John Baker
Enfield Council
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19th May 2015

Dear John

Guidance for PTAL levels at Meridian Water

You have requested guidance for the public transport service options required at Meridian Water, to achieve high housing densities. This follows the previous JRC report of 10th February 2015, which identified the PTAL consequences of raising train service levels to 4 trains per hour (tph).

The 10th February report is not repeated here in detail. It was concluded then that the combination of improved rail and existing local bus services (slightly increased to reflect extra bus mileage by 2018) would generally achieve only a PTAL level of 1b or 2, with PTAL 3 in only a few cases, throughout much of the Meridian Water area. Some distant parts of the development area would still see no PTAL coverage, while a PTAL level of 2 would not be adequate to permit higher densities.

JRC has researched the analytical case for a different public transport offer, and has reached various conclusions about the volume and density of the bus network which is required, and options for location of bus services. It is hoped that this will be useful guidance for your new transport and masterplanning advisers. Essentially, new and better bus services penetrating the Meridian Water area, and a high density of bus stops, are fundamental building blocks to achieve a higher housing density.

With kind regards

Jonathan

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Public Transport Accessibility Levels at Meridian Water 20th May 2015

Summary

1. This JRC report has modelled a combination of Accessibility Indices for a rail service at Meridian Water station – testing 4 and 6 trains per hour – and bus route density, service frequency and proximity of access to bus stops.

2. On its own, a 4 tph service would achieve an Accessibility Index (AI) of 2.7-4.7, and a 6 tph service an AI of 3.3-6.95. This is only just a PTAL 2 score (achieved at 5.01 and above), but not PTAL 3 (10.01+) nor PTAL 4 (15.01+). So there is major reliance on the volume and proximity of a local bus network to drive the AI values up to PTAL levels 3 and 4.

3. Extensive modelling of a single bus route, through to a 4-bus route network, at varying levels of frequency, shows that the Accessibility Index is most sensitive to distance (=access time) from a bus stop, followed by volume of routes and overall service frequencies. Modelling points to the best options being with effective bus stop catchments limited to 160-210 metres, and with a 3 or 4-bus route network in operation.

4. These principles have been applied to different areas within Meridian Water, and some general judgments reached on how to optimise the bus routeing and stop locations. The solutions vary according to the sub-sector served within MW. Sensitivities are identified, including the choices to be made in relation to the North Circular Road routes, and the use of Glover Drive/Causeway and Leeside Road, or a bus loop within the main development areas.

5. The potential for cycling facilities to enhance AI values and help the PTAL score has also been reviewed. These have a small benefit (up to a quarter-point of AI), of most use at development locations facing a long distance to reach the station.

Measuring Public Transport Accessibility Level

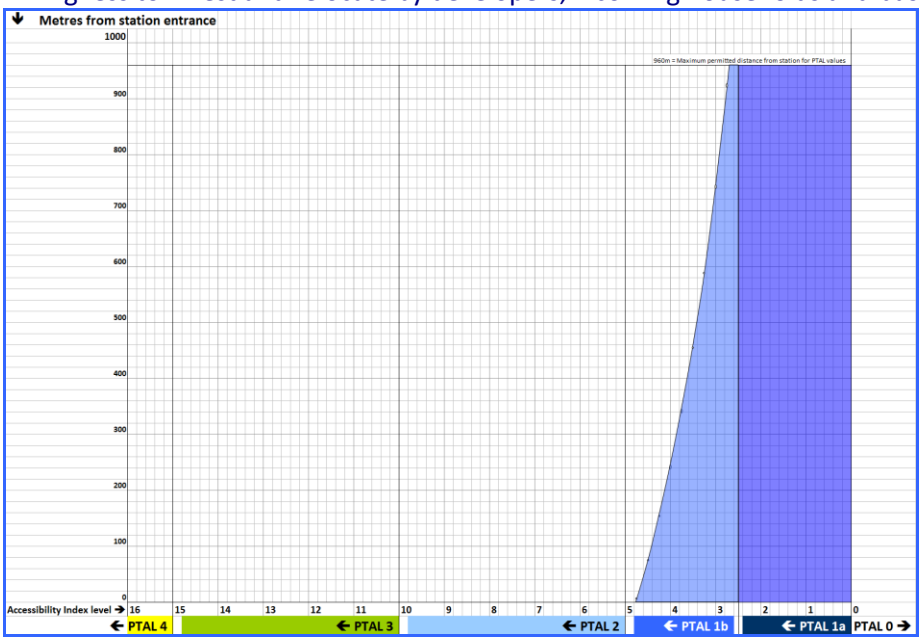
6. The philosophy behind Public Transport Accessibility Levels (PTAL) is to measure on a comparable basis the quality of service available at the doorstep of an office or household or other location. PTAL is therefore influenced by the walking time to a station entrance or bus stop, and by the differential between types of service and their frequencies.

7. Highest values are awarded to the closest, most frequent service, with only one stop scored per route, while other services available are marked down in merit. Rail scores more than bus, and also has a larger acceptable catchment area (960 metres, compared to 640 metres for a bus stop). These limits are equal to 12 or 8 minutes walk, at 80 metres per minute.

8. 'Equivalent doorstep frequencies' are created through a statistical process, and these are converted into an weighted Accessibility Index (AI). There is then some crude banding of the AI scores, into a PTAL number, as shown in the diagram below.

PTAL	Range of Index	Map Colour	Description
1a (Low)	0.01 – 2.50		Very poor
1b	2.51 – 5.00		Very poor
2	5.01 – 10.00		Poor
3	10.01 – 15.00		Moderate
4	15.01 – 20.00		Good
5	20.01 – 25.00		Very Good
6a	25.01 – 40.00		Excellent
6b (High)	40.01 +		Excellent

9. There is no mitigating factor if the AI is close to but hasn't reached the next PTAL level. Typically a 4 tph rail service on its own will only achieve a PTAL score of 1b (as set out below), even though that service level may be sufficiently attractive to be a major influence on the willingness to invest and relocate by developers, incoming households and businesses.



Accessibility Index values for rail at 4 tph

10. It is therefore clear that the bulk of PTAL scores are dependent on local bus services, where the rail service is constrained to 4 tph.

11. The Accessibility Index values for a 4 tph rail service are stated in the table below, for quarter-point changes in AI value, plus the gap to be covered by bus services to raise accessibility to achieve PTAL values of 3 or 4. This is a large requirement, with the buses having to achieve 3-4 times as much accessibility improvement as a local station, with still greater effort required for locations distant from the station:

metres from stn	Rail only AI @ 4 tph	bus extra for PTAL 3 gap to achieve AI 10.1	bus extra for PTAL 4 gap to achieve AI 15.1
3	4.75	5.35	10.35
73	4.5	5.6	10.6
152	4.25	5.85	10.85
240	4	6.1	11.1
340	3.75	6.35	11.35
454	3.5	6.6	11.6
586	3.25	6.85	11.85
740	3	7.1	12.1
921	2.75	7.35	12.35
960	2.7	7.4	12.4

Accessibility Index values for a single bus service

12. Bus services also have a high dependence on distance from the bus stop, with AI tailing off quickly until the bus catchment limit of 640 metres is reached. The AI of a single bus service is shown below, at frequencies from 4 to 12 buses per hour (bph), and at various distances from a bus stop. The colouring is NOT the same scheme as for PTAL levels, it is merely a way of differentiating banding within the Accessibility Index output:

metres from bus stop	1 bus only AI @ 4 bph	1 bus only AI @ 5 bph	1 bus only AI @ 6 bph	1 bus only AI @ 7 bph	1 bus only AI @ 8 bph	1 bus only AI @ 9 bph	1 bus only AI @ 10 bph	1 bus only AI @ 11 bph	1 bus only AI @ 12 bph	
10	3.12	3.69	4.21	4.68	5.11	5.5	5.85	6.18	6.49	bus AI => 6
40	3	3.53	4	4.42	4.8	5.14	5.45	5.74	6	
90	2.82	3.29	3.69	4.05	4.36	4.65	4.9	5.13	5.33	bus AI => 5
140	2.67	3.08	3.43	3.73	4	4.24	4.44	4.63	4.8	
190	2.53	2.89	3.2	3.46	3.69	3.89	4.07	4.22	4.36	bus AI => 4
240	2.4	2.73	3	3.23	3.43	3.6	3.75	3.88	4	
290	2.29	2.58	2.82	3.03	3.2	3.35	3.48	3.59	3.69	
340	2.18	2.45	2.67	2.85	3	3.13	3.24	3.34	3.43	bus A1 => 3
390	2.09	2.33	2.53	2.69	2.82	2.94	3.04	3.12	3.2	
440	2	2.22	2.4	2.55	2.67	2.77	2.86	2.93	3	
490	1.92	2.12	2.29	2.42	2.53	2.62	2.7	2.76	2.82	
540	1.85	2.03	2.18	2.3	2.4	2.48	2.55	2.61	2.67	bus AI => 2
590	1.78	1.95	2.09	2.2	2.29	2.36	2.42	2.48	2.53	
640	1.71	1.88	2	2.1	2.18	2.25	2.31	2.36	2.4	bus AI => 1

13. It is clear from the table that a single bus service is not going to achieve the required change in Accessibility Index at the bulk of locations within Meridian Water, even if they are close to the railway station, and won't begin to deliver enough access benefit at locations distant from a station. The distance from a bus stop is also self-evident as a critical factor.

14. The table below shown the addition of rail AI, on a simplistic basis, to a baseline single bus service. The distances values adopted are shown on the right. Both the rail and bus AIs are based on an increasing distance from a station or bus stop:

	metres	metres from	Cumulative AI at X bph and 4 tph								
	from stn	bus stop	AI @ 4 bph	AI @ 5 bph	AI @ 6 bph	AI @ 7 bph	AI @ 8 bph	AI @ 9 bph	AI @ 10 bph	AI @ 11 bph	AI @ 12 bph
bus AI => 6	3	10	7.87	8.44	8.96	9.43	9.86	10.25	10.6	10.93	11.24
		40									
bus AI => 5	73	90	7.32	7.79	8.19	8.55	8.86	9.15	9.4	9.63	9.83
	4.25	140	6.92	7.33	7.68	7.98	8.25	8.49	8.69	8.88	9.05
bus AI => 4		190									
	240	240	6.4	6.73	7	7.23	7.43	7.6	7.75	7.88	8
		290									
bus A1 => 3	340	340	5.93	6.2	6.42	6.6	6.75	6.88	6.99	7.09	7.18
		390									
	454	440	5.5	5.72	5.9	6.05	6.17	6.27	6.36	6.43	6.5
		490									
bus AI => 2		540									
	586	590	5.03	5.2	5.34	5.45	5.54	5.61	5.67	5.73	5.78
bus AI => 1		**640**									

15. Extrapolation of the AI for a single bus service up to 24 bph shows that the AI range at 10 to 640 metres is 8.89 to 2.67. Combined with the 4 tph rail AI, a single bus service will just achieve a PTAL level of 3 at distances from the railway station of 0 to 140 metres, at bus frequencies of 16 to 24 bph. This is not a realistic planning basis, neither for single bus routes nor for high density housing.

16. It will also be observed from the earlier table, that increasing bus frequency is marginally inefficient with each step change in service level, as the gain in accessibility diminishes proportionately with increased service levels.

17. A similar proportional reduction also occurs with distance from the bus stop, so that, from the point of view of a property location, a high frequency service (eg 12 bph but requiring 490 metres to reach a bus stop), achieves the same Accessibility Index (2.82) as a 4 bph service only 90 metres distant.

18. The following table sets out the initial range of Accessibility Indices achieved when two bus services are operated, at different frequency levels, with differentials of up to 12 bph on one route and 4 bph on the other. The range shown in each cell in the table is: (high value) a 10 metre distance from the two services, and (low value) a maximum 640 metres distance:-

Accessibility Index (AI) range based on two bus routes, dependent on variable route frequency									
Secondary bus	**Primary bus route frequency (bph)** ➔ (range is from 10 metres to 640 metres from bus stop)								
route freq ⬇	4	5	6	7	8	9	10	11	12
12									9.73 - 3.60
11								9.27 - 3.54	9.58 - 3.58
10							8.78 - 3.46	9.11 - 3.51	9.41 - 3.55
9						8.24 - 3.38	8.60 - 3.43	8.93 - 3.48	9.23 - 3.53
8					7.66 - 3.27	8.05 - 3.34	8.41 - 3.40	8.74 - 3.45	9.04 - 3.49
7				7.02 - 3.15	7.45 - 3.23	7.84 - 3.30	8.19 - 3.36	8.52 - 3.41	8.83 - 3.45
6			6.32 - 3.00	6.78 - 3.10	7.21 - 3.18	7.60 - 3.25	7.96 - 3.31	8.29 - 3.36	8.59 - 3.40
5		5.54 - 2.81	6.06 - 2.94	6.53 - 3.04	6.95 - 3.12	7.34 - 3.19	7.70 - 3.25	8.03 - 3.29	8.33 - 3.34
4	4.68 - 2.57	5.25 - 2.73	5.77 - 2.86	6.24 - 2.96	6.66 - 3.04	7.05 - 3.11	7.41 - 3.16	7.74 - 3.21	8.04 - 3.26

19. Adding a baseline rail Accessibility Index as set out earlier (a range of 4.75 high to 2.7 low), achieves a combined AI score range (maximum-minimum) shown in the following table:

Train AI based on 4 tph		4.75	max rail AI	2.7	min rail AI				
Bus AI as set out above, based on two bus routes									
Secondary bus		**Primary bus route frequency (bph) ➔** (range is from 10 metres to 640 metres from bus stop)							
route freq ⬇	4	5	6	7	8	9	10	11	12
12									14.48 - 6.3
11								14.02 - 6.24	14.33 - 6.28
10							13.53 - 6.16	13.86 - 6.21	14.16 - 6.25
9						12.99 - 6.08	13.35 - 6.13	13.68 - 6.18	13.98 - 6.23
8					12.41 - 5.97	12.8 - 6.04	13.16 - 6.1	13.49 - 6.15	13.79 - 6.19
7				11.77 - 5.85	12.2 - 5.93	12.59 - 6	12.94 - 6.06	13.27 - 6.11	13.58 - 6.15
6			11.07 - 5.7	11.53 - 5.8	11.96 - 5.88	12.35 - 5.95	12.71 - 6.01	13.04 - 6.06	13.34 - 6.1
5		10.29 - 5.51	10.81 - 5.64	11.28 - 5.74	11.7 - 5.82	12.09 - 5.89	12.45 - 5.95	12.78 - 5.99	13.08 - 6.04
4	9.43 - 5.27	10 - 5.43	10.52 - 5.56	10.99 - 5.66	11.41 - 5.74	11.8 - 5.81	12.16 - 5.86	12.49 - 5.91	12.79 - 5.96

20. The max-min range itself demonstrates that even with 2 bus services, the effective AI - and hence PTAL - is variable, and is dependent on distance from the public transport service. A long walk to a stop will negate much of the bus's benefits, even if there are two services.

Effect of bus stop proximity on accessibility

21. So it is essential to understand in more detail the required proximity of bus stops to the local catchment, and the effect on the combined rail + bus Accessibility Index.

22. Three tables are shown below in sequence for a 2-bus route network: taking a nominal mid-point for maximum access to a bus stop (ca. 315 metres), also a one-third location (210 metres) and a one-quarter location (ca. 160 metres maximum access to a bus stop). The range of rail AI at 4 tph is added:

Midpoint values for distance from bus stop (range 10-640 metres ~ 315 metres), with two bus routes, plus rail AI variable 4.75-2.7									
Secondary bus		**Primary bus route frequency (bph) ➔** (range is from 10 metres to 640 metres from bus stop)							
route freq ⬇	4	5	6	7	8	9	10	11	12
12									11.42 - 9.37
11								11.16 - 9.11	11.33 - 9.28
10							10.87 - 8.82	11.06 - 9.01	11.23 - 9.18
9						10.56 - 8.51	10.77 - 8.72	10.96 - 8.91	11.13 - 9.08
8					10.22 - 8.17	10.45 - 8.4	10.66 - 8.61	10.85 - 8.8	11.02 - 8.97
7				9.84 - 7.79	10.09 - 8.04	10.32 - 8.27	10.53 - 8.48	10.72 - 8.67	10.89 - 8.84
6			9.41 - 7.36	9.69 - 7.64	9.95 - 7.9	10.18 - 8.13	10.39 - 8.34	10.58 - 8.53	10.75 - 8.7
5		8.93 - 6.88	9.25 - 7.2	9.54 - 7.49	9.79 - 7.74	10.02 - 7.97	10.23 - 8.18	10.41 - 8.36	10.59 - 8.54
4	8.38 - 6.33	8.74 - 6.69	9.07 - 7.02	9.35 - 7.3	9.6 - 7.55	9.83 - 7.78	10.04 - 7.99	10.23 - 8.18	10.4 - 8.35
One-third values for distance from bus stop (range 10-640 metres ~ 210 metres), with two bus routes, plus rail AI variable 4.75-2.7									
Secondary bus		**Primary bus route frequency (bph) ➔** (range is from 10 metres to 640 metres from bus stop)							
route freq ⬇	4	5	6	7	8	9	10	11	12
12									12.44 - 10.39
11								12.11 - 10.06	12.33 - 10.28
10							11.76 - 9.71	11.99 - 9.94	12.21 - 10.16
9						11.37 - 9.32	11.63 - 9.58	11.86 - 9.81	12.08 - 10.03
8					10.95 - 8.9	11.23 - 9.18	11.49 - 9.44	11.73 - 9.68	11.94 - 9.89
7				10.48 - 8.43	10.79 - 8.74	11.08 - 9.03	11.33 - 9.28	11.57 - 9.52	11.79 - 9.74
6			9.96 - 7.91	10.3 - 8.25	10.62 - 8.57	10.9 - 8.85	11.16 - 9.11	11.4 - 9.35	11.61 - 9.56
5		9.38 - 7.33	9.77 - 7.72	10.12 - 8.07	10.42 - 8.37	10.71 - 8.66	10.97 - 8.92	11.2 - 9.15	11.42 - 9.37
4	8.73 - 6.68	9.16 - 7.11	9.55 - 7.5	9.9 - 7.85	10.2 - 8.15	10.49 - 8.44	10.74 - 8.69	10.98 - 8.93	11.2 - 9.15

One-quarter values for distance from bus stop (range 10-640 metres ~ 160 metres), with two bus routes, plus rail AI variable 4.75-2.7									
Secondary bus	Primary bus route frequency (bph) ➔ (range is from 10 metres to 640 metres from bus stop)								
route freq ⬇	4	5	6	7	8	9	10	11	12
12									12.95 - 10.9
11								12.59 - 10.54	12.83 - 10.78
10							12.2 - 10.15	12.46 - 10.41	12.7 - 10.65
9						11.78 - 9.73	12.06 - 10.01	12.32 - 10.27	12.56 - 10.51
8					11.31 - 9.26	11.62 - 9.57	11.91 - 9.86	12.17 - 10.12	12.4 - 10.35
7				10.8 - 8.75	11.15 - 9.1	11.46 - 9.41	11.73 - 9.68	11.99 - 9.94	12.24 - 10.19
6			10.24 - 8.19	10.61 - 8.56	10.95 - 8.9	11.26 - 9.21	11.55 - 9.5	11.81 - 9.76	12.04 - 9.99
5		9.61 - 7.56	10.03 - 7.98	10.41 - 8.36	10.74 - 8.69	11.05 - 9	11.34 - 9.29	11.6 - 9.55	11.83 - 9.78
4	8.9 - 6.85	9.37 - 7.32	9.79 - 7.74	10.17 - 8.12	10.51 - 8.46	10.82 - 8.77	11.1 - 9.05	11.36 - 9.31	11.6 - 9.55

23. The **coloured-in green** above shows AI values wholly within PTAL 3. Within a wider range, some AI values will be within PTAL 3 (**outline green**), but not across the full distance range. The importance of a high level of penetration of bus services, and a close proximity of bus stops to residential and other locations, is self-evident. Even so, there is only a limited volume of wholesale conversion to PTAL 3, using two bus routes combined with a 4 tph rail service.

A 6 tph, 2-bus route network

24. JRC has therefore tested a 6 tph rail service plus two bus services, to see what the difference *could be*. Bus midpoint, one-third and one-quarter stop tables are shown below plus 6 tph AI:

Midpoint values for distance from bus stop (range 10-640 metres ~ 315 metres), with two bus routes, plus rail AI variable 6.95-3.3									
Secondary bus	Primary bus route frequency (bph) ➔ (range is from 10 metres to 640 metres from bus stop)								
route freq ⬇	4	5	6	7	8	9	10	11	12
12									13.62 - 9.97
11								13.36 - 9.71	13.53 - 9.88
10							13.07 - 9.42	13.26 - 9.61	13.43 - 9.78
9						12.76 - 9.11	12.97 - 9.32	13.16 - 9.51	13.33 - 9.68
8					12.42 - 8.77	12.65 - 9	12.86 - 9.21	13.05 - 9.4	13.22 - 9.57
7				12.04 - 8.39	12.29 - 8.64	12.52 - 8.87	12.73 - 9.08	12.92 - 9.27	13.09 - 9.44
6			11.61 - 7.96	11.89 - 8.24	12.15 - 8.5	12.38 - 8.73	12.59 - 8.94	12.78 - 9.13	12.95 - 9.3
5		11.13 - 7.48	11.45 - 7.8	11.74 - 8.09	11.99 - 8.34	12.22 - 8.57	12.43 - 8.78	12.61 - 8.96	12.79 - 9.14
4	10.58 - 6.93	10.94 - 7.29	11.27 - 7.62	11.55 - 7.9	11.8 - 8.15	12.03 - 8.38	12.24 - 8.59	12.43 - 8.78	12.6 - 8.95
One-third values for distance from bus stop (range 10-640 metres ~ 210 metres), with two bus routes, plus rail AI variable 6.95-3.3									
Secondary bus	Primary bus route frequency (bph) ➔ (range is from 10 metres to 640 metres from bus stop)								
route freq ⬇	4	5	6	7	8	9	10	11	12
12									14.64 - 10.99
11								14.31 - 10.66	14.53 - 10.88
10							13.96 - 10.31	14.19 - 10.54	14.41 - 10.76
9						13.57 - 9.92	13.83 - 10.18	14.06 - 10.41	14.28 - 10.63
8					13.15 - 9.5	13.43 - 9.78	13.69 - 10.04	13.93 - 10.28	14.14 - 10.49
7				12.68 - 9.03	12.99 - 9.34	13.28 - 9.63	13.53 - 9.88	13.77 - 10.12	13.99 - 10.34
6			12.16 - 8.51	12.5 - 8.85	12.82 - 9.17	13.1 - 9.45	13.36 - 9.71	13.6 - 9.95	13.81 - 10.16
5		11.58 - 7.93	11.97 - 8.32	12.32 - 8.67	12.62 - 8.97	12.91 - 9.26	13.17 - 9.52	13.4 - 9.75	13.62 - 9.97
4	10.93 - 7.28	11.36 - 7.71	11.75 - 8.1	12.1 - 8.45	12.4 - 8.75	12.69 - 9.04	12.94 - 9.29	13.18 - 9.53	13.4 - 9.75

One-quarter values for distance from bus stop (range 10-640 metres ~ 160 metres), with two bus routes, plus rail AI variable 6.95-3.3									
Secondary bus		Primary bus route frequency (bph) ➔ (range is from 10 metres to 640 metres from bus stop)							
route freq ➔	4	5	6	7	8	9	10	11	12
12									15.15 - 11.5
11								14.79 - 11.14	15.03 - 11.38
10							14.4 - 10.75	14.66 - 11.01	14.9 - 11.25
9						13.98 - 10.33	14.26 - 10.61	14.52 - 10.87	14.76 - 11.11
8					13.51 - 9.86	13.82 - 10.17	14.11 - 10.46	14.37 - 10.72	14.6 - 10.95
7				13 - 9.35	13.35 - 9.7	13.66 - 10.01	13.93 - 10.28	14.19 - 10.54	14.44 - 10.79
6			12.44 - 8.79	12.81 - 9.16	13.15 - 9.5	13.46 - 9.81	13.75 - 10.1	14.01 - 10.36	14.24 - 10.59
5		11.81 - 8.16	12.23 - 8.58	12.61 - 8.96	12.94 - 9.29	13.25 - 9.6	13.54 - 9.89	13.8 - 10.15	14.03 - 10.38
4	11.1 - 7.45	11.57 - 7.92	11.99 - 8.34	12.37 - 8.72	12.71 - 9.06	13.02 - 9.37	13.3 - 9.65	13.56 - 9.91	13.8 - 10.15

25. This is an improvement, with stronger coverage with the one-third and one-quarter stop range – maximum 160-210 metres from bus stops. The increase in AI value, compared to a 4 tph rail service, would be 2.2 at locations close to the station, reducing to an AI increase of only 0.6 at the maximum distance from the station.

26. Only the areas most distant from a low frequency two-bus service would experience a PTAL level less than 3.

A 3-bus route network

27. However, 6 tph is not considered to be an early option for rail service levels. So this outcome is noted, and investigation has continued with a 3-bus route offer.

28. In that case, for simplicity of analysis, one route is adopted as a main corridor service, at 4-12 bph, and the other two routes are assumed in principle to be local services whose frequencies are taken as the same as each other. Those local frequencies can themselves vary between 4-12 bph.

29. It will be appreciated that offering a high stopping density network, in addition to potentially high volume bus services, could have a significant impact on bus service funding requirements – as well as the obvious impact on road network specification within the Meridian Water masterplan.

30. However this modelling is directed at understanding the consequences of seeking to achieve a high PTAL level, to the point that higher housing densities are then accepted by the GLA and other parties. Unless the public transport network can offer the required level of accessibility, the desired strategic scale of housing densities may not be authorised.

31. The following table looks at the accessibility implications of a 3-bus route network, in a similar way as before, with two of those routes being local in purpose and identical in service levels:

Midpoint values for distance from bus stop (range 10-640 metres ~ 315 metres), with three bus routes, plus rail AI variable 4.75-2.7									
Secondary bus	Primary bus route frequency (bph) ➔ (range is from 10 metres to 640 metres from bus stop)								
route freq	4	5	6	7	8	9	10	11	12
12									13.64 - 11.59
11								13.29 - 11.24	13.47 - 11.42
10							12.92 - 10.87	13.1 - 11.05	13.28 - 11.23
9						12.5 - 10.45	12.71 - 10.66	12.9 - 10.85	13.07 - 11.02
8					12.04 - 9.99	12.27 - 10.22	12.48 - 10.43	12.67 - 10.62	12.84 - 10.79
7				11.53 - 9.48	11.79 - 9.74	12.02 - 9.97	12.22 - 10.17	12.41 - 10.36	12.59 - 10.54
6			10.96 - 8.91	11.25 - 9.2	11.5 - 9.45	11.73 - 9.68	11.94 - 9.89	12.13 - 10.08	12.3 - 10.25
5		10.32 - 8.27	10.64 - 8.59	10.93 - 8.88	11.18 - 9.13	11.41 - 9.36	11.62 - 9.57	11.8 - 9.75	11.98 - 9.93
4	9.58 - 7.53	9.95 - 7.9	10.27 - 8.22	10.56 - 8.51	10.81 - 8.76	11.04 - 8.99	11.25 - 9.2	11.44 - 9.39	11.61 - 9.56

One-third values for distance from bus stop (range 10-640 metres ~ 210 metres), with three bus routes, plus rail AI variable 4.75-2.7									
Secondary bus	Primary bus route frequency (bph) ➔ (range is from 10 metres to 640 metres from bus stop)								
route freq	4	5	6	7	8	9	10	11	12
12									15 - 12.95
11								14.57 - 12.52	14.78 - 12.73
10							14.1 - 12.05	14.33 - 12.28	14.55 - 12.5
9						13.58 - 11.53	13.84 - 11.79	14.07 - 12.02	14.29 - 12.24
8					13.01 - 10.96	13.29 - 11.24	13.55 - 11.5	13.79 - 11.74	14 - 11.95
7				12.39 - 10.34	12.7 - 10.65	12.99 - 10.94	13.24 - 11.19	13.48 - 11.43	13.7 - 11.65
6			11.7 - 9.65	12.04 - 9.99	12.36 - 10.31	12.64 - 10.59	12.89 - 10.84	13.13 - 11.08	13.35 - 11.3
5		10.92 - 8.87	11.31 - 9.26	11.66 - 9.61	11.97 - 9.92	12.25 - 10.2	12.51 - 10.46	12.74 - 10.69	12.96 - 10.91
4	10.05 - 8	10.49 - 8.44	10.87 - 8.82	11.22 - 9.17	11.53 - 9.48	11.81 - 9.76	12.07 - 10.02	12.31 - 10.26	12.52 - 10.47

One-quarter values for distance from bus stop (range 10-640 metres ~ 160 metres), with three bus routes, plus rail AI variable 4.75-2.7									
Secondary bus	Primary bus route frequency (bph) ➔ (range is from 10 metres to 640 metres from bus stop)								
route freq	4	5	6	7	8	9	10	11	12
12									15.68 - 13.63
11								15.21 - 13.16	15.44 - 13.39
10							14.69 - 12.64	14.95 - 12.9	15.18 - 13.13
9						14.12 - 12.07	14.4 - 12.35	14.66 - 12.61	14.9 - 12.85
8					13.5 - 11.45	13.81 - 11.76	14.09 - 12.04	14.35 - 12.3	14.59 - 12.54
7				12.82 - 10.77	13.16 - 11.11	13.47 - 11.42	13.75 - 11.7	14.01 - 11.96	14.25 - 12.2
6			12.07 - 10.02	12.44 - 10.39	12.79 - 10.74	13.1 - 11.05	13.37 - 11.32	13.63 - 11.58	13.88 - 11.83
5		11.22 - 9.17	11.65 - 9.6	12.02 - 9.97	12.37 - 10.32	12.68 - 10.63	12.96 - 10.91	13.21 - 11.16	13.46 - 11.41
4	10.28 - 8.23	10.76 - 8.71	11.18 - 9.13	11.55 - 9.5	11.89 - 9.84	12.2 - 10.15	12.48 - 10.43	12.74 - 10.69	12.98 - 10.93

32. The results show a much more useful outcome across the development area, based on a 3-bus route network plus rail at 4tph, compared to a 2-bus route network with rail at 6 tph. Even so, in no option is a full PTAL at level 4 achieved, although some locations with high bus frequencies and close to the station will attain that result. The results also confirm that having several bus routes rather than just a single high frequency service, increases the Accessibility Index because of the way the AI is calculated. It also a token of the benefits of offering a wider range of services and destinations, even if this is only reflected nominally.

33. A 3-bus route network plus 6 tph rail would achieve greater coverage at PTAL 4, as shown in the table below. As noted previously, the increase in AI value, compared to a 4 tph rail service, would be 2.2 at locations close to the station, reducing to an AI increase of only 0.6 at the maximum distance from the station. So proximity to a bus stop, overall bus volume, and proximity to the station are all important elements in achieving a high AI at individual locations. It is unlikely that a 6 tph rail service would be achieved until during the 2020s, therefore this could affect the phasing of developments distant from the station.

Midpoint values for distance from bus stop (range 10-640 metres ~ 315 metres), with three bus routes, plus rail AI variable 6.95-3.3									
Secondary bus	Primary bus route frequency (bph) ➔ (range is from 10 metres to 640 metres from bus stop)								
route freq	4	5	6	7	8	9	10	11	12
12									15.84 - 12.19
11								15.49 - 11.84	15.67 - 12.02
10							15.12 - 11.47	15.3 - 11.65	15.48 - 11.83
9						14.7 - 11.05	14.91 - 11.26	15.1 - 11.45	15.27 - 11.62
8					14.24 - 10.59	14.47 - 10.82	14.68 - 11.03	14.87 - 11.22	15.04 - 11.39
7				13.73 - 10.08	13.99 - 10.34	14.22 - 10.57	14.42 - 10.77	14.61 - 10.96	14.79 - 11.14
6			13.16 - 9.51	13.45 - 9.8	13.7 - 10.05	13.93 - 10.28	14.14 - 10.49	14.33 - 10.68	14.5 - 10.85
5		12.52 - 8.87	12.84 - 9.19	13.13 - 9.48	13.38 - 9.73	13.61 - 9.96	13.82 - 10.17	14 - 10.35	14.18 - 10.53
4	11.78 - 8.13	12.15 - 8.5	12.47 - 8.82	12.76 - 9.11	13.01 - 9.36	13.24 - 9.59	13.45 - 9.8	13.64 - 9.99	13.81 - 10.16

One-third values for distance from bus stop (range 10-640 metres ~ 210 metres), with three bus routes, plus rail AI variable 6.95-3.3									
Secondary bus	Primary bus route frequency (bph) ➔ (range is from 10 metres to 640 metres from bus stop)								
route freq	4	5	6	7	8	9	10	11	12
12									17.2 - 13.55
11								16.77 - 13.12	16.98 - 13.33
10							16.3 - 12.65	16.53 - 12.88	16.75 - 13.1
9						15.78 - 12.13	16.04 - 12.39	16.27 - 12.62	16.49 - 12.84
8					15.21 - 11.56	15.49 - 11.84	15.75 - 12.1	15.99 - 12.34	16.2 - 12.55
7				14.59 - 10.94	14.9 - 11.25	15.19 - 11.54	15.44 - 11.79	15.68 - 12.03	15.9 - 12.25
6			13.9 - 10.25	14.24 - 10.59	14.56 - 10.91	14.84 - 11.19	15.09 - 11.44	15.33 - 11.68	15.55 - 11.9
5		13.12 - 9.47	13.51 - 9.86	13.86 - 10.21	14.17 - 10.52	14.45 - 10.8	14.71 - 11.06	14.94 - 11.29	15.16 - 11.51
4	12.25 - 8.6	12.69 - 9.04	13.07 - 9.42	13.42 - 9.77	13.73 - 10.08	14.01 - 10.36	14.27 - 10.62	14.51 - 10.86	14.72 - 11.07

One-quarter values for distance from bus stop (range 10-640 metres ~ 160 metres), with three bus routes, plus rail AI variable 6.95-3.3									
Secondary bus	Primary bus route frequency (bph) ➔ (range is from 10 metres to 640 metres from bus stop)								
route freq	4	5	6	7	8	9	10	11	12
12									17.88 - 14.23
11								17.41 - 13.76	17.64 - 13.99
10							16.89 - 13.24	17.15 - 13.5	17.38 - 13.73
9						16.32 - 12.67	16.6 - 12.95	16.86 - 13.21	17.1 - 13.45
8					15.7 - 12.05	16.01 - 12.36	16.29 - 12.64	16.55 - 12.9	16.79 - 13.14
7				15.02 - 11.37	15.36 - 11.71	15.67 - 12.02	15.95 - 12.3	16.21 - 12.56	16.45 - 12.8
6			14.27 - 10.62	14.64 - 10.99	14.99 - 11.34	15.3 - 11.65	15.57 - 11.92	15.83 - 12.18	16.08 - 12.43
5		13.42 - 9.77	13.85 - 10.2	14.22 - 10.57	14.57 - 10.92	14.88 - 11.23	15.16 - 11.51	15.41 - 11.76	15.66 - 12.01
4	12.48 - 8.83	12.96 - 9.31	13.38 - 9.73	13.75 - 10.1	14.09 - 10.44	14.4 - 10.75	14.68 - 11.03	14.94 - 11.29	15.18 - 11.53

A 4-bus route network

34. A 4-route bus network has also been modelled. Modelling a 4-bus route network and 4 tph in place of a 3-bus route network and 6 tph, shows this would be more effective in achieving high AI values with greater PTAL 4 coverage. At long distances from the rail station, only lower housing densities would be do-able, unless a high bus volume was run with a close mesh of bus stops. This is shown overleaf:

Midpoint values for distance from bus stop (range 10-640 metres ~ 315 metres), with four bus routes, plus rail AI variable 4.75-2.7									
Secondary bus	Primary bus route frequency (bph) ➔ (range is from 10 metres to 640 metres from bus stop)								
route freq	4	5	6	7	8	9	10	11	12
12									15.86 - 13.81
11								15.43 - 13.38	15.6 - 13.55
10							14.95 - 12.9	15.14 - 13.09	15.32 - 13.27
9						14.44 - 12.39	14.64 - 12.59	14.83 - 12.78	15.01 - 12.96
8					13.86 - 11.81	14.09 - 12.04	14.3 - 12.25	14.49 - 12.44	14.66 - 12.61
7				13.23 - 11.18	13.48 - 11.43	13.71 - 11.66	13.92 - 11.87	14.11 - 12.06	14.28 - 12.23
6			12.52 - 10.47	12.8 - 10.75	13.05 - 11	13.28 - 11.23	13.49 - 11.44	13.68 - 11.63	13.85 - 11.8
5		11.71 - 9.66	12.03 - 9.98	12.32 - 10.27	12.57 - 10.52	12.8 - 10.75	13.01 - 10.96	13.2 - 11.15	13.37 - 11.32
4	10.79 - 8.74	11.16 - 9.11	11.48 - 9.43	11.76 - 9.71	12.02 - 9.97	12.25 - 10.2	12.46 - 10.41	12.65 - 10.6	12.82 - 10.77

One-third values for distance from bus stop (range 10-640 metres ~ 210 metres), with four bus routes, plus rail AI variable 4.75-2.7									
Secondary bus	Primary bus route frequency (bph) ➔ (range is from 10 metres to 640 metres from bus stop)								
route freq	4	5	6	7	8	9	10	11	12
12									17.56 - 15.51
11								17.02 - 14.97	17.24 - 15.19
10							16.43 - 14.38	16.66 - 14.61	16.88 - 14.83
9						15.79 - 13.74	16.04 - 13.99	16.28 - 14.23	16.5 - 14.45
8					15.08 - 13.03	15.36 - 13.31	15.62 - 13.57	15.85 - 13.8	16.07 - 14.02
7				14.3 - 12.25	14.61 - 12.56	14.9 - 12.85	15.15 - 13.1	15.39 - 13.34	15.61 - 13.56
6			13.44 - 11.39	13.78 - 11.73	14.09 - 12.04	14.37 - 12.32	14.63 - 12.58	14.87 - 12.82	15.08 - 13.03
5		12.47 - 10.42	12.85 - 10.8	13.2 - 11.15	13.51 - 11.46	13.79 - 11.74	14.05 - 12	14.29 - 12.24	14.5 - 12.45
4	11.37 - 9.32	11.81 - 9.76	12.2 - 10.15	12.54 - 10.49	12.85 - 10.8	13.14 - 11.09	13.4 - 11.35	13.63 - 11.58	13.85 - 11.8

One-quarter values for distance from bus stop (range 10-640 metres ~ 160 metres), with four bus routes, plus rail AI variable 4.75-2.7									
Secondary bus	Primary bus route frequency (bph) ➔ (range is from 10 metres to 640 metres from bus stop)								
route freq	4	5	6	7	8	9	10	11	12
12									18.42 - 16.37
11								17.82 - 15.77	18.06 - 16.01
10							17.17 - 15.12	17.43 - 15.38	17.67 - 15.62
9						16.46 - 14.41	16.75 - 14.7	17.01 - 14.96	17.24 - 15.19
8					15.69 - 13.64	16 - 13.95	16.28 - 14.23	16.54 - 14.49	16.78 - 14.73
7				14.84 - 12.79	15.18 - 13.13	15.49 - 13.44	15.77 - 13.72	16.03 - 13.98	16.27 - 14.22
6			13.9 - 11.85	14.28 - 12.23	14.61 - 12.56	14.92 - 12.87	15.21 - 13.16	15.47 - 13.42	15.7 - 13.65
5		12.85 - 10.8	13.27 - 11.22	13.64 - 11.59	13.98 - 11.93	14.29 - 12.24	14.57 - 12.52	14.83 - 12.78	15.07 - 13.02
4	11.67 - 9.62	12.14 - 10.09	12.56 - 10.51	12.93 - 10.88	13.27 - 11.22	13.58 - 11.53	13.87 - 11.82	14.13 - 12.08	14.36 - 12.31

35. With a 4-bus route network, more of the catchment is a guaranteed PTAL 4 as well as PTAL 3, depending on where the Accessibility Index exceeds 15. To be consistent, areas above with partial PTAL 4 have been coloured coded in the same way as previously, as PTAL 3, but much will be PTAL 4. This highlights that, in the final analysis, a closer mesh of bus stops can achieve a higher AI than an increment of bus service frequency.

From theory into practice

36. The preceding modelling has been based on TfL's formal PTAL calculation processes, but without reference to the specific geography faced by Meridian Water.

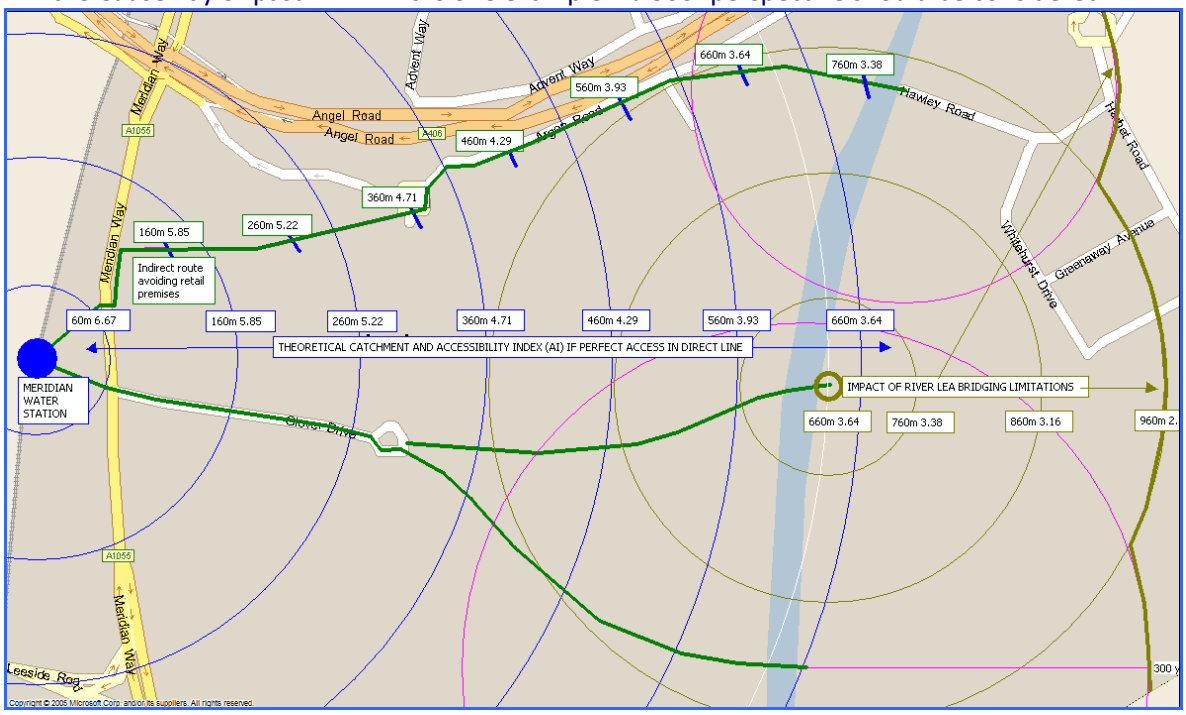
37. JRC has not been instructed to define local inputs and detailed routeings – this is a matter for Enfield's masterplanners and other consultants. However JRC has been asked to consider some basic rules and opportunities which arise when the modelling parameters are applied in an outline form to the Meridian Water development area.

Direct walking access routes

38. The proposed railway station location and its direct pedestrian/cycling access routes will strongly influence the Accessibility Index values. The modelling has already shown that the AI is sensitive to overall access distance/time to the station. Indirect routes if built into masterplanning will reduce the AI values (compared to what they could be) from wherever the line of access starts to deviate from a straight line to/from the station entrance.

39. The presence of existing land uses such as IKEA, and other geography such as the River Lea and Pymmes Brook, means that there will be restrictions on passing and bridging locations, which will reduce accessibility. This could have a significant impact on AI values, so that means to maintain a reasonably direct routeing within those limitations must be considered.

40. The mapping below illustrates the reduction in accessibility – and related AI rail-only values – when seeking to apply a walkable route east from the proposed Meridian Water station via the Causeway or past IKEA. This is one example – a 360º perspective should be considered.



Proximity and accessibility of bus stops to new development

41. The modelling above is emphatic that proximity of bus stops to development areas will have a profound effect on the Accessibility Index for those areas. There is a close correlation between the adoption of bus stops which achieve a maximum access value of 160-210 metres to developments, and (subject to overall bus volume per hour) a high AI which in turn permits higher density development.

42. Little of Meridian Water is close to existing bus routes, nor are these high frequency. This is analysed in the JRC report of 10th February 2015.

43. The low Accessibility Index scores which arise in that report are a combination of:
    - Widely spaced bus stops on the existing bus roads.
    - Limited penetration of the Meridian Water development area – mainly restricted to the IKEA bus terminus.
    - No bus routes directly accessing the eastern parts of the Meridian Water development area, which is also too far from the new station to achieve much rail-based accessibility.

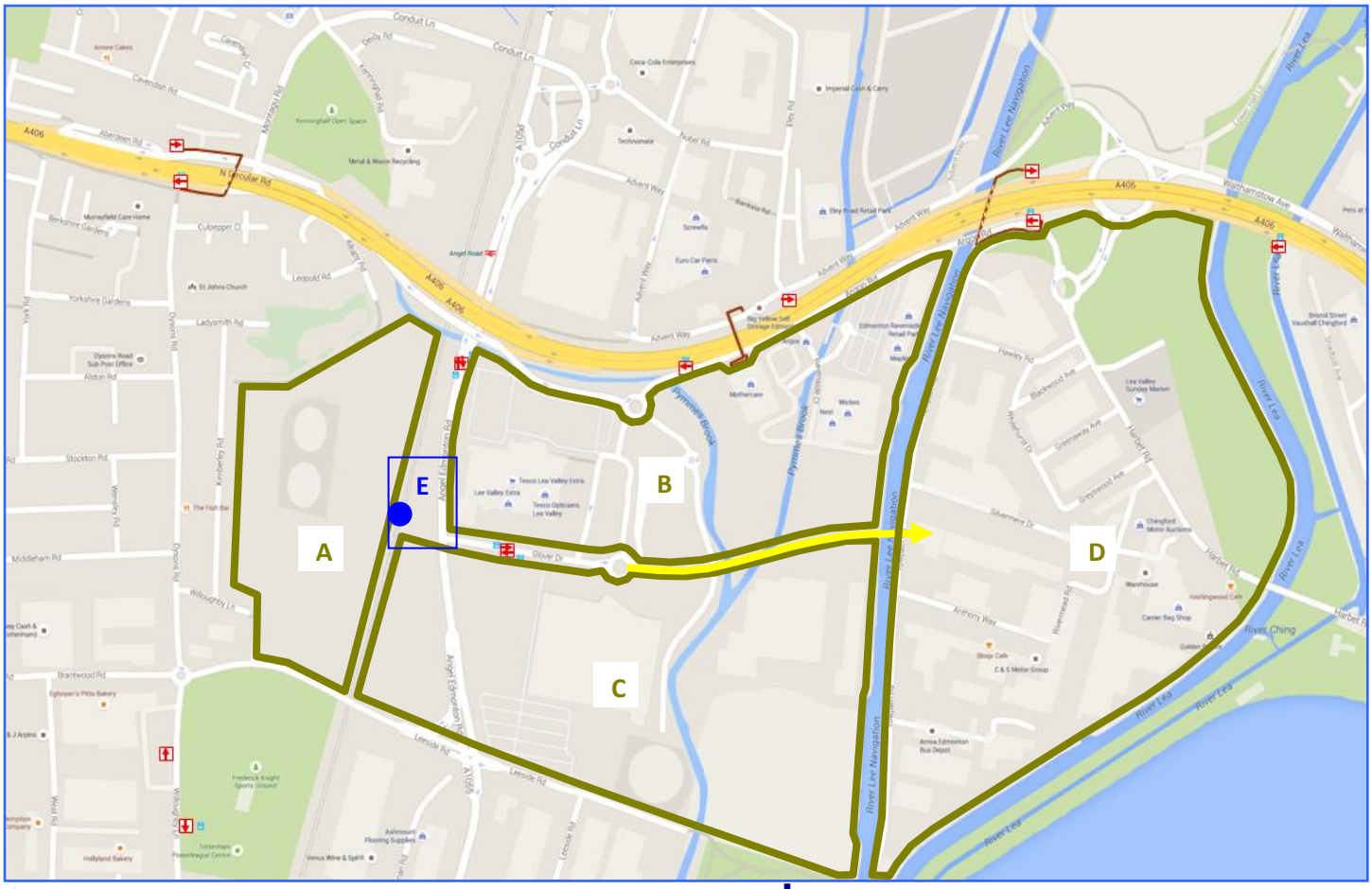
44. This situation cannot be changed without fundamental decisions to increase the bus network density and frequency, stop density, and a deliberate decision to design Meridian Water main internal routes to permit bus services to penetrate the residential areas.

45. It will also be desirable to allow good connectivity with main rail interchanges, including Meridian Water, Edmonton Green, and possibly Walthamstow Central.

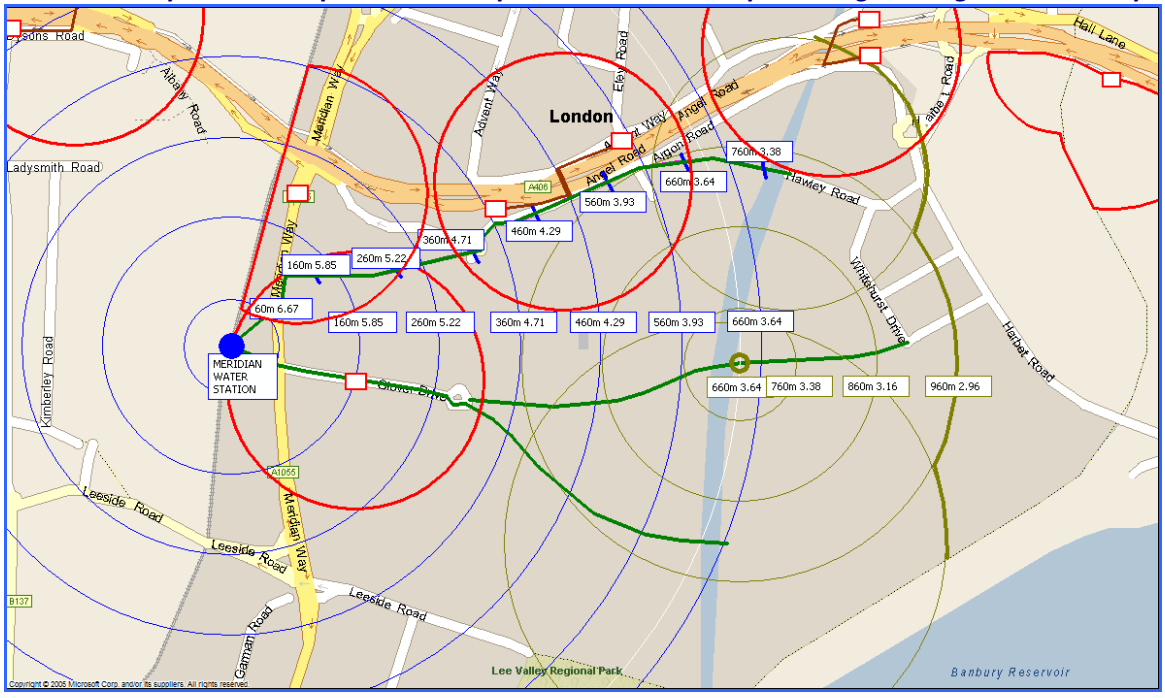
46. There are five areas to address, shown on the geographical map overleaf:
    A. Meridian Water western development area (*assuming land NW of the North Circular Road is allocated to Strategic Industrial Land – much is currently a scrap yard*).
    B. Bus stop access improvements and bus routeing along the North Circular Road corridor, including the Meridian Water eastern development area **north** of Glover Drive, **west** of the River Lee Navigation.
    C. Meridian Water eastern development area **south** of Glover Drive, **west** of the River Lee Navigation.
    D. Meridian Water eastern development area **south** of Glover Drive, **east** of the River Lee Navigation.
    E. There is also the area in the immediate vicinity of Meridian Water station, which may in due course be capable of high density development over the station.
    F. It will also be desirable to allow good connectivity with main rail interchanges, including Meridian Water, Edmonton Green, and possibly Walthamstow Central.

47. Within the map, existing bus stops are highlighted with arrows showing the direction of travel.

48. The same mapping is repeated further below with an interactive map able to show distances from bus stops and Meridian Water station. Existing stop locations are shown on this, with a 160 metre catchment overlaid (a highly accessible bus catchment, scoring high AI). Bus stops are only shown if their catchment is relevant for the Meridian Water development area.



↑ *Meridian Water development area: potential transport zones*

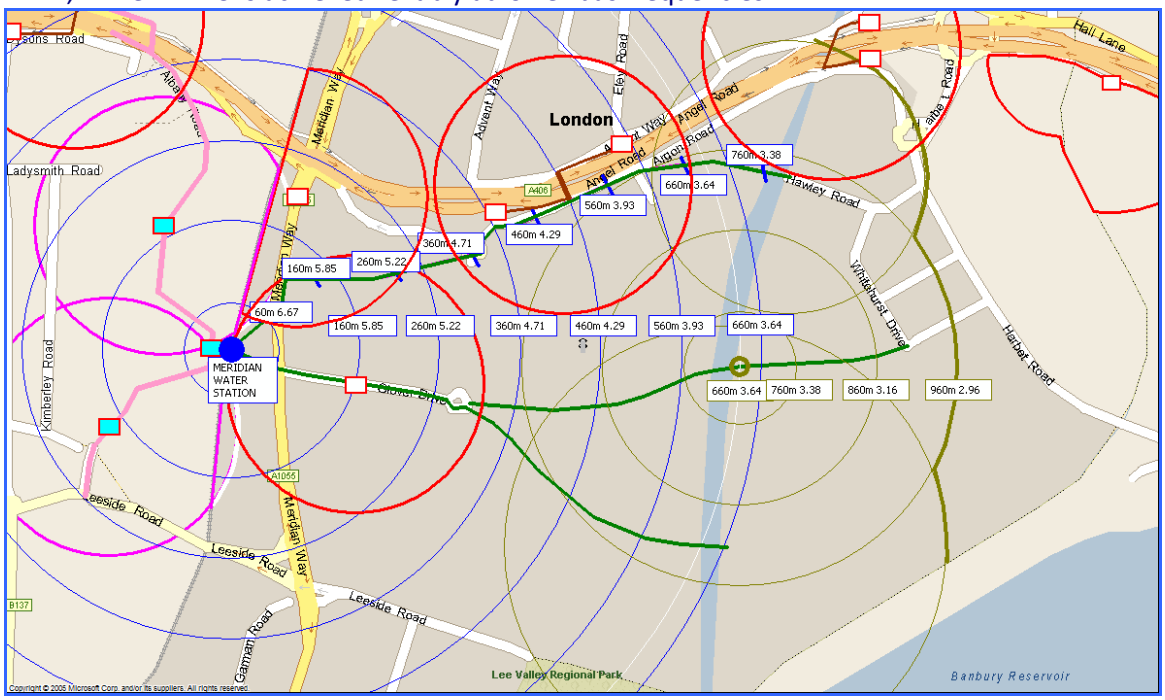


↓ *Map showing existing 160m bus stop catchments plus distances and AI for rail access*

49. A 160 metre catchment is shown from each bus stop – allowing for indirect walking distances along roads and footpaths, this is broadly equivalent to a maximum 200m bus stop access. Achieving PTAL level 3 would be subject to delivery of high bus frequency on at least one route, and operation of two other routes (so a large increase above current bus service levels), and only within the bus catchments west of the River Lee Navigation, as the rail accessibility declines quickly east of this point – because of limited bridging points. The bulk of the housing potential is unable to achieve PTAL 3; some areas are still PTAL 0, as set out in the 10th February report.

Meridian Water Transport Area A (*western MW lands****)***

50. At 4 tph, this area has a rail Accessibility Index of 5-6, so the additional bus frequencies required are less demanding to achieve PTAL 3 or 4, than some other parts of the Meridian Water area. A notional routeing is shown in the map below. It is possible that this would link north to Edmonton Green/Enfield and east into the eastern MW development area via the retail zone. A combination of moderate to high 3-route bus frequencies would achieve PTAL 4, while PTAL 3 is achieved reliably at lower bus frequencies.



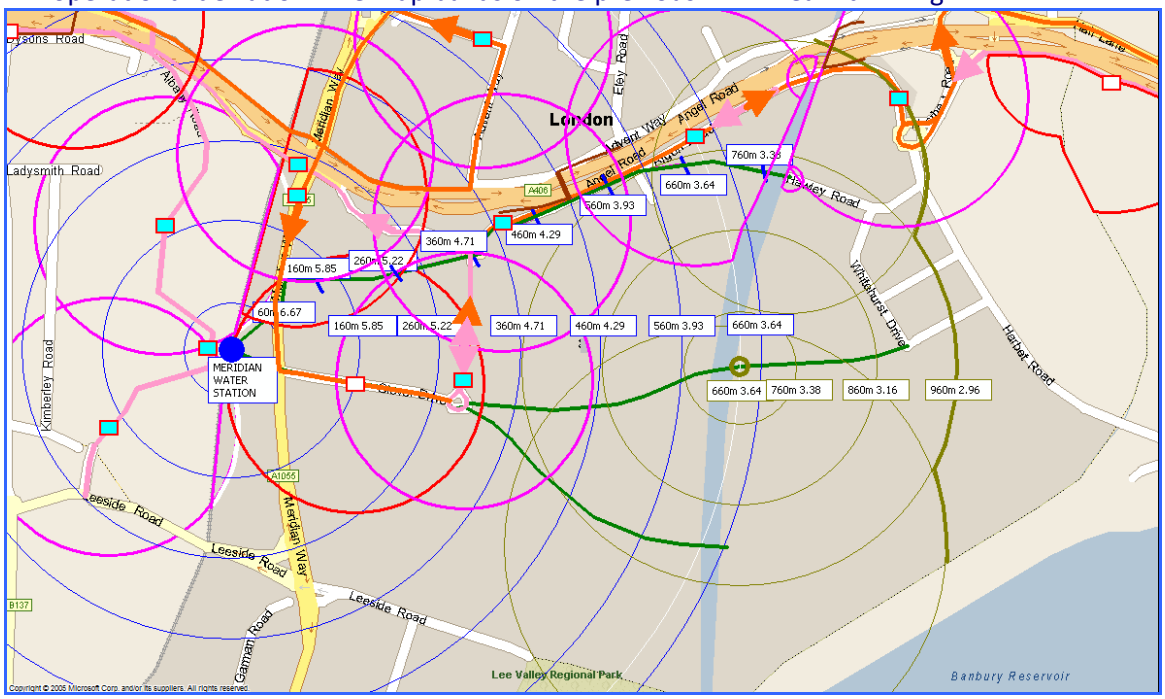
Pink: Meridian Water Transport Area A catchment

MW Transport Area B *(North Circular Road, and north of Glover Drive)*

51. There is an underlying problem for the high density housing development at Meridian Water, that the accessibility of bus stops along the North Circular Road (NCR) is poor. This is demonstrated by the dual carriageway which divides communities, and the limited crossing facilities. There JRC has averaged the bus stop catchment to be based on where pedestrians can cross the NCR.

52. It might be possible to increase bus catchment density, closer to the desired 160-210 metres (plus some overlap), if more pedestrian crossing/bridging arrangements were provided. This should be investigated. However JRC's judgment is that this cannot be seen as a satisfactory offer for a high accessibility housing community, as it can only be as good as the extent to which severance is camouflaged – the severance still exists. It can be argued instead that it is the bus routes which need to be altered, to support high MW accessibility by virtue of bus stop location and in service frequency.

53. Without multi-million costs in new road bridges capable of supporting buses (which is a further option), it is worth looking at the scope for limited bus re-routeing irrespective of frequency, for the NCR 34 and 444 bus routes. The following proposition is put forward in the map below, to enable better access within Meridian Water without incurring large-scale operational deviation. The map builds on the previous MW Area A thinking:



***Pink*: Meridian Water Transport Area A, and Area B (North Circular Road element)**

54. The proposition is that all NCR buses should run via the Glover Drive 'IKEA Central' roundabout, but that access to the suggested bus stop (N of the roundabout) should be (**EB orange arrow**) left off NCR via Advent Lane then onto Conduit Lane and Meridian Way to IKEA, while, from the Waltham Forest direction buses both ways (**WB pink arrow**) should use Argon Road (westbound, buses then return immediately to the NCR having served the 'IKEA Central' roundabout stop).

55. Two-way stops would be sited appropriately to maximise the catchment, including two or three on Argon Road (three are shown) and one WB on the NCR near Meridian Way (improved pedestrian access required). The EB bus could serve Meridian Way directly, and also offer a stop within the NE industrial zone adjoining Advent Way.

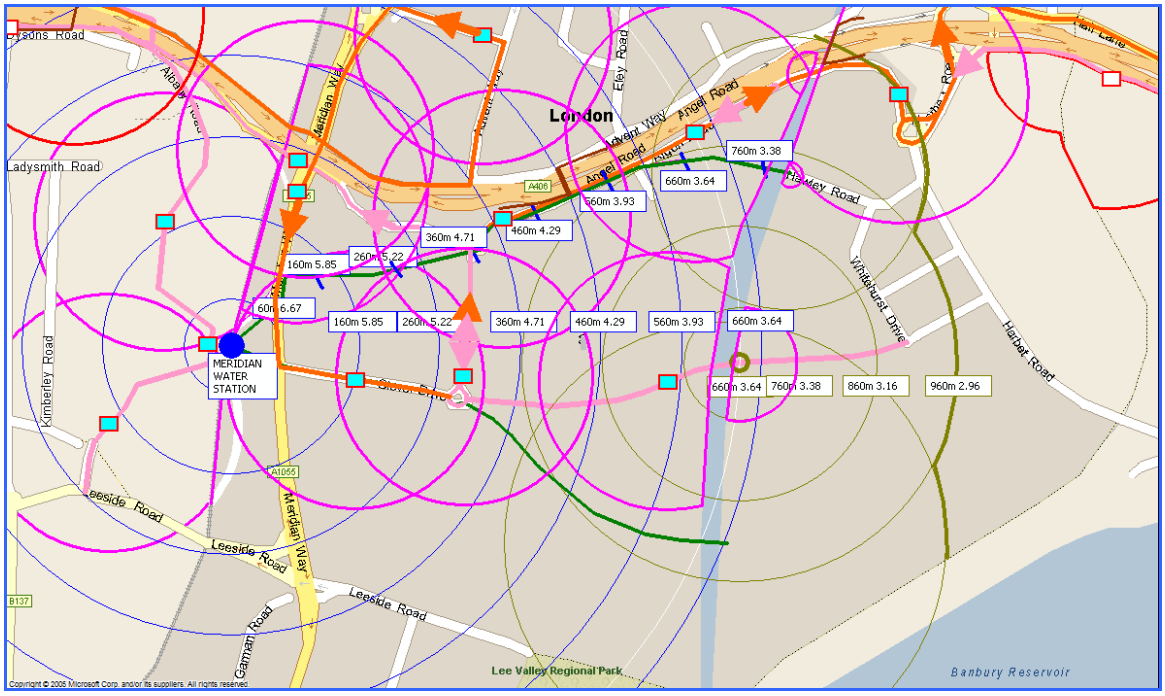
56. This option would require a few 'bus-preference' road works, with general traffic excluded, eg along Advent Way and from the 'IKEA Central' stops to/from Argon Road. The bus re-routeing does NOT address service frequencies required to achieve PTAL 3 or 4, but is intended to show how the existing NCR routes could possibly be adapted (subject to TfL agreement) to enhance the PTAL volumes within Meridian Water. Re-routeing would, importantly, also enable access between MW and cross-Lea Valley locations such as Walthamstow Central and Chingford.

57. If re-routeing of the NCR bus services via Argon Road were not accepted by TfL Surface Directorate, then a different outcome might materialise – or might be worthwhile in any event.

58. The proposition is that good housing access north of Glover Drive will rely on three choices:
    B1. Argon Road (ex NCR routes) plus the 'Causeway' corridor as the main bus routes.
    B2. NCR, inadequately if 'as is', plus the 'Causeway'.
    B3. An intermediate bus-only corridor between NCR and Glover Drive, with good access inwards to bus stops along that route.

59. In masterplanning, the housing choices are whether the preferential corridors for pedestrian flow are 'outwards', towards existing routes such as NCR and Glover Drive, or 'inwards' towards a new intermediate corridor supporting high-frequency public transport. Choices about this will have a knock-on impact on the later MW options, C and D.

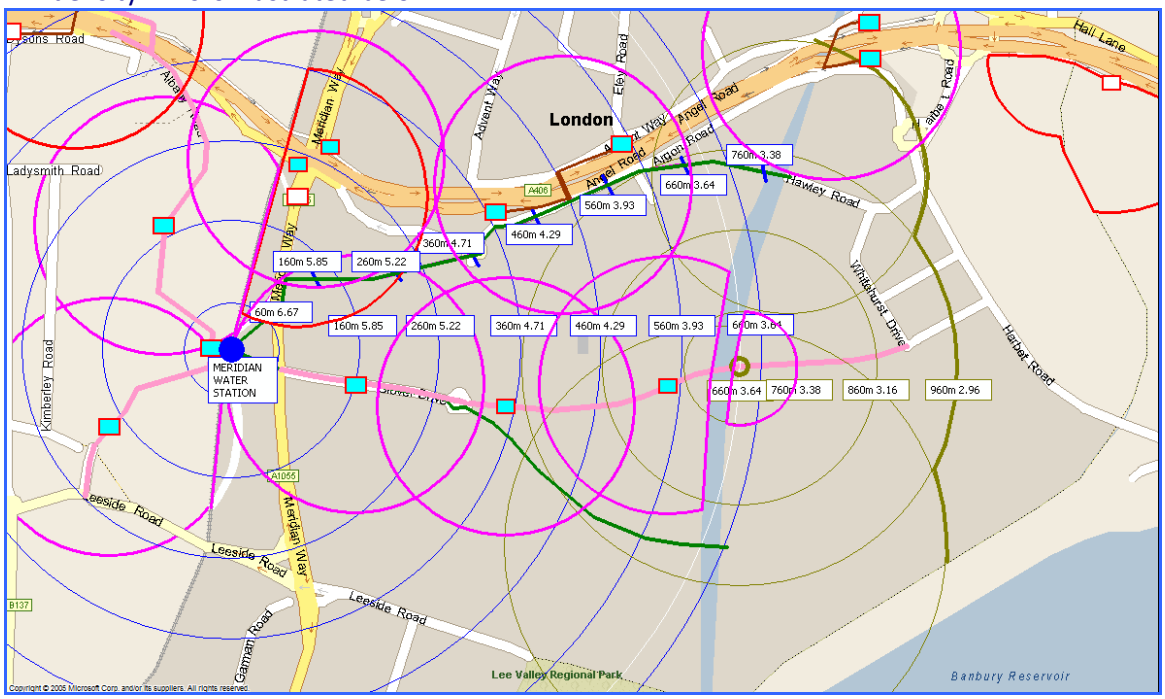
60. The mapping above shows the NCR element of **Option B1**. Combined with possible high frequency stops along Glove Drive and a bus-compatible Causeway eastwards, the stop catchment for Area B could look like this:



***Pink*: Meridian Way Transport Areas A and Option B1**

61. This gives a catchment overlap for some housing, between the NCR and Glover Drive/ Causeway. In those cases, the PTAL methodology only focuses on the better service volume – it is not possible to count the overlap as a doubly-served zone unless the different catchments are separate bus routes. So the overall PTAL level depends on the combination of rail Accessibility Index (an AI range of 3-6), and bus AI, where the bus AI at locations towards the River Lee Navigation would need to achieve at least 6-7 to qualify as PTAL 3, and at least 11-12 to achieve PTAL 4.

62. **Option B2** offers no change to the present stopping pattern along the North Circular Road (with one exception, a stop in both directions on the slip road over Meridian Way, which requires improved pedestrian access – locations for bus bays exist already). This option relies mainly on Glover Drive/Causeway to achieve an adequate bus stop frequency and density. This is illustrated below:



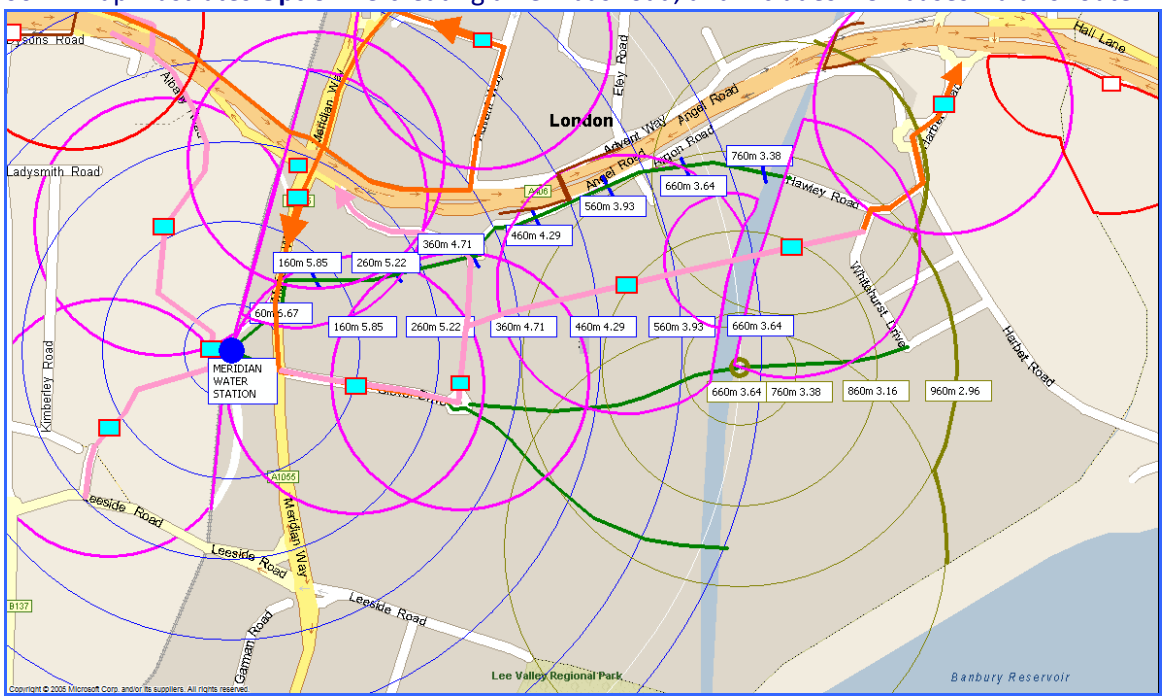
63. There is a less comprehensive bus stop catchment coverage along the NCR, though this may be compensated by ability to increase service levels, or by acceptance of lower stop density. The accessibility of the NCR services would be hindered by the severance arising with the dual carriageway. General accessibility of bus services between Meridian Water and travel objectives such as Walthamstow Central could be impaired by the absence of through NCR buses serving 'IKEA Central'. However the required new MW bus services (to achieve the desired PTAL) might themselves run through to such travel objectives.

64. **Option B3** would ignore the NCR entirely, and instead proposes a bus-only corridor on new roads, in-between the NCR and Glover Drive/Causeway. This is an option to consider if it were desired to keep the Causeway as pedestrian/cycling-only. It would require additional bridging of the River Lee Navigation. It would also cause housing access routes to face in several directions, depending on the mode of access. It is possible that NCR bus services

could be diverted (as above), and then routed to use the bus-only corridor. That could have the benefit of increasing service volume, frequency and accessibility to other destinations, on what otherwise might be an internalised bus service connecting Meridian Water developments with places such as Edmonton Green and Enfield (which may be required, but will not be the full range of preferred destinations).

65. The corollary might be a requirement to serve the industrial estates to the north of the NCR with a separate service, although the EB NCR buses could serve it.

66. A map illustrates **Option B3** creating a new bus road, and includes NCR buses via this route:

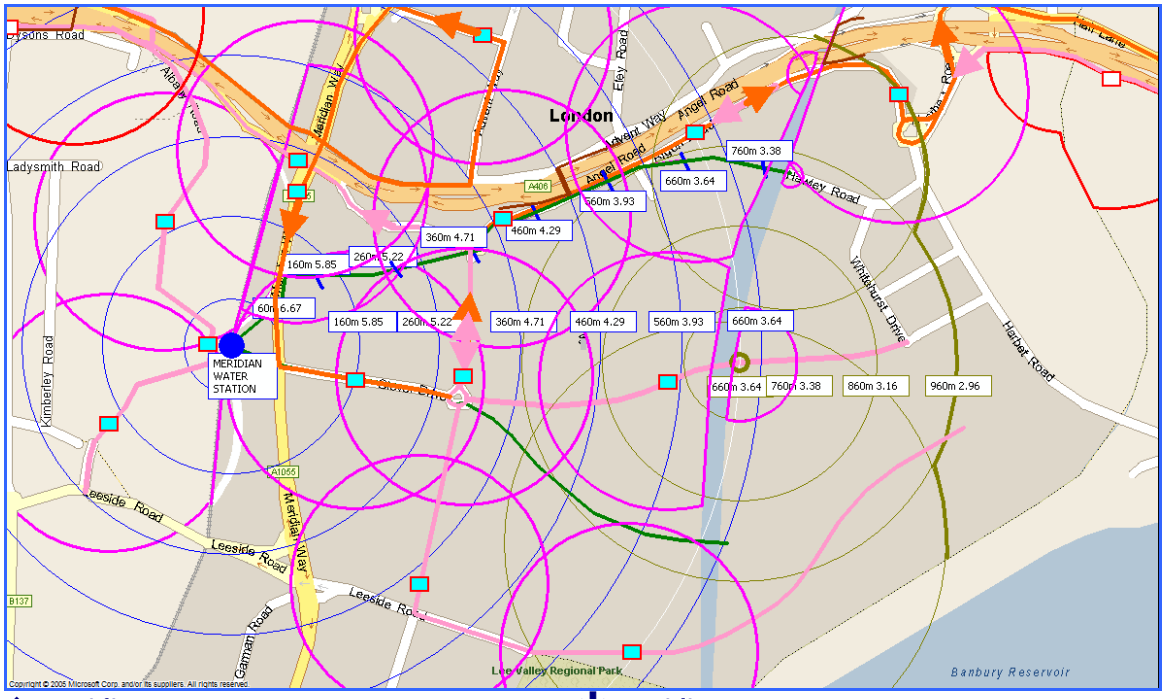


67. This looks an efficient means of maximising user and service density along a bus corridor, providing that housing density can be arranged appropriately.

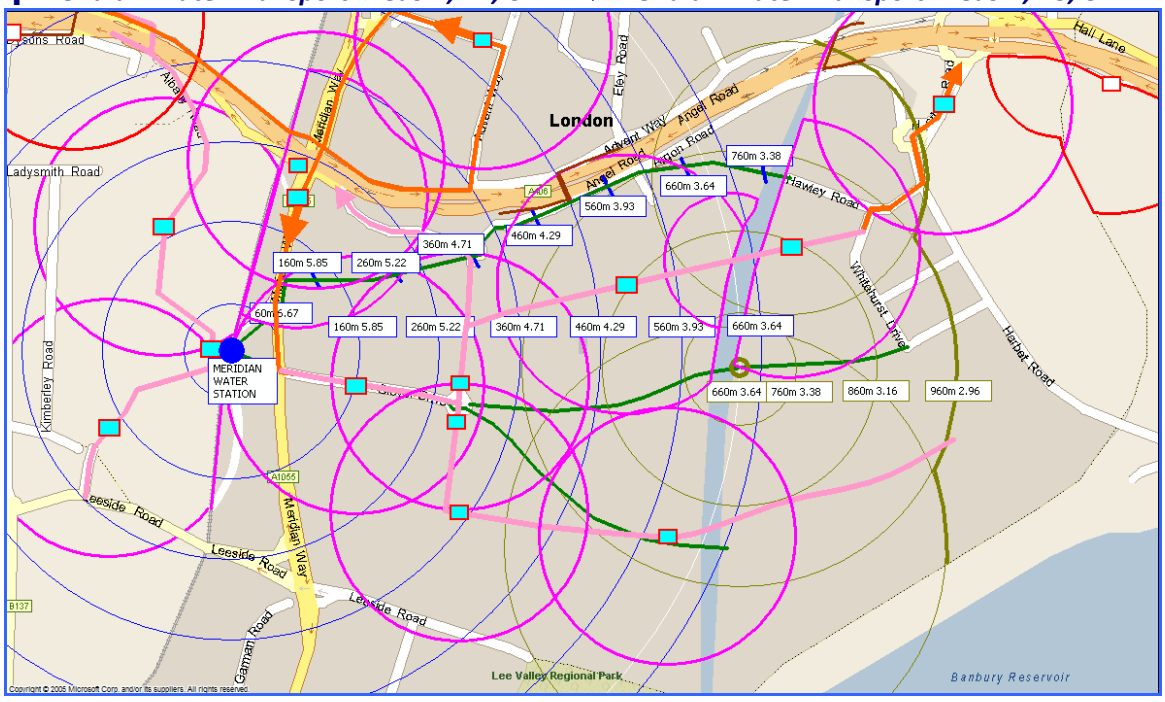
MW Transport Area C *(south of Glover Drive, west of River Lee Navigation)*

68. There is a binary choice for Area C, which is led by the choices adopted for Area B. These are:
    C1: To complete an '**E**' layout for main bus routes, with the middle and lower eastern 'limbs' of the '**E**' being Glover Drive/Causeway, and an extended Leeside Road.
    C2: To continue the creation of a busway loop in-between these two roads.

69. There is a requirement throughout this part of Meridian Water for high volume bus services (rail AI in Area C is a range of 3-6). Dispersing this need over two main bus corridors rather than one will be inefficient. This situation complements the MW geography already seen in Area B. It may be more efficient to support a bus loop, Option C2, rather than C1. Serving Leeside Road also increases coverage of protected parts of the Lee Valley Regional Park and other locations outside Meridian Water development area, rather than the housing areas:



↑ ***Meridian Water Transport Areas A, B1, C1*** ↓ ***Meridian Water Transport Areas A, B3, C2***



MW Transport Area D *(east of River Lee Navigation)*

70. If the objective is to increase local housing density, the fundamental difficulty with Area D is its distance from the railway station at Meridian Water. Much of the area remains within a 960 metre walking distance, as shown above even after the impact of crossing the river and its navigation.

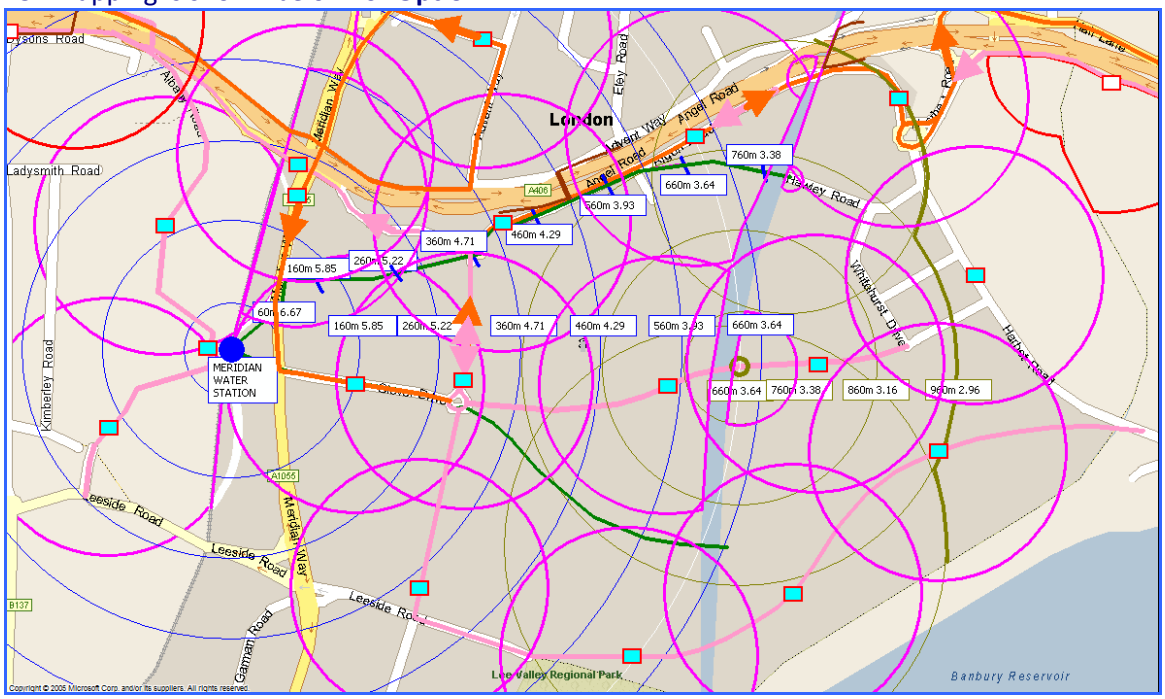
71. Rail AI, where relevant, will be in the low 3.decimal to high 2.decimal, at 4 tph. In general the rail Accessibility index level is much diminished, around 2-3, with some areas excluded from the catchment because they exceed the PTAL rules. So bus services must achieve the bulk of accessibility, measured as a PTAL level (3, or 4), and especially in terms of basic service volume to compensate for the rail deficiency.

72. Consequently, in Area D buses must achieve AI levels of 7-10, to enable the area to achieve sufficient accessibility to qualify even as PTAL 3. This is a challenge, and points to a major requirement for high bus accessibility (assuming that it is intended to define this area as fit for high density housing). When rail exceeds its 960 metre PTAL limit, the bus requirement will be an absolute.

73. Based on the earlier modelling, a high frequency of bus stops must be used to assist here. Long distances to reach bus stops will deny the area its development possibilities.

74. The main access options which are available are
    D1. Use Leeside Road in conjunction with Glover Drive/Causeway (extending Option C1).
    D2. Extend Option C2 with an internal loop.

75. Mapping is shown below for **Option D1**:

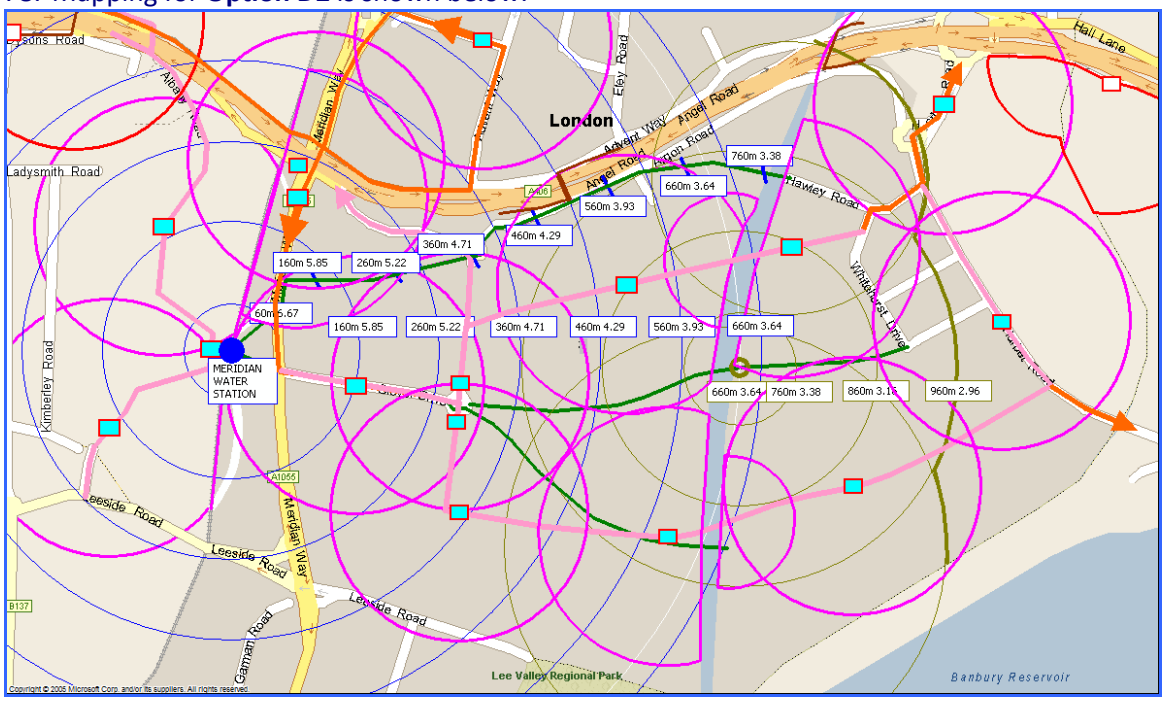


Meridian Water Transport Areas A, B1, C1 - plus Area D as an extension of B1 and C1

76. The onwards eastern options for routes via Glover Drive/Causeway and via Leeside Road are unclear within the specific context of Meridian Water. Connections to NCR via Harbet Road would rely either on a lengthy route via the roundabout near Lower Hall Lane [at the NE corner of the map], or a new EB junction to be created near Folly Lane (closer to Crooked Billet).

77. There is an increasing area of overlap between bus stops in the eastern part of the Meridian Water catchment with Option D1. This is generally an indicator that the suggested routeings are becoming inefficient, although there is also compression locally of the available catchment area so that bus corridors are likely to converge.

78. Mapping for **Option D2** is shown below:



Meridian Water Transport Areas A, B3, C2 - plus Area D as an extension of B3 and C2

79. This offers completion of a high service frequency multiple-stop bus loop through the Meridian Water development, as shown above. It might be complemented by a through bus service (eg Edmonton-Walthamstow) on the southern loop road, subject to the junction issues with the NCR as discussed above. There is less overlap between bus stop catchments with this option.

MW Transport Area E *(oversite development at Meridian Water station)*

80. The case for oversite development will be driven by several factors:
    - Land values, which may currently be too low to justify high structural costs.
    - Rail service frequency, with the case for 6 tph potentially both cause and consequence of an oversite development.
    - Bus service frequencies and accessibility, with stops required close to the station to maximise the Accessibility Index and hence PTAL
    - Masterplanning for Meridian Water featuring this location for high development density.

81. The modelling tables above show that a 3-bus route network with at least one high frequency bus service, allied to a 6 tph rail service, has the potential to achieve PTAL 4 in the proximity of Meridian Water station.

Scope for cycling to raise Accessibility Index levels

82. The use of cycling as a means of speeding access to and from Meridian Water station, should assist the AI scope, as the Index is a function of journey time between the transport service and the development location.

83. TfL does not yet attempt to measure cycling access to a station for AI purposes. It is proposed to show here the possible advantages of cycling, and how this could benefit AI. Because cycling will be a virtual extension of the station, it is possible to gauge the potential usage as a % of station users, which should increase AI from distant locations.

84. The judgments which are required are:
    - Comparative start/finish times for the station as a foot passenger compared to a cyclist. From the station entry/exit point, a cyclist may need to walk to a specific cycle rack, and don headgear/hi-vi, place light luggage on the cycle, and at times of darkness deal with lights, before heading away (and v.v. for the opposite journey).
    - Average cycling speed compared to walking.
    - Putting the cycle away (or v.v. retrieving it, etc) at the other end of the access sector.

85. Essentially there will be a start/finish penalty time for a cyclist, compared to walking, but over a distance the cyclist will have a time advantage. The 12 minute access limit applied with PTAL for pedestrian access to a station is therefore maintained, but with a 3 minute cumulative penalty applied for each journey (allowing 1½ minutes at each end). This enables 9 minutes of useful cycling time.

86. A slow 10 mph will also allow for junctions/intersections/other road users. It converts to a maximum cycling catchment of 2,640 metres. This is 2.75 times the extent of a station walking catchment, and is much greater than the maximum distance from the station within any part of Meridian Water (about 1,200 metres).

87. Taking two examples of cycling volume, at 10% and 20% of station access volume (and walking at 80-90%), shows the following improvement in AI values over a 960 metre catchment:

Rail service at 4 trains per hour, walking at 80 metres/minute, cycling at 10 miles per hour																									
Walk minutes from station	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5	8	8.5	9	9.5	10	10.5	11	11.5	12
Walking distance (metres)	40	80	120	160	200	240	280	320	360	400	440	480	520	560	600	640	680	720	760	800	840	880	920	960
Accessibility Index, walking	4.62	4.48	4.35	4.23	4.11	4.00	3.90	3.80	3.70	3.61	3.53	3.45	3.37	3.30	3.23	3.16	3.09	3.03	2.97	2.91	2.86	2.80	2.75	2.70
Accessibility Index, cycling	0	0	0	4.59	4.55	4.51	4.47	4.43	4.39	4.35	4.31	4.28	4.24	4.21	4.17	4.14	4.10	4.07	4.04	4.00	3.97	3.94	3.91	3.88
If cycle proportion is X%:	10%	(and assumed cycling NOT used for first 1½ minutes distance)																						
Walking AI = 90%	4.62	4.48	4.35	3.807	3.699	3.6	3.51	3.42	3.33	3.249	3.177	3.105	3.033	2.97	2.907	2.844	2.781	2.727	2.673	2.619	2.574	2.52	2.475	2.43
Cycling AI = 10%	0	0	0	0.459	0.455	0.451	0.447	0.443	0.439	0.435	0.431	0.428	0.424	0.421	0.417	0.414	0.41	0.407	0.404	0.4	0.397	0.394	0.391	0.388
Combined, proportioned AI	4.62	4.48	4.35	4.27	4.15	4.05	3.96	3.86	3.77	3.68	3.61	3.53	3.46	3.39	3.32	3.26	3.19	3.13	3.08	3.02	2.97	2.91	2.87	2.82
Net gain in AI with cycling %	**0.00**	**0.00**	**0.00**	**0.04**	**0.04**	**0.05**	**0.06**	**0.06**	**0.07**	**0.07**	**0.08**	**0.08**	**0.09**	**0.09**	**0.09**	**0.10**	**0.10**	**0.10**	**0.11**	**0.11**	**0.11**	**0.11**	**0.12**	**0.12**
If cycle proportion is X%:	20%	(and assumed cycling NOT used for first 1½ minutes distance)																						
Walking AI = 80%	4.62	4.48	4.35	3.384	3.288	3.2	3.12	3.04	2.96	2.888	2.824	2.76	2.696	2.64	2.584	2.528	2.472	2.424	2.376	2.328	2.288	2.24	2.2	2.16
Cycling AI = 20%	0	0	0	0.918	0.91	0.902	0.894	0.886	0.878	0.87	0.862	0.856	0.848	0.842	0.834	0.828	0.82	0.814	0.808	0.8	0.794	0.788	0.782	0.776
Combined, proportioned AI	4.62	4.48	4.35	4.30	4.20	4.10	4.01	3.93	3.84	3.76	3.69	3.62	3.54	3.48	3.42	3.36	3.29	3.24	3.18	3.13	3.08	3.03	2.98	2.94
Net gain in AI with cycling %	**0.00**	**0.00**	**0.00**	**0.07**	**0.09**	**0.10**	**0.11**	**0.13**	**0.14**	**0.15**	**0.16**	**0.17**	**0.17**	**0.18**	**0.19**	**0.20**	**0.20**	**0.21**	**0.21**	**0.22**	**0.22**	**0.23**	**0.23**	**0.24**

88. This is not a large change, with AI up 0.04-0.12 with 10% cycling, and up 0.07-0.24 with 20% cycling. It is unlikely to make any significant difference at locations close to the station. However a quarter point increase at the further distances could be termed as '*every little helps*', where the PTAL level might be close to but not quite achieving PTAL 3 or 4.

89. Enfield Council should therefore explore the potential for easy cycling access and adequate cycle parking facilities at Meridian Water station.

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