the indicative predicted vibration levels during piling and soil compaction at distances of between 10 and 100m for both steady state operations and during transient start-up and run-down conditions. Appendix A7.4 Construction Vibration in Technical Supporting Document B2.1, Environmental Appraisal Report (terrestrial) Appendices also presents the indicative predicted vibration and groundborne noise levels during tunnelling at distances of between 10 and 100m, and indicative vibration levels arising from the movement of heavy vehicles.

Table 7.16 presents the assessment of potential construction vibration impacts at properties in the vicinity of the indicative location for SESRO. The predicted vibration levels are for transient ground compaction (high vibration amplitude, 2.1mm) or vibratory piling works, with a 5% chance of exceedance, unless stated otherwise, and have been extrapolated beyond 100m where applicable. Where construction vibration levels during ground compaction are predicted to exceed 1mm/s (when assuming high vibration amplitude setting), a lower vibration level has also been presented, which assumed a lower vibration amplitude setting (0.98mm) and is denoted by (3) in

7.88 Table 7.16.

Table 7.16: Potential construction vibration impacts

Receptor	Construction activity (distance from receptor to works site and predicted vibration/groundborne noise level)			
	Works site	Min. distance [1]	Predicted noise/ vibration level [2]	Potential significant effect?
MARCHAM				
M2 - Anson Close, Marcham	Highway works at Marcham road junction with access road (potential ground compaction works)	250m	0.4mm/s PPV	No
M4 - Mill Road (2), Marcham	Watercourses north of emergency discharge channel (potential ground compaction works)	270m	0.4mm/s PPV	No
	Bridge at emergency discharge channel (potential vibratory piling)	470m	0.2mm/s PPV	No
ABINGDON				
A3 - Oday Hill, Drayton, Abingdon	Bridge at emergency discharge channel (potential vibratory piling)	118m	0.9mm/s PPV	No
	Bridge at emergency discharge channel (potential ground compaction)	118m	0.3[3] - 1.1mm/s PPV	No[4]
	Tunnelling, potential groundborne noise (room sound pressure level, dBA) and vibration	157m	0.3mm/s PPV <20dBA	No
A4 - Stonehill, Drayton, Abingdon	Cutting/levees at emergency discharge channel (potential ground compaction)	85m	0.5[3] - 1.6mm/s PPV	No[4]
	Bridge at emergency discharge channel (potential vibratory piling)	222m	0.4mm/s PPV	No
	Tunnelling, potential groundborne noise (room	128m	0.3mm/s PPV <20dBA	No

Receptor	Construction activity (distance from receptor to works site and predicted vibration/groundborne noise level)			
	Works site	Min. distance [1]	Predicted noise/ vibration level [2]	Potential significant effect?
	sound pressure level, dBA) and vibration			
DRAYTON				
D4 - Willow Way, Drayton	Cutting/levees at emergency discharge channel (potential ground compaction)	195m	0.6mm/s PPV	No
	Tunnelling, potential groundborne noise (room sound pressure level, dBA) and vibration	85m	0.6mm/s PPV 23dBA	No
D5 - Steventon Road, Drayton	Screening mound (potential ground compaction)	34m	1.6[3] – 5.1mm/s PPV	No[4]
STEVENTON				
S2 - Hanney Road, Steventon	Screening mound (potential ground compaction)	60m	0.8[3] – 2.5mm/s PPV	No[4]
	Access Road construction (potential ground compaction)	3m	>20[3]mm/s PPV	No[4]
S3 - Hanney Road (2), Steventon	Screening mound (potential ground compaction)	102m	0.4[3] – 1.3mm/s PPV	No[4]
	Access Road construction (potential ground compaction)	20m	3.1 [3] – 8.1mm/s PPV	No[4]
S4 - Prior Crescent, Steventon	Screening mound (potential ground compaction)	390m	0.2mm/s PPV	No
	Access road construction (potential ground compaction)	240m	0.4mm/s PPV	No
EAST HANNEY				

Receptor	Construction activity (distance from receptor to works site and predicted vibration/groundborne noise level)			
	Works site	Min. distance [1]	Predicted noise/ vibration level [2]	Potential significant effect?
EH2 - Steventon Road, East Hanney	Screening mound and access road construction (potential ground compaction)	17m	3.7[3] – 11.6mm/s PPV	No[4]
NORTH/SOUTH OF EAST HANNEY (NR OXFORD RD)				
NS-EH1 - Old Mans Lane, Grove	Screening mound (potential ground compaction)	175m	0.6mm/s PPV	No
	Access road construction (potential ground compaction)	220m	0.5mm/s PPV	No
	Watercourse culvert at Steventon - East Hanney road diversion (potential ground compaction)	260m	0.4mm/s PPV	No
NS-EH4 – Oxford Road	Replacement flood plain storage (potential ground compaction)	125m	0.3[3] – 1.0mm/s PPV	No[4]
	Utilities removed - electrical 11kV (potential ground compaction)	375m	0.2mm/s PPV	No

NOTES
(1) Minimum horizontal distance between works site and property (including for tunnelling works).
(2) Predicted vibration levels are for transient ground compaction (high vibration amplitude, 2.1mm) or vibratory piling works, with a 5% chance of exceedance, unless stated otherwise. Predicted noise and vibration levels have been extrapolated beyond 100m where applicable.
(3) Predicted vibration level at lower vibration amplitude setting 0.98mm for transient works and with a 5% chance of exceedance.
(4) See discussion of potential significant effects in paragraphs 0 and 7.90 below.

Human impacts

The vibration levels presented in

7.89 Table 7.16 show that vibration from earth compaction works is predicted to range from 0.2mm/s PPV to >20mm/s PPV. Vibration levels from piling works are predicted

to range from 0.2mm/s to 0.9mm/s PPV. Vibration levels at or in excess of the SOAEL value, 1.0mm/s, are predicted at the following sample receptors during the ground compaction works:

- Abingdon – A3 Oday Hill (ground compaction at bridge);
- Abingdon – A4 Stonehill, Drayton (ground compaction at the emergency discharge channel);
- Drayton – D5 Steventon Road (ground compaction at screening mound);
- Steventon –S2 Hanney Road (ground compaction at screening mound and during access road construction);
- Steventon – S3 Haney Road (ground compaction at screening mound and during access road construction);
- East Hanney –EH2 Steventon Road (ground compaction at screening mound and during access road construction); and
- North of East Hanney – NS-EH4 Oxford Road (ground compaction at replacement flood plain storage).

7.90 In considering the above, potential significant adverse effect during vibratory compaction works may arise. However, typical methods to control vibration impacts during compaction are outlined in Section 7.6 and would be adopted by the construction contractor. With the adoption of these measures, such as running start up and run down modes away from sensitive properties and adopting low vibration amplitude or non-vibratory techniques when working in close proximity to sensitive properties, it is anticipated that vibration impacts can be controlled and significant adverse effects can be avoided.

Structural impacts

7.91 With vibration control measures implemented to mitigate human vibration impacts (as outlined in Section 7.6), including operating vibratory compactors on a low vibration amplitude setting and using non-vibratory techniques when working in close proximity to properties, damage to buildings is considered to be unlikely and significant effects are not predicted.

Heavy vehicle movements

7.92 The information presented in Appendix A7.4 Construction Vibration in Technical Supporting Document B2.1, Environmental Appraisal Report (terrestrial) Appendices shows that vibration impacts associated with the movement of heavy lorries on uneven (poor) road surfaces are likely to be <1mm/s PPV at ~2m, while vibration impacts associated with the movement of bulldozers are likely to be in the order of 2.0 to 2.5mm/s PPV at 4m and <1mm/s PPV at 8m.

7.93

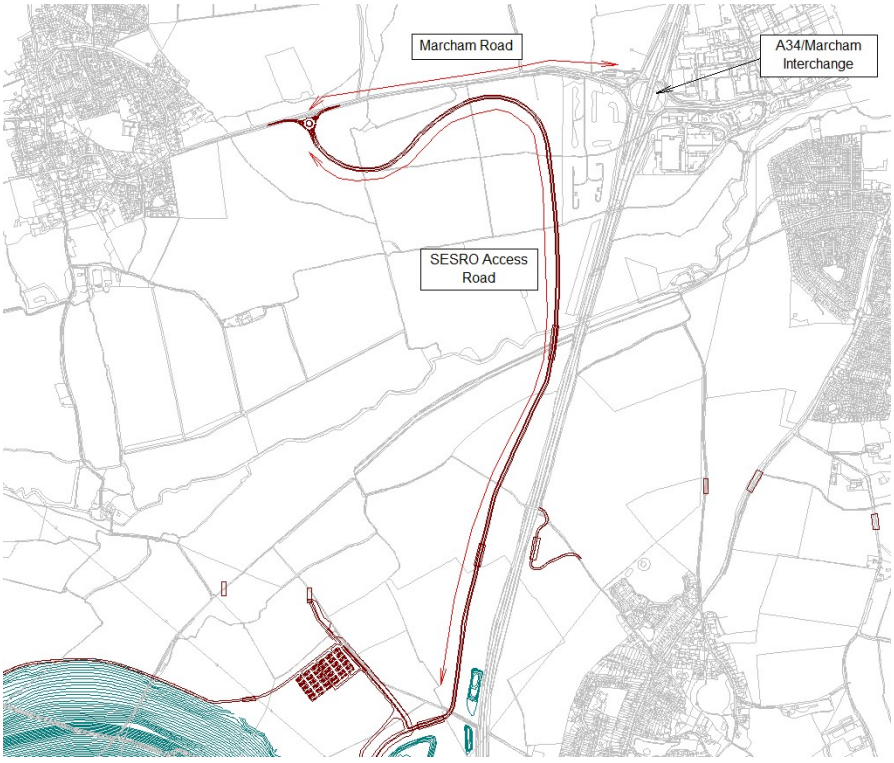
7.94

7.95 Table 7.16 shows that there is the potential for heavy vehicle movements within approximately 3.5m of 160 Hanney Road, Steventon, and as such there is the potential for significant adverse effects (human impact) as a results of heavy vehicle movements. Therefore, restrictions on the use of heavy vehicles in close proximity to this, and where relevant, other residential properties, should apply. In terms of structural impacts, vibration levels are predicted to remain below the threshold for continuous vibration at structurally sound buildings (6mm/s PPV) and as such significant effects would not be anticipated. However, it is recommended that a structural survey be undertaken prior to works commencing and a risk assessment produced. See Section 7.6 for more detail.

7.5.2.3 Construction Road Traffic

7.96 At this time, it is assumed that construction vehicle access to SESRO would be during general site working hours (07:00 to 18:00 weekdays and 07:00 to 13:00 on Saturday) and via the northern access road off Marcham Road and via the A34 Marcham interchange. The proposed access road that would be created for SESRO would be in the order of 4km in length and would be positioned approximately 80 to 150m west of the A34 for much of the length of the road. The A34 Marcham interchange is approximately 1.3km east of the new roundabout that would be created at the junction of the proposed access road and Marcham Road. The proposed construction access road is illustrated in Plate 7.1.

Plate 7.1: Indicative construction access route for SESRO



7.97 Indicative construction traffic flows are presented in the WRMP09 Constructability

Report (2006)[116] and have been used in developing updated construction traffic flows for Gate 2[117]. The forecast traffic flows have been used in the assessment of potential construction noise impacts arising from traffic movements to and from the indicative location for SESRO. A peak daily traffic flow of 458 vehicle movements entering SESRO is forecast, of which 77 would be heavy vehicles (>3.5 tonne). This data has been assessed following the approach set out in Appendix A7.2 Construction Assessment Approach in Technical Supporting Document B2.1, Environmental Appraisal Report (terrestrial) Appendices and the following construction noise levels are predicted:

- 10m from carriageway edge and 15mph average speed – 60dB (facade);
- 10m from carriageway edge and 30mph average speed – 60dB (facade); and
- 10m from carriageway edge and 60mph average speed – 66dB (facade).

7.98 The distance at which the onset of a potentially significant effect may occur, i.e. where construction traffic noise is at 55dBA, are shown below:

- 40m from carriageway edge and 15mph average speed – 55dB (facade);
- 40m from carriageway edge and 30mph average speed – 55dB (facade); and
- 185m from carriageway edge and 60mph average speed – 55dB (facade).

7.99 No noise sensitive properties have been identified within 185m of the proposed construction access route, and as such no significant construction traffic impacts are anticipated. Furthermore, existing traffic flows (AAWT, derived from AADF) on Marcham Road and the A34 are in the order of 10500 and 46200 (north) to 56600 (south), respectively (see Section 7.5.4 below for operational road traffic flows). As such, traffic noise increases as a result of construction traffic would be predicted to be less than 3dB and again indicate no significant effects are likely.

7.5.2.4 Construction Rail Movements

7.100 Material and equipment would be transported to the indicative location for SESRO during the construction phase via rail movements on the GWML. Indicative rail movements during construction are presented in the WRMP09 Constructability Report (2006)[116] and shows a peak of between 2 and 3 trains per day. The current construction strategy, which assumes unloading of materials between 06:00 and 18:45) considers two trains arriving per day, the first arriving at approximately 05:15 and departing at 12:00, the second arriving at 12:40 and departing at 23:40. A later arrival for the second train of 15:20 (departing at 00:50), is also being considered but would only be practical if the sidings remain open for unloading until 21:00.

7.101 As discussed in Appendix A7.3 Strategic Noise Mapping in Technical Supporting

[116] The Upper Thames Major Resource Development, Upper Thames Reservoir, Constructability Report, version 0.1 (July 2006). Thames Water, prepared by Costain Ltd and the Walters Group

[117] SESRO - Construction Material Delivery Estimate 20220509-output.xlsx (provided by engineering design team on 09 May 2022)

Document B2.1, Environmental Appraisal Report (terrestrial) Appendices and Section 7.4, the noise climate in the vicinity of the GWML would be influenced by existing rail movements. The GWML was included within the strategic noise mapping for England and therefore, has annual train movements of at least 30,000, which equates to an approximate average of 80 movements per day (assuming consistent weekday/weekend flows.

7.102 At this time, details regarding the composition of locomotive(s) and wagons for the proposed trains has not been finalised. Therefore, it is not currently possible to quantify the noise emission that might result from the train movements associated with the construction of SESRO. However, when considering the high number of daily movements that already occur along the GWML, together with the assessment criteria set out in Section 7.3.7 (and Appendix A7.1 Assessment Criteria in Technical Supporting Document B2.1, Environmental Appraisal Report (terrestrial) Appendices), significant construction noise effects are not anticipated.

7.5.3 Summary of construction noise and vibration impacts

7.103 A summary of potential noise and vibration impacts at receptors in the vicinity of the indicative location for SESRO is presented in Table 7.17. As previously stated, with the exception of tunnelling works, it is assumed that all works would take place during general site working hours (07:00 to 18:00 weekdays and 07:00 to 13:00 on Saturday).

Table 7.17: Summary of potential construction noise and vibration impacts

	Works site	Activity	Commentary	Potential significant effect?
MARCHAM				
Construction noise	Works towards north and north-east of indicative location for SESRO	Various construction activities (inc. access road creation, site clearance, ADC excavation, and formation of embankments)	Construction noise levels are predicted to remain below the 65dB $L_{Aeq,T}$ SOAEL (and 55dB $L_{Aeq,T}$ during embankment formation works).	No
	Construction access route (Marcham Road, via A34 interchange)	Road traffic movements	Construction road traffic noise is predicted to remain below 55dB at nearby sample receptors, and	No

	Works site	Activity	Commentary	Potential significant effect?
			noise change is predicted to be <3dB	
Construction vibration	Access road and bridge at emergency discharge channel	Ground compaction & piling	Vibration levels are predicted to be <1.0mm/s at nearby sample receptors	No
ABINGDON				
Construction noise	Works towards north/east of indicative location for SESRO	Site clearance, bridge piling, ADC excavation and fill	Construction noise levels are predicted to exceed the 65dB $L_{Aeq,T}$ SOAEL	**Yes**
	Construction access route (Marcham Road, via A34 interchange)	Road traffic movements	Construction road traffic noise is predicted to remain below 55dB at nearby sample receptors, and noise change is predicted to be <3dB	No
Construction vibration	Bridge at emergency discharge channel	Ground compaction	Pre-mitigation vibration levels are predicted to be up to 1.1mm/s at nearby sample receptors, but it is anticipated that vibration impacts can be controlled, and significant adverse effects avoided	No, with additional vibration controls outlined in Section 7.6
		Piling	Vibration levels are predicted to be <1.0mm/s at nearby sample receptors	No
Groundborne noise and vibration	Construction of tunnel between SESRO and River Thames	Tunnelling (Tunnel Boring Machine, TBM)	Vibration levels are predicted to be <1.0mm/s and noise	No

	Works site	Activity	Commentary	Potential significant effect?
			levels <20dB at nearby sample receptors	
DRAYTON				
Construction noise	Works towards east of indicative location for SESRO	Construction of screening mounds	Construction noise levels are predicted to exceed the 65dB $L_{Aeq,T}$ SOAEL	**Yes**
Construction vibration	Cutting/levees at emergency discharge channel	Ground compaction	Vibration levels are predicted to be <1.0mm/s at nearby sample receptors	No
	Screening mound	Ground compaction	Pre-mitigation vibration levels are predicted to be up to 1.1mm/s at nearby sample receptors, but it is anticipated that vibration impacts can be controlled, and significant adverse effects avoided	No, with additional vibration controls outlined in Section 7.6
Groundborne noise and vibration	Construction of tunnel between SESRO and River Thames	Tunnelling (Tunnel Boring Machine, TBM)	Vibration levels are predicted to be <1.0mm/s and noise levels in the order of 23dB at nearby sample receptors	No
STEVENTON				
Construction noise	Works towards south-east of indicative location for SESRO	Various construction activities (inc. formation of embankments and screening mounds, service diversions, and access road construction)	Construction noise levels are predicted to exceed the 65dB $L_{Aeq,T}$ SOAEL	**Yes**

	Works site	Activity	Commentary	Potential significant effect?
	Rail sidings	Material handling/ unloading	Construction noise levels are predicted to exceed the 45dB $L_{Aeq,T}$ night-time SOAEL	**Yes**
	Great Western Main Line	Rail movements	Construction rail movements are not anticipated to result in a significant uplift in noise on the GWML	No
Construction vibration	Access road and screening mounds	Ground compaction	Pre-mitigation vibration levels are predicted to be in excess of 20mm/s at least one sample receptor, should vibratory compaction techniques be adopted during access road creation, and in the order of 2.5mm/s during the formation of screening mounds. However, it is anticipated that vibration impacts can be controlled and significant adverse effects avoided	No, with additional vibration controls outlined in Section 7.6
EAST HANNEY				
Construction noise	Works towards west of indicative location for SESRO	Various construction activities (inc. site clearance, formation of embankments and screening mounds, service diversions, bridge piling and flood plain storage construction)	Construction noise levels are predicted to exceed the 65dB $L_{Aeq,T}$ SOAEL	**Yes**

	Works site	Activity	Commentary	Potential significant effect?
	Rail sidings	Material handling/ unloading	Construction noise levels are predicted to exceed the 45dB $L_{Aeq,T}$ night-time SOAEL	**Yes**
Construction vibration	Access road and screening mounds	Ground compaction	Pre-mitigation vibration levels are predicted to be in excess of 11mm/s at least one sample receptor, should vibratory compaction techniques be adopted during access road creation and the formation of screening mounds. However, it is anticipated that vibration impacts can be controlled, and significant adverse effects avoided	No, with additional vibration controls outlined in Section 7.6
NORTH/SOUTH OF EAST HANNEY (NR OXFORD RD)				
Construction noise	Replacement flood plain storage	Construction of replacement flood plain storage	Construction noise levels are predicted to exceed the 65dB $L_{Aeq,T}$ SOAEL	**Yes**
	Rail sidings	Material handling/ unloading	Construction noise levels are predicted to exceed the 45dB $L_{Aeq,T}$ night-time SOAEL	**Yes**
	Great Western Main Line	Rail movements	Construction road movements are not anticipated to result in a significant uplift in noise on the GWML	No
Construction vibration	Access road, screening mounds, watercourse	Ground compaction	Vibration levels are predicted to be	No

	Works site	Activity	Commentary	Potential significant effect?
	culvert at diverted road, and utilities removal		<1.0mm/s at nearby sample receptors	
	Replacement flood plain storage	Ground compaction	Pre-mitigation vibration levels are predicted to be up to 1.0mm/s at nearby sample receptors, but it is anticipated that vibration impacts can be controlled, and significant adverse effects avoided	No, with additional vibration controls outlined in Section 7.6

7.5.4 Operation

7.104 The following potential sources of operational noise have been identified:

- road traffic;
- water intake/ outfall structure; and
- pump station.

7.5.4.2 Operational road traffic

Access Road

7.105 There is the potential for adverse operational impacts arising from increased road traffic movements to and from SESRO. As with construction traffic movements, it is assumed that the majority of movements would be via Marcham Road and the A34 Marcham Interchange.

7.106 Indicative traffic flows are presented in the SESRO Engineering Movement Strategy Report (2021)[118], which states that traffic movements would likely be higher in the summer months, with August likely to experience the peak monthly traffic flows. Section 4 of the Movement Strategy Report presents forecast average daily traffic flows of 571 vehicles during weekdays and 1527 vehicles at the weekend. The SESRO movement strategy has been further developed during the Gate 2 concept design and the Traffic and Transport assessment has revised the visitor estimation for the

[118] SESRO Engineering, Technical Annex A2-3: Movement Strategy Report, revision 1 (June 2021). Affinity Water and Thames Water, prepared by Mott MacDonald

SESRO access road to an average of 430 vehicles per day.

7.107 The Traffic and Transport assessment has not forecast baseline (do-minimum) road traffic flows for the SESRO year of opening. As such, to allow an initial assessment of potential operational traffic noise impacts, existing traffic flows on Marcham Road and the A34 have been derived using the DfT Road Traffic Count website[119], and converted to indicative AAWT,18hr equivalent flows[120].

7.108 The forecast uplift in average vehicle movements on Marcham Road and the A34 is predicted to result in an increase of <10%, which would result in an imperceptible increase in traffic noise of <1dB. As such, based on the assessment approach outlined in Section 7.3.7, no significant effects are anticipated.

Steventon to East Hanney Road

7.109 In addition to the proposed new access road north of the indicative location for SESRO, road traffic noise impacts would also be altered at properties in (and between) Steventon and East Hanney villages as a result of the closure of the existing Hanney Road between the two villages and creation of a new road directly south of SESRO. No change in traffic flow between the current Hanney Road and the proposed new diverted road is forecast[121].

7.110 A review of the proposed road diversion for the current indicative location for SESRO shows that:

- East Hanney: properties on Hanney Road, east of the junction with Oxford Road, are likely to experience a reduction is road traffic flow as a result of the road closure. Properties south of East Hanney, including Station Road, would experience an increase in traffic flow.
- Steventon: Hanney Road (sample receptors S2 and S3) would experience similar traffic flows.
- Between East Hanney and Steventon: all of the properties located between the villages would be demolished as part of SESRO.

7.111 Based on the review of the proposed diversion route and existing road between Steventon and East Hanney, it is likely that noise impacts resulting from road traffic movements would be generally neutral or slightly beneficial for nearby properties.

[119] Road Traffic Statistics. roadtraffic.dft.gov.uk [accessed 09 May 2022].
[120] 0.77 conversion factor applied to convert from AADF to AAWT,18hr flows. Conversion factor from Traffic and Transport assessment. Derived baseline AAWT flow for Marcham Road 10527 (with 3.6% HGV), A34 North 46192 (with 10.4% HGV), A34 South 56607 (with 9.8% HGV).
[121] Confirmed by Traffic and Transport assessment that the working assumption is there would be no increase to traffic on the Steventon – East Hanney road due to SESRO traffic. As such, at this time it has been assumed traffic flows, speeds and composition of light and heavy vehicles would remain broadly comparable.

7.5.4.3 Pump station and water intake/ outfall structure

7.112 A quantitative assessment of potential operational noise impacts associated with the proposed Above Ground Infrastructure (AGI), namely the pumping station positioned north-east of the indicative location for SESRO and the intake/outfall structure where the proposed tunnel terminates at the River Thames, has not been possible at this time. A high-level qualitative assessment of the two AGIs has been undertaken, with the consideration of noise and vibration control measures that could be used during the detailed design phase, provided in Section 7.6.

7.113 Potential operational noise impacts associated with the AGIs would be assessed using the approach detailed within BS 4142[102]. This would involve establishing targets based on prevailing background (L_{A90}) sound levels at nearby properties and would be subject to agreement with the relevant Local Authorities (Oxfordshire County Council and Vale of White Horse District Council).

7.114 The proposed pump station would be located directly north-east of the reservoir in the current indicative location for SESRO. In this location, the pump station would be over 700m from the nearest noise sensitive receptor location on Whitehorns Way, Drayton. The pump station would also be separated from the receptors by the A34, which would be the dominant noise source at the receptors. As such, no significant noise effects due to the operation of the pump station would be anticipated.

7.115 The proposed river intake/outfall structure is located adjacent to the River Thames, approximately 3.1km east of the proposed pump station. The structure would be approximately 360m from the closest noise sensitive property, which is located east of the intake/outfall structure on the opposite side of the river. Existing background sound levels at this location are likely to be relatively low; therefore, noise from the intake/outfall structure may be audible, with potential acoustic characteristic penalties (as per BS 4142[102]), such as for tonality or intermittency. However, with the implementation of noise and vibration control measures within the design of the structure (such as those described in Section 7.6) it would be anticipated that significant effects would be avoided.

7.5.5 Alternative options

7.116 The section provides a high-level commentary on how noise and vibration impacts associated with the alternative sized reservoir options. Table 7.18 discusses how the assessment presented above for the largest SESRO option would likely differ between the various alternative reservoir options.

Table 7.18: SESRO alternative reservoir options comparison

SESRO Option			
125Mm^3 capacity reservoir	**100Mm^3 capacity reservoir**	**75Mm^3 capacity reservoir**	**80/42 and 30/100Mm^3 capacity, two-phase construction reservoirs**
Construction noise			
This design option has a similar footprint to the largest SESRO option and based on the approximate distances between SESRO and other nearby villages/ properties, no significant change in construction noise impact, compared to the largest SESRO option, would be anticipated.	The embankments and, to a lesser extent, the flood plain storage area, are located further from East Hanney village for this option than in the largest SESRO option, which would result in lower levels of construction noise in East Hanney.	The embankments and flood plain storage area are located further from East Hanney village for this option than in the largest SESRO option, which would result in lower levels of construction noise in East Hanney.	These options are similar in overall footprint to the largest SESRO option and based on the approximate distances between SESRO and other nearby villages/ properties, no significant change in construction noise impact, compared to the largest SESRO option, would be anticipated.
Construction vibration			
As above for construction noise, construction vibration impacts are likely to be broadly comparable to those presented for the largest SESRO option.	As above for construction noise, construction vibration impacts are likely to be lower in East Hanney (due to an increased offset distance between SESRO and the village) than those predicted for the largest SESRO option.	As above for construction noise, construction vibration impacts are likely to be lower in East Hanney (due to an increased offset distance between SESRO and the village) than those predicted for the largest SESRO option.	As above for construction noise, construction vibration impacts are likely to be broadly comparable to those presented for the largest SESRO option.
Groundborne noise and vibration (tunnelling) Note: It is assumed that the realigned pipeline tunnel that is included in the latest concept design for the largest SESRO option would be adopted for all options			
Impacts would be comparable to those resulting from the largest SESRO option.			

SESRO Option			
125Mm^3 capacity reservoir	100Mm^3 capacity reservoir	75Mm^3 capacity reservoir	80/42 and 30/100Mm^3 capacity, two-phase construction reservoirs
Construction road traffic			
No significant change in access road location. So, assuming construction traffic flows remain broadly comparable, impacts would be comparable to those resulting from the largest SESRO option.			
Construction rail movements			
It is assumed that the rail siding options would not differ significantly from the option included in the largest SESRO option and that rail movements would remain comparable. As such, construction rail noise impact would be comparable to those resulting from the largest SESRO option.			
Operational noise			
The sources of operational noise (namely road traffic of the access road and the Steventon to East Hanney road, and the pump station and water intake/outfall structure) would remain broadly consistent between the design options. As such, operational noise impacts would be comparable to those resulting from the largest SESRO option.			

7.117 The smaller capacity options (75 and 100Mm^3) would likely result in lower construction noise and vibration impacts at properties in East Hanney, and as such these would be considered preferred options in terms of noise and vibration impacts.

7.6 Mitigation

7.118 This section details noise and vibration control measures that would be considered, and where practicable, implemented, during the construction of SESRO and during the detailed design of elements of SESRO that have the potential to generate noise emissions during operation.

7.119 Embedded mitigation, namely the earth screening mounds incorporated into the current concept design for SESRO, have been considered in the noise assessment. The screening mounds vary in height from approximately 2m when located close to sensitive properties, up to approximately 10m where they are positioned between sensitive receptors and the reservoir embankments.

7.6.2 Construction

7.6.2.1 Noise and vibration management – general provision

7.120 The works would be carried out in accordance with Best Practicable Means as defined in Section 72 of the Control of Pollution Act 1974[122] and in accordance with the recommendations of BS 5228 part 1[88] and part 2[89].

7.121 The contractor would undertake a risk assessment prior to commencing works, based on the latest construction methodology and design information, and used to update/supplement the assessments presented in this environmental assessment report.

7.122 The contractor would develop and implement a noise and vibration control strategy in order to minimise construction noise and vibration emissions at nearby receptors. Where appropriate, this may include agreeing noise and vibration limits at receptors. This strategy would be documented in a Construction Environmental Management Plans (CEMP) and agreed with the Local Planning Authority.

7.123 The mitigation measures outlined below are indicative of the measures implemented on major infrastructure projects and therefore would be appropriate to be applied to SESRO:

- where possible works would be programmed to take place on weekdays (or Saturday mornings, where necessary) during general site working hours as set out in Section 7.3.4;
- Construction plant would be operated and maintained appropriately, having regard to the manufacturer's recommendations or using other appropriate operation and maintenance programmes that reduce noise and vibration emissions. All vehicles and plant would be switched off when not in use;
- Vehicle and mechanical plant would be fitted with effective exhaust silencers;
- The use of silencers on pneumatic tools;
- Construction plant and activities would be positioned so as to minimise noise at sensitive locations (where practicable), for example locating generators away from site boundaries if there are nearby properties or community assets;
- The use, where necessary, of effective sound reducing enclosures or barriers;
- Haul roads would be well maintained and avoid steep gradients;
- Start up plant and equipment would be done sequentially and start up and run down of plant in the vicinity of sensitive properties avoided;
- Where refined predictions demonstrate potential for significant adverse vibration effects, low amplitude vibratory compaction or non vibratory compaction techniques would be adopted. Piling methods adopted during construction would be selected to minimise potential noise and vibration impacts where practicable,

[122] Her Majesty's Stationery Office (1974). Control of Pollution Act. London, HMSO

for example adopting auger bore (continuous flight auger (CFA)) methods rather than vibratory piling methods where ground conditions allow;

- Heavy vehicle movements should not be permitted in close proximity to sensitive properties, e.g. 160 East Hanney (distances to be confirmed by the construction contractor once appointed and plant and construction methods are known);
- Community engagement would be established and would give notice of when construction activities would take place and their duration, as well as the measures in place to reduce nuisance; and
- Prior to any works commencing, structural surveys would be undertaken at properties identified to be subject to vibration impacts during the works. Properties would be initially identified from the environmental assessment (to be reviewed at a later design stage), with the list kept under review through the detailed design stage once construction methods are fixed. Risk assessments would be undertaken by the construction contractor when appointed. The structural surveys would be undertaken by an independent structural engineer. The surveys would be used to determine whether a building is in any way structurally unsound and also inform construction working methods.

7.6.2.2 Noise and vibration monitoring

7.124 Noise and vibration sensitive locations adjacent to the construction site areas would be identified in consultation with the relevant Environmental Health Officer(s).

7.125 Baseline noise and vibration monitoring (e.g. prior to the commencement of construction) and monitoring during construction would be undertaken where appropriate, based on the findings of the contractor's risk assessments and agreement with the local planning authority (Oxfordshire County Council and Vale of White Horse District Council).

7.6.3 Operation

7.126 The intake/outfall building, and pump station would include a number of different noise sources (for example pumps, compressors, and mechanical ventilation systems) and all have the potential to generate noise that may be audible at nearby sensitive receptors. Acoustic control measures would be integrated into the design of the permanent AGI. This section discusses the noise control measures that may be incorporated in the final design of the AGIs.

7.127 The overriding principles of noise control are set out in Table 7.19.

Table 7.19: Hierarchy of noise/vibration control

	Description
Preferred option	Remove noise source (e.g. change process)
	Replace the noise source (e.g. quieter equipment available)

	Description
	Manage the source (e.g. restrict operating times)
	Control at source (e.g. enclose the noise source, close gaps in buildings)
	Control along the transmission path (e.g. erect a barrier)
Least favoured option	Control at receiver (e.g. secondary glazing/ PPE)

7.128 Noise and vibration control options can be broadly defined as:

- enclosures;
- barriers;
- muffling devices; and
- vibration isolation control measures.

7.6.3.2 Enclosures

7.129 Enclosing static plant items to reduce noise impact can be an effective control measure where operating requirements such as the need for access to undertake periodic maintenance activities or observations permit. One of the main considerations where such noise control measures are to be deployed is the potential build-up of sound energy within the enclosure. In such circumstances, the enclosure may become a more aurally hazardous working environment, and as such it may be necessary to consider both the acoustic performance of the enclosure in terms of sound transmission through the surfaces and reflections within the enclosure. Acoustically hard surfaces, such as masonry and steel, would allow more reflection of sound, consequently resulting in a highly reverberant environment inside the enclosure. As such, applying absorbent materials to internal surfaces can reduce internal noise levels and potentially the emission of sound energy from the structure to atmosphere (for example).

7.6.3.3 Barriers

7.130 The use of acoustic screening along the sound transmission path can effectively reduce noise levels at the receiver point. For a suitable length of noise barrier, the level of noise control is related to the height of the screening object relative to the noise source and receiver. At grazing incidence, i.e. where the noise source is just visible from the receptor location over the screening object, the level of noise reduction is approximately 5dB, with greater levels of noise reduction achieved where the path difference increases.

7.131 For noise barriers to be effective, it is important that they are free from any gaps and are of sufficient surface density[123].

[123] ISO 9613 Acoustics – Attenuation of sound during propagation outdoors, Part 2 General method of calculation, Section 7.4 states 'surface density is at least 10 kg/m^2.

7.6.3.4 Muffling Devices

7.132 Muffling devices are often referred to as silencers, and are commonly used to reduce noise associated with, for example, internal combustion engine exhausts, high pressure gas or steam vents, compressors and fans.

7.133 Muffling devices may function by:

- suppressing the generation of noise at source;
- attenuate noise that has already been generated; or
- redirect noise away from sensitive areas.

7.134 Muffling devices may be designed to employ one or any combination of the functions listed above.

7.6.3.5 Vibration Isolation

7.135 Vibrations occur to some degree in all industrial machinery and can occur on a surface either due to mechanical excitation (e.g. resulting from forces generated by mechanical equipment) or acoustical excitation (e.g. resulting from the acoustic field of the equipment).

7.136 Vibration isolators are a common form of vibration control, and work by inhibiting the transmission of vibration from a piece of equipment (such as a pump) to the surrounding environment, thereby reducing the potential noise and vibration impacts associated with the item of equipment. The four resilient materials most commonly used for this type of application are:

- rubber compression or shear pads;
- metal springs or mesh pads;
- cork compression pads; and
- felt compression pads.

7.137 The most suitable form of vibration isolator would be dependent upon the characteristics of the vibration (namely the level of deflection (mm), and natural frequency (Hz)), and the environment (e.g. oily, corrosive, etc).

7.7 Next steps

7.138 The assessment of noise and vibration impacts associated with the construction of SESRO shows there is the potential adverse effects at nearby sensitive receptors. The impacts associated with the operation of SESRO are not predicted to result in significant effects.

7.139 The next steps in terms of noise and vibration would involve:

- An update to the construction assessment presented in this Gate 2 chapter when the design is further developed and when Early Contractor Involvement (ECI) is available to inform the likely construction strategy. This would include more detailed consideration of construction road and rail impacts during construction[124] and tunnelling.
- Baseline sound level monitoring to define noise limits at noise sensitive receptors, this is particularly relevant for the assessment of potential operational noise impacts.
- Consideration of potential impacts arising from the operation of SESRO.
- Noise and vibration mitigation would remain embedded in the design of SESRO, this would include adopting best practice (as detailed in Section 7.6) for construction mitigation and in the design of AGIs, for example. More detailed consideration of noise and vibration mitigation to control construction and operational impacts would also be considered as the design for SESRO is further developed.

[124] Rail noise assessment - further details regarding numbers and types of locomotives and wagons to be used, with predictions made using the prediction methodology detailed within CRN

8. Soils, Geology and Contaminated Land

8.1 Introduction

8.1 Building on the work undertaken to support the Gate 1 process, this chapter presents an environmental appraisal of the potential soils, geology and contaminated land impacts associated with SESRO.

8.2 This chapter sets out the key legislation and policy relevant to soils, geology and contaminated land followed by the methodology and study area used for the environmental appraisal. An analysis of the baseline is presented, followed by an appraisal of the effects of SESRO and an evaluation of their significance. An overview of likely mitigation measures that may be adopted to avoid, reduce or offset any potential effects is provided followed by recommendations for further work.

8.3 This chapter focusses on the largest SESRO option (i.e. 150Mm^3) with narrative provided on the relative performance of the alternative reservoir options (i.e. 125Mm^3, 100Mm^3, 75Mm^3, 30+100Mm^3 and 80+42Mm^3).

8.4 This chapter is supported by Appendix A8.1 Zetica UXO Preliminary Desk Study Assessment which can be found in Supporting Document B2.1, Environmental Appraisal Report (terrestrial) Appendices.

8.5 This chapter is supported by the following figures which can be found in Supporting Document B2.2, Environmental Appraisal Report (terrestrial) Figures:

- Figure 8.1 Bedrock Geology and Aquifer Properties;
- Figure 8.2 Superficial Geology and Aquifer Properties;
- Figure 8.3 SESRO Agricultural Land Classification; and
- Figure 8.4 Unexploded Ordnance.

8.2 Legislation and policy

8.6 The relevant legislation for this geology, soils and contaminated land assessment is set out in Table 8-1.

Table 8-1: Relevant legislation

Legislation	Description	Relevance to assessment
Part 2A of the Environmental Protection Act (EPA) 1990	Part 2A of the EPA sets out the legislative framework for dealing with historically contaminated land including the requirement to take action where there are 'unacceptable risks to human health and the	Risks to human health and the environment have been assessed to determine whether action is required to deal with past land contamination.

Legislation	Description	Relevance to assessment
	environment', based on the 'suitable for use' approach.	
The Contaminated Land (England) Regulations 2006	These Regulations make provision for the identification and remediation of contaminated land under Part 2A of the Environmental Protection Act 1990.	Risks to human health and the environment have been assessed to determine whether action is required to deal with past land contamination.
Water Resources Act 1991	The Act regulates pollution, water quality, flood defence and discharges to controlled waters in England and Wales.	Contamination risks to controlled waters have been assessed to determine whether action is required to deal with potential past land contamination. Mitigation measures have been identified where relevant.

8.7 Table 8-2 sets out relevant planning policy for geology, soils and contaminated land.

Table 8-2: Relevant Planning Policy

Policy	Description	Relevance to this assessment
National		
National Planning Policy Framework[125]	The National Planning Policy Framework sets out the government's planning policies for England and how they are expected to be applied by local planning authorities. The relevant national planning policy and associated guidance with respect to contaminated land are presented in the section on ground conditions and pollution. Paragraph 178 states "Planning policies and decisions should ensure that: a) a site is suitable for its proposed use taking account of ground conditions and any risks arising from land instability and contamination."	An assessment of the potential sources of contamination which could impact the development will be undertaken by means of desk studies.
Draft National Policy Statement for Water	The Draft National Policy Statement for Water Resources Infrastructure sets out the need and government's policies for development of nationally	The sections of the policy statement relevant to soils, geology and contaminated land are:

[125] (Ministry of Housing Communities and Local Government, 2019)

Policy	Description	Relevance to this assessment
resources Infrastructure[126]	significant infrastructure projects (NSIPs) for water resources in England. Applications for development are assessed using these criteria.	4.10 – Land use 4.12 – Resource and Waste Management 4.15 – Water Quality and resources

8.8 Table 8-3 provides a summary of relevant geology, soils and contaminated land guidance for this assessment.

Table 8-3: Relevant Guidance

Guidance	Description	Relevance to this assessment
Environmental Protection Act 1990: Part 2A Contaminated Land Statutory Guidance[127]	Section 57 of the Environment Act 1995 created Part 2A of the Environmental Protection Act 1990 which establishes a legal framework for dealing with contaminated land in England. The guidance is intended to explain how local authorities should implement the regime, including how they should go about deciding whether land is contaminated land in the legal sense of the term.	Potential effects to human health and the environment will be assessed and recommendations will be given for obtaining data to establish whether the indicative location for SESRO contains significant levels of contamination.
Construction Code of Practice for the Sustainable Use of Soils on Construction Sites[128]	This guidance gives advice on good practice for maintaining soil quality and structure during construction.	The approach set out in this guidance has been considered in reviewing mitigation for the protection of soils.
The Definition of Waste: Development Industry Code of Practice[129]	This guidance gives advice on determining if material is waste and principles of the use of material as	The approach set out in this guidance has been considered in reviewing mitigation for the reuse of soils.

[126] (Department for Environment, Food & Rural Affairs, 2018)
[127] (Defra, 2012)
[128] (Defra, 2009)
[129] (CLAIRE, 2011**,** The Definition of Waste: Development Industry Code of Practice (DoWCoP))

Guidance	Description	Relevance to this assessment
	non-waste through the development of a Material Management Plan.	
Guide to Assessing Development Proposals on Agricultural Land[130]	This guidance sets out the government policies and legislation that should be followed when considering development proposals that affect agricultural land and soils.	The approach set out in this guidance has been used to assess the potential impacts to agricultural land.
Agricultural Land Classification (ALC) of England and Wales: revised guidelines and criteria for grading the quality of agricultural land[131]	This document provides guidelines and criteria for grading the quality of agricultural land.	The grading for ALC from the guidance document has been used to inform the assessment the agricultural land within the study area.
Technical Information Note 049 (TIN049)[132]	This technical note gives information on the Agricultural Land Classification system in England, legislation and how classifications are derived.	This technical note has been used to inform the assessment of agricultural land within the study area.
Land Contamination: Risk Management (LCRM)[133]	This guidance sets out a UK risk-based approach for the management of land contamination.	This approach has been used to inform the contamination assessment. Recommendations for further assessment will be based on the procedures set out in this guidance.
Design Manual for Roads and Bridges (DMRB) guidance documents LA 104 Environment Assessment and	LA 104 sets out the requirements for environmental assessment, including reporting and monitoring	Although DMRB guidance has been developed for highways schemes, the assessment criteria given in the guidance documents can be applied to other infrastructure projects. This assessment uses the general principles

[130] (Natural England, 2021)
[131] (Ministry of Agriculture, Fisheries and Food, 1988)
[132] (Natural England's Technical Information Note 049 Agricultural Land Classification: protecting the best and most versatile agricultural land (TIN049)
[133] (Environment Agency, 2019)

Guidance	Description	Relevance to this assessment
Monitoring[134], LA 109 Geology and Soils[135] and LA 113[136] Road drainage and the water environment	of significant adverse environmental effects. LA 109 sets out the requirements for assessing and reporting the effects of highway projects on geology and soils. LA 113 sets out the requirements for assessing and reporting the effects of highway projects on controlled waters.	set out in these guidelines with respect to an initial assessment of likely impacts to geology, soils, human health and groundwater

8.9 The legislation, policies and guidance listed have been considered in the assessment of the potential effects on geology, soils and contaminated land in this chapter as a result of the largest SESRO option and in the development of appropriate mitigation measures.

8.3 Methodology

8.10 This assessment was undertaken through a review of available desk-based source material and a site walk over within the indicative location for SESRO.

8.3.2 Sources of Information

8.11 The following sources of information have been consulted in the preparation of this report:

- BGS GeoIndex online;
- Google earth and Google maps;
- National Library of Scotland online historical map portal, accessed 2021 and 2022 (contains historical maps for wider UK);
- MAGIC online map;

[134] Highways England et al. (2019a). Design Manual for Roads and Bridges, LA 104 Environmental assessment and monitoring (LA 104).
[135] Highways England et al. (2019b). Design Manual for Roads and Bridges, LA 109 Geology and Soils (LA 109).
[136] Highways England et al. (2020). Design Manual for Roads and Bridges, LA 113 Road Drainage and the water environment (LA 113).

- Groundsure Enviro + Geo Insight report and GIS shapefiles / layers, GSIP-2021-12379-8636_A, 18/01/2022;
- Documents reporting on various previous studies covering the indicative location for SESRO;
- Thames Valley Environmental Records Centre: Local Geological sites (formerly RIGS); and
- Oxfordshire County Council, Adopted Mineral and Waste Core Strategy and accompanying Minerals and Waste Local Plan Policies Map South[137].

8.12 The study area encompasses the indicative location for SESRO and a 250m buffer.

8.4 Sensitivity and magnitude

8.13 The assessment approach follows the general methodology outlined in DMRB LA104[134], DMRB LA109[135] relevant to geology, soils and human health and DMRB LA113[136] relevant to groundwater, in that it considers the likely effects of the development based on the sensitivity of the receptors and a preliminary assessment of the magnitude of the impacts with respect to contamination as described in Table 8-4 and 8-5 below. These tables have been adapted from those in the DMRB guidance to better reflect the context of SESRO. This approach covers all SESRO options.

8.14 The assessments of potential impacts to surface water are based on the information presented in SESRO Supporting Document B1 Environmental Assessment Report (Aquatic). Sensitivity criteria are therefore not included in Table 8-4 below. Professional judgement has been used to assess the preliminary potential surface water impacts and it is possible that the criteria used may be revised as more surface water studies are undertaken and more information becomes available.

Table 8-4: Receptor sensitivity

Sensitivity	Criteria
Very high	Geology: very rare and of international importance with no potential for replacement (e.g. UNESCO World Heritage Sites, UNESCO Global Geoparks, Sites of Special Scientific Interest (SSSIs) and Geological Conservation Review (GCR) sites where citations indicate features of international importance). Geology meeting international designation citation criteria which is not designated as such. Soils: soils directly supporting an EU designated site (e.g. Special Areas of Conservation, Special Protection Area, Ramsar); and / or ALC grade 1 & 2. Human health: very high sensitivity land use such as residential or allotments.

[137] Oxfordshire County Council (2017). Adopted Mineral and Waste Core Strategy and accompanying Minerals and Waste Local Plan Policies Map South. Online. Available at: https://www.oxfordshire.gov.uk/residents/environment-and-planning/planning/planning-policy/minerals-and-waste-policy/adopted-core-strategy. Accessed February 2022.

Sensitivity	Criteria
	Groundwater: Principal aquifer providing a regionally important resource and/or supporting a site protected under EC and UK legislation. Groundwater locally supports Groundwater Dependant Terrestrial Ecosystem (GWDTE). Source Protection Zone (SPZ) 1.
High	Geology: rare and of national importance with little potential for replacement (e.g. geological SSSI, Areas of Special Scientific Interest, National Nature Reserves). Geology meeting national designation citation criteria which is not designated as such. Soils: soils directly supporting a UK designated site (e.g. SSSI); and / or ALC Subgrade 3a. Human health: High sensitivity land use such as public open space. Groundwater: Principal aquifer providing locally important resource or supporting a river ecosystem. Groundwater supports a GWDTE. SPZ2
Medium	Geology: of regional importance with limited potential for replacement (e.g. Local Geological Sites (LGS)). Geology meeting regional designation citation criteria which is not designated as such. Soils: soils supporting non-statutory designated sites (e.g. Local Nature Reserves and Sites of Nature Conservation Importance); and / or ALC Subgrade 3b. Human health: medium sensitivity land use such as commercial or industrial. Groundwater: Aquifer providing water for agricultural or industrial use with limited connection to surface water. SPZ3.
Low	Geology: of local importance / interest with potential for replacement (e.g. non designated geological exposures, former quarries / mining sites). Soils: ALC grade 4 & 5; and / or soils supporting non-designated notable or priority habitats. Human health: low sensitivity land use such as highways and rail. Groundwater: Unproductive strata
Negligible	Geology: no geological exposures, little / no local interest. Soils: previously developed land formerly in 'hard uses' with little potential to return to agriculture. Human health: undeveloped surplus land / no sensitive land use proposed. Groundwater: N/A

8.15 Table 8-5 sets out the criteria used for assessing the magnitude of effects on geology, soils, human receptors, groundwater and surface water.

Table 8-5: Magnitude of effects and typical descriptions

Magnitude	Typical criteria descriptors	Criteria
Major	Adverse - Loss of resource and/or quality and integrity of resource; severe damage to key characteristics, features or elements.	Geology: loss of geological feature / designation and/or quality and integrity, severe damage to key characteristics, features or elements. Total loss/sterilisation of the identified reserve/resource. Soil: physical removal or permanent sealing of soil resource or agricultural land greater than 20 hectares (ha). Human health: significant contamination identified. Contamination levels significantly exceed background levels and relevant screening criteria (e.g. category 4 screening levels) with potential for significant harm to human health. Contamination heavily restricts future use of land. Surface Water: Major permanent or long-term change to water quality. Irreparable impact on existing resource use. Changes to quality or water table level would have an impact on local ecology. Groundwater: Loss of, or extensive change to, an aquifer. Loss of regionally important water supply. Loss of, or extensive change to GWDTE or baseflow contribution to protected surface water bodies. Reduction in water body WFD classification.
	Beneficial - Large scale or major improvement of resource quality; extensive restoration; major improvement of attribute quality.	Geology: Extraction and beneficial reuse of the identified reserve/resource. Soil: Permanent gain or creation of new Best and Most Versatile (BMV) soil resources. Human health: Removal of all identified pollutant linkages that pose a risk to identified receptors. Surface Water: Major permanent or long-term improvement of water quality and local ecology. Groundwater: Removal of existing polluting discharge to an aquifer or removing the likelihood of polluting discharges occurring. Recharge of an aquifer. Improvement in water body WFD classification.

Magnitude	Typical criteria descriptors	Criteria
Moderate	Adverse - Loss of resource, but not adversely affecting its integrity; partial loss of/damage to key characteristics, receptors or elements	Geology: partial loss of geological feature / designation, potentially adversely affecting the integrity; partial loss of/damage to key characteristics, features or elements. Permanent sterilisation of a significant part (greater than 50%) of the identified reserve/resource with extraction and beneficial reuse of a significant part (up to 50%) of the identified reserve/resource. Loss of access to the whole of the identified resource (although the reserve/resource remains intact). Soils: physical removal or permanent sealing of 1ha – 20ha of agricultural land; or permanent loss / reduction of one or more soil function(s) and restriction to current or approved future use (e.g. through degradation, compaction, erosion of soil resource). Human health: contaminant concentrations exceed background levels and are in line with limits of relevant screening criteria (e.g. category 4 screening levels). Significant contamination can be present. Control / remediation measures are required to reduce risks to human health / make land suitable for intended use. Surface Water: Moderate impacts to water quality, predicted to have an impact on resource use and local ecology. Groundwater: Partial loss or change to an aquifer. Degradation of regionally important public water supply or loss of significant commercial/ industrial/ agricultural supplies. Partial loss of the integrity of GWDTE. Contribution to reduction in water body WFD classification.
	Beneficial – Benefit to, or addition of key characteristics, receptors or elements; improvements of attribute quality	Geology: Partial (greater than 50%) or total creation of a geological site of medium value by, for example, exposing geology previously obscured from view or creation of part (between 15% and 50%) of a geological site of high to very high value. Soils: Measurable improvement in quality of BMV soil resources. Human health: Removal of the majority of identified pollutant linkages so that risks to receptors are reduced. Surface Water: Changes to the local water quality predicted to result in a moderate improvement to resources, water quality or to local ecology. Groundwater: Contribution to improvement in water body WFD classification. Improvement in water body catchment abstraction management Strategy (CAMS) (or equivalent) classification. Support to significant improvements in damaged GWDTE.

Magnitude	Typical criteria descriptors	Criteria
Minor	Adverse – Some measurable change in attributes, quality or vulnerability; minor loss of, or alteration to minimal key characteristic, receptors or elements	Geology: minor measurable change in geological feature / designation attributes, quality or vulnerability; minor loss of, or alteration to, one (maybe more) key characteristics, features or elements. Soils: temporary loss / reduction of one or more soil function(s) and restriction to current or approved future use (e.g. through degradation, compaction, erosion of soil resource). Human health: contaminant concentrations are below relevant screening criteria (e.g. category 4 screening levels). Significant contamination is unlikely with a low risk to human health. Best practice measures can be required to minimise risks to human health. Surface Water: Slight changes to water quality not representing a risk to existing resource use or ecology. Groundwater: Minor effects on an aquifer, GWDTEs, abstractions and structures
	Beneficial – Minor benefit to, or addition of, one (or maybe more) key characteristic, receptor or element; some beneficial effect on attribute or a reduced risk of negative effect occurring	Geology: Partial (less than 50%) creation of a geological site of medium value by, for example, exposing geology previously obscured from view. Soils: Measurable improvement in quality of other (non BMV) soil resources. Human health: Removal of some identified pollutant linkages so that risks to receptors are reduced slightly. Surface Water: Slight changes to water quality resulting in a minor improvement to existing resource use or ecology. Groundwater: Reduction of groundwater hazards to existing structures. Reductions in waterlogging and groundwater flooding.
Negligible	Adverse – Very minor loss or detrimental alteration to one (or maybe more) characteristic, receptor or element	Geology: very minor loss or detrimental alteration to one or more characteristics, features or elements of geological feature / designation. Overall integrity of resource not affected. Soils: minor loss / reduction of soil function(s) that restrict current or approved future use. Human health: contaminant concentrations substantially below levels outlined in relevant screening criteria (e.g. category 4 screening levels). No requirement for control measures to reduce risks to human health / make land suitable for intended use.

Magnitude	Typical criteria descriptors	Criteria
		Surface Water: Negligible measurable impact on water quality or ecology. Groundwater: Negligible measurable impact upon an aquifer and/or groundwater receptors
	Beneficial – Very minor benefit to, or positive addition of, one (or maybe more) characteristic, receptor or element	Geology Soils: Minor improvement in other (non BMV) soils. Human health: Removal of very few identified pollutant linkages so that risks to receptors are very slightly reduced. Surface Water: Negligible measurable impact on water quality or ecology. Groundwater: Negligible measurable impact upon an aquifer and/or groundwater receptors.
No Change	No change	Geology: no temporary or permanent loss / disturbance of characteristics features or elements. Soils: no loss / reduction of soil function(s) that restrict current or approved future use. Human health: reported contaminant concentrations below background levels. Surface Water: No measurable impact on water quality or ecology. Groundwater: No measurable impact upon an aquifer and/or groundwater receptors.

8.16 Table 8-5 describes the adverse (negative) and beneficial (positive) effects on geology, soil, human health and controlled waters. Where potentially adverse and beneficial effects are identified, these are outlined in Section 8.6.

8.17 In accordance with DMRB guidance, effects with magnitudes of moderate or major are considered potentially significant.

8.4.2 Site Walkover

8.18 A site walkover using public rights of way (PRoWs) was undertaken in January 2022. This site walkover focused on observing the locations of potential sources of contamination identified from the desk study where possible.

8.4.3 Consultation

8.19 No consultation was undertaken as part of this assessment.

8.4.4 Assumptions and Limitations

8.20 All information accessible for this assessment is assumed up to date and reliable, and where this is not evident, this has been be stated.

8.21 For the January 2022 site walkover access was limited to PRoWs. While suitable for reviewing certain areas of interest, some could not be accessed such as the storage depot off Steventon Road.

8.22 The most recent agricultural land classification detailed soil survey undertaken in 2008/09 was completed before the solar farms were constructed. There is potential for this to have altered the classification of soils around the indicative location for SESRO.

8.23 There is very limited data on soil quality from soil samples across the site therefore information of contamination across the site is lacking.

8.5 Understanding of the baseline

8.5.1 Site history

8.24 Generally, the indicative location for SESRO has remained arable farmland with isolated farm and residential buildings shown on the earliest to the most recent maps reviewed[138,139,140,]. The London to Bristol Great Western Railway train line bounds the southern site extent and the Thames River the eastern site extent. The train line has been present since the 1898 historical mapping. The A34 travels north-south along the eastern part of the indicative location for SESRO and was constructed between 1960 and 1980. The former Wiltshire and Berkshire Canal crosses the indicative location for SESRO from the southwest to the northeast and it is noted as disused on the 1913 mapping.

8.25 A depot, originally Ministry of Defence, was constructed between 1920 and 1950 towards the southern area of the indicative location for SESRO off Steventon Road. Prior to this the area is shown as open fields. The depot has remained mostly the same layout to the present day. 1956 mapping shows various trainline branches off the mainline extending into the depot. On the 1974 mapping these are no longer present. A small Sewage Treatment Works (STW) was originally located in the southwest corner of this depot but has been removed. A small reservoir which formed part of the STW remains visible on current maps.

8.26 There is a STW, gravel pits and landfills located to the east of the indicative location for SESRO, near to and along the routes of the proposed auxiliary drawdown channel and tunnel. The Thames Water STW was constructed between 1960 and 1980. Although not labelled, the symbology on the historical mapping suggests two gravel pits are present in 1980 to the south of the STW. The gravel pit immediately south of

[138]Groundsure Enviro + Geo Insight report and GIS shapefiles / layers, GSIP-2021-12379-8636_A, 18/01/2022
[139] Google Earth and Google Maps Accessed 2021 and 2022
[140] National Library of Scotland online historical map portal, access 2021 and 2022

the STW is present and labelled on 1992 mapping up to the present day, though the other pit to the south of this is no longer shown. The Environment Agency notes this location as a historical landfill. The 1992 mapping shows another gravel pit immediately east of the STW which is shown as a lake in the 2001 mapping.

8.27 A substation to the northwest of Steventon village is shown to have been built between 1950 and 1980. It is still present today.

8.28 Recent aerial imagery shows that two large solar farms were built on the indicative location for SESRO between 2014 and 2017. These are located in the central and north-western areas of the indicative location for SESRO.

8.5.2 Geology

8.29 The bedrock and superficial geology for the indicative location for SESRO is shown in Figures 8. 1 and 8.2.

8.5.2.2 Artificial ground

8.30 The BGS records[141] do not indicate artificial ground within the indicative location for SESRO. Artificial ground is recorded off-site to the immediate north of the Thames Water STW at the eastern end of the indicative location for SESRO. This is Southern Town Park historical landfill.

8.5.2.3 Superficial

8.31 The majority of the indicative location for SESRO is covered by various sand and gravel members. These comprise the Northmoor Sand and Gravel Member Lower Facet, Summertown – Radley Sand and Gravel Member and Wolvercote Sand and Gravel Member. Alluvial deposits are found in the northwest and eastern area as well as a small area along the centre of the indicative location for SESRO. Head deposits can be found in the central and southeast area of the indicative location for SESRO.

8.5.2.4 Bedrock

8.32 The majority of the indicative location for SESRO is underlain by Amphill Clay Formation and Kimmeridge Clay Formation (undifferentiated). A thin strip of Lower Greensand Group sandstone crosses the indicative location for SESRO from the southwest to the east.

8.5.2.5 Mineral Safeguarding Areas (MSA)

8.33 The Oxfordshire County Council Adopted Mineral and Waste Core Strategy and accompanying Minerals and Waste Local Plan Policies Map South[142] has been reviewed. This strategy outlines the Oxfordshire County Council's approach to

[141] BGS GeoIndex online, accessed 2021 and 2022

[142] Oxfordshire County Council, Adopted Mineral and Waste Core Strategy and accompanying Minerals and Waste Local Plan Policies Map South, online (accessed Jan / Feb 2022)

mineral and waste policy and planning across the county up to 2031. The strategy identifies MSAs. MSAs are areas identified by a mineral planning authority as areas of locally or nationally important mineral resources which should not be prevented from being extracted due to non-mineral development. Development should avoid the sterilisation of those mineral resources.

8.34 The Minerals and Waste Local Plan Policies Map South shows there are no MSAs located on site or within 250m of the indicative location for SESRO.

8.35 However, local gravel extraction planning permission has been approved for the expansion west of the current gravel extraction pit located at the eastern end of the indicative location for SESRO.

8.5.2.6 Local Geological Sites (LGSs)

8.36 The Thames Valley Environmental Records Centre keeps the record of LGSs (formerly RIGS - Regionally Important Geological and Geomorphological Sites)[143]. These sites exhibit important geological and geomorphological features and range from sarsen stones and rock outcrops to geological faces in active quarries. For Oxfordshire these are designated by the Oxfordshire Geology Trust.

8.37 The LGS map for Oxfordshire indicates there are no sites within the indicative location for SESRO or within 250m.

8.5.2.7 Aquifers

8.38 The alluvium, sand and gravel superficial deposits across the indicative location for SESRO are secondary A aquifers while the Head deposits are secondary undifferentiated aquifers.

8.39 The Amphill Clay Formation and Kimmeridge Clay Formation are noted as unproductive aquifers. The Lower Greensand Group is noted as a secondary A aquifer.

8.40 There is no Source Protection Zone within 250m of the indicative location for SESRO[144].

8.5.2.8 Surface Water

8.41 See SESRO Supporting Document B1 Environmental Assessment Report (Aquatic) for detailed information on the surface water bodies located within the indicative location for SESRO and the surrounding area.

8.42 There are various main rivers, named ordinary watercourses (streams and ditches) and unnamed watercourses across the indicative location for SESRO. These are shown in the SESRO Supporting Document B1 Environmental Assessment Report

[143] Thames Valley Environmental Records Centre: Local Geological sites (formerly RIGS) website: (accessed Jan/Feb 2022)
[144] MAGIC online map: https://magic.defra.gov.uk/ (accessed Jan / Feb 2022)

(Aquatic).

8.5.2.9 Agricultural Land Classification (ALC)

8.43 A soil survey of the indicative location for SESRO was undertaken over the period 2008 – 2009 and identified the majority of the site to comprise of soils of ALC grade 3a and 2. This would categorise them as BMV. A plan showing the soil grades across the indicative location for SESRO area identified from this survey is presented in Figure 8.3. Table 8-6 presents the results of this soil survey.

Table 8-6: Results of the 2008/9 soil survey of the indicative location for SESRO.

Grade	Areas of agricultural land within the indicative location for SESRO	
	Approximate Hectares (ha)	**Approximate Percentage (%)**
Grade 2	158.7	10
Grade 3a	929.2	58.5
Grade 3b	492.9	31
Grade 4	6.9	0.4
Un-surveyed agricultural land	57.7	-
Total agricultural land	1645.5	-
Other land	110	-
Total land	1755.7	-

Note: This survey does not cover the entire indicative location for SESRO. Some small areas were not accessible at the time of the survey.

8.44 Two solar farms have been built in the area since the 2008/2009 survey. They now cover areas previously identified as BMV. It is unclear what impacts the solar farm developments may have had on ALC.

8.5.3 Land Quality

8.45 The potential sources of contamination identified within the indicative location for SESRO and 250m buffer are described below.

8.5.3.2 Landfills

Historical Landfills

8.46 The EA records indicate there are no historical landfills located within the indicative location for SESRO however there are four that are located within 250m of the boundary. These are discussed below.

8.47 Sutton Wick No.1 landfill is located to the east of the site. The license was issued in 1981 and never surrendered. The landfill is recorded to have accepted inert, industrial, household, special and liquid sludge waste. The recorded first input date is 1981. There is no recorded last input date.

8.48 Southern Town Park landfill is located to the east of the indicative location for SESRO, directly north of the Thames Water STW. Records indicate that the landfill license was held by Vale of White Horse District Council and Residential. The license was issued in 1978 and never surrendered. The landfill is recorded to have accepted inert, commercial, household and liquid sludge waste. The recorded first and last input dates are 1967 and 1978 respectively.

8.49 Drayton Golf Course landfill is located to the south of Drayton village to the east of the indicative location for SESRO. The license was issued in 1977 and surrendered in 1984. The landfill is recorded to have accepted inert, commercial, household and liquid sludge waste. The recorded first and last input dates are 1977 and 1990 respectively.

8.50 Drayton landfill is located to the south of Drayton to the east of the indicative location for SESRO, south of the A34. The license was issued in 1979 and surrendered in 1993. The landfill is recorded to have accepted inert and industrial waste. The recorded first and last input dates are 1977 and 1982 respectively.

Authorised Landfills

8.51 The EA records indicate there are no active or current landfills located within the indicative location for SESRO however there is one located within 250m of the boundary.

8.52 Hales Waste Control Ltd landfill is located to the east of the indicative location for SESRO. Records indicate that this landfill is in closure. The landfill is recorded as taking non-biodegradable wastes. There are no recorded input dates or closure date.

8.53 This landfill was observed during the January 2022 site walkover. Apparent landfill management infrastructure was observed including gas management and monitoring boreholes. Observed on the landfill boundary were warning signs noting explosive gases.

8.54 A previous study covering the indicative location for SESRO area reports on an options assessment of the water transfer tunnel connecting the reservoir to the Thames. This has taken into account the presence of landfills around the eastern area of the indicative location for SESRO and has been used to select a preferred option for the tunnel. The tunnel route has been selected to avoid the landfill sites as far as possible. The report also noted the tunnel would be excavated through the band of Kimmeridge Clay and is therefore expected to lie at a sufficient vertical distance below the base of the landfill for no significant impacts to occur.

8.5.3.3 Gravel pits

8.55 Based on the concept design for the largest SESRO option, the gravel pits noted in Section 8.5.1 are located towards the eastern end of the indicative location for SESRO where the tunnel and auxiliary drawdown channel are proposed to be located.

8.56 It is acknowledged that there is to be a planned expansion to the west of the current gravel pit for extraction operations in the near future.

8.5.3.4 Storage Depot

8.57 A storage depot is located towards the south of the indicative location for SESRO adjacent to the Steventon – Hanney Road. Based on concept design for the largest SESRO option, this depot is located within the largest SESRO option reservoir footprint.

8.58 The depot comprises of Nissen huts and various large warehouses. Very limited records have been found indicating what was historically stored on this site, although as the site was a military depot, it is likely that military equipment was used and stored here.

8.59 The depot is now used as a self-storage depot and various commercial enterprises such as a freight distribution service, scaffolding service, freight forwarding company and a tyre shop.

8.60 The site has several potential sources of contamination:

- Historical use as a depot of military equipment indicates the potential for Unexploded Ordnance (UXO) around the site, among other potential contaminants;
- The suggestion of fire engines being kept on site historically suggests Polyfluoroalkyl and Polyfluoroalkyl Substances (PFAS) may be a potential contaminant;
- Based on the age of the buildings it is expected that asbestos could be present on site;
- The GroundSure report indicates a number of above ground tanks across the site and it is currently unknown what is stored in these or their condition;
- The historical presence of a small STW in the southwest corner of the site indicates the potential for associated contaminants within the soil and groundwater; and
- The historical presence of railway lines and sidings on site indicate the potential for associated contaminants within the soil and groundwater.

8.5.3.5 Substation outside Steventon

8.61 Based on the largest SESRO option, the substation is located approximately 700m from the largest SESRO option reservoir footprint.

8.62 The presence of the substation presents the potential for contaminants that have entered the soil and groundwater such as Polychlorinated Biphenyls (PCBs), hydrocarbons and oils.

8.5.3.6 Farms and associated activity

8.63 There are various farm, residential and commercial buildings located around the indicative location for SESRO and many are located within the largest SESRO option reservoir footprint. Recent aerial imagery shows areas of waste material associated with some of these including old cars, tyres and made ground.

8.64 Overground tanks and silos were observed during the January 2022 site walkover at one location. These appeared to be old and rusted. The contents are unknown.

8.65 A private airstrip is located at one farm, catering for private light aircraft and helicopters including aircraft servicing. There is potential for fuel, oil and other chemical spills and leaks here associated with this activity.

8.66 Some farm buildings around the indicative location for SESRO are indicated to be used by commercial enterprises such as a vehicle garage, a valeting service, specialist steel and fabrication, plant and vehicle maintenance workshop, furniture production and engineering and contracting companies. There is potential for fuel, oil and chemical spills and leaks associated with these activities.

8.67 Based on the age of the farm building around the indicative location for SESRO and observations made during the January 2022 site walkover, it may be expected that asbestos material is contained within some farm buildings.

8.68 It is anticipated that the farmland covering the indicative location for SESRO area would have been subject to herbicide and pesticide application. Due to the lack of soil quality data across the site the presence of agricultural chemicals across the site cannot be confirmed at this stage.

8.69 On the southwest edge of one of the Solar Farms within the indicative location for SESRO, recent aerial imagery shows a small area of hardstanding with a stockpile of tyres, approximately between 2005 – 2012. The area is now grassed over.

8.5.3.7 A34 and other highways

8.70 The A34 bounds the eastern side of the indicative location for SESRO, while Marcham Road bounds the north and the A338 to the west. These are not located in an area which is planned to be excavated. However, the A338 is adjacent to the currently planned flood compensation area and excavation would be taking place here.

8.71 There is a road between East Hanney and Steventon which is located within the largest SESRO option reservoir footprint and therefore would be excavated. Additionally, there are various smaller lightly used hardstanding tracks across the indicative location for SESRO which provide access to the various farm buildings. These would also be excavated as part of the reservoir construction. Potential

evidence of a minor fuel leak was observed along the hardstanding track of Landmead farm during the January 2022 site walkover.

8.72 Roads present a potential source of contamination through historical use and the associated potential for vehicle accidents and leaks of fuel, oil and chemicals which could lead to contamination of soil and groundwater. Additionally, the made ground used to construct the roads could be a potential contaminant source.

8.5.3.8 The London – Bristol Great Western Rail trainline

8.73 The trainline is located approximately 600m from the largest SESRO option reservoir footprint. A material handling area is planned to be developed adjacent to the trainline and a new railway siding built and therefore potential for earthworks near to the railway.

8.74 The London-Bristol line is an existing mainline railway used frequently by passenger and freight trains. There is potential for contaminants associated with the ballast and made ground and the historical use as a trainline.

8.5.3.9 Kimmeridge Clay Bituminous Deposits

8.75 Kimmeridge clay underlies the majority of the indicative location for SESRO.

8.76 The bituminous content of the Kimmeridge clay could be a potential source of contamination.

8.77 Current concept design assumptions are that all material excavated from the borrow pit which would be located in the central area of the reservoir, and the tunnel between the reservoir and the River Thames, would be reused as bunding, baffle mounds and other landscaping. The majority of material excavated from the borrow pit and tunnel is likely to be Kimmeridge Clay. The presence of bituminous material may limit the use of this material without some form of treatment. Additionally, if the Kimmeridge Clay is exposed at the base of the reservoir or on the bunding, leaching of contaminants into the stored water could occur.

8.78 However, there is a lack of environmental chemical data to confirm the bituminous content at the indicative location for SESRO.

8.5.3.10 Infilled canal

8.79 The disused Wiltshire and Berkshire canal crosses the indicative location for SESRO from the southwest to the northeast through the central area of the largest SESRO option reservoir footprint.

8.80 A previous study of the SESRO area reports on a 2007 site walkover along the length of the Wiltshire and Berkshire canal involving no intrusive work. The report notes the infilling of the canal and indicates that historically disused canals have sometimes been used as landfills for household or industrial waste. The results of the walkover are summarised below:

'Along the canal route there was observed a mixture of open channel being utilised as a drainage ditch with apparent attempted restoration works and infilled channel, either artificial infill or the channel having been allowed to silt up. The nature of the infill is uncertain. Some isolated patches of fly tipping including pieces of concrete and potential ACM were noted were noted in the central area of the site.'

8.5.3.11 Solar farms

8.81 Two solar farms are both located within the largest SESRO option.

8.82 There is potential for minor contamination associated with construction and operation of these solar farms.

8.5.3.12 Sewage Treatment Works (STW)

8.83 The Thames Water STW is located at the eastern end of the indicative location for SESRO adjacent to the planned auxiliary drawdown channel and tunnel.

8.84 The historical and current operation of the STW presents the potential for contaminants associated with construction and operation to have leached into the surrounding soil, groundwater and surface water.

8.5.3.13 Unexploded Ordnance (UXO)

8.85 A previous report identified a risk of UXO within the indicative location for SESRO, with specific identification of a "Target Field" which was used as a practice bombing area.

8.86 A magnetometer survey was undertaken covering the "Target Field" location area and identified a large number of magnetic anomalies which were attributed to practice bombs, a few of which were identified during the survey and removed from site. This survey is shown in Figure 8.4.

8.87 A preliminary desk study assessment has been undertaken by Zetica (2022) for the indicative location for SESRO to confirm the findings of the previous desk study. This has been included as Appendix A8.1 which can be found in Supporting Document B2.1 Environmental Appraisal Report (terrestrial) Appendices. The results of the preliminary desk study assessment are broadly in line with BACTEC's desk study, identifying various UXO hazards across the indicative location for SESRO and recommending further investigation.

8.5.3.14 Water Abstractions

8.88 There are no recorded licensed surface water abstraction points within the indicative location for SESRO and within 250m of this.

8.89 There are four recorded licensed groundwater abstraction points within the indicative location for SESRO. These are all recorded as historical with start dates from 1966 – 2001. One has a recorded expiration date of 2013. These are located in

the southern and northern area of the indicative location for SESRO and were used for farming and gardening. The abstraction used for gardening is also recorded as used for potable (drinking) water.

8.5.3.15 Discharges

8.90 There are four active discharge permits located in the southeast of the indicative location for SESRO. These were effective from 2001 and are for non-water company sewage. The receiving water body is the tributary of East Hanney Ditch.

8.91 There is one historical discharge permit, active between 1963 and 1991, located in Steventon Depot. This was for non-water company sewage discharge and the receiving body was the Moor Ditch.

8.92 There is a discharge permit for non-water company sewage located east of Drayton, effective from 2002 with no revocation date. The receiving body is a tributary of the River Ock.

8.93 There are various discharge permits for sewage discharges at the east end of the indicative location for SESRO dating from 1980 up to 2019 which are still active. The receiving bodies are the Oday Hill Ditch, the River Thames and Big Ditch (a tributary of the Ginge Brook).

8.94 There are various discharge permits located within 250m of the indicative location for SESRO eastern end. These are noted as trade discharge for mineral workings and are dated from 1992 to 2016 and are still active. The receiving body is Oday Hill Ditch. An active discharge permit from 2006 for site drainage from a recycling centre is also recorded. The receiving body is noted as a tributary of the Ginge Brook.

8.5.3.16 Pollution Incidents

8.95 A minor pollution incident to water is recorded by the Environment Agency in 2001 along the proposed route of the auxiliary drawdown channel. It is recorded as “other pollutant type”. No other Environment Agency recorded pollution incidents have been identified within the indicative location for SESRO.

8.96 A minor pollution incident to air and water involving kerosene and aviation fuel is recorded to the east of the indicative location for SESRO (approximately 130m) between Drayton and Abingdon in 2003.

8.97 One Local Authority recorded, licensed, pollutant release activity has been identified in Hanney related to an historical permit for a waste oil burner.

8.5.3.17 Control of Major Accident Hazard (COMAH)

8.98 No HSE recorded COMAH sites have been identified within the indicative location for SESRO or within 250m.

8.5.3.18 Regulated explosive sites

8.99 No HSE recorded regulated explosive sites have been identified within the indicative location for SESRO or within 250m.

8.5.3.19 Part 2A Contaminated Land

8.100 No Local Authority recorded site determined as Contaminated Land under EPA Part 2a has been identified within the indicative location for SESRO or within 250m.

8.5.3.20 Hazardous Substance Storage

8.101 No HSE recorded hazardous substance storage has been identified within the indicative location for SESRO or within 250m.

8.102 No EA licensed industrial activities have been identified within the indicative location for SESRO or within 250m.

8.5.3.21 List 1 & 2 Dangerous Substances

8.103 No EA recorded List 1 dangerous substances have been identified within the indicative location for SESRO or within 250m.

8.104 Seven EA recorded List 2 dangerous substances have been identified within the indicative location for SESRO and 1within 250m

8.6 Assessment outcomes

8.105 This section presents an initial assessment of the likely construction and operation effects of the largest SESRO option for geology, soils and contaminated land and summarises the relative effects of the alternative options under consideration.

8.106 The potential significance of the effect based on the results of the initial assessment is reported here.

8.107 Based on the limitations of this initial assessment presented in Section 8.4.4 the outcomes may require revision following the implementation of the next steps presented in Section 8.8.

8.6.2 Potential effects during the construction phase of the largest SESRO option

8.108 The potential construction effects identified in this assessment are:

- Permanent loss of agricultural land. The areas of permanent land take to construct the largest SESRO option would result in permanent loss of agricultural land as the land would not be available for agriculture during and after construction. Best and most versatile (BMV) land of ALC grade 2 and 3a land would be lost and therefore this effect is potentially significantly adverse without mitigation proposed in Section 8.7. Mitigation measures may result in neutral (no change) or

beneficial effects by limiting loss of BMV and improving soil quality elsewhere by reuse of this soil resource;

- The potential to encounter UXO and the subsequent health risks that could result. This effect may be potentially significantly adverse without mitigation proposed in Section 8.7. Mitigation measures may result in a beneficial effect by removing the risk of UXO to receptors;
- Contamination of surface and groundwater and harm to human health through construction activities causing exposure, mobilisation or leaching of potential existing contamination on site and the introduction of new sources of contamination. This includes activities such as:
  - Exposure of receptors to contaminated soil and groundwater during excavation of reservoir borrow pit, tunnel and flood compensation area at the potential contaminant sources described in this chapter;
  - Exposure to asbestos and other potentially hazardous materials from demolition of asbestos-containing buildings and fuel/oil/chemical storage tanks;
  - Increased mobilisation of existing on site contamination;
  - Spills and leaks of chemical such as oil and fuels from plant and machinery during construction activity;
  - Compaction of soil by improper soil and traffic management causing destruction of soil resources and increased runoff.

  These effects may be potentially significantly adverse without mitigation proposed in Section 8.7. Mitigation measures may result in beneficial effects by removing the risk of contamination from these sources to receptors.

- Potential sterilisation of mineral resources by construction on or near to (including tunnelling under) the sand and gravel resources towards the eastern end of the indicative location for SESRO where expansion of extraction operations is proposed. This could result from geotechnical considerations of the potential structural integrity of the tunnel if minerals are extracted from above the tunnel both during or after construction. These effects may be potentially significant without mitigation proposed in Section 8.7.

8.6.3 Potential effects during the operation phase of the largest SESRO option

8.109 The potential operation effects identified in this assessment are as follows:

- Contamination of surface and groundwater and damage to human health from operation activities. This includes activities such as accidental spills (e.g., fuel, oils, chemicals) and mismanagement of solid and liquid wastes. These impacts may be potentially significant without mitigation proposed in Section 8.7; and
- Potential contamination of water within the reservoir from exposed bitumen within the Kimmeridge Clay. This impact may be potentially significant without mitigation proposed in Section 8.7.

8.6.4 Potential construction and operation effects for alternative options

8.110 An overview of the relative potential effects of the alternative options is presented below.

8.111 The alternative options are all smaller than the largest SESRO option. Excavation of the borrow pit would still require the loss of significant areas of agricultural land, and potential impacts from contamination associated with the potential contamination sources identified in this chapter such as infilled canal, farm buildings, solar farm areas, the storage depot, the substation outside Steventon, roads and possible presence of UXO. Additionally, the proposed route of the auxiliary drawdown channel and tunnel at the eastern end of the indicative location for SESRO are unchanged from the largest SESRO option. Therefore, the potential effects posed by the alternative options are similar to those of the largest SESRO option.

8.112 However, the alternative options would result in less agricultural land being lost as part of the reservoir borrow pit and flood compensation areas, with the 75Mm^3 option resulting in the lowest loss.

8.7 Mitigation

8.113 The permanent loss of agricultural land cannot be fully mitigated. However, to reduce the potential effects of the loss of agricultural land, the development should re-use topsoil and subsoil whenever possible. The soil could be used to improve the quality of agricultural land elsewhere, to be placed on land which would be used for landscaping or to create new areas of agricultural land and result in a neutral or beneficial effect. A Soil Resource Plan (SRP) should be developed which sets out the approach to the management and re-use of soil resources and how to maintain the condition of the high grade soil during handling and placement. The management of soil resources shall follow the Construction Code of Practice for the Sustainable Use of Soils on Construction Sites[128]..

8.114 Clearance of UXO should be undertaken. A remediation strategy which includes UXO would need to be developed to identify and mitigate the risks.

8.115 The quality of soil, groundwater and surface water should be assessed and if necessary, a remediation strategy should be developed to mitigate the risks posed by elevated levels of contamination. This should include chemical assessment of bitumen within the Kimmeridge Clay and the subsequent development of site-specific acceptability criteria for the reuse of material and a Material Management Plan (MMP) in line with The Definition of Waste: Development Industry Code of Practice[129].

8.116 To mitigate the potential sterilisation of mineral resources, further assessment of the extraction proposals in relation to the water transfer tunnel and pipeline route should be undertaken at subsequent project stages. If unacceptable impacts could result from the extraction works, it may be possible to programme the works so that they are complete before the tunnel is constructed. Alternatively, excavation of the

minerals could be undertaken in small zones to reduce the potential impacts.

8.117 Good industry working practices and procedures should be incorporated into construction and operation, aimed at limiting potential contamination and risk to human health and the environment.

8.8 Next steps

8.118 The following recommendations are made for subsequent project stages to further inform the baseline for the indicative location for SESRO and the potential mitigation measures:

- Consultation should be undertaken with Natural England regarding the loss of agricultural soil resources and the mitigation. An updated Soil Resource Survey (SRP) should be undertaken where there are gaps in data and a Soil Resource Plan should be developed;
- Consultation should be undertaken with the Environment Agency to provide any available information on historical environment and land use, landfills, groundwater and surface water abstraction (private, small scale), discharges, contamination;
- Consultation should be undertaken with Vale of White Horse District Council and Oxfordshire County Council to provide any available information on historical environment and land use, landfills, groundwater and surface water abstraction (private, small scale), discharges, contamination, unauthorised burials, unlicensed waste disposal
- Further assessment of the UXO risk should be undertaken at subsequent project stages and a remediation strategy should be developed to mitigate the risks where necessary. A specialist UXO company should undertake the assessment and development of the remediation strategy;
- A preliminary contamination risk assessment report should be prepared and a ground investigation should be designed to include collection of environmental samples of soil, groundwater and surface water for chemical testing. This should target the potential contamination sources identified where there could be an impact from the largest SESRO option, the areas of potential herbicide and pesticide use/runoff and the Kimmeridge clay to assess the bituminous content of this material;
- A quantitative assessment of the soil, groundwater and surface water quality and Kimmeridge Clay bituminous content should be undertaken following the ground investigation to better understand potential risks to sensitive receptors (preliminary risk assessment update) and allow development of appropriate mitigation measures;
- Geotechnical assessment should be undertaken to assess the risk to the tunnel at the proposed mineral extraction operations; and

- Discussions should be held with the operators of the quarry at the east end of the indicative location for SESRO to determine the timing of their planned mineral extraction works.

9. Natural Capital

9.1 Introduction

9.1 Building on the work undertaken to support the Gate 1 process, this chapter presents an environmental appraisal of the potential natural capital impacts associated with SESRO.

9.2 This chapter sets out the key legislation and policy relevant to natural capital followed by the methodology and study area used for the environmental appraisal. An analysis of the baseline is presented, followed by an appraisal of the effects of SESRO and an evaluation of their significance. An overview of likely mitigation measures that may be adopted to avoid, reduce or offset any potential effects is provided followed by recommendations for work at subsequent project stages.

9.3 This chapter focusses on the largest SESRO option (i.e. 150Mm^3) with narrative provided on the relative performance of the alternative reservoir options (i.e. 125Mm^3, 100Mm^3, 75Mm^3, 30+100Mm^3 and 80+42Mm^3).

9.4 HM Treasury's Green Book: Appraisal and Evaluation in Central Government[145] defines natural capital as:

'certain stocks of the elements of nature that have value to society, such as forests, fisheries, rivers, biodiversity, land and minerals. Natural capital includes both the living and non-living aspects of ecosystems.

Stocks of natural capital provide flows of environmental or 'ecosystem' services over time. These services, often in combination with other forms of capital (human, produced and social) produce a wide range of benefits'. (page 63)

9.5 The 25 Year Environment Plan[146] strongly encourages the adoption of a natural capital approach in decision making to support the aim of improving the state of the environment for future generations. Due to land use change, the SESRO options would impact on natural capital stocks, subsequently affecting the flows of ecosystem services both positively and negatively, therefore the value that they provide to society. In natural capital terminology, these positive impacts on wellbeing are known as benefits, whilst the negative are referred to as disbenefits.

9.6 The Natural Capital Assessment (NCA) focuses on the changes to natural capital stocks and the benefits derived from the ecosystem services that they provide. The results of the NCA have been in translated into 'Natural Capital Metrics', as aligned

[145] HM Treasury, 2020. The Green Book: Central Guidance on Appraisal and Evaluation. Available at: https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-governent [Last accessed: 12/04/2022]

[146] Defra, 2018. A Green Future: Our 25 Year Plan to Improve the Environment. Available at: https://www.gov.uk/government/publications/25-year-environment-plan [Last accessed: 12/04/2022]

with the Water Resources Planning Guideline (WRPG)[147] and Supplementary Guidance (SG)[148] and the All Companies Working Group (ACWG) guidance. It would not focus on the benefits derived from other forms of capital (such as social capital), some of which would be considered within the Wider Benefits study.

9.2 Legislation and policy

9.7 The WRPG SG requires the completion of a NCA to 'make decisions that do not devalue, and look to enhance the value of the natural world for society benefit'.

9.8 The ACWG have developed an environmental assessment method for SROs which is aligned with the WRPG SG and RAPID process: WRMP environmental assessment guidance and applicability with SROs (referred to throughout this report as ACWG guidance)[149]. At RAPID Gate 2, the ACWG guidance expects the NCA to build on Gate 1 activities to improve the detail and breadth of the assessment. This is to further aid decision making through quantifying the costs and benefits of SRO schemes from a natural capital perspective. In this way, this NCA for SESRO would support the aim of Gate 2 as outlined by the ACWG guidance, which is:

'to further enhance the funding portfolio, based on refined and consistent costs and benefits, with suboptimal solutions eliminated and viable solutions carried forward to the pre-planning stage.' (p.10)[149]

9.9 Therefore, SESRO requires a NCA to align with both WRPG SG and ACWG guidance, to support detailed feasibility, concept design and multi-solution decision making at Gate 2.

9.3 Datasets and documents reviewed

9.10 A range of different data sets were reviewed to inform the NCA, namely:

- SESRO Baseline UK Habitat Classification (UK Hab) plans which are appended to Supporting Document B6, Biodiversity Net Gain Report;
- Figure 2.1 Landscape and Environmental Design Strategy Plan in Technical Supporting Document B2.2, Environmental Appraisal Report (terrestrial) Figures;
- Flood modelling[150];
- SESRO Gate 1 submission - Technical Annex B1 Environmental Assessment Report;
- SESRO Gate 1 submission - Technical Annex B1 Appendix A11.1 NCA: Full Report;

[147] Environment Agency, Natural Resources Wales, and Office for Water Services, 2022. Water resources planning guideline. Available at: https://www.gov.uk/government/publications/water-resources-planning-guideline [Last accessed: 13/04/2022]
[148] Environment Agency, 2021. Water resources planning guideline supplementary guidance – Environment and society in decision-making. External guidance: 18643.
[149] Mott MacDonald, 2020. All Companies Working Group: WRMP environmental assessment guidance and applicability to SROs.
[150] Baseline_Flood_Extent_2022_170 and RFS_Flood_Extent_2020 provided by Mott McDonald

- Supporting Document A1: Concept Design Report; and
- Defra's Enabling a Natural Capital Approach (ENCA) guidance[151].

9.4 Methodology

9.11 As is consistent with Gate 1, the NCA methodology comprised of six steps, which are outlined in Plate 9.1. The approach taken at each stage was proportional to requirements of Gate 2. The following sections outline each of these six steps.

Plate 9.1: Steps in the Natural Capital Assessment (NCA)

9.4.2 NCA Method Step 1: Natural capital baseline

9.12 To align with the Biodiversity Net Gain aspect of the Gate 2 assessment, the baseline habitat plan completed for each SESRO option has been used as the natural capital asset baseline. As explained in Chapter 4, this UK Habitat Classification (UK Hab) plan was developed through aerial imagery, subsequent digitisation and partial ground-truthing through a site walk over. Though a full ecological site survey was not possible, integration of local habitat data allowed the Gate 2 NCA to be progressed with a more accurate natural capital baseline, aligning with best practice as set out within the WRPG SG. The NCA does not cover impacts outside of this boundary for each option. This is consistent with the WRPG SG, which specifies the option footprint as the minimum spatial extent of the assessment.

9.13 In alignment with the ACWG guidance's requirements for Gate 2, natural capital assets were quantified in respect to the following broad habitat types and their relevant sub-habitats:

- Urban natural capital;
- Enclosed farmland;
- Mountains, Moors and heathland;
- Freshwater;
- Woodland;
- Coastal margins;
- Marine environment; and
- Semi-natural grassland.

9.14 In addition to asset quantity, the NCA explored the use of condition data to inform natural capital quality. Assessing natural capital asset quality and location (where data allows) in addition to quantity can provide a more detailed and robust NCA. However, it should be noted that a method for integrating quality and location

[151] Defra, 2020. Enabling a Natural Capital Approach. Available at: https://www.gov.uk/guidance/enabling-a-natural-capital-approach-enca [Last accessed: 13/04/2022]

indicators is not well defined within the ACWG guidance or the WRPG SG. The principal source of condition data considered for inclusion was the habitat condition assessment scores used for the Biodiversity Net Gain assessment. However, these scores are largely based on assumptions owing to a lack of a full condition assessment having been collated. As such, these elements have not been included within the assessment.

9.4.3 NCA Method Step 2: Change in natural capital assets

9.15 The natural capital assets under the landcover scenario associated with the largest SESRO option (as shown in Figure 2.1 Landscape and Environmental Design Strategy Plan in Technical Supporting Document B2.2, Environmental Appraisal Report (terrestrial) Figures) were quantified for the Biodiversity Net Gain process (Chapter 4). The landcover scenarios for the other options were estimated based on the process outlined in Supporting Document, B6 Biodiversity Net Gain Report. The stocks of natural capital assets were quantified for each option in a natural capital asset register to be compared against the baseline. As with Gate 1, a static baseline has been assumed whereby no changes to the existing natural capital assets would occur (e.g., due to climate, demographics, or land use change).

9.16 The Gate 1 assessment made broad assumptions regarding the nature of land use change due to a lack of detailed design information. The NCA for Gate 2 built upon this by using updated design information, including environmental mitigation and enhancement measures. To provide a greater level of detail, the timing of when land use change may occur has also been considered where possible using information from Supporting Document A1: Concept Design Report. The assumptions made in this regard are:

- habitat clearance would occur at the end of the development stage, with a total lead time of 6 years; and
- habitat creation would occur at the end of the construction stage, with a total lead time of 15 years for the 150Mm^3 and 125 Mm^3 options and 14 years for the 100Mm^3 and 75Mm^3 options.

9.4.4 NCA Method Step 3: Identify ecosystem services

9.17 The WRPG SG sets out the following five ecosystem services to be included in the assessment as a minimum (with definitions adapted from the WRPG SG):

- Biodiversity and Habitat;
- Climate Regulation (carbon storage);
- Natural Hazard (flood and drought) Regulation;
- Water Purification; and
- Water Regulation.

9.18 As Biodiversity and Habitat is considered in detail within Chapter 4 Biodiversity, this

would not be covered as part of the NCA. However, it is recognised that biodiversity is a fundamental component of natural capital, with biodiversity underpinning the provision of ecosystem services.

9.19 The Gate 1 assessment excluded the drought-related aspects of Natural Hazard Regulation due to a lack of established methodology, as acknowledged in the WRPG SG. Whilst drought is a factor of major importance in water resource management planning, no common approaches to assessing the value of natural capital assets in mitigating against the risk of drought which are applicable to a UK context are currently available. Therefore, the Gate 2 NCA for natural hazard (flood and drought) regulation focuses on flood regulation only.

9.20 Though the five ecosystem services listed above are minimum requirements, the WRPG SG states that the NCA should consider including additional ecosystem services where relevant. As such and in alignment with the WRSE regional NCA methodology, the Gate 1 assessment also included:

- Food production;
- Air pollutant removal; and
- Recreation.

9.21 The Gate 2 NCA takes these additional ecosystem services forward to a more detailed level of assessment.

9.22 There is the potential for SESRO to generate renewable energy through solar panels and/or wind turbines, with solar arrays already present within the indicative location for SESRO. Consideration has been given as to whether renewable energy should be assessed for the SESRO NCA. Potential for double counting was identified, as the likely output (gigawatt hours) and associated monetary value are likely to be considered at later stages of the project.

9.4.5 NCA Method Step 4: Qualitative assessment

9.23 The ecosystem services chosen for the Gate 2 NCA were assessed qualitatively for each SESRO option, as is required in the WRPG SG. This is to complement the quantitative assessment and support the interpretation of the valuation. As per the ACWG guidance's requirements for Gate 2, this is to supplement the option assessment where confidence in monetisation is lacking.

9.24 Where relevant and practicable, the methodology for the Gate 1 NCA has been developed to better align with the WRPG SG's best practice. Note, for Climate and Natural Hazard Regulation, there is no distinction between the minimum and best practice approaches at Step 4 (as outlined within the WRPG SG), aside from incorporating local habitat data as developed in Step 1.

9.25 For Water Purification, best practice involves considering dilution services within the assessment. The WRPG SG defines dilution services as being '*provided by an asset which, by virtue of its type, quality and/or management, [does not] generate*

pollution. For example, an area under semi-natural habitat or very low input agricultural land. This means it is effectively diluting pollution elsewhere in the catchment by the quality of the runoff it is providing to the river environment or groundwater aquifers.' To explore dilution services within the qualitative assessment, the extent of zero or low input land use has been considered.

9.26 To align with best practice for the qualitative assessment of Water Regulation, estimated reductions in abstractions in other locations because of SESRO were sought, particularly for vulnerable chalk streams. However, through discussions with Thames Water, it was understood that this work is still ongoing and that the results were not available at the time of the Gate 2 NCA.

9.4.6 NCA Method Step 5: Quantitative assessment and monetisation

9.27 As with Gate 1 and in line the ACWG guidance and WRSE regional NCA, the ecosystem services were quantified and monetised for four of the SESRO options (150Mm^3, 125Mm^3, 100Mm^3 and 75Mm^3). The dual-phased options (30+100Mm^3 and 80+42Mm^3) were not assessed quantitatively for the Gate 2 assessment due to a lack of information on how the impacts would occur over time.

9.28 The method of valuation broadly aligns with the WRPG SG and has been supplemented by recognised datasets where appropriate. These supplementary and alternative methods have been drawn from the suggested list provided in the WRPG SG and ENCA[151], and are justified where used.

9.29 Sensitivity analysis has been completed using lower and upper transfer values alongside central values for the ecosystem services identified where available and appropriate. All values are based on 2022 prices, with the most recent Government Gross Domestic Product (GDP) deflator[152] used to convert monetary values where necessary. Prices are uplifted based on the forecast inflationary rate, consistent with the Office for Budget Responsibility's 2022 Spring Statement economic and fiscal outlook data.[153] There is some uncertainty around these forecast rates given changes to the economic climate since their publication.

[152] National Statistics, 2022. GDP deflators at market prices, and money GDP March 2022 (Quarterly National Accounts). Available at: https://www.gov.uk/government/statistics/gdp-deflators-at-market-prices-and-money-gdp-march-2022-quarterly-national-accounts [Last accessed: 28/04/2022]

[153] Office for Budget Responsibility, 2022. Economic and fiscal outlook – March 2022. Available at: https://obr.uk/efo/economic-and-fiscal-outlook-march-2022/ [Last accessed: 01/08/2022]

Table 9-1: Methodology summaries for each of the ecosystem services assessed and comparison to the relevant guidance.

Ecosystem service	Quantification and valuation method	Alignment with relevant guidance
Climate regulation	Climate regulation has been quantified based on the change in asset quantities within the indicative location of each SESRO option. The carbon sequestration rates (tCO_2e/ha/year) used have been taken from WRPG SG Table 7, where possible. The translation used is presented in Table 9-2. For habitat types not covered by the WRPG SG, sequestration rates have been drawn from the wider literature using sources provided by ENCA.[154,155,156] This is in line with recommendations made within the Gate 1 assessment. Monetary values were drawn from the Government's most recent carbon values for use in policy appraisal and evaluation.[157] This approach aligns with the methods set out in the Green Book[145] and supplementary guidance.[158] The lower and upper carbon values were considered alongside central values by way of sensitivity testing, as a refinement of the Gate 1 assessment.	See 'Quantification and valuation method'. The monetisation of climate regulation using more recent Government carbon values[157] rather the Interim Non-Traded Carbon Values stated in the WRPG SG is not contrary to the WRPG SG, as the guidance recommends using the most up to date values available.
Natural hazard regulation	Natural hazard regulation has been quantified based on the change of woodland natural capital assets within the indicative location for the largest SESRO option that intersect with an active floodplain. This method is based on the Joint UK Land Environmental Simulator (JULES) model approach developed by Forest Research.[159] As with the Gate 1 assessment, this approach is not	The adopted method fully aligns with the WRPG SG and WRSE regional NCA methodology. The inclusion of updated hydraulic modelling to capture the change

[154] Alonso, I., Weston, K., Gregg, R. & Morecroft, M., 2012. Carbon storage by habitat - Review of the evidence of the impacts of management decisions and condition on carbon stores and sources. Natural England Research Reports, Number NERR043. Available at: http://publications.naturalengland.org.uk/publication/1412347 [Last accessed: 29/04/2022]
[155] Biffi, S., Chapman, P. J., Grayson, R., Ziv, G. (2021). 'Resilient Dairy landscapes: Sequestering Carbon by Planting Hedgerows'. University of Leeds School of Geography Briefing Note Series. Available at: https://www.resilientdairylandscapes.com/publications [Last accessed: 29/04/2022]
[156] Van Den Berge, S., Vangansbeke, P., Baeten, L., Vanhellemont, M., Vanneste, T., De Mil, T., Van den Bulcke, J. and Verheyen, K., 2021. Biomass increment and carbon sequestration in hedgerow-grown trees. Dendrochronologia, 70.
[157] Department for Business, Energy & Industrial Strategy, 2021. Valuation of greenhouse gas emissions: for policy appraisal and evaluation. Available at: https://www.gov.uk/government/publications/valuing-greenhouse-gas-emissions-in-policy-appraisal [Last accessed: 29/04/2022]
[158] Department for Business, Energy & Industrial Strategy, 2012. Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal. Available at: https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal [Last accessed: 29/04/2022]
[159] Forest Research, 2018. Valuing flood regulation services of existing forest cover to inform natural capital accounts.

Ecosystem service	Quantification and valuation method	Alignment with relevant guidance
	based on the Flood Hazard Research Centre's Multi-coloured Manual[160] and is an approximation based on habitat type only. However, to refine the approach, the Gate 2 assessment uses the project's hydraulic modelling rather than the Environment Agency's Indicative Flood Risk Areas[161] to identify the floodplain and the relevant habitats contained therein, both for the baseline and post-development. For the alternative options, the area of woodland natural capital assets was scaled up from the largest SESRO option in a manner consistent with that explained in Supporting Document, B6 Biodiversity Net Gain Report. This is a limitation, as with without knowing the actual location of the woodland assets, it cannot be known whether they are inside or outside of the active floodplain and therefore whether they are providing flood regulation benefit. As a further refinement of the Gate 1 assessment, upper and lower replacement costs were considered alongside central values for sensitivity analysis. Replacement costs in this case represent the average capital and operation costs of flood reservoir storage that would be required in the absence of the ecosystem service.	in floodplain area and location provides an additional level of detail.
Water purification	Water purification has been assessed based on the change in agricultural land cover and wetland habitats. The approach for agricultural land has been informed by FARMSCOPER, which is a decision support tool used to assess diffuse agricultural pollutant loads.[162] The average kilogram of nitrate and phosphorus pollution lost from agricultural land per hectare taken from FARMSCOPER and used within the Gate 1 natural capital assessment were used again at Gate 2. These were then converted into monetary values using the annul values associated with reducing a kilogram of each type of pollutant in water from agricultural sources. This approach was discussed with the team that completed the Gate 1 natural capital assessment to ensure consistency across the different stages of the RAPID process. Underpinning this valuation is the assumption that pollutants from agricultural	The approach taken differs from the recommendation of the WPRG SG, which suggests using the Natural Environment Valuation Online (NEVO) tool. However, as recognised in the Gate 1 assessment, the 2km^2 resolution of NEVO is insufficient for assessing the SESRO options. The FARMSCOPER values in combination with higher resolution asset mapping is thought to be a more suitable alternative to

[160] Flood Hazard Research Centre, 2013. Multi-coloured Manual. Available at: https://www.mcm-online.co.uk/ [Last accessed: 29/04/2022]
[161] Environment Agency, 2020. Indicative Flood Risk Areas (shapefiles). Available at: https://data.gov.uk/dataset/7792054a-068d-471b-8969-f53a22b0c9b2/indicative-flood-risk-areas-shapefiles [Last accessed: 29/04/2022]
[162] Environment Agency and Defra (ADAS), 2020. FARMSCOPER Version 5. Available as: https://adas.co.uk/services/farmscoper/ [Last accessed 26/05/2022]

Ecosystem service	Quantification and valuation method	Alignment with relevant guidance
	input would enter water courses via agricultural runoff. Therefore, increasing or decreasing the area of agricultural land reduces or improves water quality accordingly. The change in wetland habitats has been valued using the benefit transfer values from the UK National Ecosystem Assessment.[163] These values capture the marginal water quality benefits provided by an additional hectare of inland wetlands in terms of the dilution, absorption and detoxification of waste products and pollutants.	assessing water purification impacts. This approach also promotes consistency across the Gate 1 and 2 NCAs.
Water regulation	As discussed in Section 9.4.5, the estimated reductions in abstractions in other locations as a result of SESRO were sought out but are currently unavailable. As such, quantifying and monetising the value of water left in the environment for other uses is not possible at this stage. However, it was possible to quantify and monetise water regulation based on SESRO's utilisation across several Water Resource Zones.[164] The utilisation values were provided by Thames Water and were taken from the 'st-hybrid-dy-w1-tree15.06-options-v32-gov-led-hybridb-2075' model run with the jet-20220607-000002 dataset. This is the final dataset produced prior to the inclusion of licence capping sustainability reductions and therefore would shortly be superseded. However, this dataset represents the best available data at the time of assessment. The results were taken from two branches, Branch 4 and Branch 8, representing high and low utilisation scenarios, respectively. Branch 4 involves the local plan-based population forecasts and high environmental destination. Branch 8 involves the ONS' central population forecast and medium environmental destination forecast. Both scenarios relate to the largest SESRO option, so do not allow for comparison across options. The values provided by Thames Water cover the period 2026 to 2075, so were extrapolated for the whole of the appraisal period. For Branch 8, which appears to fluctuate over the given period, an	The WRPG SG requires that this service should be assessed both qualitatively and quantitatively as a minimum. This has been completed as far as possible for Gate 2 given the availability of the data.

[163] Morris and Camino, 2011. UK National Ecosystem Service Assessment – Economic Assessment of Freshwater, Wetland and Floodplain (FWF) Ecosystem Services. http://uknea.unep-wcmc.org/Resources/tabid/82/Default.aspx [Last accessed 26/05/2022]

[164] The Water Resource Zones were Swindon and Oxfordshire (SWOX); Slough, Wycombe and Aylesbury (SWA); Southern Western Area; Affinity London Area; London; and Kennet Valley.

Ecosystem service	Quantification and valuation method	Alignment with relevant guidance
	annual average was used to project utilisation post 2075. For Branch 4, for which utilisation rises and then plateaus after 2050, the plateaued value is maintained for the remainder of the appraisal period. To monetise the utilisation, the indicative 5-year average for unit resource rent for abstracted water (£/m^3) from the WRPG SG was applied.	
Air pollutant removal	To quantify the change in air pollutant removal, the method set out in ENCA's Services Databook[165] has been followed. For this, the change in natural capital assets providing air quality regulation benefits within the indicative location for SESRO has been quantified. To monetise impacts associated with this service, the Office for National Statistics (ONS)' average annual values for air pollution removal by rural woodland and enclosed farmland were used.[166] The pollution reduction effect is expected to decline overtime due to long-term trends in background pollution. To account for this, a linear decrease to the ONS average values has been assumed between the reported years of 2015 and 2030, plateauing after 2030. The translation from UK Hab classification to the habitat types used in the ONS valuation required some interpretation, with the final translation presented in Table 9-2. Floodplain wetland in particular was difficult to find an appropriate match for. This was assumed to be enclosed farmland for the assessment of air pollutant removal. This is thought to be a reasonable assumption based on comparable height and surface area of vegetation. Further, the air pollutant removal value attributed to enclosed farmland is relatively low. Therefore, the benefit provided by floodplain wetland mosaic is unlikely to have been overestimated.	No method for this service is set out within the WRPG SG or ACWG guidance.
Food production	Food production has been quantified based on the change in area of agricultural land within the indicative location for the largest SESRO option. Following ENCA guidance, this service was monetised using a resource rent approach, which is an indicator of the contribution of the	No method for this service is set out within the WRPG SG or ACWG guidance.

[165] Defra, 2021. Enabling a Natural Capital Approach: Services Databook. Available at: https://www.gov.uk/guidance/enabling-a-natural-capital-approach-enca#enca-services-databook [Last accessed: 29/04/2022]

[166] Jones et al., 2017. Developing estimates for the valuation of air pollution removal in ecosystem accounts. Final report for Office of National Statistics. Wallingford, NERC/Centre for Ecology & Hydrology, 75pp. (CEH Project no. C06156). Available at: http://nora.nerc.ac.uk/id/eprint/524081/ [Last accessed: 29/04/2022]

Ecosystem service	Quantification and valuation method	Alignment with relevant guidance
	provisioning service provided by the land on agricultural output. The multi-year averages given in the ENCA Services Databook[165] have been used to address the uncertainty created by the year-on-year volatility of agricultural production. The change in approach from the Gate 1 assessment reflects the development of the natural capital discipline since the initial assessment was completed.	
Recreation	Recreational benefit was quantified using the visitor number analysis completed for Gate 2. This analysis quantified the number of current visitors to the site, as well as the number of predicted visitors under each Conservation, Access and Recreation (CAR) Strategy scenario. The visitor numbers associated with Scenario 2 were used as this scenario is thought to best reflect the provisions made for the masterplan of the largest SESRO option, as illustrated on Figure 2.1 Landscape and environmental design strategy plan in Technical Supporting Document B2.2, Environmental Appraisal Report (terrestrial) Figures. This service was monetised using the average values of recreational day visits given in the ENCA Services Databook,[165] which are based on a meta-analysis of the Outdoor Recreational Valuation (ORVal) tool.[167] The same estimate of visitor numbers was used for all options. As the recreational visitor numbers are taken from the CAR Strategy scenario that best reflects the provisions made for the masterplan, low and high values are not given for recreational benefit.	No method for this service is set out within the WRPG SG or ACWG guidance.

[167] Sen, A., Harwood, A.R., Bateman, I.J., Munday, P., Crowe, A., Brander, L., Raychaudhuri, J., Lovett, A.A., Foden, J. and Provins, A., 2014. Economic assessment of the recreational value of ecosystems: methodological development and national and local application. Environmental and Resource Economics, 57(2), pp.233-249.

9.30 To align with WPRG SG best practice, consideration has been given as to how new habitats would change over the lifetime of the option. To attempt to account for the inherent uncertainty and risk of failure of habitat creation or enhancement, the risk multipliers set out in the Biodiversity Metric 3.0 have been applied for sensitivity analysis. These pre-defined multipliers reflect the difficulty of habitat creation or enhancement and, within Biodiversity Metric 3.0, reduce biodiversity scores accordingly. These risk multipliers have been applied to changes in natural capital assets where relevant to reflect the likelihood of newly created or enhanced habitats failing. For example, the creation of new lowland mixed deciduous woodland is of 'high' technical difficulty for creation within Biodiversity Metric 3.0, which relates to 0.33 penalty multiplier i.e. an assumed failure of 67%.

9.31 In addition to delivery risks, efforts have been made to greater account for how the ability of natural capital assets to provide ecosystem services change over time. To factor this in, the assessment has considered the 'time to reach target condition' of newly created habitats. This refers to the time for new assets to mature before they deliver their full ecosystem service potential. The time to reach target condition may vary by ecosystem service for the same habitat type or asset. For example, a new woodland may take 25 years to reach its flood regulation potential but 40 years to provide air quality regulation to the best of its ability. For the purpose of the NCA, these values have been taken from the Environmental Benefits from Nature tool[168], which is an ENCA featured tool and therefore aligned with ACWG guidance and the WRPG SG. A linear increase from zero to the time to reach target condition has been assumed. This is a notable simplification as this relationship is likely non-linear. However, this is considered proportional to the requirements of ACWG guidance and the WRPG SG at Gate 2.

9.32 Translation of habitat types from UK Hab to the classification system used by the Environmental Benefits from Nature tool required some interpretation. The translation used is given in Table 9-2. Not every habitat has a direct translation, so a 'best fit' has been used where necessary. However, this is thought not to impact the time to reach target condition substantially as they are generally similar across the habitat types assessed.

9.33 The Gate 1 NCA presented the monetary values associated with a change in natural capital assets as static annual values. As such, they cannot account for habitat maturity and a change in service provision over time. As the Gate 2 NCA considers these elements, static annual values are no longer appropriate. Instead, the monetary values are presented as a series of 'snapshot' values at different points over the lifetime of the option. These are 10, 15, 25, 50, and 100 years from the beginning of the planning stage. Monetisation in this manner may allow acknowledgment of when the 'tipping point' in the balance of benefits might occur i.e., when disbenefits transition to benefits and vice versa.

9.34 As a complementary approach to providing snapshot values, values are also

[168] Natural England, 2021. The Environmental Benefits from Nature Tool – Beta Test Version (JP038). Available at: http://nepubprod.appspot.com/publication/6414097026646016 [Last accessed: 29/04/2022]

expressed as 'present value' estimates that reflect the expected flow of benefits over many years. For this approach, the relevant discount rates taken from HM Treasury's Green Book have been applied to future values. To project future ecosystem service flows, a 100-year appraisal period has been chosen, aligned with ENCA and the UK Natural Capital Accounts.[169]

[169] Office for National Statistics (2017). Principles of Natural Capital Accounting. Available at: https://www.ons.gov.uk/economy/environmentalaccounts/methodologies/principlesofnaturalcapitalaccounting [Last accessed: 20/05/2022]

Table 9-2: Habitat translation used within quantitative assessment and monetisation.

Broad habitat type	UKHab Description	BM3.0 habitat type	EBN habitat type	Assumed habitat within climate regulation modelling*	Assumed habitat within air pollutant removal modelling
Enclosed farmland	Arable and horticulture	Cropland - Cereal crops	Arable fields, horticulture and temporary grass	Arable land	Enclosed farmland
Enclosed farmland	Modified grassland	Grassland - Modified grassland	Improved grassland	Pastoral land	Enclosed farmland
Enclosed farmland	Hedgerows	Native Hedgerow	Hedgerows	N/a	N/a
Enclosed farmland	Line of trees	Line of Trees	Tree	N/a	N/a
Enclosed farmland	Hedgerows with trees	Native Hedgerow with trees	Hedgerow with trees	N/a	N/a
Enclosed farmland	Native Species rich with Trees	Native Hedgerow with trees	Hedgerow with trees	N/a	N/a
Freshwater	Floodplain Wetland Mosaic	Grassland - Floodplain Wetland Mosaic (CFGM)	Other swamps	N/a	Enclosed farmland
Freshwater	Standing open water and canals	Canals	Canals	N/a	N/a
Freshwater	Eutrophic standing waters	Lakes - Ponds (Non-Priority Habitat)	Standing open water	N/a	N/a
Freshwater	Canal	Canals	Canals	N/a	N/a
Freshwater	Other rivers and streams	Other rivers and streams	Running water	N/a	N/a
Freshwater	Reservoirs	Lakes - Reservoirs	Standing open water	N/a	N/a
Freshwater	Reedbeds	Wetland - Reedbeds	Reedbeds	N/a	N/a
Freshwater	Ditches	Ditches		N/a	N/a
Mountain, moor and heathland	Mixed scrub	Heathland and shrub - Mixed scrub	Dense scrub	N/a	Rural woodland
Mountain, moor and heathland	Other inland rock and scree	Sparsely vegetated land - Other inland rock and scree	Inland rock	N/a	N/a
N/a	Buildings	Urban - Developed land; sealed surface	Sealed surface and buildings	Urban	N/a

Broad habitat type	UKHab Description	BM3.0 habitat type	EBN habitat type	Assumed habitat within climate regulation modelling*	Assumed habitat within air pollutant removal modelling
N/a	Developed land; sealed surface	Urban - Developed land; sealed surface	Sealed surface and buildings	Urban	N/a
N/a	Built linear features			Urban	N/a
Semi-natural grassland	Other neutral grassland	Grassland - Other neutral grassland	Neutral grassland	Grassland	Enclosed farmland
Urban natural capital	Built-up areas and gardens	Urban - Vegetated garden	Suburban/ mosaic of developed/ natural surface	Green urban	N/a
Urban natural capital	Artificial unvegetated, unsealed surface	Urban - Artificial unvegetated, unsealed surface	Artificial unvegetated, unsealed surface	Urban	N/a
Woodland	Lowland mixed deciduous woodland	Woodland and forest - Lowland mixed deciduous woodland	Broadleaved, mixed and yew semi-natural woodland	Woodland (deciduous)	Rural woodland
Woodland	Other woodland mixed	Woodland and forest - Other woodland; mixed	Broadleaved, mixed and yew plantation	N/a	Rural woodland
Woodland	Wet woodland	Woodland and forest - Wet woodland	Broadleaved, mixed and yew semi-natural woodland	Woodland (deciduous)	Rural woodland

(*) These habitat types are taken from the WRPG SG Table 7. For habitat types not covered by the WRPG SG, sequestration rates have been drawn from the wider literature.

9.4.7 NCA Method Step 6: Calculate natural capital metrics

9.35 The quantified and monetised natural capital impacts were then translated into natural capital metrics within the final stage of NCA. As with Gate 1, the Gate 2 NCA presented three series of metrics to capture the benefits and disbenefits associated with each option more holistically. These include:

- Total disbenefit: sum of services with negative change values at each 'snapshot' year, as well as the present value disbenefit;
- Total benefit: sum of services with positive change values at each 'snapshot' year, as well as the present value benefit; and
- Net benefit: overall change in value across all services at each 'snapshot' year, as well as the overall present value benefit (or disbenefit).

9.5 Understanding of the baseline

9.36 As shown in Table 9-3, the majority of the baseline for each of the options comprises arable and horticultural land. The baseline also consists of substantial areas of 'manmade' landcover types, which are of limited natural capital value. Neutral grassland and lowland mixed deciduous woodland are the dominant semi-natural habitats for each option. Table 9-4 outlines the linear natural capital assets found across the indicative location for each SESRO option.

Table 9-3: Landcover baseline for the SESRO options.

Landcover type	Baseline Area (ha)			
	150Mm^3	125Mm^3	100Mm^3	75Mm^3
Arable and horticulture	1381.87	1347.05	1246.32	1179.08
Other neutral grassland	72.23	72.23	72.23	72.36
Modified grassland	40.01	30.58	29.58	29.58
Mixed scrub	7.54	7.36	7.36	7.36
Standing open water and canals	0.75	0.75	0.75	0.75
Eutrophic standing waters	4.05	3.78	3.21	2.72
Canal	0.23	0.23	0.16	0.00
Other rivers and streams	6.18	6.16	5.83	5.64
Other inland rock and scree	1.18	1.18	1.18	1.18
Built-up areas and gardens	146.24	146.24	146.24	146.24
Developed land; sealed surface	25.34	25.34	25.27	25.17

Landcover type	Baseline Area (ha)			
	150Mm^3	125Mm^3	100Mm^3	75Mm^3
Artificial unvegetated, unsealed surface	0.80	0.80	0.80	0.80
Built linear features	9.60	9.29	8.62	8.52
Lowland mixed deciduous woodland	62.39	59.83	54.92	52.25
Other woodland mixed	2.35	2.35	2.35	2.35
Total	1760.76	1713.17	1604.83	1534.01

Table 9-4: Linear natural capital asset baseline for the SESRO options.

Natural Capital Asset	Baseline Length (km)			
	150Mm^3	125Mm^3	100Mm^3	75Mm^3
Hedgerows	57.72	56.67	51.47	50.28
Line of trees	32.02	31.47	30.69	30.06
Hedgerows with trees	10.16	10.16	10.16	10.16
Total	99.90	98.31	92.32	90.50

9.37 The baseline for each of the options contains areas of solar farms. During the transition from Gate 1 to Gate 2, major updates were made to the underlying habitat mapping in the form of the UK Hab plans. For the Gate 1 assessment, these solar farms were treated as modified grassland due to presence of vegetation between solar panels. Within the updated plans, the solar farms are classified as built-up areas and gardens. For the Gate 2 NCA, these areas have only been considered for climate regulation due to uncertainty around how the use of the land for solar power would impact on the provision of other ecosystem services. As discussed in Section 9.4.4, the value of the natural environment in providing renewable energy is considered elsewhere. Site surveys at later Gates may be able to provide greater insight into the provision of ecosystem services by land these solar farms are located on.

9.6 Assessment outcomes

9.6.1 Change in natural capital assets

9.38 For consistency with the Biodiversity Net Gain assessment, the change in natural capital assets has been assessed only within the indicative location for the four SESRO options considered and not within the wider zone of influence. The change in landcover type associated with each option is presented in Table 9-5. The Gate 2 NCA has been able to consider the areas of landcover which would be retained during construction and therefore do not constitute a change. This is an update on the Gate 1 assessment, which assumed all areas to be lost during construction. However, areas of temporary land take to be used during the construction process have not

been considered as this information is not yet available. The changes in linear natural capital features are outlined in Table 9-6.

9.39 For each option, the direction of change in assets is broadly similar but the extent to which they are likely to change varies. For each option, the largest losses are seen in arable and horticultural land, whilst the largest gains are seen in the standing open water of the reservoir and the associated neutral grassland of the embankment. In terms of semi-natural habitats, substantial gains are seen for floodplain wetland mosaic, wet woodland and mixed scrub, with the largest losses seen for lowland mixed deciduous woodland. As explained in Supporting Document, B6 Biodiversity Net Gain Report, the scaling up of habitats to estimate post-development landcover for each of the smaller SESRO options is underpinned by the assumption that the smaller the reservoir and associated embankment, the more area there is for habitat creation relative to the indicative location for each SESRO option. This explains why the lower volume options have relatively larger areas of certain habitats such as floodplain wetland mosaic.

9.40 Regarding linear natural capital assets, the largest losses are expected to be seen for existing hedgerows, with substantial losses also seen for lines of trees and hedgerows with trees. The most substantial gains would come from newly planted native species-rich hedgerow with trees.

9.41 For both Table 9-5 and Table 9-6, the area or length of habitat that would be retained throughout construction and therefore not contributing to an overall change has been provided. Similarly, the area or length or habitat created under each option is also provided. Both are compared against the existing baseline habitats to calculate the overall change. The exclusion of built assets from Table 9-5 accounts for the discrepancy in baseline and future-baseline areas.

Table 9-5: Change in landcover associated with the SESRO options.

Natural capital asset	150Mm³ (ha)				125Mm³ (ha)				100Mm³ (ha)				75Mm³ (ha)			
	Baseline	Retained	Created	Change	Baseline	Retained	Created	Change	Baseline	Retained	Created	Change	Baseline	Retained	Created	Change
Arable and horticulture	1381.87	10.44	80.36	-1291.07	1347.05	0.00	84.97	-1262.08	1246.32	0.00	84.47	-1161.84	1179.08	0.00	84.92	-1094.17
Built-up areas and gardens	146.24	6.75	0.00	-139.49	146.24	0.00	0.00	-146.24	146.24	0.00	0.00	-146.24	146.24	0.00	0.00	-146.24
Canal	0.23	0.00	35.07	34.84	0.23	0.00	0.00	-0.23	0.16	0.00	0.00	-0.16	0.00	0.00	0.00	0.00
Eutrophic standing waters	4.05	1.94	10.58	8.47	3.78	2.01	11.21	9.43	3.21	2.00	11.14	9.93	2.72	2.01	11.20	10.49
Floodplain Wetland Mosaic	0.00	0.00	127.58	127.58	0.00	0.00	134.92	134.92	0.00	0.00	134.13	134.13	0.00	0.00	134.83	134.83
Lowland mixed deciduous woodland	62.39	17.28	14.94	-30.17	59.83	17.98	0.00	-41.85	54.92	17.87	0.00	-37.05	52.25	17.96	0.00	-34.28
Mixed scrub	7.54	1.37	24.66	18.49	7.36	0.00	6.82	-0.54	7.36	0.00	6.78	-0.58	7.36	0.00	6.82	-0.55
Modified grassland	40.01	3.73	1.97	-34.31	30.58	0.00	2.11	-28.46	29.58	0.00	2.10	-27.48	29.58	0.00	2.11	-27.47
Other inland rock and scree	1.18	0.00	0.00	-1.18	1.18	0.00	0.00	-1.18	1.18	0.00	0.00	-1.18	1.18	0.00	0.00	-1.18
Other neutral grassland	72.23	5.32	695.12	628.21	72.23	0.00	724.78	652.55	72.23	0.00	705.45	633.22	72.4	0.00	736.11	663.74
Other rivers and streams	6.18	0.62	0.00	-5.56	6.16	0.00	0.00	-6.16	5.83	0.00	0.00	-5.83	5.64	0.00	0.0	-5.64

Natural capital asset	150Mm³ (ha)				125Mm³ (ha)				100Mm³ (ha)				75Mm³ (ha)			
	Baseline	Retained	Created	Change	Baseline	Retained	Created	Change	Baseline	Retained	Created	Change	Baseline	Retained	Created	Change
Other woodland mixed	2.35	1.20	0.00	-1.15	2.35	1.27	15.86	14.78	2.35	1.26	15.77	14.68	2.35	1.27	15.85	14.77
Standing open water and canals	0.75	0.75	653.38	653.38	0.75	0.00	581.50	580.75	0.75	0.00	495.49	494.49	0.75	0.00	391.81	391.06
Wet woodland	0.00	0.00	21.54	21.54	0.00	0.00	22.78	22.78	0.00	0.00	22.64	22.64	0.00	0.00	22.76	22.76

Note: With the exception of built-up areas and gardens, the change in areas of built assets are not included here as they do not contribute to natural capital value.

Table 9-6: Change in linear natural capital assets associated with the SESRO options.

Natural Capital Asset	150Mm³ (km)				125Mm³ (km)				100Mm³ (km)				75Mm³ (km)			
	Baseline	Retained	Created	Change	Baseline	Retained	Created	Change	Baseline	Retained	Created	Change	Baseline	Retained	Created	Change
Hedgerows	57.72	8.00	0.00	-49.72	56.67	8.46	0.00	-48.21	51.47	8.41	0.00	-43.06	50.28	8.45	0.00	-41.82
Line of trees	32.02	8.00	0.00	-24.02	31.47	8.46	0.00	-23.01	30.69	8.41	0.00	-22.28	30.06	8.45	0.00	-21.61
Hedgerows with trees	10.16	0.00	0.00	-10.16	10.16	0.00	0.00	-10.16	10.16	0.00	0.00	-10.16	10.16	0.00	0.00	-10.16
Native species-rich hedgerow with trees	0.00	0.00	42.20	42.20	0.00	0.00	44.62	44.62	0.00	0.00	44.36	44.36	0.00	0.00	44.59	44.59

9.6.2 Qualitative assessment

9.42 Table 9-7 provides a qualitative narrative around the impacts of the SESRO options on ecosystem service provision relative to baseline. A general narrative is given for all of the options, as the direction of their impacts and the expected order of magnitude are thought to be similar for each. For the two phased options, the impacts are also thought to be similar due to the total footprint of each. However, the impacts would be experienced over a longer time frame and would be aligned to planned phases of construction etc.

Table 9-7: Qualitative Natural Capital Assessment (NCA) outcomes.

Ecosystem Service	Narrative	Score
Climate regulation	Agricultural land is difficult to generalise in terms of carbon storage and sequestration due the variation in management approaches and their associated impacts on carbon dynamics. Nevertheless, arable land is generally considered to be a source of carbon emissions rather than a sink.[170] Each option involves a substantial area of agricultural land, particularly arable and horticulture, being taken out of agricultural use and partially replaced with land capable of sequestering carbon. A large portion of this land would fall within the footprint of the reservoir. The evidence base for the carbon dynamics of reservoirs is limited, with the available literature focused on reservoirs in peat catchments.[170] There is evidence to suggest that annual variability in rainfall and temperature can cause these reservoirs to shift from net emitters to net carbon sinks and vice versa. However, given the limited evidence base, it is difficult to apply these findings more generally. Woodland is likely the most substantial carbon store and carbon sequestering habitat present. Net losses of woodland habitat are expected under each option, though the carbon impacts are likely to be counteracted by the creation of new habitats, such as the substantial area of floodplain wetland mosaic and native species-rich hedgerow with trees. Findings of the quantitative assessment for this ecosystem service should be considered along with construction and operational carbon emissions to provide a more holistic lifecycle carbon assessment.	↗
Natural hazard regulation	Under each option, the area of woodland within the active floodplain is expected to change by relatively small quantities, with the loss of lowland mixed deciduous woodland being roughly equal to the created wet woodland. The wet woodland would take time to reach its full potential regarding flood regulation. However, this would likely be countered by a greater capacity for flood water storage. The creation of floodplain wetland mosaic from arable land in the areas surrounding the diverted watercourses is likely to provide some flood regulation benefit, though it has not been possible to quantify this for the NCA.	→
Water purification	The removal of land from agricultural use to a greater variety of habitats is likely to lead water quality improvements. This is due to an anticipated reduction in nutrients and pesticides entering local watercourses. With the exception of areas of retained and reinstated agricultural land, all other post-development habitat types are likely to receive low or zero input. As such, all options are likely to	↗

[170] R Gregg, J. L. Elias, I Alonso, I.E. Crosher and P Muto and M.D. Morecroft (2021) Carbon storage and sequestration by habitat: a review of the evidence (second edition) Natural England Research Report NERR094. Natural England, York. Available at: http://publications.naturalengland.org.uk/publication/5419124441481216 [Last accessed: 23/05/2022]

Ecosystem Service	Narrative	Score
	improve dilution services. The creation of extensive areas of wetland floodplain mosaic and wet woodland along the length of diverted water courses is likely to increase the capacity of the natural environment to absorb pollutants.	
Water regulation	As stated in the Gate 1 assessment, all of the options would deliver an additional deployable output in water supply. The extent of this additional output would depend on the capacity of each option, but all would represent a positive change in water regulation for customers. The reservoir would be filled with water abstracted from the River Thames during times of higher flow, with discharge back into the River then occurring at drier times of the year. Therefore, the value of this service would be maintained whilst supporting abstractions for other users. Another way in which it has been proposed that SESRO options may benefit water regulation is through reducing abstraction in vulnerable areas, such as chalk streams. Again, this benefit is likely to depend on the capacity of the option.	↑/↗
Air pollutant removal	All options are expected to result in a net loss of woodland, the habitat type with the greatest capacity to absorb air pollutants. However, each option is also expected to result in the conversion of a substantial area of agricultural land into a greater variety of vegetated habitat types. At the same time, background air pollution is not expected to be high as no Air Quality Management Areas fall within the indicative location for each of the SESRO options, though there is one located nearby in the centre of Abingdon. Overall, the impact to air pollutant removal is expected to be limited.	→
Food production	All options are likely to result in a substantial loss of agricultural land, particularly arable and horticultural fields. The reinstatement of some areas of arable and horticultural land following construction goes someway to counter this impact, but there would likely be an overwhelming net loss in each case. Based on the Provisional Agricultural Land Classification data,[171] the indicative location for each of the SESRO options contains a mix of the best and most versatile agricultural land and lower grade agricultural land. As such it is likely that the value of food production varies across the areas of impacted agricultural land more than it was possible to capture within the quantitative assessment.	↓
Recreation	Some Public Rights of Way (PRoW) already exist across the indicative location for each of the SESRO options, suggesting baseline recreational value. Some of these routes are likely to be diverted due to the options. However, the options would also lead to a shift in	↑

[171] Natural England, 2020. Provisional Agricultural Land Classification (ALC). Available at: https://data.gov.uk/dataset/952421ec-da63-4569-817d-4d6399df40a1/provisional-agricultural-land-classification-alc [Last accessed: 25/05/2022]

Ecosystem Service	Narrative	Score
	landcover from agricultural use to a greater variety of habitat types, with improved accessibility from new walking routes and car parking. As such, the recreational value is expected to increase substantially under each option.	

Key

↑	Potential substantial positive ecosystem service impact
↗	Potential moderate positive ecosystem service impact
→	Limited ecosystem service impact expected
↘	Potential moderate adverse ecosystem service impact
↓	Potential substantial adverse ecosystem service impact

9.6.3 Quantitative assessment and monetisation

9.43 The following ecosystem services were assessed quantitatively and monetised:

- Climate regulation;
- Natural hazard regulation;
- Water purification;
- Air pollutant removal;
- Food production; and
- Recreation.

9.44 The results are for each of these are summarised in

9.45 Plate 9.2. Water regulation was also quantified, though it was not possible to monetise this service, as discussed in Section 9.6.3.8.

9.46 It should be noted that the valuation of the following ecosystem services is only partial. However, partial valuation can still support discussion around the trade-offs of different benefits and disbenefits and inform decision making.

9.47 The monetised value of ecosystem services could change due to multiple drivers, such as climate change. For example, climate pressures may drive food scarcity which in turn could drive an increase in the value of food production services.

9.48 It is important to note that natural capital benefits would only be realised with proper a long-term management regime in place. The development and implementation of a long-term Landscape and Ecological Management Plan (LEMP) is discussed in Chapter 6 Landscape and Visual.

Plate 9.2: Change in present value benefit for each ecosystem service (£) - 2022 prices.

9.6.3.2 Climate regulation

9.49 As shown in Table 9-8, the present value benefit of climate regulation is estimated to be positive for each SESRO option. This increase is based on the conversion of arable land to habitats with a greater capacity for carbon sequestration, such as woodland, floodplain wetland mosaic and hedgerows. The smaller the volume of storage, the larger the benefit due to the smaller reservoir footprint relative to the location of the SESRO option leaving a greater proportion available for enhancement. The 75Mm^3 SESRO option is predicted to provide the largest benefit and the largest SESRO option the lowest.

Table 9-8: Present value benefit of climate regulation for each option (£) – 2022 prices.

Option	Central		Low		High	
	Present value benefit	Sensitivity analysis applied	Present value benefit	Sensitivity analysis applied	Present value benefit	Sensitivity analysis applied
150Mm^3	£ 1,922,000	-£ 549,000	£ 961,000	-£ 275,000	£ 3,843,000	£ 137,000
125Mm^3	£ 2,324,000	-£ 289,000	£ 1,162,000	-£ 144,000	£ 4,418,000	£ 498,000
100Mm^3	£ 2,776,000	£ 127,000	£ 1,388,000	£ 63,000	£ 5,095,000	£ 1,122,000
75Mm^3	£ 3,175,000	£ 513,000	£ 1,588,000	£ 256,000	£ 5,694,000	£ 1,700,000

9.50 This relationship is in contrast to the findings of the Gate 1 assessment, in which climate regulation benefit increased with storage volume, though all options were still found to benefit. In part, this is likely due to development of the UK Hab data and detailed Masterplan and the corresponding change in woodland area. The Gate 1 assessment also used the WRPG SG reference values without accounting for habitat maturity, which was acknowledged to likely be an overestimate. To capture the change in climate regulation over time as habitats mature, Table 9-9 provides a series of 'snap shot' monetary values. Based on the central values, each option is expected to transition from a net loss to a net gain between the years 15 and 25.

9.51 Sensitivity analysis has been used to demonstrate the potential impacts of habitat failure based on the difficulty of habitat creation. In this way, Table 9-8 reflects the habitat losses as a result of SESRO in addition to the habitat losses as a result of habitat failure (i.e. with sensitivity analysis applied). As can be seen in Table 9-8, the failure of habitats with higher sequestration potential is likely to cause the largest SESRO option and the 125Mm^3 SESRO option to shift towards being negative overall, if central and low carbon values are used.

Table 9-9: 'Snapshot' monetary values for climate regulation benefits – 2022 prices.

Option	'Snapshot' monetary value (£) at years				
	10	15	25	50	100
150Mm^3	-£85,000	-£77,000	£5,000	£45,000	£38,000
125Mm^3	-£94,000	-£85,000	£1,000	£54,000	£47,000
100Mm^3	-£87,000	-£29,000	£8,000	£58,000	£49,000
75Mm^3	-£82,000	-£23,000	£13,000	£62,000	£52,000

9.52 It is important to consider these results alongside the emissions associated with construction and operation. As such, these results should be read together with the SESRO Carbon Report[172] to provide a more holistic view of whole lifecycle carbon.

9.6.3.3 Natural hazard regulation

9.53 Table 9-10 shows that the natural hazard regulation benefit is expected to decrease under each option. In each case, the area of woodland within the active floodplain is expected to change by a relatively small quantity. The loss of lowland mixed deciduous woodland is roughly equal to the area of wet woodland being created. However, the wet woodland would take time to reach its full potential regarding flood regulation. This effect could be somewhat counteracted by a greater capacity of wet woodland for water storage. However, the WPRG SG does not provide specific wet woodland storage values, so this could not be considered within the NCA. As such, there is potential that the provision of this service has been underestimated, possibly counteracting the negative values presented in Table 9-10 to an extent. The potential flood storage benefits of other habitat types have not been considered either due to a lack of available methodology.

9.54 The Gate 1 assessment found flood regulation benefits for all options. The difference seen here is in part due to updated UK Hab data and detailed Masterplan, which sees a net loss rather than gain in woodland areas at Gate 2. The impact of habitat maturity is also a factor, as the Gate 1 assessment assumed no change in benefits over time.

[172] Mott MacDonald, 2022. South East Strategic Reservoir Option Carbon Report.

Table 9-10: Present value benefit of natural hazard regulation for each option (£) – 2022 prices.

Option	Central		Low		High	
	Present value benefit	Sensitivity analysis applied	Present value benefit	Sensitivity analysis applied	Present value benefit	Sensitivity analysis applied
150Mm³	-£50,000	-£68,000	-£12,000	-£16,000	-£141,000	-£193,000
125Mm³	-£53,000	-£72,000	-£13,000	-£17,000	-£149,000	-£204,000
100Mm³	-£50,000	-£70,000	-£12,000	-£17,000	-£143,000	-£200,000
75Mm³	-£51,000	-£71,000	-£12,000	-£17,000	-£144,000	-£201,000

9.55 The change in natural hazard regulation benefits over time presented in Table 9-11 show that negative impacts are expected to decrease over the appraisal period. This is in part due to the effects of discounting.

Table 9-11: 'Snapshot' monetary values for natural hazard regulation benefits (£) – 2022 prices.

Option	'Snapshot' monetary value at years				
	10	15	25	50	100
150Mm³	-£3,000	-£2,000	-£2,000	-£1,000	£0
125Mm³	-£3,000	-£3,000	-£2,000	-£1,000	£0
100Mm³	-£3,000	-£3,000	-£2,000	-£1,000	£0
75Mm³	-£3,000	-£3,000	-£2,000	-£1,000	£0

9.56 There are a range of considerable limitations relating to the JULES model approach used, which is based on a replacement cost method. As such, the values presented here represent the lower bound of welfare effects from flood regulation by woodland. The full welfare effect could be better captured by estimating the damage costs increased or avoided to property.

9.57 It should be noted that the assessment only focuses on the contribution of natural capital assets to flood regulation and not an assessment of the flood risk impacts of each option as a whole. It is understood that, overall, the scheme is expected to have a minimal impact on fluvial flood risk. As such, it is expected that the loss of flood risk benefits from natural capital assets would be offset by other elements of the scheme. Future work will explore the overall impact that different options will have on fluvial flood risk, with a flood risk assessment to be undertaken in subsequent project stages.

9.6.3.4 Water purification

9.58 Table 9-12 shows that all of the options are expected to provide a water purification benefit. This positive change is expected due to the shift in landcover from arable and horticultural land to non-agricultural land, reducing agricultural runoff. In addition to this, the creation of wetland habitats along the diverted water courses is expected to provide greater water purification services.

9.59 The 125Mm^3 SESRO option is estimated to bring about the largest increase water purification. This is because this option sees the second largest loss of area of arable and horticultural land by a relatively small margin and creation of the largest area of floodplain wetland mosaic among each option. This finding is in line with that of the Gate 1 assessment.

9.60 The sensitivity analysis indicates that even if some of the wetland habitats were to fail due to difficulty in creating them, the overall water purification benefit would likely still be positive. This holds even when low values are applied.

Table 9-12: Present value benefit of water purification for each option (£) – 2022 prices.

Option	Central		Low		High	
	Present value benefit	Sensitivity analysis applied	Present value benefit	Sensitivity analysis applied	Present value benefit	Sensitivity analysis applied
150Mm^3	£3,028,000	£2,389,000	£2,451,000	£1,811,000	£3,605,000	£2,966,000
125Mm^3	£3,039,000	£2,363,000	£2,476,000	£1,800,000	£3,602,000	£2,927,000
100Mm^3	£2,910,000	£2,218,000	£2,391,000	£1,699,000	£3,429,000	£2,737,000
75Mm^3	£2,806,000	£2,114,000	£2,317,000	£1,625,000	£3,295,000	£2,603,000

9.61 The increase in the value of water purification services shown in Table 9-13 between years 15 and 25 show how the water purification services provided by newly created wetland habitats are likely to mature over time. The decline seen between years 50 and 100 is due to the effect of discounting.

Table 9-13: 'Snapshot' monetary values for water purification benefits (£) – 2022 prices.

Option	'Snapshot' monetary value at years				
	10	15	25	50	100
150Mm^3	£54,000	£46,000	£56,000	£30,000	£11,000
125Mm^3	£53,000	£45,000	£56,000	£30,000	£11,000

Option	'Snapshot' monetary value at years				
	10	15	25	50	100
100Mm^3	£49,000	£48,000	£54,000	£29,000	£11,000
75Mm^3	£46,000	£45,000	£52,000	£28,000	£10,000

9.6.3.5 Air pollutant removal

9.62 Table 9-14 demonstrates that the value of air pollutant removal services is expected to decrease for each option. This is mostly due to the net loss in woodland and the removal of large swathes of agricultural land estimated for each option. The rural location of the options has lessened the impact of these losses as the levels of background air pollution are lower than more urban areas. The largest loss is seen for the 125Mm^3 option as this would result in the removal of the largest areas of habitat with a higher capacity to regulate air pollution. The largest SESRO option performs more favourably than the 125Mm^3 and 100Mm^3 options due to an expected increase in, rather than loss of, mixed scrub habitats. The 75Mm^3 option is the least impactful due to the smaller reservoir footprint relative to the location of the SESRO option leaving a greater proportion available for habitat enhancements that benefit air quality.

9.63 Low and high estimates of the health impacts associated with air pollution were not available so have not been applied here.

9.64 These findings differ from those of Gate 1 but this is largely due to the updated UK Hab data and detailed Masterplan, which sees a net loss rather than gain in woodland areas at Gate 2. As woodland habitats offer a high capacity for the absorption of pollutants, the impacts are considerable.

Table 9-14: Present value benefit of air pollutant removal for each option (£) – 2022 prices.

Option	Central		Low		High	
	Present value benefit	Sensitivity analysis applied	Present value benefit	Sensitivity analysis applied	Present value benefit	Sensitivity analysis applied
150Mm^3	-£326,000	-£392,000	N/a	N/a	N/a	N/a
125Mm^3	-£436,000	-£506,000	N/a	N/a	N/a	N/a
100Mm^3	-£353,000	-£424,000	N/a	N/a	N/a	N/a
75Mm^3	-£297,000	-£367,000	N/a	N/a	N/a	N/a

9.65 Though the value of air pollutant removal services improves over time with the maturation of newly planted woodland habitat (as seen in Table 9-15), it is not enough to offset the expected losses.

Table 9-15: 'Snapshot' monetary values for air pollutant removal benefits (£) – 2022 prices.

Option	'Snapshot' monetary value at years				
	10	15	25	50	100
150Mm³	-£14,000	-£13,000	-£4,000	-£2,000	-£1,000
125Mm³	-£15,000	-£14,000	-£7,000	-£3,000	-£2,000
100Mm³	-£14,000	-£8,000	-£5,000	-£2,000	-£1,000
75Mm³	-£13,000	-£12,000	-£5,000	-£2,000	-£1,000

9.6.3.6 Food production

9.66 All options would result in large areas of land being taken out of agricultural use and as such see substantial losses in food production. As demonstrated by Table 9-16, the largest losses are for the largest SESRO option, which is associated with the largest loss of agricultural land. Conversely, the least disbenefit is seen for the 75Mm³ SESRO option. These findings align with those of the Gate 1 assessment. Sensitivity analysis was not possible in this case as reinstating agricultural land for food production is not considered to be technically difficult and, therefore, is not associated with a penalty risk multiplier (see Section 9.4.6 for more information on how sensitivity analysis was performed). Table 9-17 shows the change in food production benefits overtime.

Table 9-16: Present value benefit of food production for each option (£) – 2022 prices.

Option	Central		Low		High	
	Present value benefit	Sensitivity analysis applied	Present value benefit	Sensitivity analysis applied	Present value benefit	Sensitivity analysis applied
150Mm³	-£7,934,000	N/a	-£6,915,000	N/a	-£8,952,000	N/a
125Mm³	-£7,733,000	N/a	-£6,738,000	N/a	-£8,728,000	N/a
100Mm³	-£7,125,000	N/a	-£6,209,000	N/a	-£8,041,000	N/a
75Mm³	-£6,717,000	N/a	-£5,853,000	N/a	-£7,580,000	N/a

Table 9-17: 'Snapshot' monetary values for food production benefits (£) – 2022 prices.

Option	'Snapshot' monetary value at years				
	10	15	25	50	100
150Mm^3	-£214,000	-£180,000	-£128,000	-£69,000	-£26,000
125Mm^3	-£209,000	-£176,000	-£125,000	-£68,000	-£26,000
100Mm^3	-£192,000	-£162,000	-£115,000	-£62,000	-£24,000
75Mm^3	-£181,000	-£153,000	-£108,000	-£59,000	-£22,000

9.6.3.7 Recreation

9.67 The same estimate for visitor numbers have been used in valuing recreation services across different options. The present value benefit of recreation for the following options has been estimated to be:

- largest SESRO option and 125Mm^3 SESRO option: £35,365,000; and
- 100Mm^3 SESRO option and 75Mm^3 SESRO option: £36,418,000.

9.68 The difference seen in these numbers is due to the lower volume options having a shorter total lead time by one year. This assumes that each option would also include the built recreational features incorporated into the masterplan for the largest SESRO option, as illustrated on Figure 2.1 Landscape and Environmental Design Strategy Plan in Technical Supporting Document B2.2, Environmental Appraisal Report (terrestrial) Figures, such as improved access, visitor centre and café. A range has not been provided for each scenario as the visitor numbers are taken the CAR Strategy scenario that best reflects the provisions made for the masterplan.

9.69 The baseline recreational value has not been estimated the for Gate 2 assessment. However, the Gate 1 assessment estimated the baseline recreational value to be £141,910 per year in 2019 prices.

9.70 Using the Gate 2 visitor numbers, the annual recreational value is £1,683,770 in 2019 prices, an increase of £1,541,860 per year from the baseline. This is an improvement of £462,829 from the £1,079,031 increase seen in Gate 1.

9.6.3.8 Water regulation

9.71 Table 9-18 demonstrates the range in potential water regulation benefit for the largest SESRO option. Utilisation data for the other options were unavailable so it is not possible to make a comparison across the different options. However, it is expected that water regulation benefits would be broadly proportional to the deployable output of each option.

9.72 As noted in the Gate 1 NCA:

'any potential positive benefit to this service is not due to changes in natural capital stocks, but effectively changing the location where the ecosystem service benefit will be experienced, rather than actually increasing its provision in absolute terms.'

9.73 The water regulation benefits are considerable and outweigh the other ecosystem service benefits by a wide margin, even based on the lower utilisation scenario.

Table 9-18: Water regulation benefit of the 150 Mm^3 option.

Utilisation Scenario	PV Benefit (£)
Lower Utilisation	296,119,000
Higher Utilisation	1,936,586,000

9.6.4 Natural Capital Metrics

9.74 The impact of each option on the ecosystem services considered is summarised in Table 9-19 except for water regulation, for which it was not possible to make a comparison across the different options. If it were possible to include water regulation services for all options, it is likely that it would provide the most significant benefits across the board.

9.75 It is important to recognise that natural capital impacts can act in both directions, providing benefits and disbenefits. The most substantial benefit outlined in Table 9-19 relates to recreation, whilst the largest disbenefit is from food production. Identifying such changes highlights the trade-offs associated with the change in land use for each option and can be used to support decision making.

9.76 Due to developments since the Gate 1 assessment, the values presented in Table 9-19 capture natural capital impacts during development and construction rather than the operational period of the reservoir only. These values also capture the maturity of habitats and their ability to provide the various ecosystem services over time. The effect of this is demonstrated in Table 9-20, where ecosystem service benefits generally improve with time. The large difference between the two larger volume options and the two lower volume options at year 15 is due to the recreational benefits commencing earlier for the lower volume options due to their shorter lead time. The drop in net benefits from 50 to 100 years is due to the effect of discounting for social time preference.

Table 9-19: Summary of change in present value benefits of ecosystem service provision (£) – 2022 prices.

Ecosystem Service	Present Value Benefit			
	150Mm^3	125Mm^3	100Mm^3	75Mm^3
Climate regulation	£1,922,000	£2,324,000	£2,776,000	£3,175,000
Natural hazard regulation	-£50,000	-£53,000	-£50,000	-£51,000
Water purification	£3,028,000	£3,039,000	£2,910,000	£2,806,000
Food production	-£7,934,000	-£7,733,000	-£7,125,000	-£6,717,000
Air pollutant removal	-£326,000	-£ 436,000	-£353,000	-£297,000
Recreation	£35,365,000	£35,365,000	£36,418,000	£36,418,000
Total	£32,005,000	£32,506,000	£34,576,000	£35,334,000

Table 9-20: The total benefit, disbenefit and associated net benefit from changes in ecosystem service provision for each of the options at several 'snapshot' years (£) – 2022 prices.

Option	'Snapshot' monetary value at years														
	10			15			25			50			100		
	Benefit	Disbenefit	Net Benefit	Benefit	Disbenefit	Net Benefit	Benefit	Disbenefit	Net Benefit	Benefit	Disbenefit	Net Benefit	Benefit	Disbenefit	Net Benefit
150Mm³	£54,000	-£316,000	-£262,000	£46,000	-£272,000	-£226,000	£807,000	-£134,000	£673,000	£479,000	-£72,000	£407,000	£204,000	-£27,000	£177,000
125Mm³	£53,000	-£321,000	-£268,000	£45,000	-£278,000	-£232,000	£803,000	-£134,000	£672,000	£841,000	-£72,000	£769,000	£343,000	-£28,000	£315,000
100Mm³	£49,000	-£321,000	-£272,000	£1,101,000	-£202,000	£899,000	£808,000	-£122,000	£686,000	£841,000	-£65,000	£776,000	£343,000	-£25,000	£318,000
75Mm³	£46,000	-£279,000	-£233,000	£1,098,000	-£191,000	£907,000	£811,000	-£115,000	£695,000	£811,000	-£62,000	£749,000	£332,000	-£23,000	£309,000

9.7 Conclusions

9.77 Based on the Gate 2 NCA, the following main conclusions can be drawn:

- All options demonstrate an overall positive impact on climate regulation, water purification, and recreation ecosystem service provision. Disbenefits are seen for food production, air pollutant removal, and natural hazard regulation services. All of the options have the potential to significantly impact ecosystem service provision, but to varying degrees and in different directions, as highlighted by the valuation exercise.
- Though it was not possible to quantify and monetise water regulation benefits for all options, it is likely that they would be the most substantial benefits across the board. The next most substantial benefits are likely to come from the recreational value of each option.
- Based on central transfer values, the 75Mm^3 SESRO option is expected to yield the largest natural capital benefit. This is likely due the scaling of habitat types to estimate the future habitat baseline, which was underpinned by the assumption that smaller reservoir footprints allow a greater proportion of habitats to be created.
- The results broadly align with those from the Gate 1 assessment, though expected losses were only seen for food production within the earlier assessment. The difference in air pollutant removal and natural hazard regulation between Gate 1 and Gate 2 can be explained by the change in woodland areas. For Gate 1, a net gain in woodland area was expected. However, following updates to both the baseline and future-baseline habitat areas at Gate 2, a net loss is expected. Woodland has a high capacity to deliver these ecosystem services and a shift to a net loss explains some of this disbenefit. Another important factor is that the Gate 2 assessment considers the maturity of newly created woodland, rather than assuming a constant delivery of services. As such, it takes time for the air pollutant removal and natural hazard regulation benefits provided by new woodland to scale up.

9.8 Next Steps and Future Assessment Framework

9.78 Future NCAs at subsequent project stages should consider the following:

- The ACWG guidance states that at Gate 3, the NCA should be further refined to better integrate with the EIA process. The NCA should also be further updated to capture developments in the SESRO concept design. This would allow better examination of the effect that the different sizes of reservoir may have on natural capital value.
- The NCA would be developed to better quantify and monetise the impact on water regulation services by considering the economic value of water left in the environment for other existing or future users. This not possible at Gate 2 as research into the reduction of abstractions elsewhere, in particular vulnerable chalk streams, had not been completed. However, at subsequent project stages

this information would be available to integrate into the next iteration of the NCA. Similarly, information may be available to monetise the utilisation for all of the options, rather than just the largest SESRO option as has been the case at Gate 2.

- Due to a lack of available information on the time frames involved for the two phased options, it has not been possible to consider these within Gate 2 NCA. Subsequent project stages would consider the programme of works for these options, the areas impacted and associated timeframes to allow better comparison with the other options.
- Assessment at subsequent project stages would expand on the ecosystem services considered at Gate 2. The *Gate Two Environmental Appraisal Approach to Wider Benefits*[173] document includes a review of the ENCA natural capital services and how these would be considered by SROs. This appendix would be consulted on to support the identification of additional ecosystem services that would be considered for subsequent project stages. Stakeholder consultation would be undertaken as part of the consenting process and would provide a useful means of identifying relevant ecosystem services.
- Following the completion of ecological site surveys, subsequent project stages would integrate asset quality and locational indicators into the NCA to better align with the WRMP SG.

9.79 The findings of the Gate 2 and subsequent NCAs should be considered within the iterative design process. This would help to optimise the delivery of multiple benefits, for example through feeding into landscape design. Further, the consideration of natural capital value alongside biodiversity would support SESRO to move beyond Biodiversity Net Gain towards environmental net gain.

[173] Mott MacDonald, 2022. Gate Two Environmental Appraisal: Approach to wider benefits. 100104412.

10. Wider Benefits

10.1 Introduction

10.1 Building on the work undertaken to support the Gate 1 process, this chapter presents an environmental appraisal of the wider economic, environmental, and social benefits (hereafter referred as 'wider benefits') arising from SESRO.

10.2 This chapter sets out the appropriate guidance relevant to wider benefits followed by the methodology and baseline used for the appraisal of wider benefits.

10.3 This chapter focusses on the largest SESRO option (i.e. 150Mm^3) with narrative provided on the relative performance of the alternative reservoir options (i.e. 125Mm^3, 100Mm^3, 75Mm^3, 30+100Mm^3 and 80+42Mm^3).

10.4 Other chapters in the EAR assess benefits from varying perspectives and this chapter aligns with those, avoiding double counting of impacts. The wider benefits assessed:

- Economic Activity;
- Health;
- Education;
- Financial Asset Value; and
- Customer Bills.

10.5 In measuring the impact of each benefit, elements of disbenefit will also be recorded whereby negative impacts are felt by certain groups within the local, regional or national community. This does not represent a net impact but instead provides context of the differing nature of certain impacts.

10.6 This Gate 2 assessment focuses on presenting quantitative and qualitative analysis of wider benefits, following on from the Gate 1 assessment which focused on establishing the type of benefits that should be assessed and how they align with other subject matter areas.

10.2 Guidance

10.7 Various forms of guidance have shaped the scope and methodology of each benefit assessment within this EAR. The Water Resources Planning Guidelines (WRPG) and Supplementary Guidance (SG) "Environment and society in decision making"[174] require environmental, social and economic valuations to be delivered through a Natural Capital Assessment (NCA). The wider benefits assessment captures elements not covered within the scope of the NCA and sub-topics of the EAR.

[174] Environment Agency, Ofwat and Natural Resources Wales (2021). Water Resources Planning Guidelines (WRPG) and
Supplementary Guidance (SG) Environment and Society in Decision Making

10.8 The WRPG SG and RAPID process were then reviewed by the All Companies Working Group, which in the past informed the RAPID Gate 1 NCA assessment and therefore the optioneering process. It is be expected that the WRPG SG guidelines should therefore apply to the wider benefits assessment as an additional element to the NCA and EAR.

10.9 With SESRO falling within the Water Resources South-East (WRSE) region, the NCA and wider benefits assessment is undertaken at a regional level. This would ensure that representative data of the Oxfordshire region is used within this wider assessment.

10.10 In review of the WRSE regional strategy, this assessment was conducted in the context of their overarching goals and objectives to deliver a safe, secure and resilient water network for the public, industry and natural environment.

10.11 Within the Gate 1 submission of the EAR, wider benefits of SESRO were outlined, including broader environmental and social benefits. Within this Gate 2 assessment, guidance[175] has recommended that:

- Environmental Appraisal (section 6.3) work should:
  - include '*consideration of resilience (climate change), biodiversity net gain, climate change and carbon effects*'; and
  - develop '*mitigation and enhancement opportunities*'.
- (ii) Best Value and solution benefits (section 8.2) work should:
  - include the '*consideration of financial cost and how it will achieve an outcome that increases the overall benefit to customers, the wider environment and overall society*';
  - '*follow the WRMP24 best value guidance*'; and
  - '*be aligned with the Public Value principles from Ofwat, published in July 2021 Public value in the water sector: a supporting set of principles*'.

10.12 The Ofwat Public Value Principles[176] are relevant to the concept of wider benefit assessment. Principle 1 states that: 'Companies should seek to create further social and environmental value in the course of delivering their core services, beyond the minimum required to meet statutory obligations. Social and environmental value may be created both in direct service provision and through the supply chain.' Therefore, it is important for water companies to demonstrate the costs and benefits (and therefore value) of their activities – in this case the development of SESRO.

[175] Ofwat, 2022. Strategic Regional Water Resource Solutions Guidance for Gate Two. Available at: https://www.ofwat.gov.uk/publication/strategic-regional-water-resource-solutions-guidance-for-gate-two/, [Last accessed 29/04/2022]

[176] Ofwat, 2022. Ofwat's Final Public Value Principles. https://www.ofwat.gov.uk/publication/ofwats-final-public-value-principles/, [Last accessed: 29/04/2022]

10.3 Methodology

10.3.1 Introduction

10.13 This section outlines the approach used to estimate benefits as part of the wider benefit assessment. It presents the method, assumptions, frameworks, guidance and datasets utilised to produce the analysis. Results are shown in Section 10.5.

10.3.2 Six Capitals framework and scope

10.14 This Gate 2 submission is a continuation of the approach set out in Gate 1. This approach committed to the Six Capitals framework and identified benefits that could be estimated as part of a wider benefit assessment. The result of Gate 1 was a clear idea of what could be considered a wider benefit whilst avoiding double counting with other concurrent assessments like the NCA. Gate 2 progresses the overall assessment by analysing the benefits in more detail, quantitatively where possible.

10.15 The Six Capitals framework[177] aligns with the aims of the wider benefits assessment. This methodology is used by organisations and water companies to identify wider social, environmental, and economic considerations of any intervention or project. By using this approach, wider benefits can be assessed at an appropriate level of detail, whilst also categorising how and who each benefit would impact.

10.16 Table 10.1 shows the different capitals and their relevance to SESRO in terms of potential impacts and benefits.

Table 10.1: Six Capitals Framework and descriptions

Capital	Description	Relevance to SESRO
Financial	The pool of funds available for use in the production of goods or provision of services, obtained through financing or generated through operations or investments.	• Impact on water company finances, including customer bills; and • Local / regional economic benefits (e.g. tourism).
Human	People's competencies, capabilities and experiences, and their motivation to innovate.	• Employment opportunities (construction and operation); • Workforce skills development; • Volunteering opportunities; and • Educational value.
Manufactured	Manufactured physical objects available to an organisation for	• The value of physical assets; and

[177] Value Reporting Foundation, 2021. International <IR> Framework. Available at: https://www.integratedreporting.org/resource/international-ir-framework/, [Last accessed: 29/04/2022]

Capital	Description	Relevance to SESRO
	use in the production of goods and services.	• Any impacts on other (existing) manufactured assets.
Intellectual	Organisational, knowledge-based intangible aspects such as intellectual property, systems and procedures.	• The knowledge and experience gained in development and operation.
Social	The institutions and relationships within and between communities, groups of stakeholders and other networks and the ability to share information to improve individual and collective wellbeing.	• Health and wellbeing of local communities (construction and operation); • Health and wellbeing of users of new infrastructure (e.g. recreation / amenity); • Stakeholder relationships and partnerships; and • Levels of trust in the water company.
Natural	The physical stocks of renewable and non-renewable resources that provide goods and services of value to society.	• Impact on natural physical assets / stocks; and • Value of ecosystem services provided by natural physical assets.

10.17 Within this Gate 2 assessment, the wider benefits listed in Table 10.2 will be assessed using the Six Capitals framework.

Table 10.2: Wider benefits assessed by Capital

Benefit	Capital	Description
Employment and economic activity	Human capital/ Financial capital	This benefit is estimated quantitatively. Employment considers labour market opportunities, employment leakage, displacement and other factors that influence the net effect of this infrastructure project. Changes to business activity are considered in the context of local economic activity.
Physical and mental health benefits from exercise	Social capital	This benefit is estimated through both quantitative and qualitative analysis. Benefits associated with the substantial increase in outdoor activities encouraged through the creation of the reservoir. Disbenefits arising during the construction period are also discussed.
Education	Human capital	This benefit is estimated through quantitative and qualitative analysis. SESRO increases learning

Benefit	Capital	Description
		opportunities for young people which translates into value for them in terms of an experience, increased interest/uptake in STEAM topics, and in turn increased productivity in terms of economic output compared to other industries.
Financial asset value	Financial capital/ Manufactured capital	This benefit is estimated through quantitative analysis. The financial value of the asset created by Thames Water would be a benefit to the organisation's overall portfolio. At this optioneering stage, it is proportionate that the asset value reflects the cost of construction.
Customer bills	Financial capital	This benefit is estimated through qualitative analysis. SESRO represents a large investment for Thames Water to provide a vital utility to its customers. This investment may change the amount customers are billed.

10.18 Two benefits are categorised as belonging to multiple capitals:

- employment and economic activity to Human and Financial capital;
- financial asset value to Financial and Manufactured capital.

10.19 This is reasonable as impacts and benefits can be categorised in multiple ways. A change in employment observed through the Human capital lens is a benefit that affects people's competencies and experiences, whilst through a Financial capital lens is a benefit that alters the local and regional economy through increased employment and supply chain activity. In a similar vein, the creation of the reservoir would create both a financial asset and manufactured asset (could be extended to the drinking water within the reservoir).

10.20 Despite a benefit being considered through multiple capitals, double counting is avoided through careful consideration of the expected change, its logic, and the receptors involved. For example, increase in additional employment generated by SESRO is considered as a benefit to the economy but this is not reinterpreted as increased income to individuals as that would be double counting.

10.21 Some elements are covered by other assessments and have not been included in the wider benefits assessment. For example, impacts on natural physical assets/stocks and the value of ecosystem services provided by natural physical assets are considered within the scope of the NCA.

10.22 Flood Risk has been looked at separately and is presented in appendices to Supporting Document A1, Concept Design Report as part of the Gate 2 submission. The Gate 2 Flood Risk assessment concluded there is no significant flood risk as a result of the SESRO. Therefore, it is reasonable for the wider benefit assessment to

scope the economic impact of flood risk out of its Gate 2 assessment.

10.3.3 Reference material

10.23 The Treasury's Green Book[178] informed the assessment period and discounting rate applied to benefits. An assessment period of 60 years has been utilised, with varying discount rates (see Table 10.3 below). These informed the Net Present Value of the health benefits.

Table 10.3: Green Book Discount Rates

Years within assessment period	0-30	31-75
Stated Time Preference Revenue (standard)	3.50%	3.00%
Health	1.50%	1.29%

10.24 Within this assessment, the Health Economic Assessment Tool (HEAT tool)[179] has been used to assess the physical benefits of SESRO. While this tool is traditionally used to assess mode shift interventions within active travel, the distinguishment between vigorous (cycling) or moderate (walking) allows the tool to provide a proxy assessment of different activities. It should be noted that while SESRO is not a travel intervention, it is enabling an increase in activities within an asset for which a general population would hold the benefits for.

10.25 The Additionality Guide[180] provides advice on assessing benefits from changes in employment. This ensures that adequate consideration is made for factors such as employment leakage and displacement which reduce the overall benefit.

10.26 As outlined in 10.2, the Gate 2 guidance[181] requires estimation of benefits associated with developments such as SESRO. Sections 10.3.3 and 10.3.4 sets out how these benefits are estimated.

10.3.4 Quantitative benefits

10.3.4.1 Employment and economic activity

10.27 SESRO is a large infrastructure project that involves a significant amount of employment and expenditure. Benefit to the local economy is created through

[178] HM Treasury, 2022. The Green Book: Central Government Guidance on Appraisal and Evaluation. Available at: https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-governent [Last Accessed: 29/04/2022]
[179] World Health Organisation, 2021. Health Economic Assessment Tool. Available at: https://www.heatwalkingcycling.org/#homepage [Last accessed: 29/04/2022]
[180] Homes & Communities Agency, 2014. Additionality Guide. Available at: https://www.gov.uk/government/publications/additionality-guide [Last Accessed: 29/04/2022]
[181] Ofwat, 2022. Strategic Regional Water Resource Solutions Guidance for Gate Two. Available at: https://www.ofwat.gov.uk/publication/strategic-regional-water-resource-solutions-guidance-for-gate-two/, [Last accessed 29/04/2022]

additional employment opportunities and economic growth generated through the infrastructure project's construction and operation. Therefore, the benefits of additional employment and increased economic activity are different ways of interpreting the same impact: positive growth for the local economy and labour market.

10.28 The following steps were used to estimate the employment benefit to the local economy.

10.29 The 13-year workforce profile forms the basis of employment over the construction period. It is acknowledged that this profile is based on previous estimations and has not been updated for Gate 2, but it is deemed appropriate for this stage of assessment. Table 10.4 below shows an average of employees in each construction activity. As can be seen by the ramp up and ramp down of employment, the 13 year profile period is a 10 year construction period with 3 years of pre and post construction; Year 0, 11 and 12 employing a minimal workforce.

Table 10.4: SESRO workforce profile by year of construction

Construction Year	0	1	2	3	4	5	6	7	8	9	10	11	12
Thames Water and Consultants	2	15	49	95	96	80	33	10	10	9	6	2	2
Main contractor management	0	10	43	73	86	89	89	89	82	54	28	10	1
Roads	0	9	28	88	60	7	0	0	0	0	0	0	0
Site offices and compound	0	0	30	20	0	0	0	0	0	0	0	0	0
Rail head construction and operation	0	0	0	16	39	11	11	11	11	7	0	0	0
Services diversion	0	0	10	8	2	0	0	0	0	0	0	0	0
Clearance and fencing	0	0	0	7	6	0	0	0	0	0	0	0	0
Demolition and recycling	0	0	0	6	11	0	0	0	0	0	0	0	0
Earthworks & Drainage	0	0	0	29	278	412	412	412	412	206	0	0	0
Structures	0	0	0	2	30	79	142	127	67	17	0	0	0

Construction Year	0	1	2	3	4	5	6	7	8	9	10	11	12
Swindon and Oxford Water Resource Zone (SWOX)	0	0	0	0	0	0	13	96	75	9	0	0	0
Finishing	0	0	0	0	0	0	0	0	0	0	29	0	0

10.30 The workforce profile provides a local and non-local employment estimate for each role. The availability of this breakdown facilitated the separate evaluation of local benefits (employment benefits to the local economy) and non-local employment benefits (representing a leakage of employment benefits from the area). Non-locals are defined as those who commute weekly to work on the construction project. Therefore, it is reasonable to assume that locals are those within the travel to work area.

Table 10.5: Proportion of employees that are non-local by construction activity

Activity	% non-local
Thames Water and Consultants	5%
Main contractor management	5%
Roads	30%
Site offices and compound	30%
Rail head construction and operation	30%
Services diversion	20%
Clearance and fencing	20%
Demolition and recycling	20%
Earthworks & Drainage	65%
Structures	30%
SWOX	30%
Finishing	30%

10.31 After obtaining an estimate of direct local employment, the next factor to consider is the displacement of resources within the labour market that do not represent a benefit. This displacement of resources is inefficient for the economy as it means movement of resources from one area or industry to another without generating extra economic activity. The Additionality Guide provides a range of displacement rates depending on the expected levels of displacement. Given the baseline of a

relatively healthy labour market (see Section 10.4) within the relevant industries (construction, civil engineering, specialist construction, waste collection and materials recovery, and architectural and engineering activities) it is reasonable that the peak employment of 745 (402 local employees) can be handled with low levels of displacement. Employees in these relevant industries would also be employed on a contractual basis and therefore the construction of SESRO would suit their business model, further reducing displacement. A displacement rate of 50% is therefore applied to SESRO with recognition that the rate may change depending on further detail of the employment process (procurement strategy, length of contracts offered, skill level/qualifications). A 25% rate of displacement was also considered given the labour pool in the region and duration of the construction but it was decided that a 50% rate of displacement would be used. This is a potentially conservative approach to the benefit estimate but this is robust given the relatively early level of assessment.

10.32 After accounting for employment leakage and displacement, a net local employment estimate was generated. From this, multipliers could be applied to estimate additional indirect and induced employment benefit as a result of SESRO. Two different multipliers were used: Type I multipliers from Office of National Statistics (ONS)[182] and Type II multipliers from the Scottish Government[183]. Type I multipliers provide an estimate of how supply chain increases employment; this is referred to as indirect employment activity. Type II multipliers provide an estimate of further induced employment activity as the direct and indirect employment creates more activity in the economy where money is spent multiple times. Table 10.6 below shows the multipliers used by industry assigned to each activity.

Table 10.6: Activity and assumed industry/multipliers

Activity	Industry of worker	Type I Multiplier	Additional Induced Multiplier*
Thames Water and Consultants	Water Collection, Treatment And Supply	1.89870	0.246898
Main contractor management	Architectural And Engineering Activities; Technical Testing And Analysis	1.69077	0.205492
Roads	Construction	2.10955	0.20069
Site offices and compound	Construction	2.10955	0.20069
Rail head construction and operation	Construction	2.10955	0.20069

[182] ONS, 2021. FTE Multipliers and effects, reference year 2017. Available at: https://www.ons.gov.uk/economy/nationalaccounts/supplyandusetables/adhocs/13359ftemultipliersandeffectsreferenceyear2017 [Last accessed: 02/05/2022]

[183] Scottish Government, 2021. Supply, Use and Input-Output Tables: 1998-2018. Available at: https://www.gov.scot/publications/input-output-latest/ [Last accessed: 02/05/2022]

Activity	Industry of worker	Type I Multiplier	Additional Induced Multiplier*
Services diversion	Construction	2.10955	0.20069
Clearance and fencing	Construction	2.10955	0.20069
Demolition and recycling	Construction	2.10955	0.20069
Earthworks & Drainage	Construction	2.10955	0.20069
Structures	Construction	2.10955	0.20069
SWOX	Water Collection, Treatment And Supply	1.89870	0.246898
Finishing	Construction	2.10955	0.20069

** This is estimated as the difference between Type I and Type II multipliers within the Scottish Government analysis. ONS did not provide Type II multipliers which estimate indirect and induced employment effects therefore it is reasonable that the difference between Type I and Type II provides an estimate of induced employment effects.*

10.33 This process produced an estimation of net benefit to the local labour market during the construction period. Negative effects of employment leakage and displacement have been taken into consideration.

10.34 This estimation of employment benefit is repeated for the operation period. There is no previous operation workforce profile to base this benefit on, therefore assumptions have been made to estimate an operation workforce based on the onsite facilities detailed in the masterplan.

Table 10.7: Estimate of operation period workforce

SESRO operation centres	Employees per annum estimate
Visitor Centre/Community Centre	5
Café	10
Education Centre	5
Sailing Clubhouse	5
Reservoir operations (maintenance of landscape and water operations)	5

10.35 Given the strategic nature of SESRO at Gate 2 details relating to level of employment were not available, professional judgement was used to estimate the workforce required to operate each facility. Within section 4.1.2 of the Gate 1 Technical Annex A-2: Concept Design report, there is detail on tasks for reservoir operations, these

were used to inform the estimate of the operations workforce. The tasks were as follows:

- routine monitoring and surveillance of reservoir embankments – Thames Water;
- grass cutting on structural parts of the embankment; and
- routine checks and maintenance of equipment in pumping station, main draw-off towers, and river intake/outfall structure.

10.36 The operation employment benefits would persist over a longer period of time than the 10 year construction period. As this is not a monetary benefit, a Net Present Value is not generated.

10.37 Estimates of increased employment and increased economic activity (through Gross Value Added (GVA)) are measures of a similar benefit to the economy. As such, to avoid double counting, they should not be considered additive.

10.38 This assessment presents GVA resulting from capital expenditure (Capex) and operation expenditure (Opex) as a local/regional economic benefit. To calculate GVA from construction expenditure, ONS data on the UK non-financial business economy was used to compare expenditure and GVA. This created a GVA rate that could be applied to SESRO's construction and operation expenditure to estimate GVA. Table 10.8 presents the estimation of a GVA rate. GVA is a measure of a project's contribution to the local economy, therefore, any GVA is positive for the economy.

Table 10.8: Process of estimating GVA %

Item	Amount
Capex (£)	1,368,128,000
Opex (£)	93,856,000
UK Construction Expenditure (£m)	223,399
UK Construction GVA (£m)	84,812
GVA as a % of Expenditure	38.0%

10.39 The Capex shown in Table 10.8 is the closest estimate of a financial asset value at this stage of assessment. The Capex and Opex figures were taken from Gate 1 Technical Annex A-2: Concept Design report and therefore are 2022 prices, uprated from 2021 prices.

10.40 All monetary figures are in 2022 prices, unless stated otherwise. Some of these were uprated from other price-years to 2022 using the Treasury's GDP deflator at market prices from Quarterly National Accounts (March 2022). Given these are the latest figures it was felt that they should be used, despite the relatively volatile economic climate at this moment in time.

10.3.4.2 Health benefits

10.41 The health benefits of SESRO would represent the avoided cost to the economy from the improvement in cardiovascular health and extended life expectancy of those visiting the site.

10.42 While the existing site provides opportunities for walking, running, and cycling, SESRO would allow provision for an increase in visitors and a range of physical activities they can enjoy.

10.43 The health benefit will be considered as the measurable improvement in life expectancy from people partaking in additional physical activities at SESRO. Physical activities will be categorised into either vigorous or moderate exercise, with separate evaluation of each. The value of a statistical life will then be used to monetise the deaths avoided within the visitor population.

10.44 Benefits will be assessed through use of the HEAT tool whereby walking, a moderate activity, and cycling, a vigorous activity, will be used as proxies to represent the different recreational activities at SESRO. Using the HEAT tool will allow the assessment to model the benefit of physical exercise at the existing site and then with SESRO.

10.45 To assess the baseline health benefits, the HEAT tool will be used to model the existing moderate (rambling) and vigorous (cycling and running) activities that take place on existing site.

10.46 In assessing the health benefits of SESRO, activities identified in the Supporting Document B3: Conservation, Access and Recreation (CAR) Strategy will be modelled into an expected frequency of visits and duration of activity that would suit the moderate and vigorous activity points. The activities identified within the CAR Strategy that would be undertaken at SESRO include:

- **Vigorous Exercise:** Running and Cycling. These activities would provide the most physical benefits to the visitor. The 10km loop at SESRO is a suitable distance for cycling and provides opportunities for endurance running.
- **Moderate Exercise:** Walking, one lap of reservoir or short scenic walk, Rambling (extended walking throughout SESRO), Birdwatching, Fishing, Swimming, and Boating. These moderate exercises at SESRO would provide much fewer physical benefits but would make up most visits to SESRO. Walking around the reservoir itself is expected to be the most popular activity, while rambling groups are also likely to use SESRO for more extensive durations of walking.

10.47 Within this assessment, the impacted population (who would be experiencing the physical health benefits) would be the residents of Oxfordshire. Within this population of 687,466, the HEAT tool will specifically assess health benefits for residents between 20-74 years old.

10.48 The expected visitation at SESRO amongst each different physical activity has been

calculated using the visitor number estimations outlined in Supporting Document A1, Concept Design Report**.** It is expected that SESRO would see 462,000 visitors per year visiting the site itself, but not all of these visitors would partake in physical exercise.

10.49 To calculate the visitors to SESRO who would be receiving physical benefit from their visit, educational visits by children and visits to the café have been estimated and subtracted from the annual visitation rate.

10.50 On the assumption that the café would see an average of 144[184] guests per day during the 356 days it would be open, it is expected that 51,000 visitors to SESRO would attend solely for the café itself. Not to assume that these visitors would not go on to partake in other physical activities at SESRO, 50% of these visitors would be assumed to walk briefly around the café facility for sightseeing purposes. These 25,000 visitors would be classified as having 'Short Visits' when walking.

10.51 Furthermore, it has been assumed that the education centre at SESRO has capacity for two school class of 27[185] children every school day of the year (175). This would result in a total of 9,310 annual visitors who are children, and will not be included within the measure of physical benefits at SESRO. This is due to the HEAT tool assessing a population within the 20-75 age range.

10.52 From this calculation, it is estimated that the remaining 558,837 visitors would be partaking in some capacity of physical exercise.

10.53 Having assumed the average daily visits to SESRO by different activities, the activities that would be enabled by infrastructure at SESRO were assessed first. This involved assessing desktop information of the average daily usage of existing reservoirs that provided activities at site[186]. Furthermore, for activities that could not be conducted within proximity of one another, the same visitation rate was applied per day under the assumption they would need to be conducted in different areas of the SESRO site (fishing, birdwatching, and swimming). The most popular remaining activities were proportioned based on a 15:15:35:35 ratio for running, rambling, cycling, and walking. This ratio was influenced by the original observations made at the existing site, assuming that future visitors partaking in these popular exercises would attend in comparable proportions.

10.54 To assess the quantity of physical benefit gained from each visit, an average distance per trip was assumed for each activity. This was estimated by assessing the total distance that could be travelled at SESRO using ArcGIS mapping tools. For activities such as running, rambling, walking, and running, distances were assumed by the most common journey a visitor might take with each visit. For example, for walking and cycling, a lap of the reservoir, 10km, would suffice for one trip or visit to SESRO.

[184] Sage Advice United Kingdom. 2022. How much profit do coffee shops make annually? - Sage Advice United Kingdom. [online] Available at: <https://www.sage.com/en-gb/blog/how-much-profit-coffee-shops-annually/> [Accessed 16 May 2022].
[185] ONS, 2022. Schools, pupils and their characteristics. United Kingdom Government.
[186] Rutlandsailingclub.co.uk. 2022. Rutland Sailing Club : Easter Camp. [online] Available at: <https://www.rutlandsailingclub.co.uk/article/189699> [Accessed 16 May 2022].

Those who visit SESRO for a run have the option of a full run of 10km or only travelling a distance around the reservoir they feel comfortable completing. In this assessment, an average distance of 7.5km was selected[187]. Lastly, for rambles at SESRO, the 10km trip around the reservoir might be part of a broader loop. As such, desktop research concluded an average trip distance of 15km[188].

10.55 For more moderate activities such as fishing, swimming and sailing, an average distance of 1km has been assumed to represent the physical excursion of the activity. The only moderate activity with a greater distance covered is that of birdwatching (2km) whereby a bird watcher is more likely to walk around SESRO in pursuit of a particular species.

10.56 The final input was the statistical life, which monetises the value of each avoided death per year through the benefit of physical exercise. This has been taken as £1,878,000 (2022) from Health and Safety England[189].

10.3.4.3 Education

10.57 Within the quantitative assessment the education benefits will be calculated through estimating the economic value SESRO provides hosting educational field trips.

10.58 While this value will not represent the consumer surplus of education to the local economy or population, it does provide insight to the potential willingness to pay of educators to use SESRO for educational field trips.

10.59 In assessing this benefit, this study will require an estimate of trips taken to SESRO for education and the average cost per trip. It will be assumed that with the scientific and engineering relevance of SESRO, the education days would provide a STEAM based curriculum of learning.

10.60 As was found within the visitor number estimates for health benefits, it is expected that the education centre would be able to facilitate two classes of 27 per day. Over one year this equates to 9,310 children visiting the SESRO education centre.

10.61 Costs for field trips and education days can range in cost. While some low activity trips are free, trips teaching specialist knowledge can cost up to £100 per class and STEAM topic education days cost upwards of £150[190]. For this assessment, it will be assumed that each school trip would be charged out at £125 based on the range of STEAM opportunities available at SESRO, but considering the facilities available in the education centre.

[187] TriRadar. 2022. New Strava Cycling & Running Data Reveals the UK's Year in Numbers | TriRadar. [online] Available at: <https://www.triradar.com/news/strava-cycling-running-data-2016/> [Accessed 16 May 2022].
[188] Timeoutdoors.com. 2022. [online] Available at: <https://www.timeoutdoors.com/expert-advice/walking/rambling/starting-out-in-rambling> [Accessed 16 May 2022].
[189] Hse.gov.uk. 2022. HSE: Economics of Health and safety - Appraisal values or 'unit costs'. [online] Available at: <https://www.hse.gov.uk/economics/eauappraisal.htm> [Accessed 16 May 2022].
[190] Planmyschooltrip.co.uk. 2022. School Trips Cost Guide. [online] Available at: <https://www.planmyschooltrip.co.uk/school-trip-costs.php> [Accessed 16 May 2022].

10.62 There is further scope to interpret this figure as an investment within education itself, with the returns benefiting local and broader socio-economic development. A global assessment by UNESCO upon education cited that every $1 (£0.81) spent could yield a return of $10 (£8.10) to $15 (£12.11) to the broader economy[191]. However, with the study population of this report being weighted towards lower- and middle-income nations it would not be appropriate to integrate these findings in this assessment of education at SESRO.

10.63 Despite not being able to use the UNESCO figure, this report still demonstrates the broader economic value of investing in education.

10.3.4.4 Financial asset value

10.64 The financial asset value of SESRO would be a benefit to the Direct Procurement for Customers (DPC) entity that is proposed to deliver SESRO. It would be an asset to utilise and form part of their balance sheet.

10.65 As shown in Table 10.8, the Capex for SESRO is estimated as £1,368,128,000 for the largest SESRO option (i.e. 150Mm^3) in 2022 prices. At this stage of appraisal, this can be seen as the closest estimate of financial asset value.

10.3.5 Qualitative benefits

10.66 The following benefits have been assessed qualitatively, with the results discussed in Section 10.5 Assessment Outcomes:

- employment and economic activity;
- education; and
- customer bills.

10.4 Understanding of the baseline

10.67 This section presents the baseline conditions for topics relevant to wider benefits.

10.4.2 Employment and economic activity

10.68 Oxfordshire performs well on multiple economic measures of success. It is situated in the South-East of England, an area which historically has high levels of productivity and low levels of unemployment. The indicative location for SESRO is within the Vale of White Horse District Council and is in close proximity to Oxford City Council with its world class university institutions such as University of Oxford and Oxford Brookes University. This creates a strong economic profile as organisations associated with science and research remain in the area to take advantage of agglomeration effects.

10.69 Table 10.9 presents unemployment information for the relevant areas. It shows that the region performs well relative to the national average but there is still

[191] UNESCO (2012) UNESCO Global Monitoring Report https://unesdoc.unesco.org/ark:/48223/pf0000218003

unemployment that can be addressed through new infrastructure projects in the area.

Table 10.9: Unemployment rate in relevant areas (%)

Year	Cherwell	Oxford	South Oxfordshire	Vale of White Horse	West Oxfordshire	South East	England
Jan 2019-Dec 2019	2.2	2.9	2.1	2.6	2	3	3.9
Jan 2021-Dec 2021	3.1	4.5	3.1	3.5	3.2	3.8	4.5

10.70 Table 10.10 presents the number of employees in various geographies (mixture of district councils for Oxfordshire, region, and nation) relevant areas and highlights the number of potential contractors that could be employed as part of construction and operation.

Table 10.10: Employees by area and industry (2019)

Industry	Oxfordshire	Cherwell	Oxford	South Oxfordshire	Vale of White Horse	West Oxfordshire
Waste collection, treatment and disposal activities; materials recovery	1,875	300	250	300	800	275
Construction of buildings	10,000	1,250	5,500	1,125	1,500	950
Civil engineering	2,000	250	45	400	1,125	180
Specialised construction activities	8,000	2,000	750	1,875	1,750	1,625
Food and beverage service activities	22,500	4,500	6,500	4,500	3,500	3,500
Architectural and engineering activities; technical testing and analysis	8,500	1,500	900	2,000	3,000	1,125
Education	59,000	5,500	36,500	5,500	7,000	4,500

Industry	Oxfordshire	Cherwell	Oxford	South Oxfordshire	Vale of White Horse	West Oxfordshire
Sports activities and amusement and recreation activities	4,500	1,125	600	800	650	1,250
Total	116,500	16,500	51,000	16,500	19,500	13,000

10.71 Table 10.11 shows the number of vacancies per 100 jobs in different industries. It shows that relevant industries, such as construction, have similar vacancy rates to other industries in the UK.

Table 10.11: Vacancies by industry in the UK per 100 jobs (seasonally adjusted) by quarter

Industry	Dec 2021-Feb 2022	Jan 2022-Mar 2022
All vacancies	4.2	4.2
Mining & quarrying	3.0	3.0
Manufacturing	4.1	4.0
Electricity, gas, steam & air conditioning supply2	3.8	3.7
Water supply, sewerage, waste & remediation activities	3.7	3.6
Construction	3.2	3.2
Wholesale & retail trade; repair of motor vehicles and motor cycles	3.8	3.8
Transport & storage	3.8	3.8
Accommodation & food service activities	7.6	7.5
Information & communication	5.6	5.4
Financial & insurance activities	4.9	4.8
Real estate activities	2.9	2.9
Professional scientific & technical activities	4.6	4.8
Administrative & support service activities	3.2	3.2
Public admin & defence; compulsory social security	2.4	2.4
Education	2.7	2.7

10.72 At the existing site itself, there are almost 20 small, medium, and large businesses. These businesses range from storage facilities, agricultural and solar farms, dog kennels, construction and engineering firms.

10.73 These firms contribute to employment opportunities in the region by participating in local supply chains. Table 10.12 shows the full list of 19 businesses and their relevant industry, as classified by Standard Industrial Classification (SIC) Code. SIC codes are used when defining primary business or company activities.

Table 10.12: Businesses within the indicative location for SESRO

Business	SIC Code
Oxfordshire Towbars	29320 - Manufacture of other parts and accessories for motor vehicles
Savvi	29320 - Manufacture of other parts and accessories for motor vehicles
The Whispering Bob Broadcasting Co Ltd	82990 - Other business support service activities not elsewhere classified
Specialist Welding and Fabrication Ltd	25990 - Manufacture of other fabricated metal products not elsewhere classified
Drayton Construction Ltd	41201 - Construction of commercial buildings
Dragontek Automotive Ltd	45200 - Maintenance and repair of motor vehicles
Golf Buggy Services	33170 - Repair and maintenance of other transport equipment not elsewhere classified
Dragons Gate Koi	47230 - Retail sale of fish, crustaceans and molluscs in specialised stores
A34 Self Storage	52101 - Operation of warehousing and storage facilities for water transport activities
CSM Oxford	49410 - Freight transport by road
Verran Freight Ltd	49410 - Freight transport by road
H&H Distribution	49410 - Freight transport by road
H&H Contracts Scaffolding	43991 - Scaffold erection
AFFA	49410 - Freight transport by road
Tructyre	45200 - Maintenance and repair of motor vehicles
Tudor Joinery	43320 - Joinery installation
Honeybottom Kennels	96090 - Other service activities not elsewhere classified

Business	SIC Code
Robertson Envirosystems	42110 - Construction of roads and motorways
Little Bears Bakery	10710 - Manufacture of bread; manufacture of fresh pastry goods and cakes

10.74 Table 10.13 shows the number of businesses in each of the relevant local authorities and Oxfordshire as a whole. This puts the number of firms directly affected by SESRO into context.

Table 10.13: Businesses in relevant areas

Area	Total	Micro (0 to 9)	Small (10 to 49)	Medium-sized (50 to 249)	Large (250+)
Cherwell	7,055	6,260	640	125	30
Oxford	4,915	4,145	575	155	40
South Oxfordshire	8,260	7,480	660	100	25
Vale of White Horse	6,180	5,500	550	90	40
West Oxfordshire	5,755	5,180	485	65	20
Oxfordshire	32,165	28,570	2,910	535	155

10.75 Economic activity in the Oxfordshire area (regional GVA) is shown in Table 10.14. It shows Oxfordshire already has significant amounts of construction expenditure, which would form the bulk of the Capex during the construction phase.

Table 10.14: Expenditure and GVA of Oxfordshire, South-East, England, and UK

Item	Amount
UK Construction Expenditure (£)	223,399,000,000
UK Construction GVA (£)	84,812,000,000
GVA as a % of Expenditure (£)	38.0%
Oxfordshire GVA (construction) (£)	5,112,000,000
Oxfordshire GVA (total) (£)	97,635,000,000
South-East GVA (construction) (£)	19,744,000,000

Item	Amount
South-East GVA (total) (£)	285,479,000,000
England GVA (construction) (£)	108,881,000,000
England GVA (total) (£)	1,666,194,000,000

10.76 The economic value of the existing site would contribute to the wellbeing of residents and those who own businesses or are employees within the existing site. Employment itself provides financial stability and has been correlated with decreasing negative wellbeing emotions such as anxiety and stress[192].

10.4.3 Health

10.77 Recreational activities at the existing site include running, rambling (walking) on the footpaths with cyclists utilising the bridleways and Hanney Road. To estimate the health benefits at the baseline, this assessment requires data upon:

- daily trips made at the existing site of each activity (walking, cycling, running); and
- average distance travelled within the existing site for each visit (km/trip).

10.78 Data from a previous Thames Water study[193] at the existing site has informed an initial quantification of the physical health benefits generated by the existing site.

10.79 The HEAT tool quantifies physical activity benefit through calculating a local volume of exercise per person (minutes per week) within a population, in comparison to a reference volume of exercise that improves life expectancy by a set percentage. In cycling for example, partaking in 100 minutes of exercise per week ensures that an individual is 10% less likely to die than an individual not partaking in this volume of exercise.

10.80 The existing site is unlikely to facilitate the reference volume of exercise for either moderate or vigorous activity. This would mean that the annual health benefits are unlikely to be substantial.

10.81 Average distance of physical activity was determined through using desktop research on the existing site. Strava, a physical exercise app where users can track the distance and intensity of their exercise provides insights into how people use different areas for activities. This public data in conjunction with Google Maps provided an insight into estimating the likely distances per activity that people were using the existing site for.

10.82 Wellbeing and social value are benefits held by the local population based upon the

[192] Yagi, T., Urakawa, K. and Yonezaki, K., 2016. Happiness and Employment Status. Advances in Happiness Research, pp.139-162.
[193] Upper Thames Reservoir Recreation Survey's Findings Report, Thames Water, March 31st 2009

broader environmental, social, and economic interactions any individual would have within the existing site.

10.83 Wellbeing is a scalable measure of an individual's quality of life. The existing site would perhaps underpin components of wellbeing through providing a sense of community and cultural value[194]. Those living nearby green or blue space frequently demonstrate feelings of ownership or responsibility to land. Even if not the land owners themselves, these environments can contribute to an individual's daily routine (for example, dog walks or wildlife watching) or sense of space in their community.

10.84 Within the assessment so far, the existing green space has been found to provide physical benefits to the local population. While physical benefits on their own would present wellbeing and social value, the mental health gains from exercise in conjunction with time spent in nature would also benefit those spending time in this space.

10.4.4 Education

10.85 At the existing site, there is limited education value. There are currently businesses at the existing site that could provide educational value such as farms and solar farms, however there is no evidence that these businesses are actively providing educational opportunities

10.4.5 Financial asset value

10.86 Water companies update their Regulatory Capital Values (RCV) every financial year. Thames Water RCV for 2021/22 was £16.6bn and £1.5bn for Affinity Water. This shows the scale of their financial assets although, as stated in 10.3.3.4, the current plans are for a DPC entity to deliver SESRO and therefore take control of the asset value instead of Thames Water.

10.4.6 Customer bills

10.87 The forecasted Thames Water average annual household combined water bill for 2022/23 is £232. Its customers face an uncertain future in terms of bills and challenging supply conditions. SESRO is part of a broader national vision to help balance water management schemes for Thames Water and the South-East region. Through implementing the SESRO, customers of Thames water would be benefiting from a more resilient, sustainable water resource, that manages risk and lowers costs to the consumer.

10.88 Furthermore, with greater concern around the impacts of climate change, the existing water resource network across the south-east would be more vulnerable to

[194] Thomson, L., Gordon-Nesbitt, R., Elsden, E. and Chatterjee, H., 2021. The role of cultural, community and natural assets in addressing societal and structural health inequalities in the UK: future research priorities. International Journal for Equity in Health, 20(1).

the resource shocks brought upon by droughts for example.

10.89 The Vale of White Horse local authority performs well in terms of general Index of Multiple Deprivation (IMD). The Vale of White Horse is ranked 305 out of 317 local authorities in England in IMD, meaning it performs well and, relatively, its population enjoys less deprivation. There are 304 other local authorities in England that are worse off in terms of deprivation.

10.90 In terms of income deprivation[195], only 1 of 76 Lower Layer Super Output Areas (LSOA) in the Vale of White Horse is in the 20% most income deprived in England. This shows a relatively high performing local authority on this metric. A summary of other local authorities within the Oxfordshire region is presented in Table 10.15. Cherwell and Oxford have relatively high numbers of areas that experience deprivation compared to the District Council areas of West Oxfordshire and South Oxfordshire.

Table 10.15: District council deprivation (2019)

Local authority	IMD rank (/317)	LSOAs within LA that are within 20% most deprived
Vale of White Horse	305	1/76
Oxford	189	10/83
West Oxfordshire	301	0/66
South Oxfordshire	302	0/89
Cherwell	220	6/93

10.5 Assessment outcomes

10.5.1 Introduction

10.91 This section presents the results of wider benefits analysis.

10.5.2 Employment and economic activity

10.92 Employment would be positively affected by the construction and operation of SESRO. At peak employment, 745 people would be involved in SESRO and, over the 13-year construction profile, 4,297 full-time employment (FTE) years would be created for a number of skilled roles.

[195] Ministry of Housing, Communities & Local Government, 2019. The English Indices of Deprivation 2019. Available at: https://dclgapps.communities.gov.uk/imd/iod_index.html# [Last Accessed: 18/05/2022]

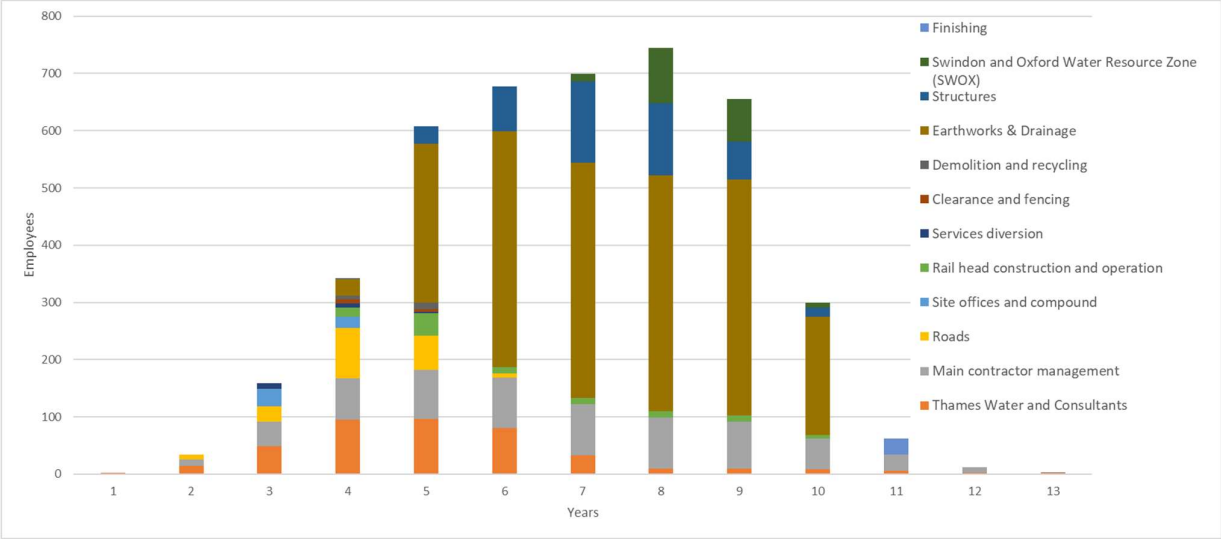


Plate 10.1: SESRO construction workforce over time by activity

10.93 The benefit for the local economy and labour market would be the additional employment created by SESRO's construction and any operations that remain in the area. As mentioned in 10.3.4.1, employment benefit estimates should be adjusted to reflect employment leakage and displacement within the local labour market. Table 10.16 shows the different measures of employment, leakage, displacement and employment benefits (local net, indirect, and induced).

Table 10.16: SESRO employment benefits

Years	0	1	2	3	4	5	6	7	8	9	10	11	12	Total (FTE years)
(1) SESRO Full Time Employment (FTE)	2	34	159	342	608	677	699	745	656	300	63	12	3	4,297
(2) Non-local SESRO FTE (leakage)	0	4	24	69	232	305	324	343	318	147	10	1	0	1,776
(3) Displacement	1	15	68	137	188	186	188	201	169	77	26	5	1	1,261
(4) Local SESRO net FTE (4 = (1-2)-3)	1	15	68	137	188	186	188	201	169	77	26	5	1	1,261

Years	0	1	2	3	4	5	6	7	8	9	10	11	12	Total (FTE years)
(5) Local indirect FTE	1	13	62	128	181	181	186	197	165	73	23	4	1	1,214
(6) Local induced FTE	0	3	15	30	40	39	39	42	35	16	5	1	0	267
(7) Total employment benefits (per annum) (7 = 4+5+6)	2	32	144	294	409	406	413	440	369	165	54	11	2	2,741

10.94 Table 10.16 shows that the overall employment benefit, having adjusted for employment leakage, displacement, and indirect employment effects, are of a similar level to the initial employment injection from SESRO. A total of 2,741 FTE years are created in the local area from SESRO's initial 4,297. This would be a significant benefit to the labour market.

10.95 In the operation phase the benefits are smaller in scale but the duration of positive effect on the labour market would be longer. Operation phase employment is assumed to have no employment leakage as employees would live within travelling distance to work.

Table 10.17: Operation phase employment benefits

Item	Amount
SESRO Full Time Employment (FTE)	30
Non-local SESRO FTE (leakage)	0
Displacement	8
Local SESRO FTE	23
Local indirect FTE	13
Local induced FTE	3
Total employment benefits (per annum)	38

10.96 Economic activity can be increased through expenditure circulating in the economy and generating growth. GVA is a measure of expenditure positively affecting the local economy. Table 10.18 shows that for both construction and operation. SESRO would

contribute significantly to the local economy given its context within regional GVA; creating GVA that equates to almost 5% of the region's annual GVA for construction is large considering SESRO would be one project. It highlights the scale of positive effect for the economy even assuming for 50% displacement in expenditure.

Table 10.18: SESRO GVA estimate

Item	Amount
Capex (£)	1,368,128,000
Opex (£)	93,856,000
Capex GVA (including 50% displacement) (£)	252,505,892
Opex GVA	34,644,756
Capex GVA as % of regional (Berkshire, Buckinghamshire and Oxfordshire) GVA per annum 2019 (construction)	4.9%
Capex GVA as % of regional GVA per annum 2019 (total)	0.3%
Opex GVA as % of regional GVA per annum 2019 (construction)	0.68%
Opex GVA as % of regional GVA per annum 2019 (total)	0.04%

10.97 The estimate of Capex may be considered an estimate of financial asset value of SESRO.

10.98 During the construction phase, it is likely that a number of apprenticeships would be offered given the scale and duration of the work (peak workforce of 745). Due to the early stage of career and education that apprentices are taken on, the social value benefits of developing a younger person can be significant, improving human capital and increasing earnings potential[196]. These benefits are different to the economic benefits of employment quantified above.

10.99 During the operations phase, businesses at SESRO would provide wellbeing and social value opportunities through the relationship between employment, financial security, and mental health. Those who are employed are less likely to be stressed or anxious due to the enjoyment of work itself and the financial security it provides[197]. Therefore, compared to a baseline scenario where a person is unemployed, there is significant social value benefit if a person is recruited. The quantifiable benefit is around £20,000 per person, per year in employment[198]. At this

[196] Social Value Portal, 2021. National TOMS. Available at: https://socialvalueportal.com/solutions/national-toms/ [Last accessed: 16/05/2022]
[197] HM Treasury, 2021. Wellbeing Guidance for Appraisal: Supplementary Green Book Guidance. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1005388/Wellbeing_guidance_for_appraisal_-_supplementary_Green_Book_guidance.pdf [Last accessed: 29/04/2022]
[198] Social Value Portal, 2021. National TOMS. Available at: https://socialvalueportal.com/solutions/national-toms/ [Last accessed: 16/05/2022]

stage, it is not possible to estimate the total social value benefit associated with employment opportunities from SESRO due to mitigation in the form of employment commitments. Despite this, it is clear that the potential social value benefit of employment opportunities at SESRO is significant.

10.100 The level of employment and economic activity would differ in the CAR low and high scenarios. The low scenario models smaller education, recreation, catering, and farming facilities resulting in less employment and economic activity during the operation phase of SESRO. This creates lower employment multipliers and GVA for the economy compared to the medium (most similar to the illustrative masterplan) and high scenarios. The high scenario is the vice versa of the low strategy, resulting in higher employment and economic activity benefits. The higher education research facility included in the high CAR scenario has the potential to create significant employment and economic benefits.

10.101 While current businesses at the existing site would be compensated through planning mechanisms (e.g. compulsory purchase orders or change in value), there may be short term negative impacts whilst SESRO is in the construction phase. These may take the form of employees moving to another role, or losing days of operation during relocation.

10.102 As shown in the baseline, 19 businesses would be directly affected by the construction of SESRO. Upon initial desk-based investigation, most of these could be relocated to a new site and operate as normal due to the nature of the businesses. This is a relatively small number of businesses in the context of the local authority (6,180) and region (32,165).

10.5.3 Health

10.103 The HEAT tool has been used to model the expected physical benefits gained from SESRO relative to the existing site. Inputs to the tool have been calculated using the visitation rate to the site, based on the facilities presented on the illustrative masterplan and the broader variety of activities expected to be possible as a result of SESRO. Table 10.19 summarises the expected trips and distances estimated to occur daily.

10.104 At the baseline, as seen in Table 10.19, the most popular physical activity undertaken at the existing site is walking (rambling) whether this be for personal leisure, dog walks or more strenuous hiking. This is followed by running and then cycling. The average trip length for these activities is limited to the existing PRoW within the indicative location for SESRO, with the longest trip on a footpath being 5km and bridleway 4km.

Table 10.19 Daily Visitors and Distance per Activity at the Existing Site, Previous Thames Water Report

Exercise	Distance of Physical Activity	
	Daily Visitors	**Distance per trip (km)**
Vigorous Intensity Exercise		
Running	5	5
Cycling	28	3
Moderate Intensity Exercise		
Walking (Rambling)	57	4

10.105 Within the baseline the limited range and opportunity for recreation at the existing site is demonstrated within the physical exercise benefit. As seen in Table 10.20, the total annual physical benefits are seen to avoid 0.06 deaths per year, with a value of £113,000.00 in 2022.

Table 10.20 Physical Benefit Outputs from HEAT at the Existing Site

HEAT Outputs		
Vigorous Intensity Exercise		
	Annual Deaths Avoided	**Physical Benefits**
Running	0.001	£2,000.00
Cycling	0.001	£2,000.00
Moderate Intensity Exercise		
Walking (Rambling)	0.058	£109,000.00
Results	0.060	£113,000.00

10.106 Table 10.21 demonstrates the far greater benefits available at SESRO, hosting a greater range of activities over greater distances than the existing site. The daily visitation rate has been estimated through breaking down the annual visitation rate for the entire reservoir into the proportion of activities that are most accessible and popular at the site.

Table 10.21 Daily Visitors and Distance per Activity at SESRO

Exercise		Daily Visitor	Distance per trip or equivalent exercise
Vigorous Exercise	**Running**	197	9
	Cycling	459	10
Moderate Exercise	**Walking (Short Visit)**	70	2
	Walking (Reservoir Lap)	459	10
	Rambling	197	15
	Birdwatching	30	2
	Fishing	30	1
	Swimming	30	1
	Boating	60	1

10.107 As seen in Table 10.22, the increase in range and opportunities for physical activities at SESRO provides substantial benefits to the visiting population. Through the improvement to life expectancy due to increased physical activity, it is estimated that each year 2.1 deaths within Oxfordshire would be avoided. These deaths equate to a cost avoided to the economy of £3,908,000 in 2022 prices.

10.108 The net health benefit of SESRO annually equates to £3,795,000 which, over a 60-year period discounted in accordance with Green Book health guidance, equals £126,671,000 in 2022 prices.

Table 10.22 Physical Benefit Outputs from HEAT at SESRO

Level of exercise	Exercise	Annual Deaths Avoided	Physical Benefits (£)
Vigorous Exercise	**Running**	0.010	£19,000.00
	Cycling	0.278	£523,000.00
Moderate Exercise	**Walking (Short Visit)**	0.044	£82,000.00
	Walking (Reservoir Lap)	1.029	£1,932,000.00
	Rambling	0.666	£1,250,000.00
	Birdwatching	0.018	£34,000.00
	Fishing	0.009	£17,000.00
	Swimming	0.009	£17,000.00

Level of exercise	Exercise	Annual Deaths Avoided	Physical Benefits (£)
	Boating	0.018	£34,000.00

10.5.4 Education

10.109 SESRO's benefit to education has been estimated through the potential willingness to pay of local educators to use SESRO for school trips and education days. The annual visitation rate of school pupils to the education centre alongside the cost per classroom for a STEAM focused session was estimated to create an annual value of £52,500year. This figure is based upon the estimated annual visiting classes to the education centre and the average price of a STEAM based learning session.

10.110 With a standard discount factor applied, over a 60-year period this equates to £1,385,000 in 2022 prices of educational sessions hosted at SESRO itself.

10.111 This value demonstrates the opportunity of education available at the SESRO. The global assessment by UNESCO provides insight into the scale of opportunity when recognising the broader economic gains from education investment[199]. While this study is not directly applicable to the education investment at SESRO, it still provides context to the potential of greater impact beyond the spend.

10.112 SESRO would provide educational benefits to students visiting the education centre. Opportunities for education at SESRO would cater to a broad range of STEAM learning topics. These areas of learning could include the construction and operation of SESRO from an engineering perspective, or the science behind the construction and environmental management practiced at SESRO. Water management is also a large opportunity for science education. Softer learning topics around environmental education would also be available at SESRO with pond dipping and nature walks being made accessible to all visitors.

10.113 Educational benefits would include increased knowledge of STEAM topics for pupils and increased interest in the topic as a result of visiting a significant real-world example within their local area. In addition to this, SESRO would create long-lasting and impactful wellbeing and social value opportunities[200], assisting local and regional schools to deliver a high value of education through providing a facility, staff and subject-matter to engage students with practical STEAM skills. The improved likelihood of attending higher education through early STEAM engagement would create improved socio-economic opportunities for these individuals and benefit the broader regional and national economy through increased labour supply (in STEAM

[199] UNESCO (2012) UNESCO Global Monitoring Report https://unesdoc.unesco.org/ark:/48223/pf0000218003
[200] HM Treasury, 2021. Wellbeing Guidance for Appraisal: Supplementary Green Book Guidance. Available at: https://assets.publishing.service.gov.uk/government/uploads/sySTEAM/uploads/attachment_data/file/1005388/Wellbeing_guidance_for_appraisal_-_supplementary_Green_Book_guidance.pdf [Last accessed: 29/04/2022]

industries) and productivity.[201]

10.5.5 Financial asset value

10.114 The capital cost for SESRO is the most accurate current estimate of its financial asset value at this stage of assessment. This ranges from £1.3bn for the largest option (150Mm^3) to £1.1bn for the smallest option (75Mm^3) in 2022 prices. The scale of this financial asset value is very large when viewed within the context of Thames Water and Affinity Water's overall RCV (£16.6bn and £1.5bn respectively). SESRO represents a significant financial asset for the DPC entity that controls.

10.5.6 Customer bills

10.115 As a result of SESRO construction and operation, Thames Water customers may see an immediate increase in their water bills and, consequently, their cost of living. The impact this has on customers depends upon the magnitude of change and household capacity to absorb changes in cost without affecting quality of life. Therefore, the change would have varying impacts for different customers depending on their socio-economic status and personal financial situation.

10.116 An increase in customer bills would more adversely affect those in lower income brackets for whom any increase is a larger proportion of their net income. The baseline shows that Oxfordshire's district councils have relatively low levels of general and income deprivation. This means that any change in customer bills would most likely be absorbed by household budgets without a significant change in quality of life. Potential changes would be shared by Thames Water's customer base of 9.8 million in 2016/17 (growing to 12 million in 2044/45[202]) over an extended period of time.

10.117 As funding arrangements have not been finalised for SESRO, the extent to which it would result in a change to customer bills has also not been confirmed. It is possible that funding is secured so that changes to customer bills are minimal, but at this moment it is not possible to conclude whether the impact would be significant or not. The future basis for price review and funding that water companies receive from Ofwat has alluded to in initial publications on the 2024 Price Review[203].

10.118 The concept of paying for water infrastructure improvements to ensure long term water security should be clarified to all customers. Under the current framework, it is necessary for customers to pay water companies to ensure a sustainable supply, with projects like SESRO necessary to provide a resilient supply for a growing population. Improved resilience of supply would allow water companies to better

[201] Solanki S, McPartlan P, Xu D, Sato BK (2019) Success with EASE: Who benefits from a STEAM learning community? PLoS ONE 14(3): e0213827. https://doi.org/10.1371/journal.pone.0213827
[202] Thames Water, 2020. Current and Future Demand for Water. Available at: https://www.thameswater.co.uk/media-library/home/about-us/regulation/water-resources/technical-report/current-and-future-demand-for-water.pdf [Last accessed: 05/06/2022]
[203] Ofwat, 2021. PR24 and Beyond: Creating tomorrow, together. Available at: https://www.ofwat.gov.uk/wp-content/uploads/2021/05/PR24-and-Beyond-Creating-tomorrow-together.pdf [Last accessed: 05/06/2022]

deal with future water supply shocks that would otherwise affect customer bills and available water per capita.

10.6 Conclusions

10.119 SESRO would provide a broad range of long term benefits in Oxfordshire, providing opportunities to improve physical health, access to STEAM learning opportunities, provide employment and grow the local economy.

10.120 Employment provided by SESRO during the construction and operation would lead to further benefits for the economy through more jobs being created. In addition to the 4,297 employment years created by SESRO's construction a further 2,741 are estimated to be created through further economic activity. During operation, an estimated 30 SESRO jobs would create an additional 26 within the wider economy for the foreseeable future, therefore 56 jobs created in total due to SESRO's operation.

10.121 The benefits to the economy in the form of additional employment can also be expressed in terms of GVA as it shows SESRO's contribution to the economy. An estimated £252m of GVA over 10 years construction is significant given the size of Berkshire, Buckinghamshire and Oxfordshire's construction sector.

10.122 The increased range of physical activities at SESRO would propose significant health benefits to the visiting population locally and in Oxfordshire. Not only would more people use SESRO than the existing site for physical activities but the range of hobbies would create a more inclusive and accessible environment to exercise.

10.123 The education value of SESRO has been quantified in terms of the potential annual willingness to pay by educators to visit the facility with school children for STEAM field trips. This value should not be considered solely indicative of the total benefits of education, a much greater economic value would be felt with the long-term economy.

10.124 Furthermore, as the area has low levels of deprivation it is likely that only a small proportion of the population would be significantly affected by a change in cost of living. This can be addressed through targeted mitigation.

10.125 From this assessment, it is possible that SESRO would generate some disbenefits for local communities. Potential short term disbenefits include disturbance to local businesses but this impact is limited to 19 businesses. Potential long term disbenefit of an increase to customer bills may affect Thames Water customers as part of securing future water supply.

10.126 Ultimately, the opportunities created at SESRO should lead to long-term benefits of a far greater magnitude than the short-term disbenefits. There would be significant employment, economic activity, education, and health benefits as a result of SESRO's construction and operation.

10.7 Next Steps

10.127 The most beneficial next step for this wider benefits assessment would be to develop a more granular methodology for assessing the quantitative and qualitative benefits of SESRO.

10.128 While the HEAT tool serves as a suitable proxy for assessing the benefits of vigorous and moderate exercise at SESRO, there are limitations in this evaluation as physical benefits are not measured specific to the activity.

10.129 If further analysis is produced by Flood Risk and Air Quality teams then economic analysis of potential wider impacts may be required..

10.130 Impacts on customer bills can be further assessed when research into willingness to pay for added value is concluded.

10.131 Regarding the wellbeing and social value benefits of SESRO, a greater assessment of the socio-economic benefits generated by SESRO itself (in terms of its impact upon quality of life) would be suitable. This would encapsulate the different benefits under one term to allow for easier communication upon the opportunities and benefit.

11. Summary and Next Steps

11.1 Introduction

11.1 Building on feedback received at Gate 1, this EAR presents the terrestrial environmental appraisal work undertaken to date, including a desk based assessment that includes potential risks, barriers and mitigation measures of six different size options for the reservoir and a discussion of the environmental effects and proposed mitigation for the largest of the SESRO options.

11.2 The following section summarises the main findings of the terrestrial environmental appraisals set out in this report.

11.2 Summary of Main Findings of Environmental Appraisals

11.3 Table 11–1 summarised the main findings of each of the topic environmental appraisals set out in this report.

Table 11–1: Summary of main findings of the terrestrial environmental appraisals

Topic	Main Findings	Potential Mitigation
Air Quality	The changes in the concentrations of pollutants at sensitive receptors from emissions from road traffic and from plant and machinery is considered to be negligible for all SESRO variants. The likely risk of dust impact during construction for all SESRO variants is high for dust soiling impacts at sensitive human receptors and medium for human health impacts.	Good practice mitigation measures obtained from IAQM guidance.

Topic	Main Findings	Potential Mitigation
Biodiversity	Potential indirect impacts on Barrow Farm Fen Site of Special Scientific Interest (SSSI) during construction. All SESRO variants fall within the SSSI Impact Risk Zone for the listed SSSIs. Potential significant effect on Cuttings and Hutchin's Copse Local Wildlife Site (LWS), including potential parcel of ancient woodland. Ancient crack willow tree within indicative location for SESRO will be lost. Potential significant effect as a result of loss of Habitats of Principle Importance (HoPI). Potential significant impacts on protected and notable species relating to destruction/disturbance of habitat and killing/injury and disturbance. In terms of Biodiversity Net Gain, SESRO will generate a significant gain in habitat units but small loss of hedgerow units. The trading for lowland mixed deciduous woodland has also not been met. All three rail siding options have potential to impact protected species including breeding birds, great crested newts, badgers and bats. Based on desk-based information only.	Local Planning Authority should consult with Natural England regarding potential impacts to SSSIs. As far as reasonably practical, avoid or reduce direct impacts to the LWS. If unavoidable, appropriate mitigation would be required. Bespoke mitigation strategy to at least compensate for the loss of the ancient crack willow. Future air quality study results should be analysed for any likely effects to designated sites, and biodiversity in general. Where possible, avoid loss of HoPI or reduce loss as far as reasonably practical, through the design process. Any hedgerows lost should be compensated for prior to construction. Further hedgerow and tree line habitat creation should be included in the design. Retention of existing linear features should be encouraged. Propose large area of wetland mosaic habitat creation to the west of the reservoir and creation of other habitats of significant value to biodiversity and nature conservation around the perimeter of the reservoir.

Topic	Main Findings	Potential Mitigation
Historic Environment	Locally, regionally and nationally important archaeological remains potentially present within indicative location for SESRO. Impacts on the archaeological and palaeoenvironmental environment remain abundant throughout the indicative location for SESRO.	Incorporate mitigation by design to remove need for erasing or damaging an historic environment asset. Recommend preservation of assets in situ (in place). If not possible, and where the loss of an asset is deemed acceptable, damage/removal would be mitigated through preservation by record. Comprehensive archaeological investigation required including geophysical survey of all the accessible parts of the indicative location for SESRO to inform subsequent phases of archaeological trial trenching. Early-stage geoarchaeological engagement might target the extent of geoarchaeologically-specific investigations at subsequent project stages.

Topic	Main Findings	Potential Mitigation
Landscape and Visual	Effects on the AONB during construction would be relativity localised, limited to the north facing part of the escarpment that overlooks the indicative location for SESRO. During winter year 1 of operation, the presence of the reservoir and associated traffic and infrastructure within the setting of the AONB would erode some of the key characteristics and special qualities of the AONB. However, this would be localised, limited to the north-facing part of the escarpment that overlooks the indicative location for SESRO. During construction and winter year 1 of operation, the effect on the part of the AONB that falls within the study area could potentially be significant but the effect on the AONB as a whole is unlikely to be significant. During summer year 15 of operation, the indirect effects on the AONB would have reduced due to establishment of mitigation. SESRO would therefore only affect a very limited part of the AONB. It is unlikely that the effect on the part of the AONB that falls within the study area and the AONB as a whole would be significant. Potential effects of the other SESRO variants would be similar during construction and operation, when compared to the largest SESRO option.	Landscape mitigation is illustrated on Figure 2.1: Landscape and environmental design strategy plan in Technical Supporting Document B2.2, Environmental Appraisal Report (terrestrial) Figures, including, but not limited to, replacement floodplain storage, wetland creation and floating islands. Further measures in line with relevant guidance proposed including retention of vegetation, protection of trees, shrubs and hedges and strategic location of lighting during construction and the implementation of a five-year landscape period during operation, to be maintained and managed through the implementation of a long-term Landscape and Ecological Management Plan (LEMP).

Topic	Main Findings	Potential Mitigation
Noise	During construction, potential for significant noise effects in Abingdon, Drayton, Steventon, East Hanney and North and South of East Hanney as a result of construction activities throughout the indicative location for SESRO, including rail sidings. During construction, no significant effects are anticipated as a result of vibration or noise increases from construction traffic. During operation, no significant noise effects are anticipated as a result of traffic on the proposed new access road. During operation, noise effects as a result of traffic on the existing Hanney Road between Steventon and East Hanney Road and the new road proposed directly south of the indicative location for SESRO would be generally neutral or slightly beneficial for nearby properties. During operation, with implementation of control measures within the structure, it is anticipated that significant noise effects from the water intake/outfall structure would be avoided. No significant noise effects are anticipated due to the operation of the pump station.	Earth screening mounds incorporated into the current concept design for SESRO. Works carried out in accordance with Best Practicable Means and recommendations of BS 5228 part 1 and part 2. Contractor would undertake risk assessment prior to commencing works to update/supplement this appraisal. Contractor would develop and implement a noise and vibration control strategy. This strategy would be agreed with the Local Planning Authority.

Topic	Main Findings	Potential Mitigation
Soils, Geology and Land Contamination	Potential significant adverse effects as result of permanent loss of agricultural land during construction without mitigation. Potential significant adverse effect during construction from potential to encounter UXO and subsequent health risks without mitigation. Potential significant adverse effect during construction from contamination of surface and groundwater and harm to human health without mitigation. Potential significant adverse effect during construction from potential sterilisation of mineral resources towards the eastern end of the indicative location for SESRO without mitigation. Potential significant adverse effect during operation from the contamination of surface and groundwater and damage to human health from operation activities without mitigation. Potential significant adverse effect during operation from contamination of water within the reservoir from exposed bitumen within the Kimmeridge Clay without mitigation.	Re-use of topsoil and subsoil to improve the quality of agricultural land elsewhere and the implementation of a Soil Resource Plan (SRP) could result in neutral (no change) or beneficial effects. Clearance of UXO and a remediation strategy that includes UXO to identify and mitigate risks may result in a beneficial effect by removing the risk of UXO to receptors. Further assessment of quality of soil, groundwater and surface water to develop remediation strategy may result in beneficial effects by removing the risk of contamination from these sources to receptors. Further assessment of extraction proposals in relation to the water transfer tunnel and pipeline route. May be possible to programme works so they are complete before the tunnel is constructed. Alternatively, excavation of minerals could be undertaken in small zones to reduce potential impacts. Incorporate good industry working practices and procedures into construction and operation.

Topic	Main Findings	Potential Mitigation
Natural Capital	Positive impact on climate regulation, water purification, and recreation ecosystem service provision for all SESRO variants. Disbenefits for food production, air pollutant removal, and natural hazard regulation services for all SESRO variants. Potential significant impact on ecosystem service provision for all of SESRO variants, but to varying degrees and in different directions.	n/a

Topic	Main Findings	Potential Mitigation
Wider Benefits	During construction, an estimated 4,297 employment years would be created by SESRO. A further 2,741 are estimated to be created through further economic activity. During operation, an estimated 56 jobs would be created. An estimated £252m of GVA over 10 years construction is significant given the size of Berkshire, Buckinghamshire and Oxfordshire's construction sector. Potential significant health benefits from the increased range of physical activities and improved accessibility at SESRO for visitors and local people in Oxfordshire. Potential educational benefit from increased knowledge of and interest in STEAM topics for pupils. This would create improved socio-economic opportunities for these individuals and benefit the broader regional and national economy. Potential short-term disbenefit from disturbance to 19 local businesses. Potential long-term disbenefit of an increase to customer bills.	n/a

11.3 Next Steps

11.4 This EAR has been informed by desk based assessments using publicly available information in line with the requirements of the Gate 2 submission. The work is at a preliminary stage and establishes an initial appraisal that can be built on during subsequent project stages. In future, this will also be informed by the undertaking of site surveys and collection of additional information and data that will inform an Environmental Impact Assessment likely to be required as part of any future consenting process.

11.5 Table 11–2 sets out recommendations for future technical work at subsequent project stages.

Table 11–2: Recommendations for future technical work at subsequent project stages

Topic	Next steps
Air Quality	• Should additional baseline air quality data be required, it may be necessary to undertake air quality monitoring survey(s), the type, monitoring locations and duration of which, would be agreed with the Vale of White Horse District Council and other relevant stakeholders. • As SESRO develops and construction related traffic data is finalised, working with the traffic modellers, it would be necessary to understand the construction vehicle distribution north and south of the A34 interchange as this, in addition to the finalised traffic data, would determine whether there is a need for a more detailed assessment. If a more detailed assessment is required, the scope and methodology would be agreed with the Vale of White Horse District Council prior to commencement. • As more construction related information becomes available, following IAQM guidance, a construction dust risk assessment more specific to the proposals and more accurately reflecting SESRO construction activities, can be undertaken. Appropriate recommendations can then be made as to which good practice mitigation measures should be taken forward into the Construction Environmental Management Plan or equivalent management plan.
Biodiversity	• Undertake a full Preliminary Ecological Assessment (PEA) for the habitats located within the indicative location for SESRO and within a suitable buffer around SESRO. The survey would aim to identify all potential ecological constraints within the indicative location for SESRO. • Undertake a full UK Hab survey and habitat condition assessment as part of the PEA to form the baseline of a full Ecological Impact Assessment for SESRO. • Undertake phase 2 surveys for specific species and habitats including an assessment of woodlands for ancient trees and ancient woodland indicator species, and surveys to identify the presence/likely absence of protected species. Depending on the survey results, legal compliance may require mitigation, additional survey, and European Protected Species Mitigation Licence.

Topic	Next steps
Historic Environment	• Specialist historic environment studies covering areas such as the palaeoenvironment, the setting of heritage assets and the level of impact on historic built heritage would be crucial at subsequent project stages. Mitigation would then be informed by these specialist assessments. • The DBA has identified the data gaps which need to be addressed in order to fully inform detailed assessment for the assorted SESRO options. Specialist sub-consultant assistance would be required. These requirements are common to all the SESRO reservoir options. The detailed assessments would encompass the full array of potential impacts to the historic environment. • Consultation with the Oxfordshire County Council archaeological advisor has highlighted the need to implement archaeological investigation at the earliest opportunity. The scale of SESRO requires a very large amount of geophysical survey and trial trench investigation. • All archaeological work must be carried out in accordance with a method statement (Written Scheme of Investigation) approved by the Oxfordshire County Council archaeological advisory service prior to commencement on site. For a scheme of this scale, a strategic WSI would be required.
Landscape and Visual	• Undertake a comprehensive Landscape and Visual Impact Assessment (LVIA) in conjunction with design development to enable the iterative process of design and assessment to continue. • Undertake a topographical survey, arboricultural survey and Phase 1 habitat survey to inform the LVIA and design development. • Use the high-level landscape mitigation principles to guide any future development of the operational design.

Topic	Next steps
Noise	• Update construction assessment when the design is further developed and when early contractor involvement is available to inform the likely construction strategy. This would include more detailed consideration of construction road and rail impacts during construction and tunnelling. • Baseline sound level monitoring to define noise limits at noise sensitive receptors, this is particularly relevant for the assessment of potential operational noise impacts. • Further consideration of potential impacts arising from the operation of SESRO. • More detailed consideration of noise and vibration mitigation to control construction and operational impacts as the design is developed.

Topic	Next steps
Soils, Geology and Land Contamination	• Consultation with Natural England regarding the loss of agricultural soil resources and the proposed mitigation. An updated Soil Resource Survey should be undertaken where there are gaps in data and a Soil Resource Plan should be developed; • Consultation with the Environment Agency, Vale of White Horse District Council and Oxfordshire County Council to provide any available information on historical environment and land use, landfills, groundwater and surface water abstraction (private, small scale), discharges, contamination. unauthorised burials, unlicensed waste disposal; • Further assessment of the UXO risk and a remediation strategy should be developed to mitigate the risks where necessary. A specialist UXO company should undertake this; • A preliminary contamination risk assessment report should be prepared and a ground investigation should be designed to include collection of environmental samples of soil, groundwater and surface water for chemical testing; • A quantitative assessment of the soil, groundwater and surface water quality and Kimmeridge Clay bituminous content should be undertaken following the ground investigation to better understand potential risks to sensitive receptors and develop appropriate mitigation measures; • Geotechnical assessment should be undertaken to assess the risk to the tunnel at the proposed mineral extraction operations; and • Discussions should be held with the operators of the quarry at the east end of the indicative location for SESRO to determine the timing of their planned mineral extraction works.

Topic	Next steps
Natural Capital	• In line with the ACWG guidance, the NCA should be further refined to better integrate with the EIA process. The NCA should also be further updated to capture developments in the SESRO concept design to allow better examination of the effect of the different SESRO variants. • Develop NCA to better quantify and monetise the impact on water regulation services by considering the economic value of water left in the environment for other existing or future users. • The updated NCA would consider the programme of works for the SESRO variants, the areas impacted and associated timeframes to allow better comparison with the other options. • The updated NCA would expand on the ecosystem services considered at Gate 2 and identify additional ecosystem services that would be considered for subsequent project stages. Stakeholder consultation would be undertaken as part of the consenting process and would provide a useful means of identifying relevant ecosystem services. • Following the completion of ecological site surveys, integrate asset quality and locational indicators into the NCA. • The findings of the Gate 2 and subsequent NCAs should be considered within the iterative design process. This would help to optimise the delivery of multiple benefits. • Consideration of natural capital value alongside biodiversity would support SESRO to move beyond Biodiversity Net Gain towards environmental net gain.
Wider Benefits	• Develop a more granular methodology for assessing the quantitative and qualitative benefits of SESRO. • If further analysis is produced for Flood Risk and Air Quality then economic analysis of potential wider impacts may be required. • Impacts on customer bills can be further assessed when research into willingness to pay for added value is concluded. • A greater assessment of the socio-economic benefits generated by SESRO itself (in terms of its impact upon quality of life) would be suitable. This would encapsulate the different benefits under one term to allow for easier communication upon the opportunities and benefit.

Topic	Next steps
In-combination Effects	• Project in-combination effects will be examined further when more information is available at subsequent project stages.

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