

RIIO-ED1 Reinforcement Scheme Summary

All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.

PROJECT DETAILS

NAMP	1.33.07.6105 (substation) 1.37.09.8343 (tunnel)	Region	LPN – London Power Networks	RDP	02 & 03
Category	Reinforcement	Description	West End: Establish new 3x33MVA 66/11kV Substation	Type	N-1
Project	Construct new West End main substation and associated new cable tunnel from St Johns Wood				
Site/Route	St Johns Wood - Marble Arch		Capacity Increase (MVA)	66MVA	
Cost (ED1)	£37,047k	NAMP version	Table J Less Indirect Baseline 19th Feb 2014		

Year	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23
6105 Substation	£2,776k	£3,700k	£3,700k	£6,013k	£5,948k	£463k		
8343 Tunnel	£97k	£86k	£6,109k	£6,261k	£1,894k	0		
Total	£2,873k	£3,786k	£9,809k	£12,274k	£7,842k	£463k		

PROJECT APPROVAL

This project is included in the LPN Lodge Road Regional Development Plan

PROJECT OVERVIEW

This project recommends the establishment of a new 3x33MVA 66/11kV main substation within London's West End supplied by cables installed in a new 2.7km deep cable tunnel from Lodge Road 400/66kV grid supply point (GSP).

The scheme is required to satisfy incremental demand growth in this highly sensitive and economically important area of London.

Preliminary discussions have been held with Westminster Council exploring potential sites for construction of an underground substation similar in design to Leicester Square. Options included utilising the central reservation of Park Lane (A4202) or beneath Berkeley Square provided that the mature trees can be protected.

Based on existing knowledge of street service congestion and the need to cross the Grand Union Canal, elevated Marylebone Road, the shallow 'cut and cover' District Line and congested Oxford Street, open-cut installation of EHV cables is not considered a viable option. Tunnel route feasibility studies have been undertaken which include provision for the future asset replacement of cables to substations at Hyde Park (close to Edgware Road), Duke Street (located south of Selfridges) and Carnaby Street.

The primary supply voltage of 66kV from Lodge Road has been selected to provide GSP resilience to the West End where the existing Duke Street and Leicester Square main substations are supplied at 132kV from St Johns Wood GSP.

There is sufficient capacity headroom at Lodge Road GSP without the need for upstream reinforcement with spare 66kV circuit breakers becoming available following the transfer of St Pancras substation to the new Islington GSP.

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BACKGROUND

The West End District

The West End encompasses the principal London entertainment districts of Leicester Square and Covent Garden, the shopping districts centred on Oxford Street, Regent Street and Bond Street as well principal art galleries, museums and tourist attractions.

It is densely urbanised with few, if any opportunities to acquire vacant sites. The streets exhibit high levels of service congestion with red routes, emergency evacuation routes and traffic congestion severely constraining street works. It is one of the most expensive locations in the world to rent office space.

Existing Substation Capacity

The area is supplied by 6 primary substations which are characterised by a summer peaking load profiles.

Substation Name	Nominal Voltage	N-1 Firm Capacity (MVA)	Maximum Demand 2014/5 (MVA)	Maximum Demand 2022/3 (MVA)
Bloomfield Place	66/6.6kV	36.0	39	44
Carnaby Street	66/11kV	67.5 / 114 / 129*	71	84
Hyde Park A	66/11kV	45.0	47	54
Hyde Park B	66/11kV	45.0	46	55
Duke Street	132/11kV	134.4	124	135
Leicester Square	132/11kV	134.4	128	141
Total		462.5	455	513

Three substations at Carnaby Street, Bloomfield Place and Hyde Park 'B' are predicted to be operating near, or above their firm capacity by 2015 with P2/6 compliance maintained by post fault load transfers. With the exception of Carnaby Street, all substations are forecast to reach LI4 or LI5 by the end of ED1 detailed in the load index table below (source LPN CV102).

Based on current forecasts, the incremental demand growth of 58MVA between 2015 - 2023 cannot be fully accommodated within the existing capacity headroom.

Substation	Voltage kV	Load Index	
		2015	2023
Bloomfield Place	66/6.6	5	5
Carnaby Street	66/11	5	1*
Hyde Park A	66/11	2**	5
Hyde Park B	66/11	4	5
Duke Street	132/11	2	4
Leicester Square	132/11	3	5

Note:

* the Carnaby Street load index improvement is the result of a separate reinforcement project (NAMP lines 1.33.01.4349 & 1.37.09.8637 refer) to replace the existing 4x22.5MVA transformers with 33.3MVA units and uprate the 66kV primary cables. Completion of this project is dependent on the West End cable tunnel to facilitate the replacement of the Lodge Road-Carnaby Street EHV cables.

**the forecast LI2 for Hyde Park is achieved by contracting demand side response (scheme 1.35.05.8561 refers).

Existing Substations: Design and Space Constraints

Each of the six substations has individual architectural attributes which constrain extension or reinforcement:

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Hyde Park 'A' and B: The substations are located within the same operational site located beneath the car park and gardens of a prestigious high rise apartment block in Bayswater. Cooling of the transformers is achieved via two chimneys which form an integral part of the apartment block construction with air exhausted at roof level above the 18th floor. There is no scope to enlarge the transformer chambers or install additional switch panels.

Duke Street: The substation is located in Mayfair, beneath Brown Hart Gardens, a 10,000 sq. ft. public open space featuring a pavilion, balustrade and Diocletian windows. It is a Grade II listed structure, managed and maintained by Grosvenor Estates. It was originally converted into a substation in 1902. It now contains three 60 MVA transformers, a tunnel shaft connecting to Carnaby Street and AIS tee points. There is no available space for further extension within the existing footprint.

Leicester Square: The substation is constructed beneath Leicester Square with ventilation exhaust achieved from a chimney through the theatre ticket booth. There is no spare space within the substation

Carnaby Street: Is an underground substation forming the basement of a mixed used commercial/retail development fronting Carnaby Street, close to Oxford Circus

Bloomfield Place: The substation is situated along a small passage way accessed from Bond Street. It is totally surrounded by high density developments with access to the transformer chambers achieved from a shared four bay car park. There are no options for extension with the existing footprint.

Site assessments confirm that none of the existing substations offer opportunities for reinforcement with higher rated transformers or provide sufficient space for the installation of additional 11kV or 6.6kV switchgear. Due to their subterranean locations the option of acquiring adjacent land for extension has also been discounted.

Interaction with Other Projects

Carnaby Street Substation Reinforcement

Proposals have been included in the ED1 submission for the reinforcement of Carnaby Street, the project to be delivered in two stages.

- (1) replace the existing 22.5MVA transformers with 33.3MVA units to achieve a 46.5MVA increase in firm capacity to 114MVA limited by the EHV supply cable ratings
- (2) allow full utilisation of the transformer cyclic capacity by replacing the four 66kV cables from Lodge Road thereby increasing the firm capacity by a further 15MVA to 129MVA.

Route proving studies have confirmed that open-cut replacement is not feasible and it is therefore proposed to harmonised the reinforcement with the West End substation project and install the cables in the new deep tunnel. If the tunnel project does not proceed, the Carnaby Street firm capacity would remain at 114MVA.

Detailed area studies have confirmed that the increased Carnaby Street capacity is correctly located to reinforce the Oxford Street and Regent Street and Piccadilly networks but that the interconnected distribution groups could not be reconfigured to support the Hyde Park 'A' and 'B' substations or new demand in the vicinity of Marble Arch or north of Oxford Street.

Cable Replacements

The majority of West End primary supplies are taken from either the St Johns Wood 132kV or Lodge Road 66kV super grid exit points which are collocated either side of Lodge Road, Regents Park, NW1. The EHV cables to the six substations follow open-cut routes along severely congested highways including the Edgware Road and Lisson Grove with perpendicular crossings of the Regents Park Canal Marylebone Road and Oxford Street. The cables are of mixed vintage with sections of the Carnaby Street circuits installed in 1935 with additional circuits installed to Hyde Park and Bloomfield Place in the 1960's. XLPE 132kV cables to Duke Street and Leicester Square were installed between 1989 and 1992.

Based on recent experience during the installation of 2x132kV circuits to the new LUL/Cross rail supply point at Chapel Street, no further open cut routes south from the GSP's are available leading to the recommendation for a new cable tunnel to supply the proposed West End substation.

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The ED1 plan includes schemes to replace the Lodge Road to Duke Street and Lodge Road to Carnaby Street cables (schemes 1.29.01.7957 & 1.37.09.8637 respectively) and it is proposed to utilise the tunnel as a solution to complete this work.

Transformer Asset Replacement

The ED1 plan provides for the asset replacement of the three Leicester Square 132/11kV transformers (scheme 1.51.01.7872). Due to the unique and subterranean location of the substation extended outages of between 12-15 weeks per transformer will be required. Should fault occur on one of the remaining Leicester Square transformers or at an adjacent substation that relies on post fault demand transfers there is a risk that customer supplies may be interrupted. The additional capacity provided by the new West End substation would provide increased availability of demand transfers and mitigate this risk.

Note: the transformer replacement is to be carried out on a 'like for like' basis because larger rated units cannot be accommodated in the existing transformer chambers.

OPTIONEERING

Two alternative approaches have been considered:

1. Construct a new main substation.
2. Supplying the capacity via incremental connection to the existing distribution sites

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OPTIONS CONSIDERED

Option 1: Establish a new West End 3x33MVA 66/11kV main substation.

Proposed Works:

- Land purchase or lease agreement of an appropriate site. Potential locations are under investigation at Berkeley Square and Park Lane
- Construct an underground main substation with a minimum of three transformers chambers and switch room to accept 38 panel switch board. Space permitting, provision to include a 4th transformer chamber and associated increased number of switch panels
- Install 3 x 33.3MVA 66/11kV transformers providing 66MVA of firm capacity (cyclic ratings are not available due to the flat daily load profile exceeding 66% of nameplate rating)
- Install 38 panel double busbar 11kV switchboard
- Construct a deep cable tunnel from the new substation to St Johns Wood
- Install 66kV cables between Lodge Road and new substation in tunnel
- Connection of the new cables to existing spare 66kV circuit breakers at Lodge (following the planned transfer of St Pancras substation to the new Islington GSP)
- Reconfiguration of the local 11kV network to transfer demand groups on to the new substation thereby creating capacity headroom at the existing substation and promoting efficient new connections and asset utilisation

Estimated Capital Cost: £43.86M (Substation =£29.260M, Tunnel = £14.6M)

The proposed investment phasing is given in the table below.

	DPCR5	RIIO-ED1							
		2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23
Substation	£6,660k	£2,776k	£3,700k	£3,700k	£6,013k	£5,948k	£463k	-	-
Cable Tunnel	£153k	£97k	£86k	£6,109k	£6,261k	£1,894k	0	-	-
Total	£6,813k	£2,873k	£3,786k	£9,809k	£12,274k	£7,842k	£463k	-	-

There are a number of significant risks and uncertainties associated with these proposal which may impact on both cost and programme, these include:

- Availability and cost of land
- Obtaining Planning Permission
- Ground conditions impacting tunnel condition
- Obtaining tunnel easements if the route cannot be contained under the public highway
- Identification of a suitable location for a mid-tunnel intermediate shaft
- Special measure required to reduce disruption to traffic and local communities during construction

Option 2: Incremental expansion of existing substation sites

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The constraints imposed by the subterranean design and restricted footprints of the six existing substation permits only a relatively small amount of additional demand to be connected within the local area, estimated at between 6-8 MVA

Other substations bordering the West End (detailed below) also have limited capacity headroom and suffer from similar space constraints.

Substation	Voltage kV	Load Index	
		2015	2023
Moscow Road	22/6.6	1	3
Longford Street	132/11	3	4
Shorts Gardens	22/11	5	5
Moreton Street 'B'	66/11	3	4

It is not considered a deliverable solution to install long 11kV cables routes from out-laying areas, for example Wimbledon, Camden or Fulham. This is due to the high risk of open-cut installation due to street service congestion and geographical obstacles including railways and canals. Other factors that do not support this approach are:

- long cable routes are more at risk to 3rd party damage reducing the reliability of the network.
- network efficiency is reduced with cascading, overlapping and ever increasing lengths of 11kV connections. For example if the local capacity headroom in Fulham is fully utilised to supply the West End, local demand growth would need to be supplied from other remote locations.
- long and overlapping distribution supply groups increase maintenance and operational complexity
- the medium term requirement for new capacity would not be addressed.

Option 3: Do Nothing

The existing capacity headroom would become eroded and incremental demand growth could not be supplied.

Recommended Option

Option 1 is the recommended option as it satisfies network requirements while providing for future developments.

The key deliverables are:

- construction of a new underground main substation building
- 66MVA of new firm capacity
- circa 2.7km of deep cable tunnel
- 38 panel 11kV double busbar switchboard
- 3x33.3MVA 66/11kv transformers
- 8.5km of 66kV cable
- reconfiguration of the local 11kV network to rationalise connections and reduce overlapping supply groups

The scheme provides the opportunity to harmonise this reinforcement project with the asset replacement of the Lodge Road-Hyde Park fluid filled and Carnaby Street cables within this high congested urban area.

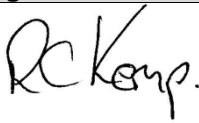
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PROJECT RISKS

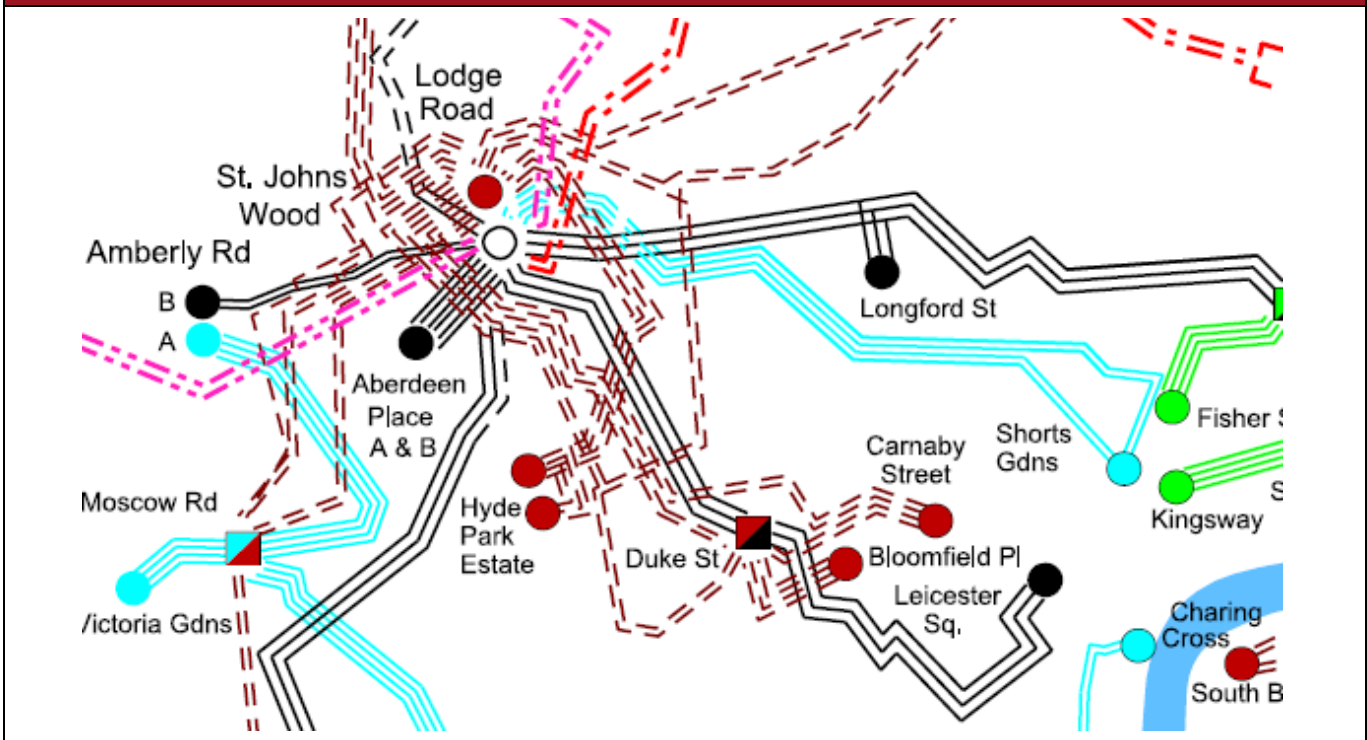
- Land availability and acquisition costs
- Obtaining planning permission
- Tunnel route proving including depth interactions with underground lines and Cross Rail
- Ground conditions for tunnel construction
- Dependence on key stakeholders including Westminster Council, landowners, local resident and businesses

Name	Title	Signature	Date
Chris Winch	Infrastructure Planning Engineer	Chris Winch	02.03.2014
Name	Title	Signature	Date
Robert Kemp	Head of System Development		02.03.2014
Name	Title	Signature	Date
Barry Hatton	Director of Asset Management		

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SINGLE LINE DIAGRAM – EXISTING NETWORK



GEOGRAPHICAL DIAGRAM

