

Date: 8 March 2017

Item: DLR Rolling Stock Replacement Programme

This paper will be considered in public

1 Summary

LR-PJ46C	DLR Rolling Stock Replacement Programme
Authority Approval: The Committee is requested to grant additional budgeted Programme and Project Authority for activities relating to the procurement of Docklands Light Railway trains and the supporting work streams, including expansion of the DLR depot at Beckton.	
Outputs and Schedule: 43 fixed formation trains to replace two-thirds of the Docklands Light Railway fleet which are life expired and to provide additional capacity to support housing and employment growth. The trains will be delivered between 2022 and 2024.	

- 1.1 A paper is included on Part 2 of the agenda, which contains exempt supplementary information. The information is exempt by virtue of paragraph 3 of Schedule 12A of the Local Government Act 1972 in that it contains information relating to the business affairs of TfL. Any discussion of that exempt information must take place after the press and public have been excluded from this meeting.

2 Recommendation

- 2.1 **The Committee is asked to note the paper and the related paper on Part 2 of the agenda and grant additional budgeted Programme and Project Authority as set out in the paper on Part 2 of the agenda, to undertake the procurement process to appoint a manufacturer for the Docklands Light Railway (DLR) trains and supporting work streams, including the expansion of the DLR depot at Beckton.**

3 Background

- 3.1 Docklands Light Railway currently runs with a mixed fleet of 149 Light Rail Vehicles (LRVs)¹ supplied by Bombardier. The specification for the LRVs is based on the original concept for the DLR, a light railway, carrying 1,000 passengers per hour in single 28 metre long LRVs. The network now carries over 115 million passengers per year and demand is predicted to grow considerably.

¹ A single Light Rail Vehicle (LRV) on the DLR is made up of a 28 metre long articulated vehicle. These are operated as two (56 metre long) or three (84 metre long) LRV consists.

- 3.2 Introduced into service between 1990 and 1992, the B90/92 LRVs, which make up two-thirds of the DLR fleet, have reached the end of their 25 year design life. Evidence of this is the number of age related issues that have begun to occur, in particular significant bogie and bolster cracking. This is being managed pro-actively to ensure that a safe and reliable service is sustained. Rolling stock Service Affecting Failures (SAF) are increasing and it is becoming more challenging to sustain the reliability and performance of the DLR service as a consequence of rolling stock failures in service.
- 3.3 At the same time, committed development around the DLR network is predicted to use up existing capacity around the Isle of Dogs and Royal Docks by 2021. Additional trains are needed to support this housing and employment growth. There are already plans in place for around 100,000 additional homes across the area served by DLR, and there could be 100,000 more, should more low-density land be released for redevelopment, as is now being proposed by the Greater London Authority (GLA) for the Royal Docks and is expected to be the case for other parts of Docklands over the next 20 years (Appendix 1).
- 3.4 By not replacing the older fleet, temporary life extension works would be required to sustain performance at a cost of £261m in the current Business Plan period, with reductions in service whilst LRVs are taken away to be overhauled.
- 3.5 Replacing the life expired fleet will contribute to delivery of the Mayoral objectives and to the TfL and London Rail objectives in a number of ways. These can be summarised as:
- (a) to support population and employment growth across the network, especially planned development in the Royal Docks, the Queen Elizabeth Olympic Park and Isle of Dogs;
 - (b) to provide crowding relief through increasing capacity;
 - (c) to improve resilience and reliability by replacing life expired B90/92 LRVs with modern, reliable trains that are fit for purpose;
 - (d) to improve customer satisfaction by increasing the amount of usable space available on trains, as well as improving ride quality and reducing journey times; and
 - (e) to increase revenue by accommodating predicted demand and drawing new customers onto a modern fleet of trains with features that provide an improved customer experience.
- 3.6 In June 2015, budgeted Project Authority of £4.9m was granted for feasibility and development of technical requirements. The TfL Business Plan approved by the Board in December 2016 includes funding of £186.3m, excluding third party contributions, for the DLR Rolling Stock Replacement Programme.
- 3.7 The project has completed feasibility and option selection stages and is ready to issue a notice in the Official Journal of the European Union (OJEU) for the design and manufacture of the replacement trains.

- 3.8 An affordable spend profile has been developed for this project and included in the approved TfL Business Plan on the basis of a finance lease arrangement which is explained further in section 5.

4 Proposal

Preferred Option

- 4.1 B09/92 SAFs are increasing and pulling down overall DLR performance. When compared with the London Underground fleet, DLR B90/92 LRVs are the worst performing across TfL (see Appendix 2).
- 4.2 In addition to age related faults, increasing operational requirements and depot stabling constraints present maintenance challenges. Daily splitting of trains into individual LRVs for maintenance and stabling, then reforming to meet service leads to coupler wear and damage over time and DLR performance data shows an increase in this type of fault.
- 4.3 DLR departure reliability² is currently at 99 per cent despite the fleet delivering a Mean Distance Between Service Affecting Failures (MDBSAF) of between 5,000 and 8,000km, which is very low compared to other TfL fleets and even worse from a world wide benchmarking comparison.
- 4.4 Overall DLR performance is achieved through tactical interventions by control centre staff, which allows speedy recovery in the event of a failure, including the use of bi-directional signalling; retention of a larger team of First Line Response Technicians (FLRTs) (some of which were specifically recruited ahead of the 2012 Games and retained since); the use of strategically placed sidings to move failed trains into; and targeted small packages of works on key systems.
- 4.5 Full life extension of the B90/92 has been considered but does not present a practical solution with a number of disbenefits. The works are not affordable within the current Business Plan period. Six LRVs would need to be taken out of service at a time to deliver the works within a three year period. This would mean no spare trains during the morning peak leading to a service reduction and/or regular gaps in the service.
- 4.6 Considerable growth is planned around the DLR network in particular in the Royal Docks and Isle of Dogs. With the Elizabeth line opening in full by 2019 and planned developments, peak hour capacity will be saturated in these areas by 2021. Full DLR automatic train control signalling capability is not being used and some trains are only two-cars (56 metres) long due to the restraint of the current fleet size. This project will start to make more use of that capability with a base order of 43 trains.
- 4.7 The most significant committed development is the Albert Business Port in the Royal Docks. Outline planning permission was granted in December 2015 for a 27 million square foot office led development which will create up to 20,000 jobs. The

² Percentage of intervals between trains at terminal stations no more than three minutes greater than the published service timetable.

developer has undertaken enabling and utility diversions works and construction of the first phase started in early 2017.

- 4.8 Work is also underway on a number of Opportunity Area Planning Frameworks, such as Poplar and the Isle of Dogs/Poplar which will increase pressure on DLR capacity.
- 4.9 The option which provides the most benefits is a fixed formation walk through train, moving away from the existing arrangement where individual LRVs are coupled together and operated in two car (56 metres) and three car (84 metres) configurations. Having fixed formation walk through trains of this type for DLR would follow the same design principles as the recent procurement of LU S7 and S8 stock, Elizabeth line Class 345, Thameslink Class 700 and London Overground Class 710 trains and the forthcoming London Underground Deep Tube Programme.
- 4.10 A minimum base order of 43 new three-car equivalent trains is required; 33 to replace the life expired B90/92 LRVs and 10 to support housing and employment growth in the Royal Docks. The contract will also include options for additional trains to support further development on the Isle of Dogs and Queen Elizabeth Olympic Park, making use of unutilised capability of the DLR infrastructure.
- 4.11 Should further growth be proposed beyond that in the emerging Opportunity Area Planning Frameworks for the Isle of Dogs and Royal Docks (both currently being drafted by the GLA), or should the potential extension to Thamesmead recently announced by the Mayor go ahead, then further train capacity will be needed. The contract will therefore include options for additional trains; of these, the first six would allow further development in Lewisham, the Isle of Dogs and South Poplar, and the Olympic Park; the remainder would permit further growth in the Royal Docks and the potential extension to Thamesmead as set out in Appendix 3.
- 4.12 Moving to a new design of train is expected to increase capacity by at least 10 per cent. It will also provide improved customer experience through real time information screens, climate control and mobile device charging points. The trains will have much improved reliability too, with 50,000km MDBSAF being specified, compared to the 5,000-8,000km currently being achieved.
- 4.13 A number of supporting work streams are necessary, the most significant being the expansion of the DLR depot at Beckton. A preferred option has been selected following a feasibility and option selection process and this is compatible with long term land requirements at Beckton. For this procurement of trains, additional sidings and a new maintenance building can be accommodated within the current footprint of land owned by TfL. Discussions on land use policy around the current DLR depot are continuing with the GLA with potential future expansion of the DLR depot in mind.
- 4.14 The new trains are required by 2022 to avoid up front, expensive, life extension costs and additional operating costs associated with staffing stations (most DLR stations are currently unstaffed) due to overcrowding. It will also minimise the amount of 'patch and mend' expenditure required on the current fleet.
- 4.15 Operations could be impacted during the construction at the depot, as entry into service and vehicle maintenance will be more challenging. Careful consideration

will be given to construction phasing in the next stage of design. This is the biggest delivery challenge for the project.

- 4.16 It is not anticipated that the project will have any negative impacts on equality or diversity. As with the current DLR fleet, train to platform access will be compliant with the Rail Vehicle Accessibility (Non-Interoperable Rail System) Regulations. On board audio and visual information will be better than existing including real time information. In addition to wheelchair spaces, trains will have multi-use areas which will accommodate pushchairs and bicycles, an improvement on the existing train design.
- 4.17 A full Equality Impact Assessment is planned and will be based on the train technical specification, once in final draft form, ahead of the ITT stage.

Benefits (and Value)

- 4.18 Docklands is still growing and speed of development is being accelerated. In order to support this growth, DLR needs to continue to run a highly reliable service and must be able to increase capacity step-by-step across the network. The next major step-up in capacity will be required in the Royal Docks, where developments of up to 36,500 jobs, and 7,000 homes, are already either under construction or have planning permission.
- 4.19 The ageing fleet of 94 B90/92s has reached the end of its 25-year design life at just the time when more DLR capacity is needed. The business case therefore considered a series of options to address the two main challenges for DLR in the 2020s – fleet reliability and increased demand.
- 4.20 Wider options such as running more buses on a saturated highway network in the area were dismissed early on as being insufficient to cope with growth. The business case has therefore focused on choices around life-extension versus replacement of the B90/92s; and for any new or additional trains, on a new train design versus one equivalent to today's LRVs.
- 4.21 The business case then looks at a series of key questions – is it worth expanding the DLR fleet to provide new capacity for growth; is it better to life-extend or replace the B90/92 fleet; and for any new trains and is it better to stay with the current design or to redesign the trains for higher capacity?
- 4.22 It is clear that there is a very strong case for new capacity to meet growth, both strategically (many planned Royal Docks developments in particular are highly dependent on DLR capacity being available – such as ABP Royal Albert Dock where 90 per cent of workers are expected to complete their journey on the DLR) and economically (with a Benefit Cost Ratio (BCR) of 6.25 to 1 compared to continuing to patch and mend).
- 4.23 Between the economies of scale of a larger order of new trains (combined with fleet expansion) and the increased reliability that could be obtained, the case for replacement rather than life extension was strong (financially positive for a combined order, versus 0.5 to 1 for life extension, both compared to a scenario where a small order of trains needs to be procured anyway). The high capital costs of life extension mean that it would struggle to generate sufficient operating cost savings or benefits over the additional 10-15 years of life obtained.

- 4.24 Finally, the case for a new walk-through design similar to the trains listed in paragraph 4.9 was very strong (financially positive when compared to more of the existing design; or a BCR of 40 to 1 compared to continuing to patch and mend) as the additional capacity and ambience benefits were substantial even when compared against the additional costs of extending the depot maintenance facilities to accommodate the fixed-formation design. When some of the capital costs can be deferred using finance lease arrangement, the BCR rises to 62.8 to 1 compared to continuing to patch and mend.
- 4.25 Consequently there is a major opportunity to replace this fleet with longer-lasting trains, fit for purpose with the volumes of passengers DLR now carries (and will carry in the future), with superior levels of reliability and a higher capacity design; and to provide additional trains to increase frequency and capacity further in the Royal Docks. This option offers substantially better value for money and would underpin the DLR Upgrade Plan and the strategy which sets out how DLR can support the development potential of Docklands through flexible step-ups in train numbers and capacity.
- 4.26 The main benefits are the increases in capacity and frequency (from the new design, from replacing some 2-car services with longer trains and from running more frequent services to Beckton); the improvement in reliability; and the increased ambience of the new trains. There are £1.4bn Present Value (PV) of benefits over the appraisal period; the PV of capital costs is relatively low (-£0.3bn PV) as replacement would eventually be needed anyway even if life extension took place; and the additional revenue generated from better services is substantial enough to generate a significant net surplus (£0.2bn PV) when taking operating costs into account as it does on the current DLR network.
- 4.27 In the long term the preferred option is less costly than other options such as life extension, and in any case, substantial investment must be made to slow down or eliminate the deterioration of the B90/92 fleet and provide the capacity required for planned growth in the Royal Docks – without which, most of the proposed development cannot successfully come forward.

Delivery of Preferred Option

- 4.28 There are three main design and construction packages, all of which will be outsourced:
- (a) trains – design and manufacture of 43 new trains will be competitively tendered as a single package;
 - (b) depot expansion – a design and build contract will be competitively tendered following the completion of the concept design. A planning application will be submitted in Autumn 2017; and
 - (c) signalling – design activities will be secured through a variation to the existing DLR signalling supply agreement. Delivery of on train signalling equipment and support for the train manufacturer will be delivered through a nominated supply agreement.

- 4.29 A draft technical train specification has been produced and developed in consultation with the train manufacturing industry. Key elements, including MDBSAF, have been benchmarked against other recent TfL train projects.
- 4.30 The biggest technical challenge comes from the introduction of a single walk through train, and issues associated with running a mixed fleet of vehicles. To mitigate this, parameters such as length and weight, will be constrained by capacity/capability of existing DLR infrastructure while others, including the kinematic envelope, will need to match the existing fleet.
- 4.31 Acceptance of the DLR Case for Safety for the revenue operation of the replacement trains will be required from the Office of Rail and Road. Letters of no objection will also need to be acquired from neighbouring infrastructure managers and operators.
- 4.32 The project is not dependant on any other programmes. There will, however, be a link to projects such as the Bank station capacity upgrade and DLR Custom House mezzanine project which will uplift station capacity.
- 4.33 The key milestones for the project are listed below.

Milestone	Target Date
Train contract award	July 2018
Depot design and build contract award	November 2018
Depot extension complete	March 2021
First train delivered for final testing	June 2021
First train in revenue service	June 2022
Final train in revenue service	June 2024

- 4.34 The top five risks have been identified through a Quantified Risk Assessment (QRA).

Risk No	Risk Description	Mitigation Actions
1	Depot is not ready for first train due to delays associated with, the complexity of the works and/or delays in obtaining planning consent.	<ol style="list-style-type: none"> 1. RIBA 2 design tender has been issued. 2. Consideration will be given to activities, such as period of fault free running, which could be reduced within the programme. 3. Ensure operator involvement in depot construction phasing development. 4. TfL Consents team engaged to support the planning application.

Risk No	Risk Description	Mitigation Actions
2	Significant delay to train delivery due to requirement to make active/passive depot capacity provision for DLR growth or joint facility with buses.	<ol style="list-style-type: none"> 1. Feasibility of decking over the existing depot being considered to allow an informed decision to be made about the impact of amending the scope to include future provision. 2. RIBA 2 Invitation to Tender amended to include option to instruct 2050 passive/ active provision design to minimise any delay if a decision is made to include it in the scope.
3	Extensive works are required to existing infrastructure to accommodate the new train.	<ol style="list-style-type: none"> 1. Initial interface standards review now complete. Work streams in response now underway. 2. A number of design parameters have been set based on existing train or infrastructure to minimise the likelihood of this.
4	On train signalling equipment does not function as expected, or does not integrate fully with new trains.	<ol style="list-style-type: none"> 1. Lessons learned from previous train procurements. 2. Early engagement with the signalling supplier. 3. Signalling experts have witnessed testing of proposed new generation of Vehicle On Board Computer (VOBC) on another network.
5	Train procurement is delayed due to the timeframes for production of critical interface control documents by signalling supplier.	<ol style="list-style-type: none"> 1. Train and signalling specifications have been provided to the signalling supplier. 2. Outline documents to be produced for ITT and developed throughout the tender period between the train manufacturers and signalling supplier.

4.35 Through the QRA process, risk has been specifically apportioned to the different work streams, rather than spread empirically as a percentage of the overall EFC. For example rolling stock capital costs, which made up the largest proportion of the EFC, are assessed as a relatively low risk item due to the diligence already

performed in benchmarking previous similar fleet procurements. Conversely other work streams, such as the depot are apportioned a much greater risk value. This is due the necessarily high degree of uncertainty associated with these elements given where we are in the programme.

5 Financial Implications

- 5.1 The project has existing Financial Authority of £186.3m. A financial contribution from London City Airport is committed to the project through a Section 106 agreement. Additional funding will be required in the early years of the next Business Plan.
- 5.2 A finance lease will be secured for the trains. This will include a purchase option exercisable after the individual trains have been accepted for service. TfL will make the initial payment to the manufacturer at contract award and then recover it from the financier when the lease is in place.
- 5.3 The finance lease creditor payments are only recognised when the asset is available for use, some time after acceptance. So all of the payments will be made by the lessor (finance company) during the build period. This will defer all of the capital expenditure for the trains to the next Business Plan when the purchase option is exercised. A traditional operating lease arrangement is not recommended given the likely low residual value owing to the very limited alternative networks a lessor could lease the DLR trains to, unlike conventional main line rolling stock on National Rail.
- 5.4 A finance lease is the most appropriate mechanism for delivering the project when it is needed. Without it activities would have to be deferred until the next Business Plan period with trains then not being delivered until 2027. This would necessitate costly, and disruptive, life extension works to keep the existing fleet going for an additional five years. Customer satisfaction would be impacted without the additional capacity, which is needed to support growth, available when it is needed resulting in increased overcrowding and necessitating staffing of the busiest stations.
- 5.5 The cost estimate for the new trains was based on the cost of the existing B2007 DLR LRVs (bought in 2005) amended to current prices. A price premium for the conversion to walk through trains and any additional functionality was then added. This was done in conjunction with external experts using benchmarking.
- 5.6 The depot costs were produced by a Quantity Surveyor team as part of the feasibility study. The project team have used costs and experience from other projects to estimate the value of the other work streams.
- 5.7 The train unit cost has been benchmarked against a number of similar projects. Whilst it is difficult to draw conclusions due to the high number of variables, such as train length, reliability and order size, the cost per metre is comparable to recent London Underground train procurements.
- 5.8 Value engineering opportunities are being explored, the largest relates to making the procurement process for the replacement trains as competitive as possible. Other opportunities include the Beckton depot scope which will be reviewed after the RIBA Stage 2 (concept design) is complete.
- 5.9 Throughout the design process the sponsor team have challenged scope and requirements to secure value for money, as illustrated by the development of the

MDBSAF target. An initial requirement for 85,000km was reduced to 50,000km. This followed a study which concluded that for anything beyond 50,000km the associated costs increased significantly in return for very little reliability gain specifically for DLR.

- 5.10 The Programme and Project Authority requested in this paper will cover all activities until the appointment of the train manufacturer. This will include all of the 2017/18 financial year spend and part of 2018/19. The spend is largely split between project management, including the management of the ITT process, and design activities including the depot. Provision for enabling works at Beckton depot has also been made, should the opportunity arise.
- 5.11 Remaining Programme and Project Authority will be requested in June 2018, when it is expected the procurement process will be completed and a recommendation for contract award (planned for July 2018) will be made.
- 5.12 The introduction of a more reliable fleet will bring an opportunity for operational and maintenance efficiencies. It is expected that the new trains will be cheaper to maintain than the current B90/92 fleet but the project has been conservative in its assumptions at this stage as the impact of maintaining any additional equipment in the train technical specification can't be quantified at this stage. Whole life costs will be assessed as part of the evaluation of bids from rolling stock manufacturers.
- 5.13 Any additional operating costs associated with running the additional trains will be covered by the revenue uplift which the improved service frequency will generate from the next Business Plan period.
- 5.14 It is likely that additional operational staff will be required temporarily, particularly during service launch, to ensure that operations are not impacted by construction works in the depot. Recruitment of additional train operators will also be required permanently ahead of the final testing period for the new trains. Provision is made for both of these items in the cost estimate.

Commercial

- 5.15 All design works to date, with the exception of some specialist items, have been secured through the TfL Railway Engineering Services Framework. Procurement strategies have been produced for remaining trains and depot works.
- 5.16 Trains will be procured through a Manufacture and Supply Agreement (MSA) contract. The train manufacturer will be responsible for design, manufacturer, testing, integration, delivery and commissioning of the trains under the terms of the MSA. Options to purchase additional trains will also be included in the MSA.
- 5.17 TfL will run a separate competition to finance the train procurement. This will be entered into once the train manufacturer has been identified.
- 5.18 Signalling equipment (for trains and testing) and associated specialist services will need be procured. The train manufacturer will retain overall risk for integration and commissioning of the on board signalling equipment for automatic train operation, including the vehicle on board computer (VOBC).
- 5.19 It is intended that the DLR franchisee will be responsible for maintenance of the new trains and a Fleet Support Agreement (FSA) will be entered into with the manufacturer for technical support and supply of spares. DLR's franchisee will be able to rely on certain obligations in the FSA under the terms of any subsequent franchise agreement.

- 5.20 The MSA and FSA will be based on similar contracts developed for recent TfL train procurements including London Underground Deep Tube, London Overground Class 710 and Jubilee and Northern Line Trains.
- 5.21 Following the publication of a Prior Information Notice in the OJEU in April 2015, DLR has had market engagement with all the main industry participants, particularly in relation to the technical requirements. Meetings have been held with seven manufacturers and a further two have shown an interest but declined to meet at this stage, overall suggesting strong market interest.
- 5.22 Following the OJEU notice a Pre-Qualification Document and Questionnaire (PQQ) will be issued. The final number to be invited to tender will be determined by the market response and relative scoring and ranking to the PQQ criteria but it is intended that up to five companies will be selected to allow for an effective competition.
- 5.23 The evaluation process will follow recent TfL and market principles. Bidders will have to demonstrate that minimum mandatory, technical, deliverability and commercial requirements have been met before the associated whole life cost is considered. This approach is designed to incentivise best value without having to accept a compromised, but lower cost, train design.
- 5.24 The evaluation will be based on the whole life cost, so in addition to the cost of new trains in the MSA and technical support and spares in the FSA, the whole life maintenance and operational costs (including traction power requirements) will also be considered.

6 Assurance

- 6.1 The project has been reviewed by TfL Project Assurance and the Independent Investment Programme Advisory Group (IIPAG). There were no critical issues identified.

List of appendices to this paper:

Appendix 1: Docklands Development Sites

Appendix 2: Fleet reliability comparison

Appendix 3: Potential additional Rolling Stock Purchase Options

Exempt supplementary information is included in a paper on Part 2 of the agenda.

List of background papers:

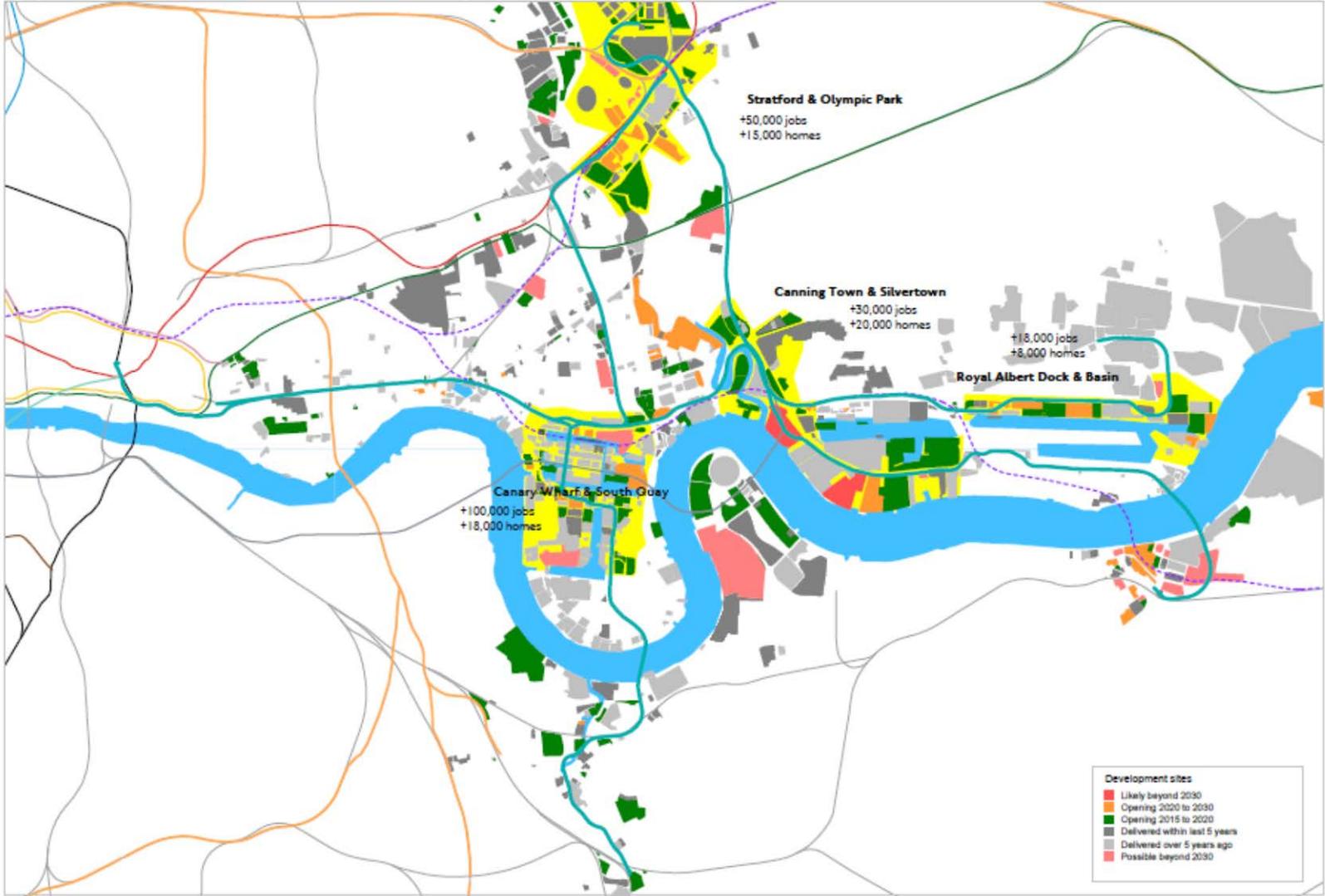
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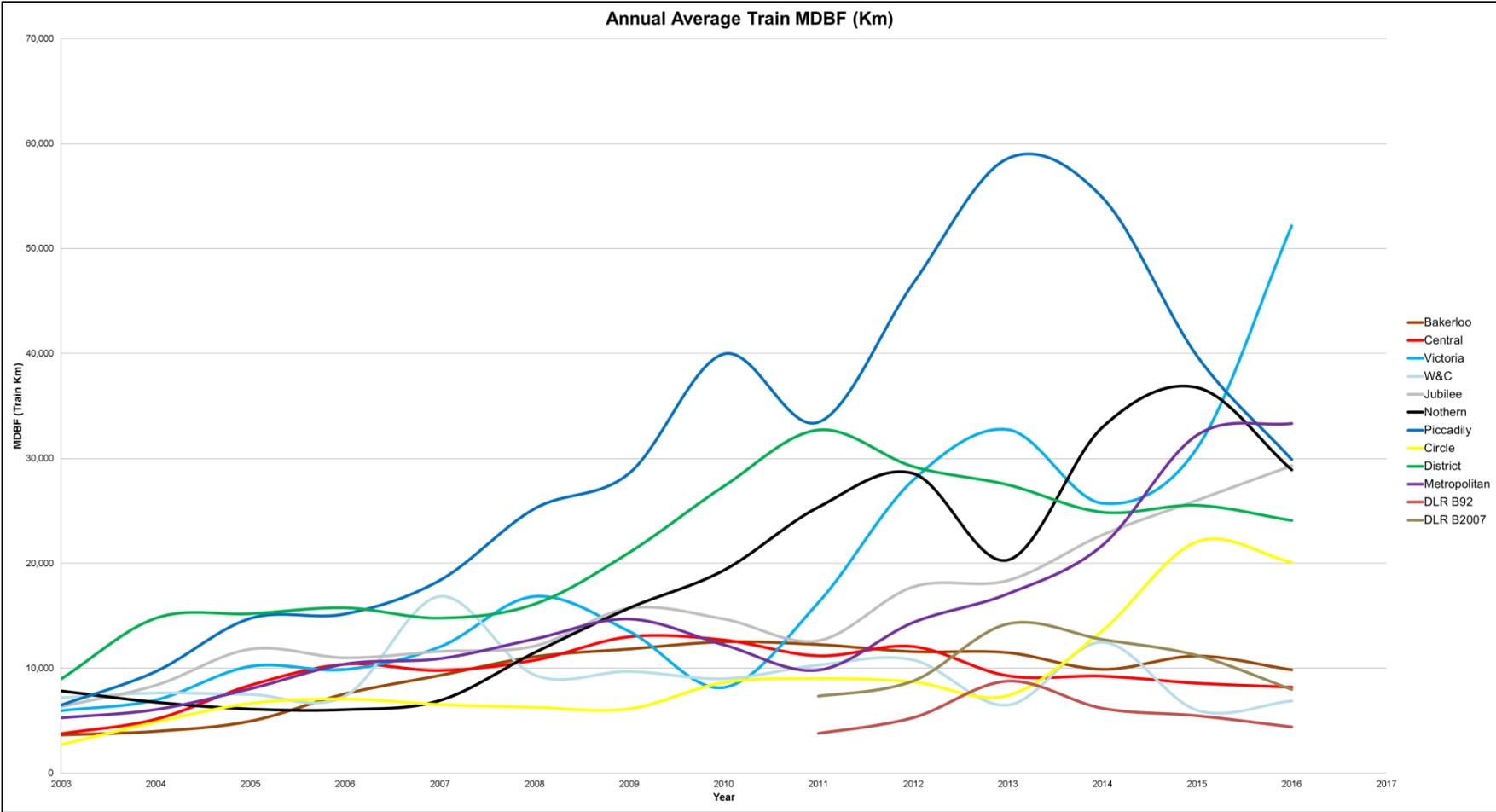
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Appendix 1 – Docklands Development Sites



Appendix 2 – Fleet Comparison



Appendix 3: Potential Additional Rolling Stock Purchase Options Beyond the Base Order of 43

Programme	Enhancement	Additional Trains	Total New Trains	Fleet size Σ 90m trains	Objective	Probability before 2030	Likely date
Isle of Dogs	Stratford-Canary 3-car	1	44	62	IoD & Stratford growth	High	2026
	Stratford-Lewisham 15tph	6	49	67		High	2032
Royal Docks 2	Extra Woolwich shuttle (22.5tph)	9	52	70	Thames Wharf development	Medium	2034
	Extra Beckton/Thamesmead shuttle (22.5tph)	15	58	76	Further Gallions development	Medium	2039
	Woolwich-Stratford 15tph	19	62	80	Enhanced links between growing Royals & Stratford	Medium	2041
	Beckton/Thamesmead-Stratford 15tph	23	66	84		Medium	2044
Royal Docks 3	Extra Woolwich-Poplar service (30tph)	28	71	89	Further redevelopment of industrial riverside	Low	2047
	Extra Beckton/Thamesmead-Poplar service (30tph)	35	78	96	Further Gallions development	Low	2050
NRDT2/3	Extra Stratford-Canary services (22.5tph)	39	82	100	Further housing growth around PML, Bow	Low	2050
	More Stratford-Canary services (30tph)	44	87	105		Low	2050
Further future inc extensions	DLR Max 36 (36tph)	66	109	127	Docklands-wide development	Low	2050
	Barking Town Barking-Thamesmead service (in DLR Max 36)		+1 +5	133	North Beckton new town centre	Low	
	Extend Thamesmead to Abbey Wood		+1 +1	135	Thamesmead housing intensification	Low	