

16 Climate Change Adaptation and Mitigation

Environmental Statement

Volume I

16 Climate Change Adaptation and Mitigation

Introduction

- 16.1** Climate change risks and opportunities to adapt to them are relevant to the design, construction, maintenance, operation and end of life phases of the Northern Line Extension (NLE). The Outline Energy Strategy document (see *Environmental Statement (ES) Volume II: Appendix O2*) provides the estimated reductions in carbon emissions savings that could be achieved, through the implementation of the 'be lean', 'be clean' and 'be green' options for the NLE.
- 16.2** This chapter presents a description of the planning policy context with regards to climate change, before dividing the chapter into the following two sections
- **Climate change adaptation** – describes how climate change has and will potentially manifest itself in London, the problems it can cause to the public transport network, and how the NLE can adapt by identifying risks, solutions and opportunities during the planning, design, construction and operational phases; and
 - **Climate change mitigation** – provides an assessment of the projected carbon emissions (the principal driving force behind climate change) of the proposed NLE and how these may be mitigated.
- 16.3** Unlike chapters 6-15, this is not an assessment chapter and therefore does not follow the typical structure.

Planning Policy Context

- 16.4** Rising international and national aspirations on climate change adaptation and mitigation has led to the strengthening of national planning policies and building control processes that contribute to the UK Government's long-term commitment to support sustainable and resilient development. The policy documents detailed below are relevant to the planning, design, construction, operation and maintenance of the NLE.

National Policy and Legislation

The Climate Change Act 2008

- 16.5** The Climate Change Act 2008 (Ref. 16-1) sets up a framework for the UK to achieve its long-term goals of reducing greenhouse gas emissions by 34% over the 1990 baseline by 2020 and by 80% by 2050 and to ensure steps are taken towards adapting to the impact of climate change. The Act introduces a system of carbon budgeting which constrains the total amount of emissions in a given time period, and sets out a procedure for assessing the risks of the impact of climate change for the UK, and a requirement on the Government to develop an adaptation programme.
- 16.6** The Climate Change Act introduced new powers and duties on climate change adaptation and mitigation. For adaptation it established a:
- UK-wide Climate Change Risk Assessment that must take place every five years;
 - National Adaptation Programme which must be put in place and reviewed every five years to address the most pressing climate change risks;

- Government power to require 'bodies with functions of a public nature' and 'statutory undertakers' - for example, water and energy utilities - to report on how they have assessed the risks of climate change to their work, and their response; and
- Adaptation Sub-Committee of the independent Committee on Climate Change (CCC) in order to oversee progress on the national programme and advise on the risk assessment.

- 16.7** The Government has published a list of those bodies that must report under the reporting power. This includes transport bodies (such as London Underground (LU)), energy and water utilities and environmental agencies.

The UK Climate Change Risk Assessment 2012

- 16.8** The Government published the UK Climate Change Risk Assessment (CCRA) (Ref. 16-2) on 25 January 2012, the first assessment of its kind for the UK and the first in a five year cycle. The CCRA has reviewed the evidence for over 700 potential impacts of climate change in a UK context. Detailed analysis was undertaken for over 100 of these impacts across 11 key sectors (including transport), on the basis of their likelihood, the scale of their potential consequences and the urgency with which action may be needed to address them.

- 16.9** The CCRA sets out key climate change risks for each sector and measures for responding to and mitigating against these risks. For the UK's transport sector, the key risks identified are:
- TR1: Flood disruption/delays to road and rail traffic;
 - TR2: Landslide impacting on the road network;
 - TR4: Cost of road carriageway repairs;
 - TR5: Rail buckling risk; and
 - TR6: Road and rail bridge failures due to scour.

National Planning Policy Framework (NPPF) 2012

- 16.10** The NPPF 2012 (Ref. 16-3) describes ways in which the challenge of climate change can be met. Chapter 10 of the NPPF highlights that planning plays a key role in mitigation against climate change. The policy also states that local planning authorities should:
- Adopt proactive strategies to mitigate and adapt to climate change taking full account of flood risk, coastal change and water supply and demand considerations;
 - Limit inappropriate development in areas at risk of flooding, but where development is necessary, making it safe without increasing flood risk elsewhere;
 - Support the move to a low carbon future, by supporting energy efficient improvements to existing buildings and set out requirements consistent with zero carbon building policy; and
 - Help to increase the use and supply of renewable and low carbon energy.

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The Department of Energy and Climate Change White Paper, 2003

16.11 The Department of Energy and Climate Change White Paper entitled *Our Energy Future - Creating a Low Carbon Economy*, 2003 (Ref. 16-4) sets a target for 10% of electricity to be produced from renewable sources nationally by 2010 and twice this by 2020, with a 60% reduction in carbon dioxide (CO₂) emissions by 2050.

The Carbon Plan, 2011

16.12 The Carbon Plan, 2011 (Ref. 16-5) sets out the Government's plans for achieving the emissions reductions committed to in the Climate Change Act, on a pathway consistent with meeting the 2050 target. This publication brings together the Government's strategy to curb greenhouse gas emissions and deliver our climate change targets, as well as the updated version of actions and milestones for the next five years.

Regional Planning Policy

The London Plan 2011

16.13 The London Plan 2011 (Ref. 16-6) is the spatial development strategy for Greater London; there are several policies within the plan relating to climate change adaptation and mitigation. These policies support the delivery of the Mayor's vision for London, in particular the objective that London should be:

"A city that becomes a world leader in improving the environment locally and globally, taking the lead in tackling climate change, reducing pollution, developing a low carbon economy, consuming fewer resources and using them more effectively."

16.14 In terms of climate change adaptation, the London Plan seeks to ensure future developments meet the highest standards of sustainable design and by considering the following at the beginning of the design process:

- Avoid internal overheating and contributing to the urban heat island effect;
- Efficient use of natural resources (including water), including making the most of natural systems both within and around buildings;
- Avoid impacts from natural hazards (including flooding);
- Ensure developments are comfortable and secure for users, including avoiding the creation of adverse local climatic conditions; and
- Promote and protect biodiversity and green infrastructure.

16.15 The policies from the London Plan that relate to climate change adaptation and mitigation are summarised below:

16.16 Policy 5.1 Climate Change Mitigation: Target to reduce overall CO₂ emissions of London to 60% below 1990 levels by 2025.

16.17 Policy 5.2 Minimising CO₂ Emissions: Development proposals should minimise CO₂ emissions and major developments should include a detailed energy assessment using the energy hierarchy, and meeting set reporting requirements. The energy hierarchy is as follows:

1. Be lean: use less energy;
2. Be clean: supply energy efficiently;

3. Be green: use renewable energy.

16.18 Policy 5.3 Sustainable Design and Construction: This policy aims to integrate sustainable design and construction into new developments, including adapting to climate change over their lifetime. Developments should minimise carbon emissions; avoid overheating; show efficient use of natural resources; minimise waste and pollution; maximise reuse or recycling; avoid natural hazards impacts; ensure comfort and security; secure sustainable procurement of materials and local supplies; and promote biodiversity and green infrastructure.

16.19 Policy 5.5 Decentralised Energy Networks: Includes a target of 25% of heat and power in London to be generated by decentralised energy systems by 2025. Developments should prioritise connection to existing or planned decentralised energy networks.

16.20 Policy 5.6 Decentralised Energy in Development Proposals: Proposals should evaluate using combined heat and power, and should select energy systems according to the energy hierarchy. Where future energy networks are identified, then the development should be designed to connect to these.

16.21 Policy 5.7 Renewable Energy: Reduce CO₂ emissions by renewable energy generation on-site where feasible.

16.22 Policy 5.9 Overheating and Cooling: The London Plan expects major development proposals to state how they will reduce potential overheating and reliance on air conditioning systems and demonstrate this in accordance with the recommended cooling hierarchy:

1. Minimise internal heat generation through energy efficient design;
2. Reduce the amount of heat entering a building in summer (through orientation, shading, green walls etc.);
3. Manage the heat within the building through exposed internal thermal mass and high ceilings;
4. Passive ventilation;
5. Mechanical ventilation;
6. Active cooling systems (choosing the lowest carbon options).

16.23 Policy 5.10 Urban Greening & Policy 5.11 Green roofs and development site environs: Urban greening is promoted as a means to contribute to the adaptation to, and reduction of, the effects of climate change. Development proposals are expected to integrate green infrastructure such as tree planting, green roofs and walls, and soft landscaping. Major development proposals should be designed to include roof, wall and site planting, especially green roofs and walls where feasible.

16.24 Policy 5.12 Flood risk management & Policy 5.13 Sustainable drainage: Relevant to flood risk and drainage, the London Plan states that development proposals must comply with the flood risk assessment and management requirements set out in Planning Policy Statement 25 (now replaced by the NPPF, 2012), and utilise sustainable drainage systems (SuDS) unless there are practical reasons for not doing so. The aim should be to achieve greenfield run-off rates (or attenuate to at least 50% of the previously developed site run off) and ensure that surface water run-off is managed as close to its source as possible in line with the recommended drainage hierarchy.

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The London Plan Supplementary Planning Guidance – Sustainable Design and Construction 2006

16.25 The Supplementary Planning Guidance (SPG) 2006 (Ref. 16-7) sets out a number of Essential and Preferred Standards for new developments. This includes designing buildings and infrastructure for flexibility of use during their projected operational lives and designing to adapt to and mitigate the effects of the urban heat island and the projected increases in hot dry summers and wet mild winters.

16.26 The standards set out in the SPG are based on the principles of:

- Adapting to climate change;
- Designing new buildings for flexible use;
- Managing overheating;
- Using high thermal mass materials;
- Mitigating for possibilities of subsidence; and
- Encouraging non carbon based transport modes.

The NLE Project Sustainability Assessment Report (included as *ES Volume II: Appendix O2*), provides an assessment of the NLE against the SPG.

Mayor's Transport Strategy 2010

16.27 The Strategy 2010 (Ref. 16-8) sets out the Mayor's transport vision and describes how Transport for London (TfL) and its partners will deliver that vision. One of the six goals set out in this document is to "*reduce transport's contribution to climate change and improve its resilience*" which is highly relevant to the Proposed Development and is in essence what this chapter is attempting to address. In addition, the strategy includes the following policies and proposals which are also relevant to the NLE

16.28 Policy 24 states that the Mayor through TfL and other organisations, will take the necessary steps to deliver the required ground-based transport to achieve a 60% reduction in London's CO₂ emissions by 2025 from a 1990 base; and to contribute to further targets that may be set by the Mayor from time to time.

16.29 Policy 25 states how the Mayor, through TfL and other organisations will take necessary steps to adapt the transport system and improve its resilience and public safety to the anticipated impacts of climate change.

16.30 Proposal 97 seeks to promote, support and improve sustainable, low CO₂ emitting transport and reduce the need to travel through integration of transport and land use planning

16.31 Proposal 108 is intended to promote CO₂ standards for vehicles and infrastructure controlled, procured or regulated by the Mayor, GLA Group and/or other public sector bodies. This includes public transport vehicles as well as station lighting and infrastructure. Standards should reduce emissions from existing and new vehicles and infrastructure, including the following which relate directly to the NLE:

- a) Trialling of low energy station lighting and automatic meter reading;
- b) Major infrastructure schemes will conduct a carbon footprint assessment.

16.32 Proposal 110 pledges to determine the vulnerability of transport assets to the impacts of climate change and maintain existing infrastructure to improve resilience to climate change

16.33 Proposal 111 will require that adaptation strategies to improve safety and network resilience to threats posed by climate change are undertaken to ensure that new infrastructure is appropriately resilient.

16.34 Proposal 112 will ensure that the transport system is developed with climate change in mind by:

- a) Designing locating and constructing new infrastructure to withstand climatic conditions anticipated over its design life;
- b) Introducing energy efficient air conditioned rolling stock where feasible;
- c) Continuing to investigate the feasibility of cooling deep tunnelled sections of the network.

16.35 Proposal 114 outlines the need to develop and test plans and procedures to minimise risk to person and property, manage disruption and ensure rapid transport systems recovery from the impact of climate change related events.

The Mayor's Climate Change Adaptation Strategy 2011

16.36 The Mayor's Climate Change Adaptation Strategy 2011 (Ref. 16-9) identifies who and what is vulnerable to extreme weather today, considers how climate change will affect the existing climatic risks, or create new risks or opportunities in the future, and provides a framework for action.

16.37 The key actions proposed in the strategy are:

- Adapting to increased flood risk:

This will be achieved through:

- mapping who, what and where is at risk of flooding today;
- using climate projections to understand how climate change will affect the floods of tomorrow;
- working with the emergency services, utilities companies and other partners to make the most critical services in London flood-resilient; and
- using green spaces and plants to absorb floodwater.

- Safeguarding London's water supply in a drought:

Making London more drought resilient and water efficient will be achieved through:

- continuing to work with the four major London water companies to ensure that the delicate balance between water supply and demand is maintained;
- helping Londoners to use less water by installing water metres in homes; and
- ensuring that new development is very water efficient.

- Keeping London cool in a heatwave:

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Building materials contribute to a major part of the city's overheating problem, and therefore the strategy is to:

- 're-green' the city by using vegetation and green-spaces to provide shading, cooling and insulation to take the edge of heatwaves; and
- make sure that new development is designed for the forecasted increases of temperature; and that mechanical cooling (e.g. air-conditioning) is only used where necessary.

Delivering London's Energy Future: The Mayor's Climate Change Mitigation and Energy Strategy 2011

16.38 In October 2011, the Mayor's Climate Change Mitigation and Energy Strategy was published (Ref. 16-10). The objectives of the strategy are to:

- Reduce London's CO₂ emissions to mitigate climate change;
- Maximise economic opportunities from the transition to a low carbon capital;
- Ensure a secure and reliable energy supply for London; and
- Meet, and where possible exceed, national climate change and energy objectives.

16.39 There are several policies in the strategy relating to transport:

16.40 Policy 10 Minimising CO₂ emissions through a shift to more carbon efficient modes of transport: Support and incentivise carbon efficient travel behaviour, minimise the need to travel, and encourage a switch to lower carbon modes of transport.

16.41 Policy 11 Minimising CO₂ emissions through more efficient operation of transport: The Mayor, working through the Promoter and with boroughs and partners, will minimise CO₂ emissions from transport including by improving driving techniques on public transport.

16.42 Policy 12 Minimising CO₂ emissions from transport through the use of low carbon vehicles, technologies and fuels: Encourage the development and use of low carbon vehicles, including encouraging regenerative braking across London's rail network and the LU network.

Local Planning Policy

London Borough of Lambeth

16.43 Lambeth Local Development Framework (LDF) Core Strategy (Ref. 16-11) was adopted in January 2011. Policy S7 relates to sustainable design and construction. Major development is required to reduce CO₂ emissions in line with London Plan targets. Where the required reduction from on site renewable energy is not feasible within major new developments, a financial contribution to an agreed borough-wide programme for emissions reduction will be sought. Developments should connect to decentralised energy where possible, and are encouraged to use natural cooling and ventilation.

16.44 The Lambeth Sustainable Design and Construction Supplementary Planning Document (SPD) (Ref. 16-7) was approved in July 2008 and provides guidance for preparation of development schemes, including that all applications should be submitted with a sustainability assessment.

16.45 The sustainability assessment must include an assessment of the energy demand and CO₂ emissions from proposed major developments, as well as the expected savings from efficiency measures. The assessment should include:

- A baseline energy demand calculation, demonstrating the projected energy use and CO₂ emissions;
- An explanation of how total energy demand and CO₂ emissions will be reduced relative to the baseline by energy efficiency measures;
- Proposals for the reduction of energy demand and emissions, including the feasibility of Combined Heat and Power (CHP) systems and community heating systems;
- Details of renewable energy technologies to be incorporated in the development. These should cover a minimum of 10% of the expected site energy use;
- A calculation of the energy demand and CO₂ emissions for the development; and
- Proposals to demonstrate that energy efficiency and renewable energy systems will be maintained throughout the lifetime of the building.

London Borough of Wandsworth

16.46 Wandsworth's Core Strategy (Adopted Version October 2010) (Ref. 16-12) has Policy IS2 relating to sustainable design, low carbon development and renewable energy which states that:

"All development will be required to make efficient use of natural resources (e.g. energy and water), employing good standards of sustainable design and construction, including sustainable drainage, working towards low carbon and zero carbon standards."

16.47 Major development proposals are expected to provide an Energy Assessment and to assess the feasibility of combined cooling, heat and power, and developments should connect to decentralised energy networks where possible.

16.48 Developments will be required to achieve a reduction in carbon emissions in line with London Plan targets (currently 20%) through on site renewable energy generation where feasible.

London Borough of Southwark

16.49 Southwark Council's Core Strategy (2011) (Ref. 16-14) includes the following Strategic Policies relevant to the Proposed Development:

16.50 Strategic Policy 2 – Sustainable Transport. This policy will promote the development and use of sustainable transport options by:

- Planning places and development with priority for walking and cycling, whilst maximising the use of public transport and minimising car use;
- Safeguarding land for planned public transport improvements and where the need arises in the future;
- Improving access to mixed use town and local centres; and

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- Requiring a transport assessment in line with the London Plan will ensure that new development encourages sustainable transport and minimises the impact of the journey.

16.51 Strategic Policy 13 - High environmental Standards. This policy requires that all new development is designed and built to minimise greenhouse gas emissions over its lifetime which will be achieved by:

- Designing all developments to so that they require as little energy to as possible to build and use;
- Expecting all new development to set up and/or connect to local energy generation networks where possible; and
- Requiring developments to use low and zero carbon sources of energy.

London Underground / Transport for London Policy

LU Climate Change Strategy

16.52 Tackling climate change and enhancing the environment is one of LU's (which is part of TfL) strategic goals (Ref. 16-13). As a transport provider it has a responsibility to operate a network that is as low-carbon as possible and resilient to the expected changes in the city's climate.

16.53 TfL supports the delivery of the Mayor of London's strategy commitment of a 60% reduction in the Capital's CO₂ emissions by 2025, against 1990 levels.

16.54 By then, the city's total number of residents is expected to have increased by one million and it is vital that TfL delivers the services London needs to support this growth while minimising its emissions and any resulting damage to the local environment.

16.55 TfL is working to tackle climate change by changing the way people travel: encouraging people to operate their vehicles more efficiently; investing in lower carbon fuels and technology; and by looking at the way it manages its business activities.

LU Environment Strategy 2008-2013

16.56 The LU Environment Strategy (revised in 2011) focuses on the impact of LU activities on the environment and sets environmental priorities until 2013 (Ref. 16-14). LU is committed to continual environmental improvement by embedding good environmental practices into the business. One of the main LU objectives is to reduce greenhouse gas emissions and to deliver a low carbon transport service. A new TfL wide Environment Strategy is currently being drafted, and will replace the LU strategy in 2014.

16.57 LU has developed a carbon emission reduction plan which sets out how they plan to understand and improve carbon emissions across their operations. The Plan is split into the following three approaches:

- Embedding energy conscious behaviour: embedding a greater understanding of energy demand across their operation. LU will ensure that energy demand is considered at all stages of business planning and project management, and will improve energy management at operational sites through mechanisms such as their 'station energy challenge';

- Energy efficient and renewable technology and systems: LU state they will investigate and trial technologies and systems which could reduce energy demand across the network. This includes considering how to incorporate renewable energy technology and working with contractors to incorporate energy efficient design and systems in new assets and infrastructure;
- Influencing the supply chain: LU state they will work with energy suppliers to improve the carbon profile of LU power demands. LU will seek to identify energy generation opportunities in London.

TfL Health, Safety and Environment Report 2011

16.58 TfL has set a target to reduce carbon emissions in grams CO₂ per passenger km by 20% in 2017/18 compared to a 2005/06 emissions baseline. In 2011/12 the normalised carbon emissions per passenger km were 70 grams CO₂ on average, which is 18% below the baseline (Ref. 16-15).

Climate Change Adaptation

Scope and Objectives

16.59 This sub section of the chapter describes the potential impact of the main climate change types projected to be experienced in London on the NLE. The purpose of this assessment is to:

- Understand the potential impacts of future climate change on the NLE through an assessment of the severity/ consequence of these impacts, probability and responsibility/ level of influence;
- Understand how the NLE will increase or reduce the magnitude and severity of climate change risks and opportunities on the built and natural environment (including ecosystems) and on society (including communities);
- Ensure planning and development decisions consider current and future climate risks;
- Understand how resilience can be increased through design (material choice, maintenance practices, location, layout etc);
- Understand and where possible, minimise the costs of planning, preparing for, facilitating and implementing adaptation measures, including transition costs;
- Understand the resources available for adaptation - information, technology, economic resources, institutions and so on; and
- Understand the likely timescale(s) for realisation of the risks - to inform design, investment planning, maintenance regimes.

Methodology

Climate Change Projections

16.60 The first stage of the assessment has been to analyse climate change projections for London. This has been conducted using UK Climate Projections 2009 (UKCP09) (Ref. 16-16) climate change projections up until 2100. UKCP09 data has been used and supplemented by additional climate change projections information from the Intergovernmental Panel on Climate Change (IPCC) (Ref. 16-17, Ref. 16-18) and the Met Office (Ref. 16-19). The UKCP09 high and medium

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emission scenarios have been assessed for a set of key climate change parameters. These scenarios were selected as the likelihood of the emissions levels from the low emissions scenario being achieved is very small. It is more difficult to identify whether the medium or high emissions scenarios will occur and for this reason both scenarios were chosen for a comparison of the impacts.

- 16.61** Through the UK Climate Impacts Programme (UKCIP), the UK has one of the most advanced projects in the world for developing scenarios of future climate change. UKCIP09 are the fifth generation of climate change information developed by UKCIP for the UK, underpinned by a new methodology developed by the Met Office (Ref. 16-19). This methodology reflects scientists' best understanding of how the climate system operates, how it might change in the future, and allows a measure of the uncertainty in future climate projections to be included. The projections are based on best available and cutting-edge science, and are designed for a wide variety of users. They provide the first probabilistic UK climate projections, and incorporate downscaled data from an ensemble of Global Climate Models.
- 16.62** An assessment of UKCIP09 projections for changes to the frequency of extreme weather events for London and an analysis of UKCIP09 projections compared to climate change projections under other available climate models has been conducted. This assessment will inform what climate change risks and opportunities the NLE may be exposed to and when, and also what action needs to be taken to adapt the scheme to the effects of a changing climate.

Review of Recent Extreme Weather Events

- 16.63** A review of recent relevant past extreme weather events in London and their direct and indirect impacts on underground rail (and other transport) infrastructure has been conducted using published London Local Climate Impacts Profiles (Ref. 16-20).
- 16.64** This review of recent events will allow the NLE's potential vulnerability to climate change and future extreme weather events to be better understood. A better understanding of the consequences of weather events provides a starting point for raising awareness of the risks and initiating a more considered approach to dealing with weather and climate impacts.
- 16.65** Finally, an initial assessment of the main potential risks and opportunities facing the NLE as a result of projected climate change and an increased frequency of extreme weather events has been conducted. This provides an indication of the considerations that should be taken into account during the planning, design, and construction stages of the NLE.

Assumptions and Limitations

- 16.66** The data sources described earlier have been used in conjunction with the URS tool Adapting to Climate Change Application (ACCA). ACCA is a tool designed to help users understand the likelihood and magnitude of climate change risks and opportunities related to their assets, projects and services, and develop prioritised adaptation responses to reduce the risks and maximise the opportunities.
- 16.67** UKCIP09 projections of the future climate are based on the current understanding of the climate system – there may be scientific unknowns that would affect the information provided. Hence UKCIP09 should be seen as providing possible projections rather than absolute predictions or forecasts of future climate. UKCIP09

provides information about the unknowns and uncertainties associated with future climate information by showing a range of possible outcomes and the probability of each outcome, based on the strength of evidence for different future climate changes. Being aware of these uncertainties and the associated assumptions is important when applying the projections during decision-making.

- 16.68** Important assumptions and uncertainties of the risk assessment methodology are as follows:
- The projections used in this chapter are based on the best available science. They offer sound evidence for making decisions about adapting the NLE's assets, processes and services to the future potential impacts of climate change. However, assumptions, limitations and uncertainties associated with any type of climate modelling should be considered at all times. TfL should acknowledge that no projections necessarily capture all possible future climate scenarios and may not be suitably sensitive to the most extreme weather types. Due to this level of uncertainty, careful consideration must be given to the level of investment deemed appropriate for the potential risk.

The Need to Adapt to Climate Change

- 16.69** The debate on climate change has recently moved away from whether or not it is happening, to what needs to be done to reduce the magnitude of further changes and minimise the impacts (Ref. 16-17). There is now an overwhelming body of scientific evidence highlighting the serious and urgent nature of climate change, largely due to emissions of greenhouse gases (GHG) as a result of human activities (Ref. 16-17). The next Assessment Report (AR5) of the IPCC is due out in mid-2013 and it will reinforce the conclusions of the previous four IPCC assessment reports which show that human-induced global warming has now driven the climate beyond natural variability.
- 16.70** Rising global temperatures are already altering weather patterns, causing sea levels to rise and increasing the frequency and intensity of extreme weather events (Ref. 16-18). Even if GHG emissions stop today, past emissions mean changes to the climate will continue at least for the next three decades (Ref. 16-21). The World Meteorological Organisation's most recent Greenhouse Gas Bulletin (Ref. 16-22) shows that levels of CO₂ rose by 2.3 parts per million (ppm) between 2009 and 2010 – a faster rate of increase than the average of 2.0ppm for the past decade.
- 16.71** The EU has set a goal of keeping global average temperature rise below 2°C, a point beyond which the risk of serious impacts may increase and what is widely accepted as the threshold of dangerous climate change. However, recent global emission trends and projections indicate that this threshold may be exceeded (Ref. 16-23). It is widely recognised that action needs to be taken now to adapt the natural and built environment to this potential change in order to ensure economic, social and environmental resilience.
- 16.72** Key climate projections for the UK (UKCIP09) are that:
- Summers will become hotter and drier;
 - Winters will become milder and wetter;
 - Soils will become drier on average;
 - Snowfall and the number of very cold days will decrease;

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- Sea levels will rise; and
- Storms, heavy and extreme rainfall, and extreme winds will become more frequent.

16.73 These changes are set to have significant impacts on the construction and maintenance of buildings and infrastructure and also on the natural environment. For example, drier and hotter summers will lead to more incidences of heat damage to structures and equipment; more frequent heavy rainfall events will result in increased incidences of flooding in low-lying areas; and increased variability in soil moisture levels will lead to increased incidences of infrastructure subsidence. These impacts will lead to disruption to services and increased operational, maintenance and emergency repair costs.

16.74 The LU is already vulnerable to, and is operating with, extreme weather. Past experience of floods, droughts, heatwaves and very cold weather have shown that severe weather events can have detrimental impacts on operations. Without action, climate change, population growth, and other factors (e.g. changes to land use) will increase the risk of disruption to LU's network. These pressures are often interlinked.

16.75 Existing construction, maintenance and management policies and standards for LU have been reviewed to include UKCP09 projections in order for services and assets to be resilient in the face of a changing climate. Therefore, action must be taken to minimise the disruption and costs caused by climate change through adaptation. Organisations must therefore adapt their policies and standards for these changes, and assist in reducing the continuation of these changes further into the future by reducing carbon emissions. Buildings and infrastructure should be designed for the climate change that they will experience over their design lifetime, or be capable of being adapted as climate change progresses.

16.76 Adapting to climate change is a process which TfL is already building into the NLE's planning, design, construction, maintenance and risk management. This allows TfL to make effective investment decisions to, ensure that the NLE is able to provide the level of service that its customers will expect. The sooner adaptation and resilience building is considered and implemented, the less it will cost and the better equipped it will be to cope with these and other potential changes in future (Ref. 16-24).

16.77 Climate change adaptation has a number of wider benefits, including:

- Reducing the risks to business continuity, to delivery of services and economic and reputational risk;
- Reducing, but not eliminating, exposure to extreme weather damage;
- Increasing the long-term sustainability of investment decisions;
- Reducing environmental pollution and enhancing environmental protection; and
- Creating a safer and more comfortable working environment for employees and travelling environment for the public.

16.78 TfL is already taking steps to mitigate and adapt to the impacts of climate change through programmes/initiatives such as 'Cooling the Tube', and risk analysis work as detailed in the Providing Transport Services Resilient to Extreme Weather and Climate Change report (Ref. 16-24). In this work TfL has assessed and evaluated

the future climate impacts on its assets and services, referencing the latest generation of climate projections UKCP09 (the same projections used for this project). This consideration of future climate projections will be an ongoing process which will be applicable to all future projects and operations, and should be adapted as new technologies or knowledge becomes available.

16.79 It is not possible to plan for every eventuality and there is inevitable uncertainty in predicting the future. Climate change is a process which is already built into TfL's planning and risk management and should remain an integral part of these procedures in order to ensure the response to climate change is effective. The sooner action is taken to plan adaptation to the effects of a changing climate, the less it will cost (Ref. 16-26). Lost revenues, reputational damage and regulatory penalties are all strong drivers for action.

16.80 TfL has already been undertaking work on assessing and responding to current and future climate change risks to its existing and planned assets and services. Its 2011 report (Ref. 16-24) to Defra (Department of Environment, Food and Rural Affairs) under the Climate Change Act 2008 Adaptation Reporting Power, identified and assessed the risks presented by climate change along with potential actions to mitigate them.

16.81 The report, and associated actions outlined within it, received positive feedback from the parliamentary undersecretary who noted that "*TfL clearly considers climate change to be a key issue for long term planning and it is excellent to see that consideration of the issues is being embedded into business practices.*"

Historical Climate Data for London

16.82 Like the rest of the UK, London's climate is generally temperate. According to Met Office records for Greenwich, between 1961 and 1990 (Ref. 16-19):

- There was an average of 585.5 millimetres (mm) of rain per year;
- September was typically the wettest month with an average of 55.3 mm of rain;
- February was typically the driest month with an average of 34.0 mm of rain;
- The average daily temperature was 11.0°C;
- The average daily maximum temperature was 14.4°C;
- The average daily minimum temperature was 7.0°C;
- July was typically the hottest month with an average maximum temperature of 22.2°C; and
- January was typically the coldest month with an average minimum temperature of 7.3°C.

Future Climate Projections for London

16.83 UKCP09 projections are provided for three different future emissions levels - low, medium and high. The three scenarios account for the uncertainties that exist about future trends and behaviours; such as population growth, technological progress and socio-economic development. The changes described for the next 40 years are based on past and current emissions and so all three scenarios display similar patterns over this timeframe. After this period, projected climate change patterns diverge as they become increasingly dependent upon differing predicted changes to emissions. The scenarios also represent varying local, regional and

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global socio-economic changes, including changes to the economy, population, technology, energy and agriculture (Ref. 16-16). The projections describe the difference between the modelled future climate and the 1961-90 observed baseline climate.

- 16.84** UKCP09 provides projections for a future climate based on averages. Therefore, they do not necessarily capture all possible extremes. More extreme possibilities (for temperature and precipitation etc) not included in the projections should therefore also be considered and should not be excluded from risk assessment development and contingency planning activities.
- 16.85** In order for TfL to be able to understand the possible full extent of climate change impacts on the NLE, UKCP09 probabilistic projections have been assessed for London for a range of climate variables. The central estimate (50% probability level) has been assessed for the range of variables. The central estimate does not indicate the average for the climate variable or the most likely outcome. It simply means that the projection is as likely as not to occur and it has the most evidence from the various runs of the climate model.
- 16.86** To account for the range of uncertainty in future climate projections, this chapter has also assessed changes to the climate under the 10% probability level for the low emission scenario and the 90% probability level for the high emissions scenario:
- The 10% probability level for the low emissions scenario – this demonstrates what the future change is unlikely to be less than. There is a 90% chance the projected change will be more than this.
 - The 90% probability level for the high emissions scenario – this demonstrates what the future change is unlikely to be more than. There is a 10% chance the projected change will be more than this.
- 16.87** The higher probability level (90%) does not mean that there is less or more chance of the values shown at these levels being reached and a lower probability level (10%) does not mean that there is a lower chance of these levels being reached. They simply show the wider range of possible future outcomes. It means that there is less evidence for the values at the edges of the ranges projected. For example, a 90% probability level of a temperature increase of 3°C means that the change in temperature is very unlikely to be more than 3°C because fewer model runs produced this particular value.
- 16.88** A summary of UKCP09 data has been developed **using the medium and high emission scenarios**. These are shown in Table 16-1. TfL are using UKCP09 and evidence obtained from the review of other IPCC-approved climate models, to make decisions about planning, designing, constructing and maintaining the NLE for future climate change. However, any proposed actions should be tested for sensitivity to a wider set of futures than indicated in any climate models.
- 16.89** These projections show that there are likely to be changes to the average weather conditions in the future. However, not all years will fit a clear trend of change,

leading to a variable and unpredictable climate. The projections will enable TfL to be able to identify the likely effects of climate change on the NLE, to a degree of certainty, and inform appropriate recommendations for changes to design, construction and maintenance policies, standards and practices.

- 16.90** It is also projected that average sea levels will continue to rise in the future, increasing the risk of coastal flooding and erosion. The frequency of extreme high water levels is also projected to increase. UKCP09 project that sea levels will rise by between 25cm and 86cm by 2100 and this, combined with a predicted increase in storm surges, will lead to a significantly increased risk of flooding.
- 16.91** UKCP09 projections do not include changes to wind or snowfall. However, the Met Office Hadley Centre regional climate model projects a decrease in winter mean snowfall of typically 65% to 80% in high altitude areas across the UK and 80% to 95% elsewhere by the 2080s. Met Office projections for wind speed are for a change of less than +3% over the UK by the 2080s.

Future Extreme Weather Events

- 16.92** In order to understand the likelihood of future extreme weather events, the UKCP09 Weather Generator (WG) and its Threshold Detector (TD) have been used to develop probabilistic daily weather conditions for the 2020s (2010-2039), the 2050s (2040-2069) and the 2080s (2070-2099).
- 16.93** The WG develops statistical relationships among daily weather variables across the baseline period (1961-90) and uses UKCP09 probabilistic projections to produce possible daily and hourly weather scenarios for future time periods for temperature, rainfall and humidity variables. The scenarios generated are consistent with the underlying probabilistic projections and are provided at a 5km resolution. The WG's TD is a post-processing tool that can be applied to outputs from the WG. It allows users to investigate how often thresholds, such as temperatures or rainfall levels, are likely to be exceeded in the future.
- 16.94** It should be noted that WG and TD outputs are not associated with specific dates, but simply a representation of what may occur based on past average conditions combined with average future projections for change. They cannot replicate or project some of the very extreme events experienced in recent years; such as the 1995 drought.
- 16.95** There are some limitations and assumptions associated with the WG's ability to project effectively future extreme weather events. Weather extremes are, by their nature, infrequent events, so there are only a small number of samples available from the observed record upon which to base future projections. The processes causing extremes are also complex and difficult to predict and model. These events also tend to sit at the extreme upper and lower 1-2% of any climate distribution and so are difficult to represent and capture in models of future climate. This is an uncertainty associated with all climate models. Extreme future events may sit outside of the range projected by UKCP09.

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Table 16-1 UKCP09 Projections for London*

Parameter and UK baseline (in brackets)	2020s (2010-2039)			2050s (2040-2069)			2080s (2070-2099)		
	Medium emissions scenario (50% level)	High emissions scenario (50% level)	Wider range	Medium emissions scenario (50% level)	High emissions scenario (50% level)	Wider range	Medium emissions scenario (50% level)	High emissions scenario (50% level)	Wider range
Change in mean winter daily temperature (3.3 °C)	+1.3°C	+1.4°C	+0.5°C to +2.2°C	+2.2°C	+2.5°C	+0.9°C to +3.8°C	+3.0°C	+3.7°C	+1.4°C to +5.7°C
Change in mean summer daily temperature (14.1 °C)	+1.6°C	+1.5°C	+0.5°C to +2.8°C	+2.7°C	+3.1°C	+1.1°C to +5.2°C	+3.9°C	+4.9°C	+1.4°C to +8.1°C
Change in mean daily summer maximum temperature (18.0 °C)	+2.1°C	+2.0°C	+0.5°C to +3.8°C	+3.7°C	+4.3°C	+1.2°C to +7.4°C	+5.3°C	+6.7°C	+1.4°C to +11.5°C
Change in mean daily summer minimum temperature (9.6 °C)	+1.6°C	+1.7°C	+0.6°C to +2.9°C	+2.9°C	+3.3°C	+1.2°C to +5.7°C	+4.2°C	+5.3°C	+1.4°C to +9°C
Change in annual mean daily precipitation (3.02mm/ day)	0%	0%	-4% to +5%	0%	0%	-5% to +5%	0%	0%	-6% to +7%
Change in winter mean daily precipitation (3.42mm/ day)	+6%	+7%	-4% to +18%	+14%	+16%	0% to +35%	+19%	+26%	+3% to +58%
Change in summer mean daily precipitation (2.56mm/ day)	-7%	-4%	-26% to +18%	-19%	-19%	-43% to +16%	-23%	-29%	-56% to +13%

* The wider range shows the range from the 10% probability level of the low emissions scenario to the 90% probability level of the high emissions scenario. The baseline is the mean conditions for the UK for the period 1961-90.

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16.96 The following threshold events have been identified as potentially being relevant to the NLE’s design, construction, operation, assets and services and have been investigated as part of this project:

- Annual number of days when the temperature is greater than 28 °C;
- Annual number of days when the temperature is greater than 25 °C;
- Annual number of heatwaves (2+ consecutive days with a maximum daily temperature of >29 °C and a minimum daily temperature of >15 °C);
- Annual number of frost days (when the minimum temperature is 0 °C or lower);
- Annual number of prolonged periods of cold weather (3+ and 5+ consecutive days where the temperature falls below 0 °C);
- Annual number of dry spells (days with no precipitation) lasting greater than 5, 10 and 20 consecutive days;
- Annual maximum temperature;
- Annual number of days when precipitation is greater than 25mm per day (the UKCP definition of ‘heavy rain’);
- Number of days per year when precipitation is greater than 40mm, especially an intense storm over a three hour period or less (as defined by the Flood Forecasting Centre (Ref. 16-27)); and
- Annual number of prolonged rainfall events (3+ consecutive days when precipitation is greater than 25mm/day).

16.97 Table 16-2 shows extreme weather events and projects changes to their frequency, using the UKCP09 high emissions scenario at the 90% probability level (10% probability level for the cold weather variables). This represents a realistic projection of the greatest possible change. UKCP09 projections under the medium emissions scenario (50% level) are shown in brackets. Projections for the UK are from UKCP09 pre-prepared outputs for a range of locations across the UK (averaged).

Table 16- 2 UKCP09 Projections for the Frequency of UK Extreme Weather Events Under the High Emissions Scenario at the 90% Probability Level (medium scenario central probability outputs shown in brackets)

Variable / parameter	Baseline observed (1961-90)	2020s (2010-2039)	2050s (2040-2069)	2080s (2070-2099)
Annual number of heatwaves (2 days with max daily temp of >29 °C and min daily temp of >15 °C)	<1	Up to 3 (1)	Up to 7 (3)	Up to 9 (4)
Annual number of days when temperature is >25 °C	5	Up to 26 (9)	Up to 58 (22)	Up to 92 (57)
Annual number of days	<1	Up to 12 (6)	Up to 28	Up to 77

Variable / parameter	Baseline observed (1961-90)	2020s (2010-2039)	2050s (2040-2069)	2080s (2070-2099)
when temperature is >28 °C			(12)	(36)
Annual maximum temperature (°C)	27.0	Up to 30.1 (27.9)	Up to 35.9 (31.0)	Up to 38.1 (30.6)
Annual number of frost days (when the minimum temperature is 0 °C or lower)	56	Up to 51 (38)	Up to 40 (25)	Up to 25 (14)
Annual number of prolonged periods of cold weather (3+ consecutive days where the temperature falls below 0 °C)	11	Up to 11 (10)	Up to 9 (7)	Up to 3 (2)
Annual number of prolonged periods of cold weather (5+ consecutive days where the temperature falls below 0 °C)	7	Up to 6 (5)	Up to 4 (3)	Up to 2 (1)
Annual number of dry spells (5+ days with no precipitation)	11	Up to 14 (12)	Up to 17 (15)	Up to 21 (16)
Annual number of dry spells (10+ days with no precipitation)	5	Up to 6 (3)	Up to 8 (4)	Up to 11 (7)
Annual number of dry spells (20+ days with no precipitation)	1	Up to 1 (1)	Up to 2 (1)	Up to 2 (1)
Number of days per year when precipitation is greater than 25mm per day (Met Office definition of ‘heavy rain’)	3	Up to 10 (7)	Up to 18 (10)	Up to 20 (10)
Number of days per year when precipitation is greater than 40mm per day (likely to cause flash flooding as defined by UKCIP)	<1	Up to 2 (1)	Up to 2 (1)	Up to 4 (1)

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Variable / parameter	Baseline observed (1961-90)	2020s (2010-2039)	2050s (2040-2069)	2080s (2070-2099)
Annual number of prolonged rainfall events (3+ consecutive days when precipitation is greater than 25 mm/day)	0	Up to 1 (0)	Up to 1 (0)	Up to 4 (1)

NLE Climate Change Risk Assessment

- 16.98** The URS tool ACCA has been used to assess, score and prioritise climate change risks relevant to the NLE as described in the previous sections. It can also be used to consider potential opportunities for the most effective adaptation strategies. Adaptation to climate change will continue to be considered as part of TfL's overall asset strategies and asset management plans.
- 16.99** Each risk and opportunity has been assessed against three variables (as shown in Table 16-3);
- Risk severity/ magnitude/ consequence;
 - Probability; and
 - Level of NLE responsibility and influence over the risk/ opportunity.
- 16.100** Using this methodology, URS assigned each risk a score (Total Risk Score = R x P x I) between 1 (no or very low risk) to 27 (very high risk) for three separate time periods:
- 2020s (present-2039);
 - 2050s (2040-2069); and
 - 2080s (2070-2099).
- 16.101** Scoring risks against three different timescales provides an indication of when action may need to be taken to adapt and increase resilience so the asset in question is able to perform effectively for its intended useful design life. For some risks, action should be taken early to avoid significant disruption and economic impact. Other risks only need to be addressed either shortly before or as they occur. For example, the risk of severe and widespread flooding may need to be addressed early through planning and design activities (such as installing high drainage capacities and flood protection). Risks to worker and passenger discomfort due to increased summer temperatures may only need a response when these events start to become more severe and frequent.
- 16.102** The scores for Risk severity/magnitude/consequence (R), Probability (P) and Influence (I) are established through URS and TfL knowledge of the specific risk and the level of resilience or exposure of the NLE to climate change, and through a review of relevant literature and climate change data. Total Risk Scores (R x P x I) are categorised as follows:

Total Risk score of 18-27	Very high risk for the specified time period
Total Risk score of 12-17	High risk for the specified time period
Total Risk score of 8-11	Medium risk for the specified time period
Total Risk score of <8	Low risk for the specified time period

Table 16-3 Variables within ACCA

<p>Risk (R) – severity, magnitude and likely consequences of the risk to the asset/ service/ investment in question. The impact may be related to the following types: operations, cost/ finance, regulation, service, safety, environment and/ or insurance and legal issues.</p> <p>The Risk (R) score represents the impact of the risk assuming it was to happen and does not reflect the probability of it occurring.</p>	<p>1 = Unknown or relatively low impact expected</p> <p>2 = Moderate impact expected across one or more impact type</p> <p>3 = Significant impact expected across one of more impact type</p>
<p>Probability (P) – likelihood of the impact occurring over the specified time period.</p>	<p>1 = Unknown or relatively low probability of the impact occurring</p> <p>2 = There is some evidence of the impact, and the severity and magnitude of the impact is likely to increase over time</p> <p>3 = There is significant evidence of the impact, and there is a high probability that the severity and magnitude of the impact will increase over time</p>
<p>Influence (I) – level of influence and responsibility of the Promoter on managing the risk or opportunity and on adapting the service, asset or investment in question to the projected impacts of future climate change.</p>	<p>1 = No or minimal influence and/ or responsibility</p> <p>2 = Moderate influence and/ or responsibility</p> <p>3 = Significant or total influence and/ or responsibility</p>

- 16.103** The cost impact of each risk and the value of assets impacted are taken into account in the scores assigned for risk severity/magnitude/consequence (R). For example, damage to tracks or tunnels from extremes of temperature of moisture will lead to a higher cost impact than passenger discomfort during heatwaves. Therefore, damage to tracks or tunnels may be scored 'three' for R and passenger discomfort may be scored 'two'. The total 'risk' scores are calculated in the same way for both risks and opportunities but the values have different meanings. A high score for an event categorised as risks means that a significant detrimental impact is likely to be seen should the event occur. Conversely, a high score for those events categorised as opportunities means that if the event occurs, benefits are likely to be realised.

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- 16.104** ACCA has been used for this project as it is a tool which has been applied to numerous other infrastructure assessments. However, it should be noted that TfL has already undertaken its own risk assessment of climate change (as reported in Ref. 16-24) in an effort to become more adaptable and resilient to the associated impacts.
- 16.105** Those risks and opportunities scored 8 or above will be assessed further in the next stage of the assessment to identify potential adaptation responses which could be implemented to reduce the likelihood, magnitude, severity and consequence(s) of the impact.

- 16.106** A detailed risk assessment of the NLE has been conducted using the above described methodology and the results of the assessment are presented in Tables 16-4 to 16-8
- 16.107** Table 16-9 presents the most significant risks and opportunities for the NLE and the point at which they become classed as a 'Medium', 'High' or 'Very High' risk. Table 16-9 also presents the maximum Risk Score for each risk and opportunity over any time period.

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Table 16-4 Risks and Opportunities to the NLE from an Increased Frequency of Flooding, Storms and Heavy/Prolonged Precipitation Events

Risk / Opportunity	Timescale	Risk Severity to the NLE (R)	Probability (P)	Influence / Responsibility (I)	Total Risk Score (RxPxI)
Risks					
Construction logistics affected by flooding and storms	2020s	2	2	2	8
	2050s	N/A	N/A	N/A	N/A
	2080s	N/A	N/A	N/A	N/A
Overwhelmed drainage and increased pumping requirements	2020s	2	1	2	4
	2050s	2	1	2	4
	2080s	2	2	2	8
Tunnel flooding	2020s	3	1	2	6
	2050s	3	1	2	6
	2080s	3	2	2	12
Damage to rolling stock from flooding and water ingress	2020s	2	1	2	4
	2050s	2	1	2	4
	2080s	2	2	2	8
Damage to power infrastructure	2020s	2	1	2	4
	2050s	2	2	2	8
	2080s	2	2	2	8
Flooding of stations and shafts	2020s	3	1	3	9
	2050s	3	1	3	9
	2080s	3	2	3	18
Track, tunnel and signal damage from flooding	2020s	3	1	3	9
	2050s	3	2	3	18
	2080s	3	2	3	18
Safety issues for passengers and the workforce	2020s	2	1	2	4
	2050s	2	2	2	8
	2080s	2	2	2	8
Pollution risk from inundated drainage	2020s	2	1	2	4
	2050s	2	2	2	8
	2080s	2	2	2	8
Damage to IT and security networks and systems	2020s	3	1	2	6
	2050s	3	2	2	12
	2080s	3	2	2	12
Disruption on the surrounding road/ rail network leading to extra pressure on the underground network	2020s	2	1	2	4
	2050s	2	2	2	8
	2080s	2	2	2	8
Inability of TfL employees to get to work during storms and periods of flooding	2020s	2	1	2	4
	2050s	2	2	2	8
	2080s	2	2	2	8
Opportunities					
To harvest rainwater for irrigation/toilet flushing	2020s	1	2	2	4
	2050s	1	2	2	4
	2080s	1	2	2	4

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Table 16-5 Risks to the NLE from Increasing Variation in Seasonal Precipitation

Risk / Opportunity	Timescale	Risk Severity to the NLE (R)	Probability (P)	Influence / Responsibility (I)	Total Risk Score (RxPxI)
Risks					
Changes in ground water levels and soil moisture content causing subsidence, instability and damage to underground tunnels, pipes, cables or wires	2020s	3	2	2	12
	2050s	3	2	2	12
	2080s	3	3	2	18
Vegetation ingress and changes to vegetation maintenance needs	2020s	1	1	2	2
	2050s	1	1	2	2
	2080s	1	2	2	4

Table 16-6 Risks and Opportunities to the NLE from Increased Summer Temperatures, Incidences of Drought and Frequency/ severity of Heatwaves

Risk / Opportunity	Timescale	Risk Severity to the NLE (R)	Probability (P)	Influence / Responsibility (I)	Total Risk Score (RxPxI)
Risks					
Failure of signal, power and communication assets due to thermal expansion and overheating	2020s	3	1	3	9
	2050s	3	2	3	18
	2080s	3	3	3	27
Overheating on trains, in stations and on platforms	2020s	3	2	2	12
	2050s	3	3	2	18
	2080s	3	3	2	18
Increased energy requirement for cooling trains, stations and platforms	2020s	2	2	2	8
	2050s	2	3	2	12
	2080s	2	3	2	12
Water shortages and increased water demand for cooling	2020s	2	1	2	4
	2050s	2	2	2	8
	2080s	2	3	2	12
Heat damage to and weakening of materials and structures	2020s	3	2	2	12
	2050s	3	2	2	12
	2080s	3	3	2	18
Increased TfL employee discomfort, reduced productivity and increased staff illness and absence	2020s	2	2	2	8
	2050s	2	3	2	12
	2080s	2	3	2	12
Disruption on the surrounding road/ rail network leading to extra pressure on the underground network	2020s	2	1	2	4
	2050s	2	2	2	8
	2080s	2	2	2	8
Reduced air quality caused by high temperatures leading to breathing difficulties	2020s	1	1	1	1
	2050s	1	2	1	2
	2080s	1	2	1	2
Odour and pest problems	2020s	1	1	2	2

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Risk / Opportunity	Timescale	Risk Severity to the NLE (R)	Probability (P)	Influence / Responsibility (I)	Total Risk Score (RxPxI)
	2050s	1	2	2	4
	2080s	1	2	2	4
Opportunities					
Savings on fuel costs for heating	2020s	2	2	1	4
	2050s	2	2	1	4
	2080s	2	2	1	4

Table 16-7 Risks and Opportunities to the NLE from Extreme Cold Weather, Snow and Ice

Risk / Opportunity	Timescale	Risk Severity to the NLE (R)	Probability (P)	Influence / Responsibility (I)	Total Risk Score (RxPxI)
Risks					
Construction logistics and schedules affected	2020s	2	1	2	4
	2050s	N/A	N/A	N/A	N/A
	2080s	N/A	N/A	N/A	N/A
Impact on train system components	2020s	2	1	3	6
	2050s	2	1	3	6
	2080s	2	1	3	6
Slip and trip risks for passengers and staff	2020s	2	2	2	8
	2050s	2	1	2	4
	2080s	2	1	2	4
Impact on track integrity, signals and equipment	2020s	2	1	3	6
	2050s	2	1	3	6
	2080s	2	1	3	6
Opportunities					
Reduced cold weather disruption to services and operations, reduced damage to assets and reduced health and safety issues	2020s	2	2	2	8
	2050s	2	3	2	12
	2080s	2	3	2	12

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Table 16-8 Risks and Opportunities for the NLE from Cascade Effects and Impacts on the Supply Chain and Interdependencies

Risk / Opportunity	Timescale	Risk Severity to the NLE (R)	Probability (P)	Influence / Responsibility (I)	Total Risk Score (RxPxI)
Risks					
Construction logistics affected due to disruption on the local road and rail network and restricted site access	2020s	2	2	2	8
	2050s	N/A	N/A	N/A	N/A
	2080s	N/A	N/A	N/A	N/A
Loss of power supply during extreme weather events (grid power and back-up generators)	2020s	3	1	2	6
	2050s	3	2	2	12
	2080s	3	2	2	12
Damage and congestion on the surrounding road and rail network(s) putting extra pressure on the underground network	2020s	2	1	2	4
	2050s	2	2	2	8
	2080s	2	2	2	8
Loss of water supply during extreme weather events	2020s	2	1	2	4
	2050s	2	2	2	8
	2080s	2	2	2	8
Restricted access to sites to repair assets and equipment during extreme weather events	2020s	2	1	2	4
	2050s	2	1	2	4
	2080s	2	2	2	8
Increased environmental degradation (e.g. air and noise pollution, loss of habitat) to the local areas	2020s	1	1	1	1
	2050s	1	2	1	2
	2080s	1	2	1	2
Rising cost of products and services vital to keep the NLE at the required level (e.g. power and fuel) during extreme weather events	2020s	2	1	2	4
	2050s	2	2	2	8
	2080s	2	2	2	8
Changing patterns of travel (modal shift etc) during extreme weather events and as a result of the changing climate	2020s	2	1	2	4
	2050s	2	1	2	4
	2080s	2	2	2	8
Population changes (e.g. people moving away from urban areas as temperatures increase)	2020s	2	1	1	2
	2050s	2	1	1	2
	2080s	2	2	1	4
Opportunities					
Increase LZC energy production in the local area due to government pressure, reducing fossil fuel availability and a changing climate	2020s	2	3	1	6
	2050s	2	2	1	4
	2080s	2	2	1	4

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Table 16-9 Most Significant Climate Change Risks and Opportunities to the NLE

Risk / Opportunity and Reference	Decade likely medium, high, very high risk / opportunity?	Maximum Total Risk Score (RxPxl)
Risks to the NLE from an increased frequency of flooding, storms and heavy/ prolonged precipitation events		
R1: Flooding of stations	2020s	18
R2: Track, tunnel and signal damage from flooding	2020s	18
R3: Damage to IT and security networks and systems	2050s	12
R4: Overwhelmed drainage and increasing pumping requirements	2080s	12
R5: Construction logistics affected by flooding and storms	2020s	8
R6: Safety issues for passengers and the workforce	2050s	8
R7: Pollution risk from inundated drainage	2050s	8
R8: Disruption on the surrounding road/ rail network leading to extra pressure on the underground network	2050s	8
R9: Inability of employees to get to work during storms and periods of flooding	2050s	8
R10: Damage to power infrastructure	2050s	8
R11: Overwhelmed drainage	2080s	8
R12: Tunnel flooding	2080s	12
R113: Damage to rolling stock from flooding and water ingress	2080s	8
Risks to the NLE from increased seasonal variation in precipitation		
R14: Changes in ground water levels causing subsidence, instability and damage to underground tunnels, pipes, cables or wires	2020s	18
Risks to the NLE from increased summer temperatures, increased incidences of drought and increased frequency and severity of heat waves		
R15: Failure of signal, power and communication assets due to thermal expansion and overheating	2020s	27
R16: Overheating on trains, in stations and on platforms	2020s	18
R17: Heat damage to and weakening of materials and structures	2020s	18
R18: Increased energy requirement for cooling trains, stations and platforms	2020s	12
R19: Increased employee discomfort, reduced productivity and increased staff illness and absence	2020s	12
R20: Water shortages and increased water demand for cooling	2050s	12
R21: Disruption on the surrounding road/ rail network leading to extra pressure on the underground network	2050s	8
Risks to the NLE from cold weather, snow and ice		
R22: Risks to the NLE from cold weather, snow and ice	2020s	8
Opportunities for the NLE from reduced cold weather, snow and ice		
O1: Reduced cold weather disruption to services and operations, reduced damage to assets and reduced health and safety issues	2020s	12
Risks to the NLE from cascade effects and impacts on the supply chain and interdependencies		
R23: Loss of power supply during extreme weather events (grid power and back-up generators)	2050s	12
R24: Construction logistics affected due to disruption on the local road and rail network and restricted site access	2020s	8
R25: Damage and congestion on the surrounding road and rail network(s) putting extra pressure on the underground network	2050s	8
R26: Loss of water supply during extreme weather events	2050s	8
R27: Rising cost of products and services vital to keep the NLE at the required level (e.g. power and fuel) during extreme weather events	2050s	8
R28: Changing patterns of travel (modal shift etc) during extreme weather events and as a result of the changing climate	2050s	8
R29: Restricted access to sites to repair assets and equipment during extreme weather events	2080s	8

16 Climate Change Adaptation and Mitigation

Adaptation Measures

16.108 To address each 'Medium', 'High' and 'Very High' risk and opportunity identified in Table 16-9, adaptation measures have been developed. These measures have been assessed to understand their suitability for implementation and potential ability to reduce the level of risk severity and to increase the NLE's future level of infrastructure, operational, and economic resilience.

Timing

16.109 The timing of adaptation investment is an important consideration in optimising their net present value (the difference between the discounted costs of adaptation and the avoided costs of climate change). The optimal approach to adaptation is one that maximises the benefit-cost ratio of the adaptation investment. This depends on factors such as the cost of the impact (for example, flooding), and the cost of repeated adaptation compared to the cost of a one-off adaptation effort.

Current Actions

16.110 Based on the study findings, there are a number of actions that TfL has already taken to improve the NLE's preparedness for climate change and extreme weather events, and some that will be considered later in the design development. TfL's proactive approach to managing the impacts of climate change and extreme weather events should result in less severe consequences, more effective approaches to responding to emergencies and, ultimately, lower financial and reputational costs. TfL is already working with the best available knowledge with regards to key weather and climate-related vulnerabilities. As new information emerges and understanding strengthens, TfL will continue to include this in its approach to managing climate change impacts. More specifically, TfL will continue to:

- Carry out an ongoing review of general trends and updates in climate parameters and projections, for example, published by UKCIP;
- Identify which specific assets and operations are critical to normal business operations, as well as for business continuity purposes, where these are located and how sensitive they are to extremes of weather;
- Ensure it has the necessary staff and skills to deal with extreme weather events during and after their occurrence; and
- Organise or participate in internal and external resilience forums and training efforts with key strategic partners such as Local Authorities, utilities suppliers, customer groups and emergency services to ensure integrated and aligned planning and emergency response.

16.111 In addition to the above activities that TfL is already carrying out, the following actions could further help to manage climate change impacts:

- Conduct a more detailed vulnerability assessment of key assets to flooding, drought, extreme heat and storms etc, including associated thresholds. Stress tests on specific assets, operations or key resources could be conducted to better understand performance levels under more extreme weather conditions and therefore identify specific performance thresholds; and

- Identify critical suppliers, including clients, business partners and sub-contractors, and evaluate their strategies and plans for dealing with severe weather events.

Future Plans/Strategies

16.112 TfL will also continue to develop methods of addressing the impacts of climate change as part of its asset strategies and asset management plans. This requires that knowledge and understanding of climate risks and current vulnerabilities are communicated to managers responsible for different aspects of service delivery. Furthermore:

- The findings are not static, and can be built upon to further understand local vulnerabilities and begin formulating responses;
- Key lessons learnt from past extreme weather events can be captured and recommendations for responses to similar events in the future need to be documented and communicated with all the stakeholders with a need to know, including cross-business support functions such as IT, Health & Safety and Procurement;
- TfL should work closely with suppliers and other stakeholders to develop a strategy for dealing with climate change as part of its approach to dealing with severe weather events (including working with emergency services and suppliers to develop plans for implementing a coordinated response to public emergencies and contingency plans to support business continuity; and
- Integrated and frequent planning discussions between the operational, environmental, and risk management departments will be increasingly important if and when potential climate change impacts begin to more directly impact the NLE and the wider LU. Close monitoring, tracking, and reporting of an increase in extreme weather events or hazards that have an impact on operations need to be documented and relayed to senior management.

Adaptation Measures – Incorporated and Considered

16.113 The sections below show the results of the adaptation option assessment for each 'Medium', 'High' and 'Very High' risk and opportunity (detailed in Table 16-9). Each risk/opportunity will be assigned an owner by TfL and a periodic review of all risks will be carried out, to include:

- A review of any new climate change projections;
- Knowledge of the risk and the level of resilience/exposure of specific assets to climate change, technologies, asset and operational performance and failure thresholds;
- Interdependencies with other relevant sectors (highway and rail networks, power supply) and the TfL supply chain; and,
- Evidence of the risk cause, probability and impact.

16.114 Where there is a commitment from TfL to incorporate a particular measure, this is stated along with where details of this are provided in the TWAO documents (including the ES).

16.115 In some cases, it is not possible for TfL to commit to an adaptation measure at this stage due to uncertainties in the detailed design of the NLE, although opportunities for the incorporation of these will be considered later in the process.

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Adaptation Measures to Reduce the Risks Associated with an Increased Frequency of Flooding, Storms and Heavy/prolonged Precipitation Events

16.116 The following measures have been incorporated into the design of the NLE, to increase resilience against the risks associated with increased frequency of flooding, storms and heavy/ prolonged precipitation events (Risks 1 to 13 in Table 16-9):

- Existing flood defences and other flood adaptation measures along the route will be maintained. A 1 metre high impermeable concrete wall will be installed around construction excavations (*ES Volume II: Appendix H1: Flood Risk Assessment*);
- Use water resistant construction materials and equipment (*Chapter 4: Description of the NLE*);
- Install waterproof membranes and sealed service ducts to the completed ventilation shafts (*ES Volume II: Appendix H1: Flood Risk Assessment*);
- Reduce risk of overland flooding by including 'passive' flood protection measures, such as raising entry or egress levels to above the flood levels and extending portal walls (*ES Volume II: Appendix H1: Flood Risk Assessment*);
- Manage surface water run-off and ensure the NLE meets the 'Essential Standard' of reducing run-off to 50% of the previously developed sites;

16.117 The following measures will be considered at a later stage:

- Locate electrical and other water sensitive equipment above flood levels, or install suitable flood resilience measures;
- Install flood warning systems and evacuation routes;
- Include a strict maintenance programme to ensure all drainage systems are kept free of debris and blockages; and
- Consider SuDS such as permeable paving and green/brown roofs to reduce run-off rates at Nine Elms station and Battersea station.

Adaptation Measures to Reduce the Risks Associated with an Increased Seasonal Variation in Precipitation

16.118 The following measures have been incorporated into the design of the NLE to increase resilience against the risks associated with an increased seasonal variation in precipitation (Risks 14 in Table 16-9):

- During construction, the changing water table level will be accounted for through consideration of drainage and subsidence issues. A thorough inspection regime will be established for vulnerable areas (for example, those built on clay) (*Chapter 13: Land Quality and Groundwater*).

16.119 The following measures will be considered at the detailed design stage:

- Inclusion of clay seals or other means to maintain steady moisture content below the ground surface;
- Use of bio-engineering solutions for soil stabilisation and incorporate erosion protection throughout the design.

Adaptation Measures to Reduce the Risks Associated with Increased Summer Temperatures, Increased Incidences of Drought and Increased Frequency and Severity of Heatwaves

16.120 The following measures have been incorporated into the NLE to increase resilience against the risks associated with increased summer temperatures, increased incidences of drought and increased frequency and severity of heat waves (Risks 15 to 21 in Table 16-9):

- Avoid removal of the most valuable trees during construction. Plant trees and incorporate vegetation into the design of the vent shafts to help reduce the re-radiation of heat in order to combat the urban heat island effect (*Chapter 4: Description of the NLE*);
- Use building materials with a high capacity to store heat, which can help reduce variation in temperature see Outline Energy Strategy for the NLE (*ES Volume II: Appendix O2*);
- Increase the capacity of exhaust and ventilation shafts in tunnels and stations;
- Capture heat from stations through air handling units and/or radiant cooling panels;
- Make maximum use of natural lighting and cooling (see earlier in this chapter and the 'be lean' section of the Outline Energy Strategy in *ES Volume II: Appendix O2*).

16.121 The following measures will be considered at a later stage:

- Insulate and protect electricity supplies from extremes of heat;
- Advise passengers to prepare for travelling in warmer conditions (for example, through the 'Hot Weather' poster campaign and advising passengers to travel with a bottle of water);
- Plan for and monitor changes to seasonal travel demand (for example, demand may reduce during heatwaves but may increase in winter as seasonal temperatures decrease);
- Encourage the inclusion of vegetated roofs and walls on any over site development (OSD);
- Install solar shading and/or use materials with reflective properties on any external surfaces to minimise the need for cooling;
- Increase design temperature parameters to account for potential thermal expansion and/ or contraction;
- Seasonal track stretching and rail replacement programmes should consider projected future peak temperatures;
- Work effectively to manage and minimise pests and odour;
- Install high efficiency cooling technologies and passive cooling systems to rolling stock, stations and buildings;
- Modify working arrangements and contractual arrangements to respond to periods of extreme heat;

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- Consider the use of track materials and equipment that have a good resistance to high temperatures;
- Install buffer zones by the use of double skin façades that allow the space to be used for air flow using thermal flue technology;
- Consider forced cooling and night-time purge ventilation at stations;
- Specify regenerative lift and elevator motors to recover energy and provide enhanced resilience to voltage fluctuation (see *ES Volume II: Appendix O2* for further information); and
- Investigate the use of tunnel piped water as a method of waste heat recovery or potentially as a cooling system to reduce temperatures and reduce energy use by ventilation fans.

Adaptation Measures to Reduce the Risks and Maximise the Opportunities Associated with Cold Weather, Snow and Ice

- 16.122** The following measures will be considered at a later stage of the NLE planning programme to reduce the risks and maximise the opportunities associated with increased cold weather, snow and ice (Risk 22 and Opportunity 1 in Table 16-9):
- Use materials, systems, technologies and equipment that are capable of withstanding and being resilient to low temperatures;
 - Establish and maintain the ability to react to extreme cold weather events, ice and snow (such as through establishing salt stocks and maintaining relevant maintenance equipment and vehicles); and
 - Protect any external power lines and equipment from low temperatures, snow and ice.

Adaptation Measures to Reduce the Risks Associated with Cascade Effects and Impacts on the Supply Chain and Interdependencies

- 16.123** The following measures will be considered at a later stage of the NLE planning programme to reduce the risks associated with cascade effects, impacts on the supply chain and interdependencies (Risk 23 to 29 in Table 16-9):
- Protect the power supply and establish and maintain contingency plans and emergency purchasing and contracting procedures;
 - Maintain adequate fuel stocks and install back-up power generators where appropriate;
 - Develop contingency plans for reduced levels of service caused by weather events;
 - Establish contingency plans for when certain staff are unable to get to work during extreme weather events;
 - Install water-efficient equipment and appliances to reduce the demand for potable water; and
 - Monitor any changes to passenger numbers and any evidence of modal shift during extreme weather events.

Adaptation Conclusions

- 16.124** There is a great deal of uncertainty when it comes to forecasting climate change, but as data sources improve, this uncertainty will reduce.
- 16.125** There are widespread implications of climate change on every geographical level. The planning, design, operation and maintenance of the NLE provides numerous opportunities to both exploit extreme weather conditions and adapt to them. There are many examples of where adaptation has already been incorporated into TfL and LUL operational policy, and many examples of where adaptation has been incorporated into the design of the above and below ground elements of the NLE.
- 16.126** The next part of this chapter investigates how effective the construction and operation of the NLE is in order to 'mitigate' the causes of climate change, particularly CO₂ emissions.

Climate Change Mitigation

Introduction

- 16.127** This sub section on climate change mitigation addresses the need to report the estimated carbon emissions that would be produced by the NLE, both during construction and throughout operation. Potential mitigation measures to reduce these estimated emissions are also considered below.
- 16.128** LU published its total carbon footprint in the Health Safety and Environment (HSE) Report 2011/12 as 2.14m tonnes CO₂ in 2011/12. This included emissions from purchased gas and electricity, company owned vehicles, traction, stations, depots, head offices. LU already operates 250 miles (402.3km) of track and between 3 and 4 million journeys per day, and compared to the overall network, the 3.1 km of track for the NLE would not significantly increase the carbon emissions operationally. However, it is important to predict and measure emissions and provide suggestions and solutions to reduce these in line with relevant planning policy.
- 16.129** This is an informative section with no significance criteria assessment as the wide potential impact of carbon emissions makes it difficult to clarify the significance under set criteria.

Assessment Methodology

Scope

- 16.130** Direct and indirect emissions have been considered in line with GHG reporting and the total carbon footprint has been reported in CO₂ equivalents (CO₂e). The emissions baselines and operational scenarios has been split by emissions scope as defined by the GHG Protocol:
- 16.131** The GHG Protocol categorises emissions into three scopes:
- Scope 1: All direct GHG emissions;
 - Scope 2: Indirect GHG emissions from the use of purchased electricity, heat or steam; and

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- Scope 3: Other indirect emissions, including transport-related activities in vehicles not owned or controlled by London Underground, outsourced activities, waste disposal, etc.

Methodology

- 16.132** Estimation and reporting of the GHG emissions baseline has been calculated using the methodology established under the World Resource Institute GHG Protocol for Project accounting. Relevant IPCC Guidance for the calculation of GHG emissions for infrastructure projects has also been followed including:
- A defined scope of reporting; and
 - Recognised GHG emissions factors – IPCC.
- 16.133** Operational and baseline models are based on full operation of the NLE in 2031; construction is based on the build period of 2014-2021.

Emissions Baseline

- 16.134** To understand the GHG impact of the NLE it is necessary to determine an emissions baseline based on a scenario if the NLE was not undertaken. An emissions baseline is a reference case against which to compare the predicted NLE activity.
- 16.135** When calculating the GHG impacts of the NLE it is necessary to not only consider emissions from the direct operation of the new project but to account for indirect impacts to the surrounding area. These indirect impacts are emissions from transport, and not emissions from other building developments outside of LU control. The baseline therefore presents the direct and indirect emissions from the surrounding area that will potentially be influenced by the NLE. The baseline includes development that would be possible without the NLE and is based on 5,239,484 jobs and 9,832,381 population in central London and boroughs surrounding the NLE development. This is based around medium density residential development in the OA (based on the 'without NLE' scenario described in *Chapter 2: EIA Methodology*), this is a realistic level of development that could come forward without building the NLE.
- 16.136** In establishing the emissions baseline, consideration was given to the materiality of data in order to improve accuracy by understanding the potential scope for data error i.e. where an emissions source is likely to represent less than 1% of total emissions it is reasonable to exclude this source as it will not have a significant bearing on the overall footprint.
- 16.137** To calculate the emissions baseline the following parameters were considered:
- Projected numbers of people living and working in the modelled area (Central London and the Boroughs where the NLE is proposed to be sited);
 - The transport mode split (car, HGV, OGV, taxi, bus, train or the Tube) used; and
 - The average trip length travelled.
- 16.138** Energy use at existing stations connecting to the NLE is unlikely to change significantly as a result of the NLE, and has therefore not been considered in this assessment on basis of materiality.

- 16.139** Emissions factors for different modes of transport and energy use at stations are taken from recognised sources including Defra /DECC's Greenhouse Gas (GHG) Conversion Factors and the GHG Protocol.

Operational Scenario

- 16.140** Operational emissions are those arising during the running of a fully operational NLE. Emissions are split into scopes as defined by the GHG Protocol:
- **Scope 1:** Gas and oil consumption at stations, depots, offices, company leased vehicles (LU vehicle fleet);
 - **Scope 2:** Consumption of purchased electricity (traction and non-traction);
 - **Scope 3:** Emissions that result as a consequence of activities outside the control of combustion of fossil fuels during the abstractions and processing of raw materials through to the manufacture of the finished product.
- 16.141** Scope 1 emissions from transport directly associated with the operation of the NLE (i.e. company leased vehicles).
- 16.142** Scope 2 emissions from non-trackside operations as calculated for the Energy Strategy for the NLE. These include emissions associated with heating and direct hot water, cooling, lighting and other power-uses such as lifts and escalators.
- 16.143** Scope 2 emissions from trackside emissions relate to trackside activities such as traction, groundwater pumps and ventilation fans.
- 16.144** Scope 3 emissions from indirect operational activities include water consumption, wastewater discharge and waste production, employee commuting and business travel, rail replacement buses, contracted maintenance vehicles and other purchased materials or activities.
- 16.145** Scope 3 transport emissions indirectly resulting from the NLE project have been modelled based on the full level of development enabled by the NLE (the 'with NLE scenario'), as set out in *Chapter 2: EIA Methodology* including a fully operational NLE service.

Construction and Embodied Carbon

- 16.146** Construction emissions and emissions associated with embodied carbon in materials have been calculated as a stand-alone element and not used in the comparison between the emissions baselines and operational scenarios. This is because it is not possible to calculate embodied emissions for the emissions baselines. Embodied carbon in materials is the total carbon emitted in producing that material.
- 16.147** Construction emissions have been calculated using the Inventory of Carbon and Energy (ICE) (January 2011). This dataset contains published embodied carbon emissions factors for construction materials. These factors have been multiplied by the estimated quantities of the major materials to be used in the construction of the NLE.
- 16.148** Two construction design options presented in *Chapter 4: Description of the NLE*; have been modelled to compare emissions. Construction Option A and B are mostly the same, with alternative tunnelling methods being applied for Construction Option B.

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16.149 As well as calculating embodied emissions within the construction materials, the emissions associated with the construction process have also been calculated. This includes:

- Transportation of excavated materials which are removed from site by truck or by barge;
- Transportation of materials to site by truck; and
- Construction site energy for the duration of the construction period.

Assessment Results

16.150 The following is a breakdown of results for each of the emissions scenarios: baseline (Table 16-10), construction (Table 16-11) and operational. (Table 16-12) Appendices are attached containing a full breakdown of calculations and assumptions made in data collection (see *ES Volume II: Appendix L*).

Table 16-10 Emissions Baseline

Emissions Baseline	Tonnes CO ₂
Scope 3	12,882,950

Table 16- 11 Construction and Embodied Carbon Emissions

Construction and Embodied Emissions	Option A: Tonnes CO ₂	Option B: Tonnes CO ₂
Embodied carbon in construction materials	161,835	161,970
Transportation of excavated materials	2,577	2,730
Transportation of materials to site	270	284
Construction site energy	25,979	25,979
Total Construction	190,662	190,964

16.151 Construction emissions are for embodied carbon, as well as carbon associated with the transport of material to and from the site and the carbon from energy use on site. The emissions from transport of materials to the site are lower than those of taking materials away from site. Transport of excavated material includes the journey from site to Wallasea island disposal and is a longer distance than the transport of construction materials from local distribution centres.

Table 16- 12 Operation Emissions

Operational Scenario 1	Tonnes CO ₂
Scope 1	4
Scope 2 & 3	12,894,316

16.152 The difference between the baseline and operational scenarios shows an overall increase in emissions. This is due to the operational scenario accounting for a

greater population and number of jobs in the area. The increase in development will support the building of the NLE, but also has the negative impact of potentially creating more car users in the area.

16.153 Scope 2 emissions associated with the operation of the NLE are included within the scope 3 transport emissions for the operation footprint. The Defra factor used to calculate emissions from tube travel takes into account operational emissions.

Table 16-13 Difference Between Baseline and Operation Emissions (based on Regional Railplan and CLoHAM models)

Operation vs. Baseline	Car	Taxi	LGV	OGV	Bus	Tube	Rail	Total tonnes CO ₂ e
Change in total distance (km/year)	21,545,108	297,351	4,506,092	3,274,373	-24,029, 940	68,774,858	-23,466, 421	
Change in total CO ₂ e	5,040	56	1,350	2,353	-2,404	5,608	-1,576	10,427

16.154 The data in Table 16-13 above is from the transport model (used in the Transport Assessment, as set out in *Chapter 6: Traffic and Transport*) representing central London and the southern London boroughs around the NLE. The baseline represents medium density development in the area that could not be supported by the NLE (the 'without NLE scenario'); the operation scenario represents high density development (including retail and office development) that would be enabled by the NLE (the 'with NLE scenario' discussed in *Chapter 2: EIA Methodology*). Note that the negative differences indicate a decrease in emissions for the operation of the NLE in comparison to the baseline.

16.155 The table shows an increase in the use of cars from baseline to operation, this accounts for a greater population and number of jobs in the area during operation. This is as a result of the development enabled by the NLE, rather than as a direct impact of the NLE. Each of these enabled developments will be required to produce their own Environmental Statement to support their planning application, which will have needed to demonstrate mitigation where possible with regard to their carbon footprint. Car use is a driver of the operational footprint as the emissions factor per km is much higher than that of public transport.

16.156 The difference between the baseline and operational scenarios also shows a shift away from bus and rail use towards use of the tube network (including the NLE). The emissions from bus and rail use decrease in the operational scenario compared to the baseline, despite there being greater development in the area. This indicates that the NLE would encourage the use of tube travel, which has a lower emissions factor than bus or rail travel.

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Mitigation

Operational Mitigation Measures

- 16.157** The operational emissions footprint presented in the results is based on basic expected emissions. LU will mitigate this impact to reduce the emissions generated by operation of the NLE.
- 16.158** TfL has set a target to reduce the normalised emissions (measured in grams CO₂ per passenger km) from its main public transport services by 20 per cent by 2017/18, against a 2005/06 baseline. LU has a Low Carbon Stations Initiative, has achieved energy, maintenance and CO₂ savings through using more efficient lighting, space heating and cooling and mechanical ventilation. Hot water equipment and hand drying equipment were also considered as low cost measures in the TfL Health, Safety and Environment Report 2011/12 (Ref. 16-29). Measures such as these have also been considered for the NLE, and detailed modelling has been undertaken in the Outline Energy Strategy Report submitted as part of the TWA application. The Outline Energy Strategy (*ES Volume II: Appendix O2*) models several levels of mitigation to reduce emissions from non-trackside elements. The baseline represents meeting building compliance regulations, then mitigation measures are modelled as follows:
- Passive design and energy efficiency (i.e. use less energy – ‘be lean’);
 - Energy efficient supply of services (i.e. ‘be clean’); and
 - On site renewable energy technologies to provide energy (i.e. use renewable energy – ‘be green’).
- 16.159** The potential emissions saving between the baseline and the ‘be lean’ scenario is approximately 24% reduction in tonnes CO₂. The ‘be clean’ scenarios present a further 0.2-0.5% depending on the availability of connection to any existing neighbouring low carbon heat distribution networks.
- 16.160** Finally the ‘be green’ scenario considered several renewable energy technologies. The most feasible form of renewable energy technology for the NLE is considered to be Air Source Heat Pumps (ASHP). It is currently estimated that a traditional ASHP could displace around 60 tonnes of CO₂/year, equivalent to around 2%. In total, these mitigation measures are estimated to have a saving of approximately 25% of trackside emissions.
- 16.161** When considering only the regulated energy uses of the stations (i.e. the heating, domestic hot water (DHW), cooling, ventilation and lighting) the proposed energy strategy could achieve 34% reduction in CO₂ emissions over the baseline.
- 16.162** Example mitigation measures to meet these energy reduction scenarios and mitigate climate change during the operation of the NLE are shown in Table 16-14 below. Further details of recommended energy reduction measures (Scope 1 and 2) are provided in the Outline Energy Strategy (*ES Volume II: Appendix O2*).

Table 16- 14 Energy Reduction Measures

Passive Measure	Design	Detail
Potential for natural ventilation		Natural ventilation modelling will be carried out. The NLE cannot be solely dependent on natural ventilation; it will be used where possible under normal operating conditions.
Humped alignment		Humped alignment means that the station is raised so that trains entering the station roll up the ‘hump’ and require less energy for braking; they also use less energy to accelerate when leaving the station as they roll off the hump. The NLE will incorporate humped alignment where possible at both proposed stations, although it is not always feasible because of below ground conditions.
Promotion of daylighting		Daylighting will be promoted wherever feasible as it helps to reduce energy consumption associated with artificial lighting. The potential of utilising light tubes for transport of light to the below ground locations will be investigated.
Thermal mass		Thermal mass will be used efficiently to manage the risk of overheating.
Sustainability Awareness scheme for staff and public		TfL will be running Sustainability Awareness schemes to encourage staff and public to reduce energy usage.
Energy Efficient Design		Detail
Energy Efficient Lighting and Controls		Light Emitting Diode (LED) lighting will be incorporated into the design wherever feasible. Daylight sensors will be provided for the external lighting and for the internal areas, which directly benefit from daylighting. Time switches and Passive Infra-Red (PIR) sensors will be provided in the areas of irregular use such as toilets and staff circulation areas.
Mechanical Ventilation Heat Recovery		Mechanical ventilation heat recovery systems will be implemented in the offices and staff rooms.
Regenerative braking		Regenerative braking is a type of energy recovery when the kinetic energy from braking is converted into another form of energy which can be re-used.
Thermal zoning and controls		The NLE will be zoned to allow for an individual temperature control for different areas of the stations.

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Passive Measure	Design	Detail
Sub-Metering of high energy consuming uses and zones		Energy metering of high consuming uses such as escalators, lifts, fans and pumps, lighting and small power, etc. will be provided to allow for efficient management of the buildings.
Building Management System (BMS)		A BMS will be provided for the NLE to control and monitor the building's services.
Energy display devices		Energy display devices will be provided to show the energy performance of the stations to staff and passengers.
Efficient fans and pumps		To reduce the energy associated with the mechanical ventilation system, high efficiency fans will be incorporated into the design including variable speed drives.
Efficient office equipment & staff appliances		Office equipment and staff appliances will be energy efficient including low energy computers, monitors and fridges.
Efficient lifts and escalators		<p>The energy consumption of the stations escalators could be reduced by adjusting the speed of the escalator to slow down when not in use, or stop during off-peak periods.</p> <p>The following measures could improve the efficiency of the lifts:</p> <ul style="list-style-type: none"> • Drive controller capable of variable speed, variable voltage and variable frequency control of the drive motor; • Energy efficient lighting such as LED lighting; • 'Standby mode' for when the lifts have been inactive for a specified time; • Regenerative drive unit to allow the recovery of energy for example as the lift brakes.
Efficient Supply of Energy		Detail
The Vauxhall, Nine Elms and Battersea District Energy Network (DEN)		The Underground network could considerably benefit from the low carbon electricity generated by the CHP units located within the DEN energy centres. Development of the area DEN is at an early stage, and therefore there is a degree of uncertainty associated with its availability for the early phases of the NLE.

Passive Measure	Design	Detail
Tunnels Waste Heat Recovery		Initial consideration has been given to utilising waste heat from the Underground tunnels and supplying it to the VNEB DEN or any OSD or other available network, further details are available in the Outline Energy Strategy Report.
Over Site Development (OSD) Energy Centres		Consideration should also be given to the development connecting to energy centres associated with the OSDs of both stations; again further details are available in the Outline Energy Strategy Report.

16.163 The future energy mix of grid electricity should also be considered, as Government policy is anticipated to lead to decarbonisation of the grid and therefore greater emissions reductions in the future. It is noted that this emissions scenario is based on assumptions regarding possible energy policy. Assumptions for decarbonisation of the grid are based on the CCC's medium carbon abatement scenario (Ref. 16-29). These assumptions do not yet form UK Government Policy but is consistent with the targets set out in the Climate Change Act. A further unknown when modelling the carbon impacts of the NLE is potential technological improvements in the carbon efficiency of cars and other modes of public transport. The modelling undertaken to form the basis of this section has been undertaken using current emissions factors for modes of transport and does therefore not account for any such decrease in emissions.

Construction and Embodied Carbon Mitigation Measures

16.164 As construction is likely to be a significant portion of the emissions from the NLE, it is important to consider mitigation measures for the construction stage of the NLE to reduce emissions associated with construction methods and embodied emissions in construction materials.

16.165 River transport for excavated materials will be used where possible to reduce road transport. Interim calculations are for transport of excavated materials by barge and road to Northfleet. Assuming 70% of materials are removed by barge, this reduces the carbon footprint of excavated materials by 63% compared to using road transport only.

16.166 Consideration will be given to the selection of materials used, for example using cement containing a higher recycled materials content and therefore lower embodied carbon. Increasing the fly ash content of concrete can reduce the embodied carbon associated with it. Current calculations assume concrete with 15% replacement fly ash. Using 15% fly ash reduces the embodied carbon in cement by approximately 7% compared to using only virgin material concrete.

16.167 A number of best practice measures will be employed to reduce emissions during construction, for example:

- Switching off machinery and vehicles when not in use;
- Reducing water consumption where possible;

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- Reducing landfill waste production, by increasing opportunities for recycling and planning material use;
- Implementing a travel plan to reduce the impact of employee business travel (e.g. car sharing schemes or similar); and
- Using efficient vehicles and machinery where possible.

Mitigation Conclusion

- 16.168** Given the current stage of design, detailed information is not available as to the exact specification of construction or operation equipment and therefore a full emissions breakdown has not been possible. Emissions have been calculated based on available data.
- 16.169** The most significant portion of the proposed NLE carbon footprint is anticipated to be associated with construction and the embodied carbon of materials. The mitigation measures summarised above will decrease the impact of this area of the NLE.
- 16.170** Car use is a driver of the operational footprint as the emissions factor per km is much higher than that of public transport. Although beyond the control of LU, there would be potential to decrease this number if future developments in the area were to encourage low car use, e.g. through the use of smart travel plans. New developments within the area will be subject to their own EIA's which should consider the impacts of development on the environment.
- 16.171** The difference between the baseline and operational scenarios also shows a shift away from bus and rail use towards use of the tube network (including the NLE). This shift results in a lower carbon-intensity method of public transport, as the emissions factor per km travelled associated with the tube are approximately 19% lower than bus transport. The emissions from bus and rail use decrease in the operational scenario compared to the baseline, despite there being greater development in the area. This indicates that the NLE would encourage more sustainable modes of public transport use in the area.
- 16.172** Over time emissions from the operation of the NLE running on a lower carbon electricity grid may decrease in comparison to use of fossil fuel vehicles for transportation, as discussed this could result in a decrease in emissions from operation of the NLE.
- 16.173** The operational scenario has potential for further mitigation of up to 24% emissions reduction from energy reduction measures and potential for renewable energy generation, as discussed in the Outline Energy Strategy (*ES Volume II: Appendix O2*),

Cumulative Effects

- 16.174** This assessment of the impacts of the NLE project on climate change considers the additional population from the development of the VNEB OA, and the impact that this would have on the baseline and the operation of the NLE. It is not possible to provide a detailed assessment accounting for all proposed developments in the area that may have a cumulative effect with the NLE. However, the impact on climate change from the NLE development is considered to be minimal, and each of the cumulative schemes will have produced Flood Risk Assessments, Transport

Assessments and Energy Strategies to help them adapt to and mitigate climate change.

References

- Ref. 16-1 HM Government (2008); Climate Change Act 2008
Ref. 16-2 Defra (2012); UK Change Risk Assessment.
Ref. 16-3 CLG (2012); National Planning Policy Framework.
Ref. 16-4 DECC (2003); Our Energy Future – Creating a Low Carbon Economy,
Ref. 16-5 DECC (2011); The Carbon Plan: Delivering our Low Carbon Future
Ref. 16-6 GLA (2011); The London Plan
Ref. 16-7 GLA (2006); The London Plan Supplementary Planning Guides: Sustainable design and construction.
Ref. 16-8 GLA (2010); Mayor's Transport Strategy
Ref. 16-9 Mayor of London (2011); Managing Risks and Increasing Resilience: The Mayor's Climate Change Adaptation Strategy.
Ref. 16-10 GLA (2011); Delivering London's Energy Future: The Mayor's climate change mitigation and energy strategy
Ref. 16-11 LBL (2010); London Borough of Lambeth Local Development Framework Core Strategy. Submission version
Ref. 16-12 LBW (2010); London Borough of Wandsworth Local Development Framework Core Strategy,
Ref. 16-13 London Underground Climate Change Strategy
Ref. 16-14 London Underground Environment Strategy 2008-13 (revised 2011)
Ref. 16-15 TfL (2012); Health, Safety and Environmental Report 2011/12
Ref. 16-16 UKCIP (2009); Climate Change Projections
Ref. 16-17 IPCC (2007); Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change
Ref. 16-18 IPCC (2007); Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.
Ref. 16-19 Met Office (2012); UK Climate Data
Ref. 16-20 UKCIP (2012); UK Climate Impacts Programme
Ref. 16-21 Defra (2009); Adapting to Climate Change: Climate Change Projections.
Ref. 16-22 World Meteorological Organization (2011); WMO Greenhouse Gas Bulletin.
Ref. 16-23 DECC (2009); Climate Change Act 2008 Impact assessment.
Ref. 16-24 TfL (2011); Providing Transport Services Resilient to Extreme Weather and Climate Change
Ref. 16-24 TfL (2011); Providing Transport Services Resilient to Extreme Weather and Climate Change
Ref. 16-25 HM Treasury (2010); Stern Review Final Report
Ref. 16-26 Range, N., et al. (2010); Adaptation in the UK: a decision-making process. Centre for Climate Change, Economics and Policy, Policy Brief 2010
Ref. 16-27 Environment Agency (2012); Flood Forecasting Centre
Ref. 16-28 SKM (2009); Vauxhall Nine Elms Battersea OA Transport Study
Ref. 16-29 TfL Health, Safety and Environment Report 2011/12 (2012); Study
Ref. 16-30 CCC (2010); Scenarios to Meet Budgets

17 In-Combination Effects Assessment

Environmental Statement

Volume I

17 In-Combination Effects Assessment

Introduction

- 17.1** This chapter presents the results of an assessment of the in-combination effects that may result from the demolition, construction and operation of the Northern Line Extension (NLE) (see *Chapter 4: Description of the NLE* of this ES for details of the proposed demolition and construction works and operational regime). In-combination effects can occur where there is more than one impact on a particular resource or receptor, for example, the combined effects of construction noise and dust on a residential or ecological receptor.
- 17.2** This chapter only considers the in-combination effects resulting from the NLE. The cumulative effects of the NLE with other planned or permitted development in close proximity are addressed within each of the individual topic chapters. The methodology for that assessment is set out in *Chapter 2: EIA Methodology*.

Assessment Methodology

- 17.3** There is no established EIA methodology for assessing and quantifying the in-combination effects of individual impacts and effects on resources and receptors; however, the European Commission (EC) has produced guidelines (Ref. 17-1) for assessing 'impact interactions' "*which are not intended to be formal or prescriptive, but are designed to assist EIA practitioners in developing an approach which is appropriate to a project...*". URS Infrastructure and Environment Ltd (URS) has reviewed these guidelines and has developed an approach which uses the defined residual effects of the NLE (see *Chapter 18: Mitigation, Residual Effects and Conclusions*) to determine the potential for impact interactions and so the potential for combined effects of individual impacts.
- 17.4** As a result of the EIA process, the ES defines a number of beneficial and adverse effects during demolition, construction and operation of the NLE as being of either neutral or negligible, or of minor, moderate or major significance. Several impacts on one resource, receptor or receptor group could potentially interact to produce a greater combined significant overall effect (e.g. several minor impacts may combine to produce an overall moderate effect). For the purposes of this assessment, only residual effects (those that remain following the implementation of mitigation measures) classified as being of minor, moderate, major and of beneficial or adverse significance have been considered in relation to the potential for in-combination effects. Residual effects of negligible or neutral significance have been excluded from the assessment of the combined effects of individual impacts as they, by virtue of their definition, are considered to be imperceptible impacts to an environmental resource or receptor.
- 17.5** The resources, receptors or receptor groups that have been considered within this assessment are those defined within *Chapter 2: EIA Methodology* of this ES, i.e. the resources, receptors or receptor groups which could be impacted upon by the NLE. For the purposes of this chapter, these resources, receptors / receptor groups have been further refined to comprise:
1. Local highway network;
 2. Public transport network;
 3. Pedestrian and cycle network, safety and amenity;
 4. Neighbouring commercial properties and local businesses;
 5. Existing local residents;
 6. Demolition and construction workers (Demolition and Construction only);
 7. Operational workers (Completed and Operational only);

8. Archaeological assets;
9. Listed Buildings;
10. Underlying geology and hydrogeology;
11. Water resources;
12. Existing utilities and infrastructure;
13. Local and London View Management Framework (LVMF) views;
14. Kennington Park – local amenity areas and community facilities;
15. Kennington Park – the lodge in the north-eastern corner of the park (Kennington Park Lodge) (Demolition and Construction only);
16. Kennington Green – Local Amenity Areas;
17. Nine Elms – Local Businesses;
18. Nine Elms – Future residents (Completed and Operational only);
19. Battersea – Local Businesses;
20. Battersea – Future residents (Completed and Operational only);
21. Battersea – The River Thames; and
22. Battersea – Local ecology.

- 17.6** These resources, receptors / receptor groups have been considered by location and in general, where they apply to all sites. Where resources, receptors / receptor groups relate to a specific site, this is stated within the description, e.g. Kennington Park – local amenity areas and community facilities.
- 17.7** For some environmental impacts, no interactions with other impacts can occur and so no in-combination effects could arise. Where there is considered to be no potential for in-combination effects, this is stated. For other environmental impacts, it is apparent that interactions with other impacts could occur and, as such, result in combined effects upon an individual resource, receptor or receptor group.
- 17.8** The identified residual effects (as set out within the individual technical chapters of this ES and summarised within *Chapter 18: Mitigation, Residual Effects and Conclusions*) have been reviewed against the resources, receptors / receptor groups they affect. Where there is more than one effect on a particular resource or receptor, consideration has been given to whether there is the potential for impact interactions. If there is the potential for interactions then an assessment has been made of the potential for any resultant combined effects and their significance.
- 17.9** As there are no recognised guidelines to enable quantification of in-combination effects, and it would be largely subjective, professional judgement has been used to broadly identify if the interaction might lead to a greater combined effect.

Assessment of In-Combination Effects

- 17.10** This section presents an assessment of the potential in-combination effects that may arise as a result of impact interactions on a particular resource or receptor. The impact interactions are firstly identified, and then a judgement is made on the likelihood of an in-combination effect.

Demolition and Construction

- 17.11** Table 17-1 presents the review of the combined effects of individual impacts throughout the demolition and construction stage of the NLE. The potential impact interactions are then further discussed below.

17 In-Combination Effects Assessment

Table 17-1 Potential Impact Interactions – Demolition and Construction

Resource / Receptor / Receptor Group	Residual Effects	Potential for Impact Interaction and so Combined Effects?
General (Applicable to all Sites)		
Local Highway Network	<p>Traffic & Transport (Temporary Loss of Parking) Minor Adverse</p> <p>Traffic & Transport (Temporary Closure of Radcot and Harmsworth Streets) Minor Adverse</p> <p>Traffic & Transport (Construction Traffic Impacts on Junctions) Minor Adverse</p>	<p>YES in relation to:</p> <p>Traffic & Transport (Temporary Loss of Parking) & Traffic & Transport (Temporary Closure of Radcot and Harmsworth Streets) & Traffic & Transport (Construction Traffic Impacts on Junctions)</p>
Public Transport Network	<p>Traffic & Transport (Temporary Closure of Kennington Station) Minor Adverse</p> <p>Traffic & Transport (Temporary Closure of the Bus Lane adjacent to Kennington Green) Minor Adverse</p>	<p>No (the periods of each closure are not likely to overlap)</p>
Pedestrian and Cycle Network, Safety and Amenity	<p>Traffic & Transport (Temporary Closure of Footways) Minor Adverse</p> <p>Traffic & Transport (Impact on Cyclists) Minor Adverse</p> <p>Traffic & Transport (Temporary Closure of Radcot and Harmsworth Streets) Minor Adverse</p> <p>Traffic & Transport (Construction Traffic Impacts on Junctions) Minor Adverse</p> <p>Noise & Vibration (Construction Noise from Surface Sites): Negligible to Minor Adverse</p> <p>Noise & Vibration (Construction Noise and Vibration from Underground Works): Negligible to Minor Adverse</p> <p>Air Quality (Emissions from increased road traffic): Minor Adverse</p> <p>Air Quality (Dust from demolition and construction activities): Negligible to Minor Adverse</p>	<p>YES in relation to:</p> <p>Traffic and Transport & Noise & Vibration & Air Quality</p>

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Resource / Receptor / Receptor Group	Residual Effects	Potential for Impact Interaction and so Combined Effects?
Neighbouring Commercial Properties and Local Businesses	<p>Traffic & Transport (Temporary Closure of Footways) Minor Adverse</p> <p>Traffic & Transport (Impact on Cyclists) Minor Adverse</p> <p>Traffic & Transport (Temporary Closure of Radcot and Harmsworth Streets) Minor Adverse</p> <p>Noise & Vibration (Construction Noise from Surface Sites): Negligible to Minor Adverse</p> <p>Noise & Vibration (Construction Noise and Vibration from Underground Works): Negligible to Minor Adverse</p> <p>Noise & Vibration (Construction Vibration): Minor Adverse</p> <p>Air Quality (Emissions from increased road traffic): Minor Adverse</p> <p>Air Quality (Dust from demolition and construction activities): Negligible to Minor Adverse</p> <p>Townscape & Visual Amenity (Effects on townscape): Negligible to Moderate/Major Adverse</p> <p>Townscape & Visual Amenity (Effects on visual amenity): Negligible to Moderate Adverse</p>	<p>YES in relation to:</p> <p>Traffic and Transport & Noise & Vibration & Air Quality & Townscape & Visual Amenity</p>
Existing Local Residents	<p>Traffic & Transport (Temporary Loss of Parking) Minor Adverse</p> <p>Traffic & Transport (Temporary Closure of Footways) Minor Adverse</p> <p>Traffic & Transport (Impact on Cyclists) Minor Adverse</p> <p>Traffic & Transport (Temporary Closure of Radcot and Harmsworth Streets) Minor Adverse</p> <p>Noise & Vibration (Construction Noise from Surface Sites): Negligible to Minor Adverse</p> <p>Noise & Vibration (Construction Noise and Vibration from Underground Works): Negligible to Minor Adverse</p> <p>Noise & Vibration (Construction Vibration): Minor Adverse</p> <p>Air Quality (Emissions from increased road traffic): Minor Adverse</p> <p>Air Quality (Dust from demolition and construction activities): Negligible to Minor Adverse</p> <p>Townscape & Visual Amenity (Effects on townscape): Negligible to Moderate/Major Adverse</p> <p>Townscape & Visual Amenity (Effects on visual amenity): Negligible to Moderate Adverse</p>	<p>YES in relation to:</p> <p>Traffic and Transport & Noise & Vibration & Air Quality & Townscape & Visual Amenity</p>
Demolition and Construction Workers	<p>Socio-economics (Employment Creation): Minor Beneficial</p>	<p>No (no effects to interact with)</p>
Archaeological Assets	<p>No Effects of Minor, Moderate or Major Significance Identified</p>	<p>N/A</p>

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Resource / Receptor / Receptor Group	Residual Effects	Potential for Impact Interaction and so Combined Effects?
Listed Buildings	<p>Noise & Vibration (Construction Noise and Vibration from Underground Works): Negligible to Minor Adverse</p> <p>Townscape & Visual Amenity (Effects on townscape): Negligible to Moderate/Major Adverse</p> <p>Townscape & Visual Amenity (Effects on visual amenity): Negligible to Moderate Adverse</p>	<p>YES in relation to:</p> <p>Noise & Vibration & Townscape & Visual Amenity</p>
Underlying Geology and Hydrogeology	No Effects of Minor, Moderate or Major Significance Identified	N/A
Water Resources	Land Quality & Groundwater (Improvement to soil and groundwater quality / Lowering the stock of contaminated land within the VNEB): Moderate Beneficial	No (No effects to interact with)
Existing Utilities and Infrastructure	Noise & Vibration (Construction Noise and Vibration from Underground Works): Negligible to Minor Adverse	No (no effects to interact with)
Local and LVMF Views	There are no LVMF views affected, and local views are considered under Townscape & Visual Amenity upon other specific receptors and receptor groups.	N/A
<i>Kennington Park</i>		
Local Amenity Areas and Community Facilities	<p>Socio-economics (At Kennington Green and Kennington Park, areas of open space would be temporarily cordoned off and closed to public access for between 12-18 months): Minor Adverse</p> <p>Traffic & Transport (Temporary Closure of Footways) Minor Adverse</p> <p>Noise & Vibration (Construction Noise from Surface Sites): Negligible to Minor Adverse</p> <p>Noise & Vibration (Construction Noise and Vibration from Underground Works): Negligible to Minor Adverse</p> <p>Noise & Vibration (Construction Vibration): Minor Adverse</p> <p>Air Quality (Emissions from increased road traffic): Minor Adverse</p> <p>Air Quality (Dust from demolition and construction activities): Negligible to Minor Adverse</p> <p>Townscape & Visual Amenity (Effects on townscape): Moderate/Major Adverse</p> <p>Townscape & Visual Amenity (Effects on visual amenity): Moderate Adverse</p>	<p>YES in relation to:</p> <p>Socio-economics & Traffic and Transport & Noise & Vibration & Air Quality & Townscape & Visual Amenity</p>
Kennington Park Lodge	Socio-economics (Community Facility (Kennington Park Lodge) will be demolished and result in two occupiers being displaced and temporarily relocated for the duration of the works): Minor Adverse	No (no effects to interact with)

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Resource / Receptor / Receptor Group	Residual Effects	Potential for Impact Interaction and so Combined Effects?
<i>Kennington Green</i>		
Local Amenity Areas	<p>Socio-economics (At Kennington Green and Kennington Park, areas of open space would be temporarily cordoned off and closed to public access for 12-18 months): Minor Adverse</p> <p>Traffic & Transport (Temporary Closure of Footways) Minor Adverse</p> <p>Noise & Vibration (Construction Noise from Surface Sites): Negligible to Minor Adverse</p> <p>Noise & Vibration (Construction Noise and Vibration from Underground Works): Negligible to Minor Adverse</p> <p>Noise & Vibration (Construction Vibration): Minor Adverse</p> <p>Air Quality (Emissions from increased road traffic): Minor Adverse</p> <p>Air Quality (Dust from demolition and construction activities): Negligible to Minor Adverse</p> <p>Townscape & Visual Amenity (Effects on townscape): Moderate/Major Adverse</p> <p>Townscape & Visual Amenity (Effects on visual amenity): Moderate Adverse</p>	<p>YES in relation to:</p> <p>Socio-economics & Traffic and Transport & Noise & Vibration & Air Quality & Townscape and Visual Amenity</p>
<i>Nine Elms</i>		
Local Businesses	<p>Socio-economics (Impact on Existing Businesses): Minor Adverse</p> <p>Traffic & Transport (Temporary Loss of Parking) Minor Adverse</p>	<p>YES in relation to:</p> <p>Socio-economics & Traffic & Transport</p>
<i>Battersea</i>		
Local Businesses	No Effects of Minor, Moderate or Major Significance Identified	N/A
The River Thames (including the Foreshore Ecology and Site of Metropolitan Importance for Nature Conservation (SMINC))	No Effects of Minor, Moderate or Major Significance Identified	N/A
Local Ecology	No Effects of Minor, Moderate or Major Significance Identified	N/A

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- 17.12** Table 17-1 shows that there is potential for a series of in-combination effects to take place, during the demolition and construction phase of the NLE, and that several of the 18 identified resources / receptors / receptor groups are potentially subject to more than one effect during this stage as follows:
1. Local Highway Network
 2. Pedestrian and Cycle Network, Safety and Amenity;
 3. Neighbouring Commercial Properties and Local Businesses;
 4. Existing Local Residents;
 5. Listed Buildings;
 6. Kennington Park – Local Amenity Areas and Community Facilities;
 7. Kennington Green – Local Amenity Areas;
 8. Nine Elms – Local Businesses; and
 9. Battersea – The River Thames.
- 17.13** Further discussion on the potential in-combination effects on the above identified resources / receptors / receptor groups is presented below.

Explanation of the Potential for Combined Effects

Combined Effects: Traffic & Transport, Socio-economics, Noise and Vibration, Air Quality and Townscape and Visual Amenity

- 17.14** Throughout the demolition and construction stage of the NLE, the following resources / receptors / receptor groups are potentially affected by in-combination effects relating to Traffic & Transport, Socio-economics, Noise and Vibration, and Air Quality:
- Local highway network;
 - Pedestrian and cycle network, safety and amenity;
 - Neighbouring commercial properties and local businesses;
 - Existing local residents;
 - Kennington Park – Local Amenity Areas and Community Facilities;
 - Kennington Green – Local Amenity Areas; and
 - Nine Elms Local Businesses
- 17.15** Individual effects that have the potential to interact are largely related to noise from surface construction sites, noise and vibration from underground construction works, emissions from an increase in road traffic, and dust particulates from demolition and construction activities. There may also be an interaction between the effects resulting from the closure of roads, suspension of parking and increased construction traffic on local roads. The effects range from negligible significance, through to minor adverse significance. When these are combined, they could potentially create a greater combined nuisance effect on the identified resources / receptors / receptor groups.
- 17.16** Although there is the potential for these adverse in-combination nuisance effects to occur throughout the demolition and construction programme, these will be temporary in nature due to the transient nature of works which generate the individual socio-economic, noise and vibration, air quality and townscape and visual amenity impacts. As works progress

around the sites, the impact experienced by the identified resources / receptors / receptor groups will vary in magnitude, duration and significance. During early construction work there will also be associated surface construction site noise and vibration and dust impacts. However, a resource / receptor that experiences the adverse combined nuisance effects during this period will not be affected to the same extent during the internal structure works for the station boxes.

- 17.17** In addition, some effects associated with the demolition and construction works are localised, examples include dust effects and noise and vibration from surface construction sites, and visual impacts in areas that are fairly enclosed (rather than open). Dust will potentially be more significant throughout the excavation of materials rather than throughout the construction of the running tunnels. As a result, although the potential for combined nuisance effects has been identified, these effects are likely to be temporary, not just in terms of the stage of works and when they occur, but in terms of where they occur across the sites as well.
- 17.18** The socio-economic impact related to areas of open space being temporarily cordoned off and closed to public access (for up to 3 years and 2 months at Kennington Green and 3 years and 9 months at Kennington Park also has the potential to interact with the aforementioned noise, vibration and air quality effects, along with the deterioration in townscape quality and visual amenity. The socio-economic effect is of minor adverse significance, yet when combined with the other effects, they could potentially create a greater effect on identified resources / receptors / receptor groups. However, this will be temporary in nature.
- 17.19** Transport for London (TfL) is committed to good environmental management throughout the demolition and construction phase of the NLE and contractors will be appointed for the demolition and construction works. Once the contractors have been appointed, they will implement specific mitigation measures set out within Part B of the CoCP and in line with the Greater London Authority's (GLA's) 'Control of Dust and Emissions from Construction and Demolition – Best Practice Guidance' (2006) (Ref. 17-2), to mitigate and reduce demolition and construction impacts as far as reasonably practicable.

Completed and Operational NLE

- 17.20** Table 17-2 presents a review of the potential for in-combination effects once the NLE is completed and operational. These are then further discussed below.

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Table 17-2 Potential Impact Interactions – Completed and Operational NLE

Resource / Receptor / Receptor Group	Completed Development Residual Effects	Potential for Impact Interaction and so Combined Effects?
General (Applicable to all Sites)		
Local Highway Network	Traffic & Transport (Changes to Local Traffic Levels and the Highway) Moderate Adverse	No (no effects to interact with)
Public Transport Network	Traffic & Transport (Increased Crowding Levels on Some London Underground Links) Minor Adverse Traffic & Transport (More Efficient Interchange at Kennington Station) Moderate Beneficial Traffic & Transport (Congestion Relief at Vauxhall Station) Moderate Beneficial Traffic & Transport (Increased Public Transport Accessibility) Major Beneficial Traffic & Transport (Decreased Crowding Levels on Some London Underground Links) Minor Beneficial Traffic & Transport (Reduced Public Transport Journey Times) Major Beneficial	YES in relation to: All Traffic and Transport residual effects listed
Pedestrian and Cycle Network, Safety and Amenity	Traffic & Transport (Changes to Local Traffic Levels and the Highway) Moderate Adverse Traffic & Transport (Improvements to the Local Cycle Network and Facilities) Moderate Beneficial Traffic & Transport (Improvements to the Local Pedestrian Environment) Moderate Beneficial Noise & Vibration (Ground borne vibration from operation of trains): Negligible to Minor Adverse	YES in relation to: Traffic and Transport (Changes to Local Traffic Levels and the Highway) Traffic and Transport (Improvements to the Local Cycle Network and Facilities) & Traffic and Transport (Improvements to the Local Pedestrian Environment) & Traffic and Transport (Other public transport services)
Neighbouring Commercial Properties and Local Businesses	Socio-economics (Access to Employment Opportunities – Greater London): Minor Beneficial Socio-economics (Impacts on Wider Development): Major Beneficial Socio-economics (Impacts on Labour Market and Productivity): Major Beneficial Traffic & Transport (Increased Public Transport Accessibility) Major Beneficial Traffic & Transport (Reduced Public Transport Journey Times) Major Beneficial Traffic & Transport (Improvements to the Local Cycle Network and Facilities)	YES in relation to: Socio-economics & Traffic and Transport & Townscape and Visual Amenity

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Resource / Receptor / Receptor Group	Completed Development Residual Effects	Potential for Impact Interaction and so Combined Effects?
	<p>Moderate Beneficial</p> <p>Traffic & Transport (Improvements to the Local Pedestrian Environment) Moderate Beneficial</p> <p>Traffic & Transport (Increased Crowding on Some London Underground Links) Minor Adverse</p> <p>Traffic & Transport (Decreased Crowding on Some London Underground Links) Moderate Beneficial</p> <p>Noise & Vibration (Ground borne vibration from operation of trains): Negligible to Minor Adverse</p> <p>Townscape & Visual Amenity (Effects on townscape): Neutral to Moderate/Major Beneficial</p> <p>Townscape & Visual Amenity (Effects on visual amenity): Neutral to Moderate/Major Beneficial</p>	
Existing Local Residents	<p>Socio-economics (Access to Employment Opportunities – Greater London): Minor Beneficial</p> <p>Socio-economics (Impacts on Wider Development): Major Beneficial</p> <p>Socio-economics (Impacts on Labour Market and Productivity): Major Beneficial</p> <p>Traffic & Transport (Increased Public Transport Accessibility) Major Beneficial</p> <p>Traffic & Transport (Reduced Public Transport Journey Times) Major Beneficial</p> <p>Traffic & Transport (Improvements to the Local Cycle Network and Facilities) Moderate Beneficial</p> <p>Traffic & Transport (Improvements to the Local Pedestrian Environment) Moderate Beneficial</p> <p>Noise & Vibration (Ground borne vibration from operation of trains): Negligible to Minor Adverse</p> <p>Townscape & Visual Amenity (Effects on townscape): Neutral to Moderate/Major Beneficial</p> <p>Townscape & Visual Amenity (Effects on visual amenity): Neutral to Moderate/Major Beneficial</p>	<p>YES in relation to:</p> <p>Socio-economics & Traffic & Transport; & Townscape & Visual Amenity</p>
Operational Workers	<p>Socio-economics (Employment Creation): Minor Beneficial</p>	<p>No (no effects to interact with)</p>
Archaeological Assets	<p>No Effects of Minor, Moderate or Major Significance Identified</p>	<p>N/A</p>
Listed Buildings	<p>Townscape & Visual Amenity (Effects on townscape): Neutral to Moderate/Major Beneficial</p>	<p>No (no effects to interact with)</p>

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Resource / Receptor / Receptor Group	Completed Development Residual Effects	Potential for Impact Interaction and so Combined Effects?
Underlying Geology and Hydrogeology	No Effects of Minor, Moderate or Major Significance Identified	N/A
Water Resources	Surface Water Resources & Flood Risk (Reducing run off rate in line with London Plan standards): Minor Beneficial	No (no effects to interact with)
Existing Utilities and Infrastructure	Surface Water Resources & Flood Risk (Reducing run off rate in line with London Plan standards): Minor Beneficial	No (no effects to interact with)
Local and LVMF Views	There are no LVMF views affected, and local views are considered under Townscape & Visual Amenity upon other specific receptors and receptor groups.	N/A
<i>Kennington Park</i>		
Local Amenity Areas and Community Facilities	Socio-economics (Rebuilding Community Facility at Kennington Park Lodge): Minor Beneficial Socio-economics (Reinstatement and improvement of open spaces at Kennington Green and Kennington Park): Minor Beneficial Townscape & Visual Amenity (Effects on townscape): Neutral to Minor/Moderate Beneficial Townscape & Visual Amenity (Effects on visual amenity): Negligible to Minor/Moderate Beneficial	YES in relation to: Socio-economics & Townscape & Visual Amenity
<i>Kennington Green</i>		
Local Amenity Areas	Socio-economics (Reinstatement and improvement of open spaces at Kennington Green and Kennington Park): Minor Beneficial Townscape & Visual Amenity (Effects on townscape): Minor to Moderate/Major Beneficial Townscape & Visual Amenity (Effects on visual amenity): Minor/Moderate Adverse to Minor/Moderate Beneficial	YES in relation to: Socio-economics & Townscape & Visual Amenity
<i>Nine Elms</i>		
Local Businesses	Traffic & Transport (Increased Public Transport Accessibility) Major Beneficial Traffic & Transport (Reduced Public Transport Journey Times) Major Beneficial Traffic & Transport (Improvements to the Local Cycle Network and Facilities) Moderate Beneficial Traffic & Transport (Improvements to the Local Pedestrian Environment) Moderate Beneficial	YES in relation to: Traffic and Transport (Increased Public Transport Accessibility) & Traffic and Transport (Reduced Public Transport Journey Times)

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Resource / Receptor / Receptor Group	Completed Development Residual Effects	Potential for Impact Interaction and so Combined Effects?
Future Local Residents	<p>Socio-economics (Access to Employment Opportunities – Greater London): Minor Beneficial</p> <p>Traffic & Transport (Increased Public Transport Accessibility) Major Beneficial</p> <p>Traffic & Transport (Reduced Public Transport Journey Times) Major Beneficial</p> <p>Traffic & Transport (Improvements to the Local Cycle Network and Facilities) Moderate Beneficial</p> <p>Traffic & Transport (Improvements to the Local Pedestrian Environment) Moderate Beneficial</p> <p>Traffic and Transport (Other public transport services): Major Beneficial</p> <p>Noise & Vibration (Ground borne vibration from operation of trains): Negligible to Minor Adverse</p> <p>Townscape & Visual Amenity (Effects on townscape): Neutral to Moderate/Major Beneficial</p> <p>Townscape & Visual Amenity (Effects on visual amenity): Negligible to Major Beneficial</p>	<p>YES in relation to:</p> <p>Socio-economics & Traffic and Transport & Townscape and Visual Amenity</p>
<i>Battersea</i>		
Local Businesses	<p>Traffic & Transport (Increased Public Transport Accessibility) Major Beneficial</p> <p>Traffic & Transport (Reduced Public Transport Journey Times) Major Beneficial</p> <p>Traffic & Transport (Improvements to the Local Cycle Network and Facilities) Moderate Beneficial</p> <p>Traffic & Transport (Improvements to the Local Pedestrian Environment) Moderate Beneficial</p>	<p>YES in relation to:</p> <p>Traffic and Transport (Increased Public Transport Accessibility) & Traffic and Transport (Reduced Public Transport Journey Times)</p>
Future Local Residents	<p>Socio-economics (Access to Employment Opportunities – Greater London): Minor Beneficial</p> <p>Socio-economics (Impacts on Wider Development): Major Beneficial</p> <p>Socio-economics (Impacts on Labour Market and Productivity): Major Beneficial</p> <p>Traffic & Transport (Increased Public Transport Accessibility) Major Beneficial</p> <p>Traffic & Transport (Reduced Public Transport Journey Times) Major Beneficial</p> <p>Traffic & Transport (Changes to Local Traffic Levels and the Highway) Moderate Adverse</p> <p>Traffic & Transport (Improvements to the Local Cycle Network and Facilities) Moderate Beneficial</p>	<p>YES in relation to:</p> <p>Socio-economics & Traffic and Transport & Townscape and Visual Amenity</p>

17 In-Combination Effects Assessment

Resource / Receptor / Receptor Group	Completed Development Residual Effects	Potential for Impact Interaction and so Combined Effects?
	<p>Traffic & Transport (Improvements to the Local Pedestrian Environment) Moderate Beneficial</p> <p>Traffic and Transport (Other public transport services): Major Beneficial</p> <p>Noise & Vibration (Ground borne vibration from operation of trains): Negligible to Minor Adverse</p> <p>Townscape & Visual Amenity (Effects on townscape): Minor to Moderate Beneficial</p> <p>Townscape & Visual Amenity (Effects on visual amenity): Neutral to Major Beneficial</p>	
The River Thames (including the Foreshore Ecology and SMINC)	No Effects of Minor, Moderate or Major Significance Identified	N/A
Local Ecology	No Effects of Minor, Moderate or Major Significance Identified	N/A

17 In-Combination Effects Assessment

17.21 Table 17-2 shows that there is potential for a series of in-combination effects to take place once the NLE is complete and operational, and that several of the 18 identified resources / receptors / receptor groups are potentially subject to more than one effect during this stage as follows:

1. Public Transport Network;
2. Pedestrian and Cycle Network, Safety and Amenity;
3. Neighbouring Commercial Properties and Local Businesses;
4. Existing Local Residents;
5. Kennington Park – Local Amenity Areas and Community Facilities;
6. Kennington Green – Local amenity Areas;
7. Nine Elms – Local Businesses;
8. Nine Elms – Future Local Residents;
9. Battersea – Local Businesses; and
10. Battersea – Future Local Residents.

17.22 When the potential for combined effects is considered, all these resources / receptors / receptor groups are potentially affected by combined effects. Further discussion on the potential combined effects to the above identified resource / receptor / receptor group is provided below.

Explanation of the Potential for Combined Effects

Combined Effects: Traffic & Transport

17.23 On completion and operation of the NLE, the following resources / receptors / receptors groups will be potentially affected by combined effects relating to various impacts of Traffic and Transport:

- Public Transport Network;
- Pedestrian and Cycle Network, Safety and Amenity;
- Neighbouring Commercial Properties and Local Businesses;
- Existing Local Residents;
- Nine Elms – Future Local Residents;
- Nine Elms – Local Businesses;
- Battersea – Future Local Residents; and
- Battersea – Local Businesses.

17.24 This process has identified the potential for a mixed (beneficial and adverse) effect in relation to changes to London Underground services on other parts of the network, and a major beneficial effect in relation to reduced travel times and increased public transport accessibility levels. These are considered to create an overall larger in-combination effect on London's public transport network and service.

17.25 There is also a likely beneficial in combination effect on the pedestrian and cycle network, safety and amenity.

17.26 Existing and future local residents as well as local businesses at both Nine Elms and Battersea will benefit from the in combination effect of reduced travel times and increased public transport accessibility.

Combined Effects: Socio-economics and Townscape and Visual Amenity

17.27 On completion and operation of the NLE, the following resource / receptor / receptor group will be potentially affected by combined effects relating to various effects of socio-economics and townscape and visual amenity:

- Neighbouring Commercial Properties and Local Businesses;
- Kennington Park – Local Amenity Areas and Community Facilities; and
- Kennington Green – Local Amenity Areas.

17.28 The EIA process has identified the potential for a minor beneficial effect in relation to the community facility of Kennington Park being rebuilt, providing a new-build facility and improving its value as a community resource, and a minor beneficial effect in relation to open spaces being reinstated to an equal or greater standard of quality. There are also beneficial effects to townscape and visual amenity in these areas. When considered together, these beneficial effects are considered to have the potential to create an overall greater beneficial in combination effect. There is also an in combination benefit related to the reinstatement and improvement of Kennington Green post construction.

17.29 On completion and operation of the NLE, the following resources / receptors / receptors groups will be potentially affected by combined effects relating to socio-economics, transport and townscape:

- Existing Local Residents; and
- Future Local Residents.

17.30 Both receptor groups are expected to experience beneficial effects from the NLE. It will provide direct, and to a greater extent indirect, employment and will act as a catalyst for delivering more residential units. Due to the improved accessibility and reduced travel time, it is expected that there will be enhanced access to more and better employment opportunities for both groups. In addition to this, the NLE will result in significant improvements to the local townscape and visual amenity, and these together will interact to create an overall beneficial combined effect of greater significance.

References

- Ref. 17-1 EC, (1999); Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions
- Ref. 17-2 GLA (2006); The Control of Dust and Emissions from Construction and Demolition – Best Practice Guidance

18 Mitigation, Residual Effects and Conclusions

Environmental Statement

Volume I

18 Mitigation, Residual Effects and Conclusions

Introduction

- 18.1** This chapter of the Environmental Statement (ES) presents (in tabulated format) a summary of the residual effects of the Northern Line Extension (NLE). Residual effects are defined as those effects that remain following the implementation of mitigation measures, which are also presented in this chapter. Mitigation measures relate to each of the key phases (demolition and construction, and operation) of the NLE and are discussed in full in the relevant technical chapters of this ES. This chapter also presents the overall conclusions of the EIA process.
- 18.2** Each technical chapter contains detailed consideration of both beneficial and adverse effects arising. The criterion applied to define the significance of the residual effects is outlined within *Chapter 2: EIA Methodology* of this ES, with further detail provided within the individual technical chapters.
- 18.3** The effects, pre- and post-mitigation, of the NLE are described with reference to:
- The nature of the impact (i.e. adverse or beneficial); and
 - The effect significance (i.e. negligible, minor, moderate or major).
- 18.4** Where adverse environmental effects are anticipated, mitigation or compensatory measures have been identified to reduce or off-set the effect respectively. The mitigation measures have been identified to avoid or reduce adverse effects and fall into three broad categories:
- Mitigation incorporated during design development (see *Chapter 3: Options and Alternatives* of this ES);
 - Mitigation through controls during demolition and construction; and
 - Mitigation through operational management.
- 18.5** Where adverse effects cannot be avoided or reduced, compensatory measures have been identified to off-set the effect.
- 18.6** One of the main means by which mitigation will be achieved during demolition and construction is through the adoption of a Code of Construction Practice (CoCP) (see *ES Volume II: Appendix N*). The purpose of the CoCP is to set out the standards and procedures for managing the environmental impact of constructing the NLE, covering environmental, public health and safety aspects of the project that may affect the interests of local residents, businesses, the general public, and the surroundings in the vicinity of the proposed construction sites. Overall, the CoCP aims to mitigate nuisance to the public and safeguard the public.
- 18.7** During operation, measures to control adverse environmental effects will include the continued implementation and maintenance of the London Underground Management System (which is aligned to the principles of ISO 14001) which includes well developed asset maintenance standards and guidance. It will also include the measures described in the Project Sustainability Assessment Report (*ES Volume II: Appendix O1*) and the Outline Energy Strategy (*ES Volume II: Appendix O2*).
- 18.8** In accordance with the methodology presented in *Chapter 2: EIA Methodology* of this ES, the anticipated residual effects have been classified according to whether they are considered to be negligible, minor, moderate or major; and beneficial or adverse. In most cases, residual effects during construction will be of a temporary

nature, but given that the duration of construction could be up to five years, some effects could be regarded as being short or medium term. Likewise, some specific construction activities will be of a very transitory nature, e.g. tunnel boring. Residual effects during operation are largely considered to be long term. For the purposes of this summary, the duration of the residual effects (minor, moderate and major) are defined as follows:

- Short term – less than six months;
- Medium term – between six months and five years;
- Long term – over five years; and
- Permanent.

18.9 Tables 18-1 and 18-2 present a summary of the likely environmental effects (pre-mitigation) and residual effects (post-mitigation) anticipated to arise as a result of the demolition / construction and operation of the NLE respectively. The tables also include details of the relevant provisions that have been included in the draft Transport and Works Act Order (TWAO) and the draft Planning Direction Conditions to secure the proposed mitigation measures.

18.10 It should be noted that for the Air Quality assessment it was assumed that all mitigation measures will be incorporated through the employment of the CoCP during construction. Therefore, the pre and post-mitigation effects presented in Table 18-1 are the same. This approach was adopted due to the degree of certainty about the effectiveness of the mitigation measures in the CoCP, most of which are well established best practice.

18 Mitigation, Residual Effects and Conclusions

Table 18-1 Summary of Impacts, Mitigation and Residual Effects – Demolition and Construction

Ref	Potential Impact	Significance of Effect	Mitigation Measures	Securing Mechanism	Residual Effects	Duration of Effect
Traffic and Transport						
CTr1	Parking – Temporary loss of parking spaces to accommodate the Radcot and Harmsworth Street worksites (Construction Option A only) and the Kennington Green, Kennington Park and Nine Elms worksites causing inconvenience to local residents.	Moderate Adverse	Parking surveys have indicated that at a neighbourhood level there is sufficient alternative parking provision nearby to accommodate demand, which residents will be able to use.	Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B) CoCP (Part 4 – Public Access and Highway)	Minor Adverse	Medium Term
CTr2	Pedestrians – Closure of footways around the Kennington Green worksite, Kennington Park worksite, the Harmsworth St. worksite (Construction Option A only) and the Nine Elms worksite will result in pedestrians needing to use alternative routes.	Moderate Adverse	Existing pedestrian island on Kennington Road will be enhanced and pedestrians will be directed to use this facility. Pedestrians will be directed to use alternative crossing points on Wandsworth Road. The western footway on Pascal Street will remain open and this will provide an alternative route for pedestrians.	Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B) CoCP (Part 4 – Public Access and Highway)	Minor Adverse	Medium Term
CTr3	Cyclists – Increased lorry movements due to the construction of NLE and other development schemes in the wider Vauxhall Nine Elms Battersea Opportunity Area (VNEB OA) will have an adverse impact on cyclists generally.	Moderate Adverse	Alternative cyclist diversion routes will be implemented around worksites. All contractors and sub-contractors working on the NLE will be signed up to the Freight Operator Recognition Scheme (FORS) and have received bronze level accreditation. FORS specifies certain minimum fleet safety standards that contractors will be expected to meet.	Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B) CoCP (Part 4 – Public Access and Highway)	Minor Adverse	Medium Term
Socio-Economics						
CSo1	Employment Creation – There would be an estimated direct construction employment of 609 full time jobs, and net	Minor Beneficial	As the impact is anticipated to be minor beneficial, no mitigation is required. However, the TfL will endeavour to use local employment resources and adhere to its Responsible Procurement Policy.		Minor Beneficial	Medium term

18 Mitigation, Residual Effects and Conclusions

Ref	Potential Impact	Significance of Effect	Mitigation Measures	Securing Mechanism	Residual Effects	Duration of Effect
	employment of 1,034, arising from the induced and indirect impacts of the activities. Of the 1,034 net jobs 901 are likely to be taken up by workers from the Greater London area. Jobs would be medium term.					
CSO2	Open Space – At Kennington Park and Kennington Green, areas of open space will be temporarily cordoned off and closed for public access for 3 years and 9 months and 3 years and 2 months respectively.	Minor Adverse	The adverse impact from the temporary loss of open space will be mitigated through provisions such as the replacement of dog walking facilities.	Land and Works Agreement with London Borough of Lambeth (LBL)	Negligible	N/A
CSO3	At Nine Elms station site, Banham Security Ltd and Covent House (the head office of the Covent Garden Market Authority), and Tropical Catering (within a railway viaduct) will be displaced as a result of the construction works. Also at this location, land on / adjacent to a temporary Sainsbury's supermarket store will be required for use and there is potential for parking at the CGMA site to be disrupted. At Battersea station site, construction works will require use of land currently in the ownership of Battersea Dogs and Cats Home.	Moderate Adverse	To reduce any adverse effect, TfL is working closely with affected landowners to minimise the impact of the NLE works on their business. This includes discussions around potential relocation and phasing of the NLE works to minimise impacts on their business operations. Any compensation will be agreed in accordance with the statutory compensation code.	Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B) Land and Works Agreements with affected landowners	Negligible	N/A
CSO4	Existing Businesses: Beefeater Gin Distillery - Construction will require the temporary possession of part of the distillery's yard area,	Minor adverse	To reduce any adverse effect, mitigation measures will be implemented to ensure the safe coexistence of the head house building and its plant/equipment alongside the adjacent ethanol discharge facilities, and provision is being made for the fire suppressant	Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B)	Negligible	N/A

18 Mitigation, Residual Effects and Conclusions

Ref	Potential Impact	Significance of Effect	Mitigation Measures	Securing Mechanism	Residual Effects	Duration of Effect
	temporary reconfiguration of the vehicular and pedestrian access arrangements from Kennington Green and the provision of certain mitigation measures.		water storage tank to be located on adjacent land to the north owned by Tesco.	Land and Works Agreement with the Gin Distillery's owners		
CSo5	Community Facility – The lodge in the north-eastern corner of the park (Kennington Park Lodge) will be demolished as a result of the NLE. This will result in the two occupiers being displaced for the 3 years and 11 months duration of works.	Minor Adverse	Replacement buildings for the two occupiers of the Kennington Park Lodge have been proposed by TfL, for use during the construction phase (<i>see Chapter 7: Socio-Economics of this ES</i>). This will ensure that the occupiers of this community facility will be able to withstand temporary displacement. There will also be opportunity for the occupiers to return to larger facilities.	Scheme design	Negligible	N/A
Archaeology and Built Heritage						
CAr1	Potential impact upon archaeological assets, resulting from the implementation of mitigation for ground settlement, in terms of grouting and the solidification of any archaeological layers.	Negligible to Major Adverse	As the location, extent, and method of mitigation for ground settlement is yet to be determined, the archaeological environmental effect and appropriate mitigation will be assessed once this is known. However, as detailed within the CoCP, TfL will design and undertake construction of the NLE in such a manner that will minimise the damage to land and property as a result of ground movement. Appropriate techniques will be implemented in order to control and limits, as far as is reasonably practicable, the effects of settlement based on other tunnelling projects within London, such as Crossrail, the Jubilee Line Extension and Channel Tunnel Rail Link. Should any archaeological assets be found during construction, TfL will work to ensure there are no significant major adverse effects upon the assets and will mitigate any effects to a negligible significance wherever possible.	TWA Order (Protective works to buildings) Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B and 10 – Archaeology) CoCP (Part 12 – Archaeology and Built Heritage and Part 13 – Settlement)	Negligible	N/A
CAr2	Potential impact upon archaeological assets, resulting from the implementation of mitigation for building damage from	Negligible to Major Adverse	As the location, extent, and method of mitigation for building settlement is yet to be determined, the archaeological environmental effect and appropriate mitigation will be assessed once this is known. However, as detailed within the CoCP, TfL will	TWA Order (Protective works to buildings) Planning Conditions (Compliance with Code of Construction Practice	Negligible	N/A

18 Mitigation, Residual Effects and Conclusions

Ref	Potential Impact	Significance of Effect	Mitigation Measures	Securing Mechanism	Residual Effects	Duration of Effect
	settlement (e.g. underpinning).		design and undertake construction of the NLE in such a manner that will minimise the damage to land and property as a result of ground movement. Appropriate techniques will be implemented in order to control and limits, as afar as is reasonably practicable, the effects of settlement based on other tunnelling projects within London, such as Crossrail, the Jubilee Line Extension and Channel Tunnel Rail Link. Should any archaeological assets be found during construction, TfL will work to ensure there are no significant major adverse effects upon the assets and will mitigate any effects to a negligible significance wherever possible.	and Code of Construction Practice Part B and 10 – Archaeology) CoCP (Part 12 – Archaeology and Built Heritage and Part 13 – Settlement)		
CAr3	Potential impact upon archaeological assets, resulting from the implementation of mitigation for utility damage from settlement.	Negligible to Major Adverse	Whilst utilities vulnerable to critical settlement damage have been identified along the proposed NLE route, the nature and extent of such mitigation has yet to be determined. Therefore, the archaeological environmental effect and appropriate mitigation will be assessed once this is known. However, as detailed within the CoCP, the TfL will design and undertake construction of the NLE in such a manner that will minimise the damage to land and property as a result of ground movement. Appropriate techniques will be implemented in order to control and limits, as afar as is reasonably practicable, the effects of settlement based on other tunnelling projects within London, such as Crossrail, the Jubilee Line Extension and Channel Tunnel Rail Link. Should any archaeological assets be found during construction, TfL will work to ensure there are no significant major adverse effects upon the assets and will mitigate any effects to a negligible significance wherever possible.	TWA Order (Protective works to buildings) Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B and 10 – Archaeology) CoCP (Part 12 – Archaeology and Built Heritage and Part 13 – Settlement)	Negligible	N/A
CAr4	Battersea Station and all Ventilation Shaft Sites: Truncation or removal of possible archaeological assets.	Negligible to Major Adverse	To reduce the construction effects of the NLE upon archaeological assets, preliminary site specific and targeted field evaluation will be carried out prior to the commencement of works, involving the creation of archaeological trial trenches and intrusive geo-environmental investigations, as set out in the CoCP. The results of the evaluation will allow the	TWA Order (Protective works to buildings) Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B and 10 – Archaeology)	Negligible	N/A

18 Mitigation, Residual Effects and Conclusions

Ref	Potential Impact	Significance of Effect	Mitigation Measures	Securing Mechanism	Residual Effects	Duration of Effect
			formulation of an appropriate mitigation strategy, if required, which may comprise targeted archaeological investigations e.g. excavation and / or watching brief. The aim of this would be to ensure a residual effect of negligible significance.	CoCP (Part 12 – Archaeology and Built Heritage)		
CAr5	<p>Nine Elms: Demolition of buildings currently on site, including unlisted buildings of the late 19th century (currently occupied by Banham Security Ltd), which are of heritage significance. Truncation or removal of possible archaeological assets.</p>	Negligible to Major Adverse	To reduce the construction effects of the NLE upon archaeological assets, preliminary site specific and targeted field evaluation will be carried out prior to the commencement of works, involving the creation of archaeological trial trenches and intrusive geo-environmental investigations, as set out in the CoCP. The results of the evaluation will allow the formulation of an appropriate mitigation strategy, if required, which may comprise targeted archaeological investigations e.g. excavation and / or watching brief. The aim of this would be to ensure a residual effect of negligible significance.	<p>TWA Order (Protective works to buildings)</p> <p>Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B and 10 – Archaeology)</p> <p>CoCP (Part 12 – Archaeology and Built Heritage)</p>	Negligible	N/A
CAr6	<p>Kennington Park Shaft site: Demolition of building (Kennington Park Lodge) currently on site, which would affect the setting of the Grade II listed Park. Truncation or removal of possible archaeological assets.</p>	Negligible to Major Adverse	<p>Proposals for works comprising the demolition of this building in a Conservation Area will be the subject of an application for Conservation Area consent. The Kennington Park Lodge, scheduled for demolition, will be subject to preservation by record - archaeological standing building recording to an appropriate level (EH Level 1-2) – in advance of the commencement of works.</p> <p>To reduce the construction effects of the NLE upon archaeological assets, preliminary site specific and targeted field evaluation will be carried out prior to the commencement of works, involving the creation of archaeological trial trenches and intrusive geo-environmental investigations, as set out in the CoCP. The results of the evaluation will allow the formulation of an appropriate mitigation strategy, if required, which may comprise targeted archaeological investigations e.g. excavation and / or watching brief. The aim of this would be to ensure a residual effect of negligible significance.</p>	<p>TWA Order (Protective works to buildings)</p> <p>Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part and 10 – Archaeology)</p> <p>Conditions attached to Conservation Area Consent.</p> <p>CoCP (Part 12 – Archaeology and Built Heritage)</p>	Negligible	N/A

18 Mitigation, Residual Effects and Conclusions

Ref	Potential Impact	Significance of Effect	Mitigation Measures	Securing Mechanism	Residual Effects	Duration of Effect
Noise and Vibration						
CNo1	Impacts of noise from surface construction sites upon adjacent sensitive receptors.	Negligible to Major Adverse	The effects from construction noise, from surface construction sites, upon adjacent sensitive receptors will be reduced as far as reasonably practicable via the implementation of mitigation measures, in line with the CoCP. Measures include, but are not limited to, the siting of plant and equipment liable to create noise away from sensitive receptors; the use of barriers to absorb and / or deflect noise away from noise sensitive areas; and the fitting and maintenance of exhaust silencers on vehicles and mechanical plant utilised on site. In accordance with the CoCP, further site specific management and mitigation will be implemented following discussions with the contractor, once appointed. In addition, to these measures, the appointed contractor will be required to submit Section 61 applications for all works. The Section 61 consents will be used to ensure that construction noise levels meet the required thresholds. There may be exceptional circumstances where it will not be practicable to meet the construction noise thresholds, in which case, the use of off-site mitigation in the form of either noise insulation or temporary rehousing will be implemented to remove any residual significant effects.	Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B) CoCP (Part 5 – Noise and Vibration)	Negligible to Minor Adverse	Medium Term
CNo2	Impacts of construction vibration upon human receptors (i.e. occupants of adjacent residential dwellings and office units) and on site structures.	Negligible to Minor Adverse	Similar to above, the effects from construction vibration upon human receptors and on site structures will be reduced as far as reasonably practicable via the implementation of mitigation measures, in line with the CoCP. For example, plant and equipment liable to create vibration will be located away from sensitive receptors. In accordance with the CoCP, further site specific management and vibration mitigation measures will be implemented following discussions with the contractor, once appointed, and Section 61 consents.	Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B) CoCP (Part 5 – Noise and Vibration)	Negligible	Short Term
CNo3	Impacts of construction traffic noise upon adjacent sensitive	Negligible to Minor	Measures will be taken to reduce the effects of construction traffic noise upon adjacent sensitive	Planning Conditions (Compliance with Code of Construction Practice	Negligible to Minor Adverse	Medium Term

18 Mitigation, Residual Effects and Conclusions

Ref	Potential Impact	Significance of Effect	Mitigation Measures	Securing Mechanism	Residual Effects	Duration of Effect
	receptors.	Adverse	receptors as far as reasonably practicable. Mitigation measures include vehicles making deliveries or removing excavated material will travel via designated traffic routes previously agreed with local authorities; and construction traffic will be controlled by means of a vehicle arrival and departure management plan, to achieve an even spread of vehicle movements during the working day.	and Code of Construction Practice Part B) CoCP (Part 4 – Traffic Management Plan and Part 5 – Noise and Vibration)		
CNo4	Impacts of noise and vibration from underground construction works (including tunnel boring machine (TBM)) upon human receptors and on site structures.	Negligible to Minor Adverse	Measures will be taken to reduce the effects of noise and vibration from underground construction works, in line with the CoCP. For example, for the construction railway, the alignment, rail jointing and mounting of the railway will be installed and maintained in a manner so as to minimise the transmission of vibration and groundborne noise from the passage of rail vehicles; and the mounting for any conveyors used to remove excavated material from the works will be designed and installed so as to mitigate the transmission of noise and vibration. In accordance with the CoCP, further site specific management and mitigation measures will be implemented following discussions with the contractor, once appointed.	Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B) CoCP (Part 5 – Noise and Vibration)	Negligible to Minor Adverse	Short Term (Note: Groundborne noise from the TBM would be audible inside properties above the line for no more than one day).
Air Quality						
CAi1	Impacts from demolition and construction dust on residential receptors adjacent to the worksites, and a nursery adjacent to the Kennington Park site.	Minor Adverse (with mitigation through employment of the CoCP)	The impacts from demolition and construction dust assume a high level of mitigation has already been incorporated into the design of the works via the implementation of the CoCP. Measures include the preparation and implementation of an Air Quality and Dust Management Plan at all worksites, which details controls to limit dust emissions, such as the use of water suppressions and regular cleaning or hardstanding areas. Adherence to the CoCP during works will ensure that effects do not go beyond minor adverse significance.	Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B) CoCP (Part 6 – Air Quality)	Minor Adverse	Medium Term
CAi2	Impacts from emissions (Particulate Matter, Sulphur Dioxide and Nitrogen Oxides) from on-site plant on	Negligible (with mitigation)	The impacts from emissions from on-site plant assume mitigation has already been incorporated via the implementation of the CoCP. As such, as this effect is anticipated to be negligible, no further	Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice	Negligible	N/A

18 Mitigation, Residual Effects and Conclusions

Ref	Potential Impact	Significance of Effect	Mitigation Measures	Securing Mechanism	Residual Effects	Duration of Effect
	residential receptors adjacent to the worksites, and a nursery adjacent to the Kennington Park site.	through employment of the CoCP)	mitigation is required.	Part B) CoCP (Part 6 – Air Quality)		
CAi3	Impacts from emissions from an increase in road traffic / heavy goods vehicle movements.	Minor Adverse (with mitigation through employment of the CoCP)	The assessment of construction phase road traffic emissions impacts assumes that mitigation measures will be implemented during construction of the NLE, as set out within the CoCP. This includes the preparation of a Travel Management Plan (TMP) which will provide a strategy for traffic management and local routes to be used by lorries generated by construction activities.	Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B)	Minor Adverse	Medium Term
Electromagnetic Compatibility (EMC)						
CEI1	Electromagnetic interference (EMI) effects to electromagnetic signals (e.g. radio signals or local television reception) through: <ul style="list-style-type: none"> • The use of ‘CAT’ scanners during ground surveys; • Potential disturbance to buried communication infrastructure; • The use of heavy construction plant and tower cranes; and • The use of private licensed site radio. 	Minor to Moderate Adverse	A number of measures will be implemented to reduce the EMC effects. Mitigation measures include, but are not limited to the following: <ul style="list-style-type: none"> • Correct administration and operating procedures to be observed as stated in the CoCP, to ensure correct frequency licensing and toolbox talks regarding the risks to sensitive equipment with metal doors from site radios; • Correct administration and operating procedures to be observed as stated in the output of Project EMC HazID and Hazard Log, to restrict use to railway engineering hours and scanner type limited to locations as informed by the Project EMC HazID and Hazard log; • Review of compliance documentation and acceptance by EMC specialist, to ensure tools, plant and machinery are CE marked to appropriate Directives, including EMC 2004/108/EC; and • Provide case by case remedy via information, aerial adjustment or alternative reception method (e.g. satellite / cable), to ensure affected users / residents are remedied. 	TWA Order (Protective Provisions – Protection for Network Rail) Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B) CoCP (Part 3.10 – Electromagnetic Interference)	Negligible	N/A
CEI2	EMI magnetic field effects to	Minor	Review and acceptance of compliance	TWA Order (Protective Provisions –	Negligible	N/A

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Ref	Potential Impact	Significance of Effect	Mitigation Measures	Securing Mechanism	Residual Effects	Duration of Effect
	nearby buried infrastructure through the use of tunnel boring machines (TBMs).	Adverse	documentation by EMC specialist, and possible additional EMC tests and suppression, to assess the TBM EMC performance before launch.	Protection for Network Rail) Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B)		
CEI3	Potential electromagnetic fields (EMF) effects, internal to TBM, on the health of TBM operators.	Minor Adverse	Review and acceptance of compliance documentation by EMC specialist, and possible additional EMC tests and suppression, to assess the TBM EMC performance before launch.	TWA Order (Protective Provisions – Protection for Network Rail) Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B)	Negligible	N/A
Surface Water Resources and Flood Risk						
CSu1	Potential pollution of the River Thames via discharge from combined sewer outflows (CSOs), resulting from the disturbance of a site of historical land contamination at Battersea and Nine Elms; leaks and spillages of fuels and pollutants due to construction activities; and concrete and cement.	Minor Adverse	In the event that contamination is discovered, work will stop immediately and measures will be taken to prevent disturbance and mobilisation of contaminants until the contamination has been treated in-situ or removed for off-site disposal. Mitigation measures will be in line with statutory guidance and industry best practice, as detailed in the CoCP, and where it is reasonable to do so, remediation will be carried out so that land no longer presents a significant risk of harm being caused. Measures will be taken to protect controlled waters from the leaks or spillages of oils or hydrocarbons, and cement or concrete, as described in the CoCP. These mitigation measures include the storage of oils and hydrocarbons in designated locations with specific measures to prevent leakage and release of their contents; the siting of storage areas away from surface water drains and on an impermeable base with an impermeable bund; the designation of an impermeable area to be used for any washing down or equipment cleaning associated with concrete; and the preparation of an Emergency Preparedness Plan (EPP) that includes spill responses.	TWA Order (Protective Provisions – Protection for Environment Agency and Protection for Port of London Authority) Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B) CoCP (Part 7 – Water Resources and Part 8 – Contaminated Land)	Negligible	N/A
CSu2	Pollution of the River Thames via discharge of suspended sediments from CSOs and	Minor Adverse	A number of mitigation measures will be employed to prevent the release of suspended sediments, as described in the CoCP. These include, but are not	TWA Order (Protective Provisions – Protection for Environment Agency and Protection for Port of London	Negligible	N/A

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Ref	Potential Impact	Significance of Effect	Mitigation Measures	Securing Mechanism	Residual Effects	Duration of Effect
	increase in flood risk to property and land in the Thames Water Utilities Limited (TWUL) sewer network sub-catchment.		limited to, the installation of cut-off ditches and / or geotextile silt-fences around excavations or exposed ground, to prevent the uncontrolled release of sediments; site access points which will be regularly cleaned to prevent build up of dust and mud; and drainage of surface run-off and de-watering effluents to settling tanks, as may be required, to remove suspended solids prior to discharge to sewer.	Authority) Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B) CoCP (Part 3 – General Site Operations, Part 7 – Water Resources and Part 11 – Ecology and Nature Conservation)		
CSu3	Pollution of the River Thames via discharge from CSOs, resulting from disturbance to TWUL assets.	Minor Adverse	In the event of damage to the TWUL assets, mitigation measures will be implemented to minimise pollution to the River Thames, as far as is reasonably practicable. Measures will be in line with the CoCP and include the implementation of an EPP.	TWA Order (Protective Provisions – Protection for Environment Agency, Protection for electricity, gas, water and sewerage undertakers and Protection for Port of London Authority) Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B) CoCP (Part 7 – Water Resources and Part 11 – Ecology and Nature Conservation)	Negligible	N/A
CSu4	Pollution of the River Thames, resulting from dredging and jetty construction works at Battersea Power Station.	Negligible	As jetty construction works are anticipated to result in negligible effects, mitigation measures are not required. A Water Framework Directive preliminary assessment (see <i>ES Volume II: Appendix H</i>) concluded that due to the limited physical extent of the intrusive works within the Thames Middle waterbody, the current ecological potential classification (Moderate) would not be impacted by the negligible change in morphology and habitat availability.		Negligible	N/A
CSu5	Increased pressure on local TWUL water resources, resulting from water consumption during construction	Minor Adverse	Water saving measures will be adopted where possible, to reduce the increased pressure on the water supply network. Means of reducing water consumption are in line with the CoCP and include the selection and specification of equipment to reduce the amount of water required; the	Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B) CoCP (Part 7 – Water Resources)	Negligible	N/A

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Ref	Potential Impact	Significance of Effect	Mitigation Measures	Securing Mechanism	Residual Effects	Duration of Effect
			implementation of staff-based initiatives such as turning off taps; the use of recycling water systems such as wheel washes; and the potential use of a rainwater harvesting system, where feasible, for use in equipment and vehicle washing.			
Land Quality and Groundwater						
CLa1	Potential health impacts upon construction workers and adjacent site users via dermal contact, inhalation and ingestion of contaminated soil and shallow groundwater on-site, which could be encountered during construction works.	Major Adverse	Health impacts upon construction workers will be reduced as far as reasonably practicable via the provision and use of personal protective equipment such as chemical-resistant gloves and dusk masks. In addition, site controls, such as the designation of areas for drinking and eating on site, will be implemented in line with a site Environmental Management Plan (EMP), which will be produced as part of the CoCP. This EMP will detail procedures for managing unforeseen contamination.	Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B and 9 – Contaminated land) CoCP (Part 2 – General Principles and Part 3 – General Site Operations)	Negligible	N/A
CLa2	Potential contamination of groundwater / degradation of the: <ul style="list-style-type: none"> • Secondary A Aquifer in the River Terrace Deposits geological layer, via the mobilisation of contaminants during construction works; and • Principal Aquifer in the Upper Chalk geographical layer, via the creation of temporary contamination pathways (through piling) or the driving of contaminants down into the aquifer. 	Moderate to Major Adverse	Measures will be taken to reduce any potential impacts upon groundwater, and the Secondary A Aquifer and Principal Aquifer, in line with the CoCP. Such measures include the covering of stockpiles of excavated material, the implementation of dust suppression during periods of dry and windy weather, and the adoption of appropriate Environment Agency piling / ground improvement techniques if required.	TWA Order (Discharge of water and Protective Provisions – Protection for Environment Agency and Protection for Port of London Authority) Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B and 9 – Contaminated land) CoCP (Part 7 – Water Resources, Part 8 – Contaminated Land, Part 9 – Materials and Waste Management and Part 11 – Ecology and Nature Conservation)	Negligible	N/A
CLa3	Potential contamination of local surface water features via the migration of contaminated shallow groundwater.	Moderate Adverse	Measures will be taken to reduce any contamination of local surface water features, in line with the CoCP, such as remediation works. Where required, remediation of existing localised contamination hotspots will be undertaken.	TWA Order (Discharge of water and Protective Provisions – Protection for Environment Agency and Protection for Port of London Authority) Planning Conditions (Compliance with Code of Construction Practice	Negligible	N/A

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Ref	Potential Impact	Significance of Effect	Mitigation Measures	Securing Mechanism	Residual Effects	Duration of Effect
				and Code of Construction Practice Part B and 9 – Contaminated land) CoCP (Part 7 – Water Resources, Part 8 – Contaminated Land and Part 11 – Ecology and Nature Conservation)		
CLa4	Ground settlement effects upon the existing environment, as a result of tunnel, cross passage and station box excavation.	Negligible to Major Adverse	Any ground settlement effects will be reduced as far as reasonably practicable, in line with the mitigation measures set out within the Ground Settlement Report (<i>Appendix 12 of this ES</i>). These measures include, but are not limited to the strengthening of ground below the affected building, via the injection of grout or freezing; the installation of a physical barrier between the foundation of the affected building and tunnel, to modify the settlement trough and reduce ground movements; and the diversion or replacement of locally existing services.	TWA Order (Protective works to buildings and Protective Provisions – Protection for electricity, gas, water and sewerage undertakers) Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B) CoCP (Part 13 – Settlement)	Negligible	N/A
CLa5	Ground settlement effects upon the Victoria Line, as a result of tunnel and station box excavation.	Negligible	Analysis of ground settlement effects to the Victoria Line, as a result of tunnel and station box excavation, has been undertaken and established to be of negligible significance. As such, mitigation is not required.		Negligible	N/A
CLa6	Potential for the lowering of groundwater levels for construction works, by groundwater control, to impact on flows / reduce groundwater contributions and deterioration of groundwater quality.	Negligible to Minor Adverse	It is not anticipated that dewatering will be necessary as part of the works. Some measures may be necessary to control the ingress of water into the works. All such measures will be implemented in accordance with the CoCP.	Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B)	Negligible	N/A
CLa7	Potential mobilisation of poor quality groundwater, resulting from groundwater control in the upper aquifer.	Negligible	As the impact is anticipated to be negligible, no mitigation of this impact is required.		Negligible	N/A
CLa8	Potential introduction of contamination from potentially contaminative materials, such as fuels, oils, hydraulic fluids and bentonite based slurries	Negligible to Minor Adverse	The effect upon the upper aquifer, Thanet Sands and Chalk Formation are not anticipated to be affected by the NLE; however, as the upper aquifer is considered to be in hydraulic continuity with the River Thames around the Battersea area, any contaminative	TWA Order (Discharge of water and Protective Provisions – Protection for Environment Agency) Planning Conditions (Compliance	Negligible to Minor Adverse	Medium Term

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Ref	Potential Impact	Significance of Effect	Mitigation Measures	Securing Mechanism	Residual Effects	Duration of Effect
	(associated with diaphragm walling and piling activities) to the ground and natural groundwater.		material entering the upper aquifer in the Battersea area is anticipated to have a subsequent minor adverse effect upon the River Thames. In line with the mitigation measures stated in the CoCP (see <i>Appendix N of ES Volume II</i>), TfL (where reasonably practicable) will avoid using materials in the permanent or temporary works that could pollute groundwater. In addition, piling or diaphragm walls will be installed to seal out the upper aquifer during construction, preventing the entering of any contaminated material.	with Code of Construction Practice and Code of Construction Practice Part B) CoCP (Part 7 – Water Resources and Part 9 – Materials and Waste Management)		
CLa9	Potential creation or altering of contaminant pathways from all areas of subsurface construction, enabling the potential mobilisation of poor quality groundwater and degradation of groundwater quality in the River Thames, London Tertiaries of Chalk Formation during construction.	Negligible to Minor Adverse	Mitigation measures will be implemented in line with the CoCP (see <i>Appendix N of ES Volume II</i>), to reduce the potential creation / altering of contaminant pathways which may result in the migration of poor quality groundwater or further degradation of groundwater quality. In particular, TfL (where reasonably practicable) will avoid using materials in the permanent or temporary works that could pollute groundwater. In addition, piling or diaphragm walls will be installed to seal out the upper aquifer during construction, preventing the entering of any contaminated material.	TWA Order (Discharge of water and Protective Provisions – Protection for Environment Agency) Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B and 9 – Contaminated land) CoCP (Part 7 – Water Resources, Part 8 – Contaminated Land and Part 9 – Materials and Waste Management)	Negligible	N/A
Ecology						
CEc1	Habitat loss and degradation of designated sites including the Kennington Park Site of Local Importance for Nature Conservation (SLINC) and Battersea Power Station Site of Borough Importance for Nature Conservation (SBINC).	Minor Adverse	Measures to mitigate and compensate for the impact upon designated sites will be in line with the CoCP, the London Underground Biodiversity Action Plan (BAP), the local borough BAPs and guidance from statutory bodies (including Natural England and the Environment Agency). In accordance with the CoCP, measures include the preparation of specific ecology reinstatement plans for each NLE site, to not only replace habitats lost during construction, but will also seek to enhance the site for biodiversity, where possible and appropriate. These reinstatement plans are likely to include measures that seek, where possible and appropriate, to create and enhance habitats for protected and notable species; increase the quantity of priority BAP habitat; and increase habitat connectivity within the local environment and	Planning Conditions (Landscaping, Replacement and protection of trees, Compliance with Code of Construction Practice and Code of Construction Practice Part B) CoCP (Part 11 – Ecology and Nature Conservation)	Negligible	N/A

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Ref	Potential Impact	Significance of Effect	Mitigation Measures	Securing Mechanism	Residual Effects	Duration of Effect
			across priority habitats.			
CEc2	Habitat loss and degradation of the River Thames and Tidal Estuaries Site of Metropolitan Importance for Nature Conservations (SMINC), through works at the BPS jetty (including dredging) and use of barges.	Minor Adverse	Measures to mitigate and compensate for the impact upon designated sites will be in line with the CoCP, the London Underground BAP, the local borough BAPs and guidance from statutory bodies (including Natural England and the Environment Agency). As stated in the CoCP, the extent of dredging will be limited as far as reasonably practicable, to limit the extent of the temporary damage and disturbance, and best practice dredging methods will be employed to limit the amount of sediment spill into the river. In addition, in accordance with the CoCP, measures include the preparation of specific ecology reinstatement plans for each NLE site, to not only replace habitats lost during construction, but will also seek to enhance the site for biodiversity, where possible and appropriate. These reinstatement plans are likely to include measures which create and enhance habitats for protected and notable species; increase the quantity of priority BAP habitat; and increase habitat connectivity within the local environment and across priority habitats.	TWA Order (Protective Provisions – Protection for Environment Agency and Protection for Port of London Authority) Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B) CoCP (Part 7 – Water Resources and Part 11 – Ecology and Nature Conservation)	Negligible	N/A
CEc3	Habitat loss through the removal of 19 trees from Kennington Park, 11 trees from Kennington Green and 8 trees from Nine Elms).	Minor Adverse	Measures to mitigate and compensate for the impact upon trees will be in line with the CoCP, the London Underground (BAP, and the local borough BAPs (Lambeth, Southwark and Wandsworth). In particular, TfL will use reasonably practicable measures to minimise the loss of trees, as stated in the TfL Arboricultural Survey Report (<i>see Appendix J in ES Volume II</i>). As such, any essential remedial or protective work to trees adjacent to construction activity will be carried out by suitably trained or qualified personnel, using recognised methods in accordance with BS 5837 'Guide for trees in relation to design, demolition and construction'.	Planning Conditions (Landscaping and Replacement and protection of trees) Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B) CoCP (Part 11 – Ecology and Nature Conservation)	Negligible	N/A
CEc4	Disturbance to and loss of foraging habitat for foraging and commuting bats.	Negligible to Minor Adverse	Measures to mitigate and compensate for the impact upon foraging and commuting bats will be in line with the CoCP, the London Underground BAP, and the local borough BAPs. In particular, such measures will include, but not be limited to, the use of sensitive	Planning Conditions (Replacement and protection of trees, Compliance with Code of Construction Practice and Code of Construction Practice	Negligible	N/A

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Ref	Potential Impact	Significance of Effect	Mitigation Measures	Securing Mechanism	Residual Effects	Duration of Effect
			lighting to ensure that any adjacent commuting routes and foraging habitat for bats are not disturbed or severed; the height of columns will be minimised and lights, where required, will be fitted with hoods and directed away from adjacent semi-natural habitats; and low-pressure sodium lamps will be selected over high-pressure sodium or mercury lamps where appropriate.	Part B) CoCP (Part 11 – Ecology and Nature Conservation)		
CEc5	Killing, injury and disturbance to low potential of roosting bats within the electricity substation at Nine Elms.	Negligible	Whilst the impact upon roosting bats is anticipated to be negligible, considering the low potential for the electricity substation to support bats and, as such, mitigation is not required, it is recommended that a pre-demolition emergence survey be undertaken approximately 6 weeks prior to that of the buildings being demolished, to confirm the absence of any bats. If bats are recorded during the survey, a Natural England development licence may be required to facilitate the development of the NLE; however, assuming this approach is taken, the residual effect on roosting bats will still be negligible.	Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B) CoCP (Part 11 – Ecology and Nature Conservation)	Negligible	N/A
CEc6	Killing, injury and disturbance to Black Redstart at the Battersea Power Station.	Minor Adverse	Black Redstart is known to nest within the Battersea Power Station site, but not at other NLE sites. As such, measures to mitigate and compensate for the impact upon Black Redstart will be in line with the CoCP, the London Underground BAP, and the local borough BAPs. In particular, to mitigate the potential for disturbance to nesting Black Redstarts, the Battersea station site will not be left dormant for more than two weeks during the construction phase and during the Black Redstart breeding season (February to mid-August). Should the site be left dormant for two weeks or more during construction of the NLE or between February and mid-August, a suitable qualified ecologist will check for the presence of nesting Black Redstart before work re-commences. In accordance with the CoCP, the construction activities will also be screened to protect nature conservation sites and reduce disturbance to adjacent habitats and species.	Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part and 8 – Construction work sites) CoCP (Part 3 – General Site Operations and Part 11 – Ecology and Nature Conservation)	Negligible	N/A

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Ref	Potential Impact	Significance of Effect	Mitigation Measures	Securing Mechanism	Residual Effects	Duration of Effect
CEc7	Disturbance to Peregrine falcon at Battersea.	Negligible	Whilst Peregrine falcon are potentially nesting on the existing Battersea Power Station and on a peregrine mast, currently located approximately 50m to the west of the conveyor belt to the north-western corner of the proposed Battersea station, there is not suitable peregrine nesting habitat and limited foraging habitat within the proposed Battersea station itself. Once construction of the NLE commences, the wider Battersea Power Station site will have been an active construction site for approximately 2 years and any peregrine nesting within the Battersea Power Station and on the mast will likely have become habituated to levels of construction disturbance higher than those resulting from the NLE. As such, the effect upon peregrine is assessed as negligible and, as such, no mitigation is required. However, in line with best practice methods, TfL will adhere to the Peregrine Falcon and Black Redstart Management Strategy during construction, as detailed within the CoCP.	Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B) CoCP (Part 11 – Ecology and Nature Conservation)	Negligible	N/A
CEc8	Killing and injury to, and loss of foraging habitat for, common breeding birds, overwintering birds and water birds.	Negligible	Whilst the impact upon common breeding, overwintering and water birds is anticipated to be negligible, due to the magnitude of the impact (low) and value of the receptor (negligible), the potential killing or injury of breeding birds would lead to a breach of legislation, should any potential killing or injury of breeding birds occur. As such, mitigation measures are proposed to ensure compliance with biodiversity legislation and the negligible effect upon birds. Such measures will be in line with the CoCP, the London Underground BAP, and the local borough BAPs. In accordance with the CoCP, where practicable, suitable breeding bird habitat removal will be undertaken outside the breeding bird season (approximately 1 st March – 31 st July), to avoid impacts on nesting birds. Where this is not practicable, breeding bird habitat will be checked by a suitable qualified ecologist for nesting birds before removal. Should any be identified, appropriate mitigation measures will be agreed with Natural England and implemented. In accordance with the	TWA Order (Protective Provisions – Protection for Environment Agency and Protection for Port of London Authority) Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B) CoCP (Part 7 – Water Resources and Part 11 – Ecology and Nature Conservation)	Negligible	N/A

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Ref	Potential Impact	Significance of Effect	Mitigation Measures	Securing Mechanism	Residual Effects	Duration of Effect
			London Underground BAP, TfL will work with partners to enhance habitats for protected species, where appropriate.			
CEc9	Killing and injury to, and habitat loss for aquatic (intertidal and subtidal) invertebrates.	Minor Adverse	Measures to mitigate and compensate for the impact upon aquatic invertebrates will be in line with the CoCP, the Environment Agency's planning policy guidance, and the Port of London Authority's (PLA) guidance on dredging.	TWA Order (Protective Provisions – Protection for Environment Agency and Protection for Port of London Authority) Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B) CoCP (Part 7 – Water Resources and Part 11 – Ecology and Nature Conservation)	Negligible	N/A
CEc10	Killing and injury to, and habitat loss for fish.	Minor Adverse	Measures to mitigate and compensate for the impact upon fish will be in line with the CoCP, the Environment Agency's planning policy guidance, sensitive timing of works, and PLA's guidance on dredging. For example, dredging will be timed to avoid the period when fish fry are migrating up the river i.e. between the months of November and February, and best practice guidance provided by the PLA will be adhered to.	TWA Order (Protective Provisions – Protection for Environment Agency and Protection for Port of London Authority) Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B) CoCP (Part 7 – Water Resources and Part 11 – Ecology and Nature Conservation)	Negligible	N/A
CEc11	Injury to common mammals (red fox and possibly hedgehog).	Negligible	Whilst the impact upon common mammals is anticipated to be negligible, due to the magnitude of the impact (low) and value of the receptor (negligible), the potential injury to common mammals would lead to a breach of legislation, should any potential injury to common mammals occur. As such, mitigation measures are proposed to ensure compliance with biodiversity legislation and the negligible effect upon birds. Such measures will be in line with the CoCP and include the covering of all deep holes and trenches overnight and / or the provision of planked escape routes for any trapped	Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B and 8 – Construction work sites) CoCP (Part 3 – General Site Operations and Part 11 – Ecology and Nature Conservation)	Negligible	N/A

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Ref	Potential Impact	Significance of Effect	Mitigation Measures	Securing Mechanism	Residual Effects	Duration of Effect
			wildlife.			
Townscape and Visual Amenity						
CTo1	Townscape: Harmsworth Street - Temporary impacts on existing views within the ZVI as a result of the removal of existing surfaces, the establishment of a compound and the operation of plant and machinery.	Minor / Moderate to Moderate Adverse	Measures to mitigate and compensate for impacts upon townscape will be in line with the CoCP. Temporary hoarding will be established around the perimeter of each worksite. Existing trees which are to be retained will be protected in accordance with BS5837. Where possible, the extent of the worksites will be reduced as the works are completed and areas restored.	Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B)	Minor to Minor / Moderate Adverse	Medium Term
CTo2	Townscape: Radcot Street - Temporary impacts on existing views within the ZVI as a result of the removal of existing surfaces and trees, the establishment of a compound and the operation of plant and machinery.	Minor / Moderate Adverse	Measures to mitigate and compensate for impacts upon townscape will be in line with the CoCP. Temporary hoarding will be established around the perimeter of each worksite. Existing trees which are to be retained will be protected in accordance with BS5837. Where possible, the extent of the worksites will be reduced as the works are completed and areas restored by the implementation of advanced replacement tree planting.	Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B)	Minor Adverse	Medium Term
CTo3	Townscape: Kennington Park - Temporary impacts on existing views within the ZVI as a result of the demolition of existing structures, the removal of existing trees and other vegetation, the establishment of a compound and the operation of plant and machinery.	Moderate / Major to Major Adverse	Measures to mitigate and compensate for impacts upon townscape will be in line with the CoCP. Temporary hoarding will be established around the perimeter of each worksite. Existing trees which are to be retained will be protected in accordance with BS5837. Where possible, the extent of the worksites will be reduced as the works are completed and areas restored by the implementation of advanced planting of grass, trees and shrubs.	Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B)	Moderate to Moderate / Major Adverse	Medium Term
CTo4	Townscape: Kennington Green - Temporary impacts on existing views within the ZVI as a result of the demolition of existing structures, the removal of existing trees and other vegetation, the establishment of a compound and the operation of plant and	Minor / Moderate to Major Adverse	Measures to mitigate and compensate for impacts upon townscape will be in line with the CoCP. Temporary hoarding will be established around the perimeter of each worksite. Existing trees which are to be retained will be protected in accordance with BS5837. Where possible, the extent of the worksites will be reduced as the works are completed and areas restored by the implementation of advanced planting of grass, trees and shrubs.	Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B)	Minor to Moderate/ Major Adverse	Medium Term

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Ref	Potential Impact	Significance of Effect	Mitigation Measures	Securing Mechanism	Residual Effects	Duration of Effect
	machinery.					
CTo5	Townscape: Nine Elms Station - Temporary impacts on existing views within the ZVI as a result of the demolition of existing structures, the removal of existing trees and other vegetation, the establishment of a compound and the operation of plant and machinery.	Negligible to Moderate Adverse	Measures to mitigate and compensate for impacts upon townscape will be in line with the CoCP. Temporary hoarding will be established around the perimeter of each worksite. Existing trees which are to be retained will be protected in accordance with BS5837. Where possible, the extent of the worksites will be reduced as the works are completed and areas restored by the implementation of advanced planting of grass, trees and shrubs.	Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B)	Neutral to Minor / Moderate Adverse	Medium Term
CTo6	Townscape: Battersea Station - Temporary impacts on existing views within the ZVI as a result of the demolition of existing structures, the removal of existing trees and other vegetation, the establishment of a compound and the operation of plant and machinery.	Minor / Moderate to Moderate / Major	Measures to mitigate and compensate for impacts upon townscape will be in line with the CoCP. Temporary hoarding will be established around the perimeter of each worksite. Existing trees which are to be retained will be protected in accordance with BS5837. Where possible, the extent of the worksites will be reduced as the works are completed and areas restored by the implementation of advanced planting of grass, trees and shrubs.	Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B)	Minor to Moderate Adverse	Medium Term
CTo7	Views: Radcot Street - Temporary impacts on existing views within the ZVI as a result of the removal of existing surfaces and trees, the establishment of a compound and the operation of plant and machinery. A full description of impacts and effects is given in <i>Appendix K2 of ES Volume II</i> .	Effects on views will range from Minor / Moderate Adverse to Major Adverse	Measures to mitigate and compensate for impacts upon townscape will be in line with the CoCP. Temporary hoarding will be established around the perimeter of the worksite. Additional measures will be incorporated at the detailed design stage.	Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B)	Residual effects on views will range from Minor Adverse to Moderate / Major Adverse	Medium Term
CTo8	Views: Kennington Park - Temporary impacts on existing views within the ZVI as a result of the demolition of existing structures, the removal of existing trees and other	Effects on views will range from Minor Adverse to Major	Measures to mitigate and compensate for impacts upon townscape will be in line with the CoCP. Temporary hoarding will be established around the perimeter of the worksite. Additional measures will be incorporated at the detailed design stage.	Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B)	Residual effects on views will range from Negligible Adverse to Moderate /	Medium Term

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Ref	Potential Impact	Significance of Effect	Mitigation Measures	Securing Mechanism	Residual Effects	Duration of Effect
	vegetation, the establishment of a compound and the operation of plant and machinery. A full description of impacts and effects is given in <i>Appendix K2 of ES Volume II.</i>	Adverse.			Major Adverse.	
CTo9	Views: Kennington Green - Temporary impacts on existing views within the ZVI as a result of the demolition of existing structures, the removal of existing trees and other vegetation, the establishment of a compound and the operation of plant and machinery. A full description of impacts and effects is given in <i>Appendix K2 of ES Volume II.</i>	Effects on views will range from Negligible Adverse to Major Adverse	Measures to mitigate and compensate for impacts upon townscape will be in line with the CoCP. Temporary hoarding will be established around the perimeter of the worksite. Additional measures will be incorporated at the detailed design stage.	Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B)	Residual Effects on views will range from Neutral to Moderate / Major Adverse	Medium Term
CTo10	Views: Nine Elms Station - Temporary impacts on existing views within the ZVI as a result of the demolition of existing structures, the removal of existing trees and other vegetation, the establishment of a compound and the operation of plant and machinery. A full description of impacts and effects is given in <i>Appendix K2 of ES Volume II.</i>	Effects on views will range from Minor Adverse to Major Adverse.	Measures to mitigate and compensate for impacts upon townscape will be in line with the CoCP. Temporary hoarding will be established around the perimeter of the worksite. Additional measures will be incorporated at the detailed design stage.	Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B)	Residual effects on views will range from Negligible Adverse to Moderate / Major Adverse	Medium Term
CTo11	Views: Battersea Station - Temporary impacts on existing views within the ZVI as a result of the demolition of existing structures, the removal of existing trees and other vegetation, the establishment of a compound and the operation of plant and machinery. A full description of	Effects on views would range from Negligible Adverse to Major Adverse.	Measures to mitigate and compensate for impacts upon townscape will be in line with the CoCP. Temporary hoarding will be established around the perimeter of the worksite. Additional measures will be incorporated at the detailed design stage.	Planning Conditions (Compliance with Code of Construction Practice and Code of Construction Practice Part B)	Residual effects on views will range from Neutral to Moderate / Major Adverse.	Medium Term

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Ref	Potential Impact	Significance of Effect	Mitigation Measures	Securing Mechanism	Residual Effects	Duration of Effect
	impacts and effects is given in <i>Appendix K2 of ES Volume II.</i>					

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Table 18-2 Summary of Impacts, Mitigation and Residual Effects – Completion and Operation

Ref	Potential Impact	Significance of Effect	Mitigation Measures	Securing Mechanism	Residual Effects	Duration of Effect
Traffic and Transport						
OTr1	London Underground users – The creation of new cross passages at Kennington station, as part of the NLE scheme, will enable the station to accommodate the demand for cross-branch interchange generated by the NLE and operate more efficiently than would be possible without the NLE.	Moderate beneficial	As the effect is anticipated to be moderate beneficial, no mitigation is required.		Moderate beneficial	Long Term
OTr2	London Underground users – Congestion relief will be provided at Vauxhall station and on the Victoria line, a key station within the VNEB OA, as some passenger demand will be transferred to NLE stations.	Moderate beneficial	As the effect is anticipated to be moderate beneficial, no mitigation is required.		Moderate beneficial	Long Term
OTr3	Public transport accessibility – The NLE will transform public transport accessibility levels (PTALs) across the VNEB OA, particularly in the western and central parts of the OA around the two new stations. This will make a significant contribution towards facilitating the sustainable development of the area.	Major beneficial	As the effect is anticipated to be major beneficial, no mitigation is required.		Major beneficial	Long Term
OTr4	Public transport journey times – There will be improvements in generalised journey times (taking into account travel time including interchange penalties and congestion levels) for passengers travelling to and	Major beneficial	As the effect is anticipated to be major beneficial, no mitigation is required.		Major beneficial	Long Term

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Ref	Potential Impact	Significance of Effect	Mitigation Measures	Securing Mechanism	Residual Effects	Duration of Effect
	from the OA.					
OTr5	<p>Highway users – As a consequence of the additional level of development that will be enabled by the NLE, principally at the Battersea Power Station site, traffic flows will increase on Queenstown Road, Nine Elms Lane and Battersea Park Road.</p> <p>Traffic speeds will also decrease on Queenstown Road and Battersea Park Road for the same reason, though speeds on Nine Elms Lane will improve due to junction improvements as part of the Battersea Power Station development.</p> <p>These highway links are concentrated in the south-west of the OA, close to the Battersea Power Station site.</p>	Moderate adverse	<p>These impacts are caused by the additional, private development that will be enabled by the NLE rather than by the NLE itself.</p> <p>As part of the planning process, each of these developments has already or will have to provide an Environmental Impact Assessment and Transport Assessment demonstrating that their forecast highway impacts can be accommodated and, where appropriate, identifying suitable mitigation measures.</p> <p>In particular, the planning consent for the Battersea Power Station development (phase 2 onwards), which is the origin or destination for the vast majority of additional highway trips enabled by the NLE requires the implementation of a set of agreed in principle improvement measures at the specific links and junctions identified in this ES to accommodate the increased traffic flows and reduce the impact of the development to an acceptable level.</p> <p>TfL will continue to work with developers and local authorities to determine the final design and suitability of the highway link and junction improvements identified in the Battersea Planning Station Planning Consent and any other improvements, and to assess the impacts of other new developments on the highway where appropriate, including advising on the suitability and design of any further mitigation measures.</p>		<p>As the final details of these mitigation measures (improved junctions and links) are the responsibility of the Battersea Power Station and other developers to implement, and have yet to be finally approved by TfL and the London Borough of Wandsworth, the residual effect remains moderate adverse with the expectation that the future improvements, implemented as part of the additional developments will reduce these impacts to either minor adverse or negligible.</p>	Long Term
OTr6	<p>Pedestrians – There will be enhancements to the pedestrian environment particularly around the new stations, including improved</p>	Moderate beneficial	<p>As the effect is anticipated to be moderate beneficial, no mitigation is required.</p>		Moderate beneficial	Long Term

18 Mitigation, Residual Effects and Conclusions

Ref	Potential Impact	Significance of Effect	Mitigation Measures	Securing Mechanism	Residual Effects	Duration of Effect
	footway conditions, signage, lighting, pedestrian crossings and improved permeability at Nine Elms by creation of new route through the railway viaduct.					
OTr7	Cyclists – There will be enhancements to cyclist facilities particularly around the new stations, including new cycle parking, signage and cycle paths as part of developments facilitated by the NLE.	Moderate beneficial	As the effect is anticipated to be moderate beneficial, no mitigation is required.		Moderate beneficial	Long Term
Socio-Economics						
OSo1	Employment Creation – There will be an estimated direct employment of 74 full time jobs, and net employment of 126, arising from induced and indirect impacts. Of the 126 net jobs, 109 are likely to be taken up by workers from the Greater London area. Jobs will be long-term.	Minor Beneficial	As the effect is anticipated to be minor beneficial, no mitigation is required. However, TfL will encourage the employment of local workers and adhere to TfL guidance such as the Responsible Procurement Policy.		Minor Beneficial	Long term
OSo2	Open Space – The open spaces at Kennington Green and Kennington Park will be reinstated in the operational phase, to a greater standard of design quality than currently exists. Occasional access will be required to undertake maintenance and repair works, including the replacement of operational structures after 125 years.	Minor Beneficial	As the effect is anticipated to be minor beneficial, on the basis that the occasional access is certified under the Acquisition of Land Act 1981 as not affecting the public's enjoyment of the open spaces, no mitigation is required.		Minor Beneficial	Long term

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Ref	Potential Impact	Significance of Effect	Mitigation Measures	Securing Mechanism	Residual Effects	Duration of Effect
OSo3	Community Facility – The NLE will result in a new-build facility, improving its value as a community resource, and for use by either the previous occupiers, should they choose to return, or the local community if otherwise.	Minor Beneficial	As the effect is anticipated to be minor beneficial, no mitigation is required.		Minor Beneficial	Long term
OSo4	Impacts on wider development – The NLE is the catalyst for delivering the objectives for the Opportunity Area with up to 18,365 new homes and 23,845 new jobs in the VNEB. This equates to over 5,500 additional homes and over 14,000 jobs that could not be delivered without the NLE. This is a significant share of the London Plan targets for housing and employment, and critical to the delivery of the borough's housing targets.	Major Beneficial	As the effect is anticipated to be major beneficial, no mitigation is required.		Major Beneficial	Long term
OSo5	Labour market and productivity impacts – More jobs will be accessible within a given travel time for existing residents of the local area, which can in turn mean they move to more productive jobs. Shorter travel times increase the density of employment in an area which is also associated with higher productivity. There will also be benefits for local unemployed or economically inactive residents.	Major Beneficial	As the effect is anticipated to be major beneficial, due to the benefits for local unemployed individuals or economically inactive residents, no mitigation is required.		Major Beneficial	Long term

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Ref	Potential Impact	Significance of Effect	Mitigation Measures	Securing Mechanism	Residual Effects	Duration of Effect
Archaeology and Built Heritage						
No impacts identified once the NLE is complete and operational.						
Noise and Vibration						
ONo1	Impacts of groundborne vibration levels from the operation of trains.	Negligible to Minor Adverse	In the absence of mitigation, incidences above the limit set out in LU's Noise and Vibration Asset Design Guidance (Number G1323) are predicted to occur for the night time only. However a range of track level mitigation could be implemented in order to bring this below the guidance threshold.	Planning Conditions (Operational Noise)	Negligible	Long Term
ONo2	Impacts from groundborne noise levels from the operation of trains.	Moderate Adverse	Measures will be taken to reduce the effects from groundborne noise levels from the operation of trains. The track to be used for the NLE running tunnels will be a modern trackform that includes some degree of resilience in the system, which has a beneficial effect in terms of groundborne noise and vibration. Whilst the final trackform has not been selected at this stage of the design, the assessment has assumed that the track to be installed will provide the same vibration performance as the system of resilient baseplates installed on the Jubilee Line Extension (JLE). These baseplates have been modelled and are expected to provide a 10dB reduction of the overall groundborne noise levels from the operation of trains.	Planning Conditions (Operational Noise)	Negligible	N/A
ONo3	Impacts from noise from ventilation shafts and stations.	Negligible	As the specification of shaft and station equipment is usually undertaken at the detailed design stage, the design target for the tunnel ventilation systems is to achieve a rating noise level 5 dB below the Background Noise Level. As such, mitigation will be incorporated during the design development. The shaft and station equipment will be designed so as to ensure that the effects from noise from ventilation shaft and stations are of negligible significance.	Planning Conditions (Operational Noise)	Negligible	Long Term
Air Quality						
OAI1	Emissions of particulates (and smoke under emergency situations) from ventilation	Negligible	The air quality of the London Underground is monitored regularly in order to ensure that no hazardous levels of gases and particulates occur. As long as this remains the case, the effect from the NLE	Scheme design	Negligible	N/A

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Ref	Potential Impact	Significance of Effect	Mitigation Measures	Securing Mechanism	Residual Effects	Duration of Effect
	shafts.		will remain negligible. In addition, the impacts from emissions of particulates from ventilation shafts assume mitigation will be incorporated into the design of the plant for the NLE. For example, it is assumed that a series of standard design and management procedures will be incorporated when selecting the proposed plant during the detailed design and maintenance of the plant over the lifetime of the NLE. Such procedures include the appropriate design of the flues to ensure adequate dispersion of pollutants and selection of equipments regarded as Best Available Technology; regular inspection of the machinery; operation to the manufacturer's instructions; and the implementation of maintenance during operation. Implementation of these standard design and management procedures will ensure that effects do not go beyond negligible significance.			
Electromagnetic Compatibility (EMC)						
OEI1	EMI effects to electromagnetic signals (e.g. radio signals or local television reception through the: <ul style="list-style-type: none"> • Use of operational communications / radio systems within stations and tunnels; and • Operation of M&E systems including lifts and escalators within stations and tunnels. 	Minor Adverse	Appropriate EMC Management Review and Administrations by an EMC Specialist through the project lifecycle, to ensure that the EMC Directive Requirements for Fixed Installations are met, in addition to the Internal Commission on Non Ionising Radiation Protection (ICNIRP) EMF human exposure requirements.	E.U. Directive	Negligible	N/A
OEI2	EMI effects through traction power arrangements and use of rolling stock.	Minor Adverse	Appropriate EMC Management Review and Administration by an EMC Specialist through the project lifecycle, to ensure that the EMC Directive Requirements for Fixed Installations are met, in addition to the ICNIRP EMF human exposure requirements.	E.U. Directive	Negligible	N/A
OEI3	EMF effects through traction	Minor	Appropriate EMC Management Review and	E.U. Directive	Negligible	N/A

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Ref	Potential Impact	Significance of Effect	Mitigation Measures	Securing Mechanism	Residual Effects	Duration of Effect
	power arrangements and use of rolling stock.	Adverse	Administration by an EMC Specialist through the project lifecycle, to ensure that the EMC Directive Requirements for Fixed Installations are met, in addition to the ICNIRP EMF human exposure requirements.			
Surface Water Resources and Flood Risk						
OSu1	Potential pollution of River Thames via discharge from CSOs, resulting from leaks and spillages.	Negligible	Measures will be taken to protect the River Thames from pollution from contaminating materials resulting from potential leaks and spillages. Pollution will be minimised through the application of cut-off measures within the drainage system to allow any spills to be contained, the use of interceptors in any high risk areas, and through adherence to legislation and best practice in the design and maintenance of new assets, which will further reduce the risk of leaks and spillages.	TWA Order (Protective Provisions – Protection for Environment Agency) Article 16 – Discharge of water Planning Conditions (CoCP Part 3 – General Site Operations and Part 7 – Water Resources)	Negligible	N/A
OSu2	Pollution of River Thames via discharge from CSOs, resulting from contamination from in-situ materials.	Negligible	The presence of below ground structures, such as the drainage network, basements, and foundations can present a source of pollutants. However, due to the dilution provided within the sewer network and the River Thames, it is considered that there would be a negligible effect on the River Thames via CSO discharges. Therefore, no mitigation measures are required.		Negligible	N/A
OSu3	Changes to the flood risk to or from all the sites, from changes to permeable land coverage and introduction of Sustainable Urban Drainage Systems.	Minor Beneficial	As a benefit will be provided to the TWUL combined sewers, in terms of a reduction in storm water discharge volumes entering the system, with drainage re-routed (of approximately 94% of the land) directly to the River Thames, this represents an improvement to the current situation as the reduction in surface water run-off will increase capacity in the surrounding sewer network. In addition, the Nine Elms site will incorporate a water attenuation tank and the buildings at the Kennington Park site will include green roofs. Therefore, this will reduce flood risk. As such, no mitigation measures are required.		Minor Beneficial	Long Term

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Ref	Potential Impact	Significance of Effect	Mitigation Measures	Securing Mechanism	Residual Effects	Duration of Effect
Land Quality and Groundwater						
OLa1	Potential health impacts upon future site users (i.e. regular employees, site maintenance workers and passengers) via inhalation, ingestion and dermal contact with any contaminated soils or groundwater.	Negligible	Future site users are locally at risk from any contamination within the soils and groundwater in any areas of soft landscaping. If identified during construction works, localised concentrations of contamination in areas of soft landscaping will be adequately mitigated through techniques presented within the CoCP, such as capping or localised source removal.; and should ground-gas monitoring indicate a risk to future users from site derived ground gas, this will be adequately mitigated through the incorporation of gas protection measures during the design and construction of buildings. These measures, which would be implemented during construction, will reduce potential impacts upon future site users. However, during operation, as the NLE is assumed to comprise a large proportion of hardstanding, there will be a reduced pathway between any contamination and site receptors. As such, no contamination specific mitigation measures during operation are considered necessary.	TWA Order (Discharge of water) Planning Conditions (Landscaping and Contaminated land) Planning Conditions (CoCP Part 8 – Contaminated Land and Part 9 – Materials and Waste Management)	Negligible	N/A
OLa2	Potential impacts upon proposed buildings and below ground services, via contaminant in soil or groundwater, or chemical attack from sulphates and organics potentially present in soils.	Moderate Adverse	As the NLE is assumed to comprise a large portion of hardstanding, there will be a reduced potential for contamination. As such, no contamination specific mitigation is considered necessary during the operational phase of the NLE beyond regular inspection and maintenance of infrastructure. However, measures, in line with the CoCP, will be undertaken during construction to minimise the potential impacts upon proposed buildings and below ground services. These include protection measures for water supply pipes and the appropriate design of concrete class in accordance with BRE Special Digest 1:25005, to protect concrete infrastructure from sulphate attack.	Planning Conditions (Contaminated land) CoCP (Part 8 – Contaminated Land)	Negligible	N/A
OLa3	Creation of contaminant pathways from permanent subsurface structures (e.g. stations at Battersea and Nine Elms, and the ventilation	Negligible to Minor Adverse	To mitigate the potential creation of contaminant pathways from permanent subsurface structures, in line with the CoCP, TfL will ensure that protection measures to control the risk of pollution to groundwater will be provided and implemented within	Planning Conditions (Contaminated land) CoCP (Part 8 – Contaminated Land)	Negligible	N/A

18 Mitigation, Residual Effects and Conclusions

Ref	Potential Impact	Significance of Effect	Mitigation Measures	Securing Mechanism	Residual Effects	Duration of Effect
	shafts).		the overall strategy to reduce pollution. These measures will be in compliance with relevant legislation and reduce the potential for the creation of contaminant pathways.			
Ola4	Physical obstruction to groundwater flow and seepage into tunnels and shafts.	Negligible	As the impact is anticipated to be negligible, no mitigation is required.		Negligible	N/A
Ecology						
OEc1	Habitat creation.	Minor Beneficial	Following construction, where appropriate, habitats or ecological features that have been affected by construction activities will be reinstated or allowed to colonise. For example, where appropriate, landscape planting will be undertaken using native species typical of specific areas. As such, this will result in a minor beneficial effect during the operation of the NLE. To ensure that the effect of habitat creation remains beneficial, a Landscape Management Plan will also be prepared and implemented.	Planning Conditions (Landscaping) Planning Conditions (CoCP Part 11 – Ecology and Nature Conservation)	Minor Beneficial.	Long Term
Townscape and Visual Amenity						
OTo1	Townscape: Harmsworth Street – the road and pavements will be returned to pre-construction conditions.	Neutral	N/A		Neutral	N/A
OTo2	Townscape: Radcot Street – the road and pavements will be returned to pre-construction conditions and trees will be replaced.	Minor to Moderate Adverse	Trees removed during construction will be replaced.	Planning Conditions (landscape)	Neutral	N/A
OTo3	Townscape: Kennington Park – the existing Kennington Park Lodge and ancillary buildings will be replaced by new head-house and community buildings. There will be direct impacts on the	Moderate Adverse to Minor/Moderate Beneficial	Trees and railings will be replaced along the northern boundary of Kennington Park and the open setting returned to grass. The garden of the head house and community building will be planted with ornamental trees, shrubs and climbing plants, enhancing the townscape and the setting of the heritage assets.	Scheme design Planning Conditions (landscape)	Neutral to Minor / Moderate Beneficial	Long Term

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Ref	Potential Impact	Significance of Effect	Mitigation Measures	Securing Mechanism	Residual Effects	Duration of Effect
	Grade II listed Kennington Park, the St. Marks CA and neighbouring listed buildings.					
OTo4	Townscape: Kennington Green – the section of wall lining the corner of Montford Place and Kennington Green will be replaced with a new head house building. Kennington Green will be restored to open space.	Minor to Moderate Beneficial	Kennington Green will be substantially improved through the provision of a new, high quality open space set within public realm and planted with trees. Tree planting will also line Kennington Road to the south. The new head house is designed to be approximately the same height and massing as the surrounding buildings and in a complementary brick colour.	Scheme design Planning Conditions (landscape)	Minor to Moderate / Major Beneficial	Long Term
OTo5	Townscape: Nine Elms Station – The existing car park, buildings and walls which occupy the site will be replaced by new station buildings at either end of Pascal Street with public realm between and lining the street. The new station ticket hall at the junction of Pascal Street and Wandsworth Road will form a new gateway and centre of activity in the area.	Minor to Moderate Beneficial	Public realm improvements will include tree planting along the length of Pascal Street, forming a new green link east-west and establishing a connection beneath the railway viaduct to the neighbouring New Covent Garden Market. Given that the changes will be limited to a small part of a large TCA, the mitigation proposed will not alter the significance of residual effects.	Scheme design Planning Conditions (landscape)	Minor to Moderate Beneficial	Long Term
OTo6	Townscape: Battersea Station – The new station entrance pavilion would replace part of a vacant and derelict site adjacent to Battersea Park Road which will be substantially opened up.	Neutral to Moderate Beneficial	A wide, high quality public scheme will extend north from Wandsworth Road, encapsulating the new station entrance pavilion. Trees flank the entrance pavilion and line Wandsworth Street, softening the appearance of the structure and emphasising the new gateway.	Scheme design Planning Conditions (landscape)	Minor to Moderate Beneficial	Long Term
OTo7	Views: Harmsworth Street – views of the road and pavements will be returned to pre-construction conditions.	Neutral	N/A		Neutral	N/A
OTo8	Views: Radcot Street - views of the road and pavements will be returned to pre-construction conditions.	Effects on views in Year 1 will range from Neutral to Major	Trees removed during construction will be replaced, restoring the existing view	Planning Conditions (tree replacement)	Neutral	N/A

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Ref	Potential Impact	Significance of Effect	Mitigation Measures	Securing Mechanism	Residual Effects	Duration of Effect
		Adverse.				
OTo9	Views: Kennington Park – views of the existing Kennington Park Lodge and ancillary buildings and their garden setting will be replaced by views of two new buildings within the same area.	Effects on views in Year 1 will range from Negligible Adverse to Moderate Adverse.	A high quality scheme of tree and shrub planting will be carried out within the garden of the head house and community building and replacement trees will be planted along the length of the northern boundary of Kennington Park. This would provide the setting for the new buildings, softening their appearance and enhancing the quality of views.	Planning Conditions (landscape)	By Year 11, the residual effects will range from Negligible Beneficial to Minor/Moderate Beneficial.	Long Term
OTo10	Views: Kennington Green – views of the new head house will partially screen views of the industrial site to the west. There will be more open views of the water tank adjacent to Montford Place. Views of Kennington Green will be enhanced by the high quality public realm and landscape treatment.	Although there will be a small number of adverse effects in Year 1, the overall effect will be beneficial.	A high quality public realm and landscape scheme will enhance views locally and will soften the appearance of the new head house building. The perceived scale of the proposed head house has been reduced through the design of a number of elements, including vertical recessed panels, which reflect the massing and proportionality of the buildings surrounding the Green.	Planning Conditions (landscape)	Whilst a small number of adverse effects will remain in Year 11, where close proximity views will be focussed on the new head house and water tank, the overall effect will be Beneficial.	Long Term
OTo11	Views: Nine Elms Station – Views of industrial buildings and a car park will be replaced by views of an architecturally strong building forming the focal point at the junction of Wandsworth Road and Pascal Street and a further building of similar appearance at the western end of Pascal Street.	Effects on views in Year 1 will range from Moderate / Major Beneficial to Moderate Adverse	A high quality public realm and landscape scheme will enhance views locally and will soften the appearance of the new station buildings.	Planning Conditions (landscape)	By Year 11, the majority of residual effects will be beneficial (ranging from Moderate/ Major Beneficial to Negligible Beneficial).	Long Term
OTo12	Views: Battersea Station – Views of an existing derelict and vacant site enclosed by hoarding and advertising boards will be replaced by views of the station entrance pavilion in an open public realm setting.	Effects on views in Year 1 will range from Moderate / Major Beneficial to Neutral	A high quality public realm and landscape scheme will enhance views locally. Tree planting has been designed to focus views towards the proposed station entrance pavilion and will also soften the appearance of the new station buildings.	Planning Conditions (landscape)	By Year 11, the residual effects will range from Major Beneficial to Neutral.	Long Term

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Summary and Conclusions

- 18.11** The primary aim of the NLE is to encourage economic growth in London and the wider UK economy by facilitating the sustainable regeneration and development of the VNEB OA. This includes the creation of major new sustainable residential, business and leisure district in London's Central Activities Zone.
- 18.12** This primary aim is consistent with a number of objectives set out in the National Planning Policy Framework (Ref. 18-1), the London Plan (Ref. 18-2), the VNEB OA Planning Framework (ref. 18-3), and borough planning policies. In particular, the NLE is intended to meet a number of goals for transport in London set out in the Mayor's Transport Strategy (MTS) (Ref.18-4). The MTS sets six goals; while the sixth is specific to the 2012 Games, the others are relevant as secondary aims of the NLE. Those goals are as follows below, with information on how the NLE will achieve them:
- 1. Support economic development and population growth:** By enabling the sustainable regeneration and development of the VNEB OA, the NLE will catalyse the creation of up to 16,000 new homes and 20,000 to 25,000 new jobs. In addition, it will enhance access to employment for local people in the surrounding area and integrate the VNEB OA with the remainder of central London.
 - 2. Enhance the quality of life for all Londoners:** The NLE will help to relieve existing congestion at Vauxhall station, and provide relief to the Victoria line and to the Northern line south of Kennington. As part of a wider package of transport and urban realm improvements, the NLE will bring economic and accessibility benefits to a wide area, including the existing and new communities around Nine Elms station.
 - 3. Improve the safety and security of all Londoners:** The Underground is a safe and secure transport mode whilst stations provide safe and attractive meeting points. By introducing new stations at Battersea and Nine Elms, new and existing communities will benefit from modern, well-designed landmarks which are integrated with high quality urban realm.
 - 4. Improve transport opportunities for all Londoners:** The NLE will transform accessibility across the VNEB OA and deliver standards available elsewhere in central London, assisting and complementing London's transport network. Both new stations will be step-free from street to train and will significantly enhance transport accessibility to all by creating new high quality access points to the Underground network.
 - 5. Reduce transport's contribution to climate change and improve its resilience:** The Underground is a sustainable transport mode and the NLE will be constructed to the most up-to-date design and environmental standards. The NLE will contribute to making the area more typical of central London in terms of providing alternatives to car travel.
- 18.13** The proposed scheme is the result of an extensive examination of alternative transport solutions, alternative routes and alternative locations and designs for the stations and shafts. Consultation with stakeholders (such as the London boroughs of Lambeth, Southwark and Wandsworth, statutory consultees, and major landowners) and the public has been important in this process. This consideration of alternatives has been informed by the EIA process and has allowed design

choices (and methods of construction) to be made with an understanding of the environmental effects. This has resulted in certain potential adverse effects being avoided or minimised.

- 18.14** The proposals have also been informed by the work presented in the Project Sustainability Assessment Report (*ES Volume II: Appendix O1*) and the Outline Energy Strategy (*ES Volume II: Appendix O2*).
- 18.15** It is acknowledged that some adverse effects will be experienced during the demolition and construction phase of the NLE, which would be expected for a project of this scale. However, the adverse effects anticipated to arise will be managed through the implementation of mitigation measures, as detailed in Table 18-1 and 18-2, through the design of the NLE and during demolition / construction and operation. Assuming the implementation of this mitigation, most effects (pre-mitigation) have been reduced to residual effects of negligible or minor significance.

References

- Ref 18-1 Department for Communities and Local Government (2012); National Planning Policy Framework
- Ref 18-2 Greater London Authority (2011); The London Plan: Spatial Development Strategy for Greater London
- Ref 18-3 Greater London Authority (GLA) (2012); Vauxhall Nine Elms Battersea. Opportunity Area Planning Framework
- Ref 18-4 Greater London Authority (2010); Mayor's Transport Strategy, May 2010



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