Aberdeen City Centre Paramics Model Audit

Aberdeen City Centre Paramics Model Audit Report

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Document history and status

Revision	Date	Description	Author	Checked	Reviewed	Approved
A	24/04/20	Draft for review	LB	NR	GD	GD
B	19/06/20	Revised draft following receipt of full Base model and updated to include model developer comments from Revision A	LB	NR	GD	GD

Contents

1. Introduction

1.1 Background

In 2019, Aberdeen City Council (ACC) commissioned the upgrading of the existing Base 2012 Aberdeen City Centre Paramics Model to facilitate the assessment of the impact of a Low Emissions Zone (LEZ) in Aberdeen.

The primary purpose of the new model is to provide output data for use within the Atmospheric Dispersion Modelling System (ADMS) air quality model and to support and inform the delivery of ACC's LEZ. The new model has been developed with the intention of assessing the air quality impact of numerous land-use and infrastructure developments in the future within Aberdeen. Its secondary purpose, therefore, is to identify locations and scope of any additional infrastructure required to accommodate the traffic demand associated with the development planned within the study area.

In September 2019, Jacobs was asked by ACC to review the 2019 base model, developed by Systra using Paramics Discovery Version 23. Jacobs received an interim version of the base model network in March 2020, with the final version received in May 2020.

1.2 Audit Scope

The objective of the review process was to provide confirmation that the Aberdeen City Centre Paramics Base model is sufficiently robust to be used for informing the development of the LEZ.

The remit of this audit commission covers:

- A full review of the 2019 base Paramics Discovery model network coding, model demand, calibration & validation and Public Transport provision;
- Presenting the results of the audit to the client or the general public (at an inquiry or consultation), if required; and
- Attending client meetings, if required.

This review has provided commentary on where potential issues have been identified with the base model development. Where appropriate, further information for clarification has been requested, or potential solutions to issues have been suggested.

2. Model Review

2.1 Model Background

The 2019 base Aberdeen City Centre Paramics Discovery Model, supplied to Jacobs in March 2020 (with an updated version supplied in May 2020), has been subject to an audit.

An initial version of the associated Model Development Report, *Aberdeen City Centre Paramics Discovery Model 2019 Model Development Report (Draft), Systra, 26th February 2020*, was received on 27th February 2020. An updated version of the report *Aberdeen City Centre Paramics Discovery Model 2019 Model Development Report (Draft2), Systra, 20th May 2020*, was received on 20th May 2020.

2.2 Base Network Review

Various elements of the model have been reviewed as part of this initial audit, with the salient results of the review reported.

For each element reviewed and reported on, the auditor provided some initial comments detailing any issues identified. These were then passed to the developer for review, with developer comments subsequently sent back to the auditor.

Following a review of the developer comments, additional comments have been added by the auditor, with any required further actions (for the developer) and a level of risk also documented.

The outcome of the review is detailed below.

Table 2.1 Base Network Review

Review Aspect	Auditor Comments	*Model Developer Comments*	Further Auditor Comments	Further Action Required / Risk
Model Coverage	The model covers approximately 20km^2, including the entire city centre of Aberdeen. To the north, the A92 extends to just north of the Bridge of Don, and to the south it extends as far as Nigg. The A96 to the northwest extends as far as Buckhead and Bucksburn, and Anderson Drive (A92) represents the western edge of the model. The model covers three time periods: ▪ 07:00 – 10:00 (with a prior 30 min 'warm up' period) ▪ 10:00 – 16:00 ▪ 16:00 – 19:00 The geographical coverage and time periods of the base model appear to be appropriate, taking cognisance of the purpose of the model. The model has been developed in Version 23.0.1 of the Paramics Discovery software. This is the latest version of the software and is therefore considered appropriate.			Further actions: **None** Risk: **None**
Basic Network Structure	The position and type of each node and link along with their associated parameters comprise the fundamental structure of the Paramics road network.		**An additional item (*Issue NS3*) has been recorded and requires a response from the model developer.**	Further actions: **Model updates and**

Review Aspect	Auditor Comments	*Model Developer Comments*	Further Auditor Comments	Further Action Required / Risk
	A visual review of this network indicated that all node positions appear to be acceptable and are representative of the extents of the model. It is noted that all nodes are coded correctly as either Normal or Roundabout type nodes. ***Issue NS1*** Clarification required why a number of roads are not fully modelled, with consideration given to their inclusion. Whilst it is appreciated this has likely been done to limit rat-running in certain areas of the model, artificially limiting route choice in the model has the potential to misrepresent traffic patterns at some locations. Consideration should be given to the inclusion of the following links: ▪ **University Road**, **Orchard Street** and **Merkland Terrace** – it is acknowledged that these are relatively minor roads, however they are valid links between College Bounds and the A956 and would provide some useful route choice between these two corridors. ▪ **Leslie Terrace** – this is a valid one-way (northbound) route from the A944 to the A96, with a missing section in the model. Links 3297:3299 and 3299:3701 should be one-way (northbound) links with the missing connection included (or justification why Leslie Terrace is not fully modelled).	***Issue NS1*** *The developer feels that the coverage of the model is appropriate for the application of the model in that the network is detailed in the city centre and intentionally less detailed further from the centre.*	***Issue NS1*** It is noted that, following further consideration, the developer has declined to revise the model coverage, as the current level of coverage is considered adequate. The auditor is satisfied that the developer has reviewed the model coverage and accepts the current model coverage.	**clarification required** Risk: **Low**

Review Aspect	Auditor Comments	*Model Developer Comments*	Further Auditor Comments	Further Action Required / Risk
	▪ **Smithfield Road** – this would be an obvious rat-run for the major road, however by using the correct modelling parameters (i.e. low speed) this could be controlled. ▪ **Weigh-House Square** – in addition to including this, the speed on Weigh-House Square could be reduced to 15mph to avoid rat-running). ▪ **Riverside Terrace**– although it is noted this is a relatively minor road, there is little connectively between the A945 and A9013 in this area, so inclusion of this link would provide some useful route choice between these two corridors. ▪ **Linksfield Road** and **Regent Walk** – there is a large gap in the model limiting east-west movements in this area, as several streets are not modelled. Whilst it is not considered necessary to include all these streets, the addition of these links would be useful to provide traffic on Golf Road and the A956 with more route choice between the corridors. ▪ **Sunnybank Road** and **Bedford Place** – similarly to the above, it is noted there is a large gap limiting the ability of traffic to travel east-west between Bedford Road and Spital. Consideration should be given to providing a connection between Sunnybank Road and Bedford Place (moreover, this passes a school and so is likely to be an attracter of traffic at certain times). ▪ **Fraser Place** – the addition of this link would be useful as it is very close to a major signalised junction and			

Review Aspect	Auditor Comments	*Model Developer Comments*	Further Auditor Comments	Further Action Required / Risk
	appears to be a valid way of travelling from George Street to the A96. ***Issue NS2*** Clarification required regarding how the zone loading proportions have been derived. It is noted that some zones have an even distribution of traffic using each demand loading portal, whilst other zones load varying levels of traffic at each portal. See example below: Zone 60 – five portals, with traffic distributed 14%, 16%, 16%, 22% and 32%. Zone 64 – two portals, with traffic distributed 50% at each. ***Issue NS3*** Link 341:340 should be a one-way northbound link.	***Issue NS2*** *Zone portal percentages have been approximated based on the relative attractiveness of the links. This will be documented in the report.*	***Issue NS2*** It is not clear from the Model Development Report how specific zone portal percentages have been derived. Therefore, further clarification is required.	
Categories and Speeds	Link categories and speeds identify how vehicles travel between nodes within the network; varying categories and speeds have a direct effect on route choice and associated costs. It is noted that all links in the model are set to Urban. Based on the urban nature of the model location, this appears to be acceptable.		**The auditor notes that a significant number of additional categories have been added since the initial audit, and these have been reviewed. It is noted that a number of category cost factors differ from the default value (1). The values used have been checked against those reported in the Model Development Report.**	Further actions: **Clarification required** Risk: Low

Review Aspect	Auditor Comments	*Model Developer Comments*	Further Auditor Comments	Further Action Required / Risk
	A review of the speeds applied to each Category has been undertaken, along with a review of the Road Class (i.e. major/minor) used. Link speeds and speed change points have been compared with street level mapping to ensure that vehicles obey the appropriate speed limit on each section of the network. ***Issue CS1*** Clarification required on the use of speeds by vehicle type – it has been noted that speeds are the same for all Vehicle Types on each Category – this has the potential to lead to overestimating freight speeds, particularly on the 70mph Category (HGVs limited to 50mph on dual-carriageways in Scotland). ***Issue CS2*** Clarification required on the justification for use of a 1.5 cost factor for the Urban Minor 20mph Category. It is noted this is the only Category to have a cost factor different from the default of 1.0. ***Issue CS3*** It is noted that some residential streets (e.g. Rosehill Place, Hayfield Crescent) have 30mph speed limits applied. However, it is unlikely this speed could be achieved (due to road width, on-street parking, traffic calming measures, etc.)	***Issue CS1*** *Heavy vehicles have been limited to a maximum of 50mph.* ***Issue CS2*** *Since the initial model was sent in February, a number of category cost factors have been altered, these will be documented in the report.* ***Issue CS3*** *Both examples given are of zone accesses and the speed limit coded on these will have no impact on model operation.*	**An additional item (*Issue CS5*) has been recorded and requires a response from the model developer.** ***Issue CS1*** The auditor is satisfied this has been added to the model. ***Issue CS2*** The auditor notes there have been several additional categories added, with some existing ones amended, and is satisfied these are as documented in the report. ***Issue CS3*** It is noted that speed limits are coded as signposted, and it is accepted that any potential discrepancies between link speed	

Review Aspect	Auditor Comments	*Model Developer Comments*	Further Auditor Comments	Further Action Required / Risk
	on these links and, therefore, consideration should be given to reducing these speeds to 20mph to better reflect anticipated actual traffic speeds. ***Issue CS4*** Orchard Street has a modelled speed limit of 30mph, however street-level mapping indicates the speed limit is 20mph on the ground. It is recommended this is checked and amended as required. ***Issue CS5*** A number of categories have names and speed limits that are inconsistent with each other. Clarification required regarding these inconsistencies: ▪ *Urban Major 20mph Esplanade* has a speed limit of 30mph; ▪ *Urban Major 30mph Skene St* has a speed limit of 20mph; and ▪ *Urban Major 30mph Holburn St* has a speed limit of 25mph.	*In general speed limits are coded as signposted unless data/observations suggest otherwise.* ***Issue CS4*** *It appears as if this is signposted as 30mph, however as it is a zone access then the speed limit used will not impact model operation.*	limit and achievable speed are located at zone accesses, and that this will have a negligible effect on model operation. Therefore, the auditor is satisfied that these speeds remain unchanged. ***Issue CS4*** This is acceptable.	

Review Aspect	Auditor Comments	*Model Developer Comments*	Further Auditor Comments	Further Action Required / Risk
Lane Configuration and Kerbs	A review was undertaken of the number and width of lanes on each modelled link. It was noted at several locations that the number of lanes on a link varied from on the ground (according to street-level mapping). These locations have been highlighted in this section for review. It was also noted that several lanes were coded wider than suggested on street-level mapping. Whilst it is acknowledged that minor discrepancies in lane widths are likely to have a negligible effect on the operational performance of the model, consideration should be given to lane width amendments at locations where the modelled lane width varies significantly from the usable width on the ground. ***Issue LC1*** Link 711:698 (roundabout link at B9077/ West Tullos Road/ Provost Watt Drive) is modelled as a single lane of width 13.50m. On the ground, this roundabout link comprises a significant area of hatching, with the actual usable road width approximately 4m.	***Issue LC1*** *The kerb and lane point positions have been altered as appropriate.*	**An additional item (*Issue LC8*) has been recorded and requires a response from the model developer.** ***Issue LC1*** The auditor accepts the kerb and lane point positions have been corrected at the specific link referred to in *Issue LC1*. However, it is suggested that the kerb placement (and trajectories) around the entire B9077/ West Tullos Road/ Provost Watt Drive junction be reviewed, as a number of kerb points could be positioned more accurately.	Further actions: **Model Updates required** Risk: **Low**

Review Aspect	Auditor Comments	*Model Developer Comments*	Further Auditor Comments	Further Action Required / Risk
	Issue LC2 Link 2865:2864 (roundabout link Hilton Drive / Hilton Street / Cairncry Road / Westburn Drive) is modelled as a single lane of width 12.2m. The stopline on Hilton Drive is pushed forward from the leading edge of the traffic island with an area of hatching, so that the actual usable road width on this link is approximately 8m.	***Issue LC2*** *The kerb and lane point positions have been altered as appropriate.*	***Issue LC2*** This has not been done.	
	Issue LC3 Link 1037:1033 (roundabout link at Hutcheon Street / A96) is modelled as a single lane of width 8.50m. On the ground, this roundabout link comprises a significant area of hatching, with the actual usable road width approximately 4m.	***Issue LC3*** *The kerb and lane point positions have been altered as appropriate.*	***Issue LC3*** The auditor is satisfied this has been amended as appropriate.	
	Issue LC4 Link 3533:254 & 3535:254 (South College Street approaching junction with Millburn Street / Palmerston Place) are both modelled as two-lane links of total width 4m. Observations of traffic queuing at these approaches using street-level mapping suggest these links operate as single-lane links, with an approximate width of 4m.	***Issue LC4*** *The two lane sections used here are to allow right turning vehicles at the junctions to sit without blocking straight ahead traffic. This matches observed conditions.*	***Issue LC4*** This is acceptable.	
	Issue LC5 Link 3537:1000 (Watson Street approaching junction with A944) is modelled as a two-lane link of total width 3.65m. Observations of traffic queuing at this approach using street-	***Issue LC5*** *The two lane sections used here are to allow right turning vehicles at the junctions to sit*	***Issue LC5*** This is acceptable.	

Review Aspect	Auditor Comments	*Model Developer Comments*	Further Auditor Comments	Further Action Required / Risk
	level mapping suggests this link operates as a single-lane link, with an approximate width of 3.65m. ***Issue LC6*** Link 3544:1419 (Whitehall Place approaching junction with Esslemont Avenue) is modelled as a two-lane link of total width 3.65m. Observations of traffic queuing at this approach using street-level mapping suggests this link operates as a single-lane link, with an approximate width of 3.65m. Furthermore, parking is permitted close to the stopline, further reducing the likelihood of traffic attempting to queue in two lanes at this approach. ***Issue LC7*** Link 1314:1310 (Rosemount Place approaching junction with A978) is modelled as a two-lane link of total width 3.65m. Observations of traffic queuing at this approach using street-level mapping suggests this link operates as a single-lane link, with an approximate width of 3.65m. ***Issue LC8*** Vehicles appear to be able to turn right from two lanes into one exit lane at Node 2687. Street-level mapping suggests only one lane is available to turn right from Link 2688:2687.	*without blocking straight ahead traffic. This matches observed conditions.* ***Issue LC6*** *The two lane sections used here are to allow right turning vehicles at the junctions to sit without blocking straight ahead traffic. This matches observed conditions.* ***Issue LC7*** *Although not marked as two lanes, analysis of the videos shows that there is queueing in two lanes on the Rosemount Place approach to the A978.*	***Issue LC6*** This is acceptable. ***Issue LC7*** This is acceptable.	
Junction Priorities	Junction priorities in the model are categorised as Low, Medium or High. Each valid movement at each stopline			Further actions:

Review Aspect	Auditor Comments	*Model Developer Comments*	Further Auditor Comments	Further Action Required / Risk
	needs the correct priority type applied to ensure that vehicle behaviour at each location is correct. Junction priorities have been reviewed to ensure they are consistent with priority arrangements on the ground. ***Issue JP1*** Link 338:323 Is a minor arm that should yield to Link 323:327, however is coded as High priority rather than Medium. ***Issue JP2*** The minor arms at Node 2483 have the following incorrect priorities that require amending: ▪ The left turn from Node 2486 is coded as a High priority rather than a Medium; and ▪ The right turn from Node 2482 is coded as a High priority rather than a Low. ***Issue JP3*** Link 342:341 is coded a as Low priority movement; however, this movement yields to one traffic stream and, therefore, this should be a Medium priority movement.			**Model updates required** Risk: **Low**

Review Aspect	Auditor Comments	*Model Developer Comments*	Further Auditor Comments	Further Action Required / Risk
Traffic Signals	A review of the locations of the signalised junctions has been undertaken to ensure that traffic signals are located correctly. A general review of the signal timings, phases, stages, cycle times and intergreens has been undertaken. However, it is important to note that no observed signals data has been received to aid this review. Therefore, only a general sense check has been possible on the signals data, to ensure they are valid and logical. ***Issue TS1*** Traffic signals are missing from Node 1257 – it is noted these were included in the previous model issue. ***Issue TS2*** Clarification required on the need to use a 4-node compound signal arrangement at the junction represented at Node 254 – this junction is a standard four-way signalised junction. ***Issue TS3*** Clarification required on the need to use a 4-node compound signal arrangement at the junction represented at Node 391 – this junction is a standard four-way signalised junction.			Further actions: **Model updates and clarifications required** Risk: Medium

Review Aspect	Auditor Comments	*Model Developer Comments*	Further Auditor Comments	Further Action Required / Risk
	Issue TS4 The left turn represented by Link 128:125 is only controlled by a give-way marker in the model; however, on the ground this is part of the signalised junction.			
Restrictions – Width, Height, PT only	A review of the locations where width and height restrictions have been modelled has been undertaken. The location and type of all modelled restrictions appears to be acceptable.			Further actions: **None** Risk: **None**
Restricted/banned turns	A review of the placement of banned turns in the model has been undertaken. The location of banned turns in the model appears to be generally acceptable. ***Issue RB1*** Modelled traffic on Link 289:290 is able to turn right to Link 290:301, however street-level mapping suggests this is not possible.	***Issue RB1*** *This banned turn has been included in the model.*	***Issue RB1*** The auditor is satisfied this has been included in the model.	Further actions: **None** Risk: **None**
Visibility	The visibility parameter is a fundamental aspect of controlling the modelled stopline capacity. If a visibility value is too low, traffic will be too cautious, and this could lead to excess queuing.			Further actions: **Further consideration of model updates**

Review Aspect	Auditor Comments	*Model Developer Comments*	Further Auditor Comments	Further Action Required / Risk
	It is important to note that vehicle behaviour at junctions is significantly affected by the visibility parameter; therefore, a further review of vehicle behaviour on approach to stoplines will be required once demand data is available. It is suggested that it is of particular importance for the visibility to be correct at locations where visibility is low (i.e. below 15m), as vehicle behaviour at these locations is particularly sensitive to the modelled value. A review of the coded visibility has been undertaken, to ensure it has been used in the appropriate locations. Generally speaking, the visibility parameter is required to be set at the following locations: ▪ Right-turns from a major to a minor road at priority junctions and signals; ▪ All give-way arms (i.e. minor arms) at priority junctions; and ▪ All roundabout approaches ***Issue VS1*** It is noted that every node in the model has either no visibility or it is set to 30m. For the vast majority of the locations where this parameter has been used, this will be an appropriate value.	***Issue VS1*** *30m has been used as a standard visibility on all give way links, these will be changed at specific locations if necessary, in the calibration*	***Issue VS1*** It is noted that, where a visibility value has been applied, no visibility value has been modified from the default value of 30m.	Risk: **Medium**

Review Aspect	Auditor Comments	*Model Developer Comments*	Further Auditor Comments	Further Action Required / Risk
	However, a number of locations have been identified (using street-level mapping) that indicate the visibility on the ground is significantly less than 30m. It is acknowledged that these locations appear to be relatively minor junctions; however, consideration should be given to modifying the visibility at some locations to better reflect conditions on the ground. Some example locations are as follows but a network wide review should be undertaken to ensure that all visibilities are appropriate: **Roundabouts** ▪ Link 2090:2091 – A92, a high wall makes visibility from the approach to the right of this arm poor, approximately 10-15m; ▪ Link 1170:1171 – Loch Street, the edge of a car park reduces visibility to approximately 10-15m; ▪ Link 803:802 – Broomhill Road, a hedge and bushes make visibility from the approach to the right of this arm poor, approximately 15-20m; ▪ Link 834:835 – Seafield Road, a hedge makes visibility from the approach to the right of this arm poor, approximately 10-15m; ▪ Link 2303:2304 – King Street, the presence of buildings reduces the visibility on all approaches to this roundabout to approximately 10-20m;	*process. A network wide alteration of visibilities to location specific values is not deemed to be appropriate as the impact of a difference in visibility between, for example 20m and 30m is negligible, especially on minor roads.*	Although it is acknowledged that a difference in visibility between 20m and 30m would not have a significant effect on the model operation, particularly on minor links, several of the recommended modifications suggest a much lower visibility (10-15m). It is recommended that these locations should have their visibility modified to a more appropriate value.	

Review Aspect	Auditor Comments	*Model Developer Comments*	Further Auditor Comments	Further Action Required / Risk
	▪ Links 1075:3513 & 1077: 3512 – minor arms on a mini-roundabout on St Clair Street that have close to zero visibility; and ▪ Link 494:500 – Fonthill Road, a building reduces the visibility to the right of this arm to approximately 10-15m. **Priority Junctions** ▪ Link 2482:2483 – Urquhart Road, the edge of buildings block visibility until traffic is approximately 10-15m from the junction centreline; ▪ Link 2530:2529 – University Road, a shop on the corner reduces the visibility to approximately 10-15m; ▪ Link 2539:2536 – School Drive, a wall, hedge and driveway parking all reduce visibility to approximately 15-20m; ▪ Link 2292:2291 – St Machar Place, a house close to the junction reduces visibility to approximately 5-10m; ▪ Link 2281:2282 – Don Street, a high wall very close to the junction reduces visibility to approximately 4-8m; ▪ Link 2493:2494 – barrier controlled egress from Mary Elmslie Court means a very slow exit so recommend visibility set to 0m; and ▪ Links 2743:2742 & 2745:2503– barrier controlled egress from Police Station means a very slow exit so recommend visibility set to 0m.			

Review Aspect	Auditor Comments	*Model Developer Comments*	Further Auditor Comments	Further Action Required / Risk
	Issue VS2 Consideration should be given to applying a visibility for the right-turn movements at Node 114 from Links 116:114 and 118:114, as these movements both run with Medium priority markers in Stages 4, 9 and 14 of the signal stage sequence.	***Issue VS2*** *Visibility has been added on the links approaching node 114.*	***Issue VS2*** The auditor is satisfied this has been added to the model.	
	Issue VS3 Consideration should be given to applying a visibility for the right-turn movement at Node 289 from Link 288:289, as this movement runs with a Medium priority marker in Stages 1 and 5 of the signal stage sequence.	***Issue VS3*** Since the model was sent to Jacobs in February, this has been corrected.	***Issue VS3*** The auditor is satisfied this has been added to the model.	
	Issue VS4 Consideration should be given to applying a visibility for the right-turn movement at Node 61 from Link 62:61, as this movement runs with a Medium priority marker in Stage 3 of the signal stage sequence.	***Issue VS4*** *Visibility has been added on link 62:61.*	***Issue VS4*** The auditor is satisfied this has been added to the model.	
	Issue VS5 Consideration should be given to applying a visibility for all right-turn movements at Node 2533, as these movements all run with Medium priority markers in the signal stage sequence.	***Issue VS5*** *Since the model was sent to Jacobs in February, this has been corrected.*	***Issue VS5*** The auditor is satisfied this has been added to the model.	
	Issue VS6	***Issue VS6***	***Issue VS6***	

Review Aspect	Auditor Comments	*Model Developer Comments*	Further Auditor Comments	Further Action Required / Risk
	Clarification required regarding the exclusion of visibility parameters at roundabout Node 1136.	*Since the model was sent to Jacobs in February, this has been corrected.*	The auditor is satisfied this has been added to the model.	
Vehicle Trajectories	The model trajectories indicate the paths the vehicles use throughout the network. These need to be relatively smooth to be consistent with observed driver behaviour. A review of the modelled trajectories has been undertaken to ensure traffic flows in a smooth manner through the network. ***Issue TR1*** It is noted that some trajectories appear inconsistent with the anticipated vehicle path, e.g. on Link 698:705. Whilst it is noted these are minor inconsistencies and, therefore, it is accepted that this is unlikely to significantly affect the model operation at these locations, it is recommended that some trajectories are revised to ensure smooth movement of vehicles travelling through the model. This should be reviewed once demand matrices have been developed.	***Issue TR1*** *During model development, vehicle trajectories have been altered where appropriate.*	**An additional item (*Issue TR2*) has been recorded and requires a response from the model developer.** ***Issue TR1*** The auditor notes there are still a number of roundabouts where the trajectories are not particularly smooth. It is acknowledged these are minor in nature and will have a negligible effect on junction performance; however, it is suggested the model would benefit from an update to these small deviations in anticipated vehicle paths, particularly at junction exits, at the following locations (and the entire roundabout):	Further actions: **Further consideration of model updates** Risk: Low

Review Aspect	Auditor Comments	*Model Developer Comments*	Further Auditor Comments	Further Action Required / Risk
	Issue TR2 The trajectories on Link 2626:2647 towards Node 2654 need smoothing.		▪ Link 702:707 ▪ Link 863:862 ▪ Link 1952:707 ▪ Link 2091:2088 ▪ Link 655:665	
Gap Acceptance Parameters	**Give way to all** This parameter ensures that vehicles on a link will yield to all vehicles conflicting with it at the next node. A review of the use of this parameter has been undertaken. ***Issue GA1*** It is noted this parameter has been set to '100%' at roundabout approaches, which is considered appropriate to ensure correct vehicle behaviour at roundabouts. However, clarification is required as to why the following roundabout junctions have not had *Give way to all* enabled: ▪ A96 / Hutcheon Street / Mounthooly / Gallowgate; ▪ Skene Square (B986) / Rosemount Place / Maberly Street; and	***Issue GA1*** *Since the model was sent to Jacobs in February, give way to all has been included at the three roundabouts noted.*	***Issue GA1*** The auditor is satisfied this has been added to the model for the first two locations. However, for the St Clair Street / Morrisons access, the *Give way to all* marker is still missing on each approach.	Further actions: **Model updates required** Risk: Low

Review Aspect	Auditor Comments	*Model Developer Comments*	Further Auditor Comments	Further Action Required / Risk
	▪ St Clair Street / Morrisons access **Give way to offside** It is noted that this parameter has not been set in any location. This appears reasonable, as no location has been identified as requiring this to be enabled. **Give way to oncoming traffic** This parameter is used for modelling locations where one vehicle must yield to another, such as at a chicane. It is noted this parameter is used in three locations. No missing locations have been identified. ***Issue GT1*** This has been set on Link 2771:2770 so that southbound traffic gives way to northbound traffic, due to a road narrowing. However, street-level mapping suggests that southbound vehicles have priority and that the parameter should be set on Link 2769:2770 instead. ***Issue GT2*** Clarification if the use of this parameter on Link 1397:1398 is to model the effect of parked vehicles forcing traffic to give way to oncoming vehicles. If so, then it is suggested, for consistency, that consideration is given to the use of this parameter elsewhere in the model where significant levels of parking is observed.	***Issue GT1*** *The model has been corrected so that the northbound traffic gives way to southbound.* ***Issue GT2*** *For consistency model wide, the give way to oncoming parameter has been removed at this location.*	***Issue GT1*** The auditor is satisfied this has been added to the model. ***Issue GT2*** The removal of this parameter at this location (for the sake of model-wide consistency) is acceptable. However, the auditor notes that this parameter has not been removed at	

Review Aspect	Auditor Comments	*Model Developer Comments*	Further Auditor Comments	Further Action Required / Risk
	On balance, it is recommended that this parameter is used in both directions on a link to avoid unduly penalising one direction if the parking occurs on both sides of the carriageway (as it does in this case). ***Issue GT3*** Clarification if the use of this parameter on Link 963:962 is to model the effect of parked vehicles forcing northbound traffic to give way to oncoming vehicles. Street-level mapping suggests the parking occurs on the east side of the carriageway and, therefore, southbound traffic should yield to northbound traffic. It is acknowledged the model may have been coded in such a way to reduce the likelihood of blocking back on the major junction immediately to the north of this link, however it is suggested the use of this parameter at this location is reviewed. **Lane Merge, Lane Cross & Path Cross** These parameters have been modified from the default values to increase throughput at several locations during the model calibration process to match observed flows. These have been reviewed and appear acceptable.	***Issue GT3*** *Give way to oncoming was included in error at this location and has been removed.*	this location in the latest version of the model. ***Issue GT3*** The auditor notes that this parameter has not been removed at this location in the latest version of the model.	
Stoplines	The stopline positions have been reviewed. ***Issue ST1***			Further actions:

Review Aspect	Auditor Comments	*Model Developer Comments*	Further Auditor Comments	Further Action Required / Risk
	The nearside (to the kerb) lane stopline on a two-lane roundabout approach should, in some cases, be moved slightly further forward, to match the curved nature of the stopline on the ground (this would have the added benefit of reducing the chance of a close interaction with a circulating vehicle). For example, the stopline on the nearside lane on Link 703:704 would better be positioned several metres further forwards. It is suggested that the nearside stopline positions on roundabout approaches are reviewed and adjusted accordingly.			**Model updates required** Risk: **Low**
Clear Exit Adherence	A review of the locations where this parameter has been altered from the default value of zero has been undertaken. It is noted that a small number of junctions, particularly along the Union Street corridor, have this parameter set to either 50, 80 or (in one case) 100. By setting this parameter, this increases the percentage of vehicles that adhere to clear exit behaviour. This effectively means a yellow box should be present on the ground at all locations where this parameter is used. ***Issue CE1*** All movements at Node 2 appear to have this parameter set to 80 except the right-turn movement from Link 3:2 to Link 2:63. Clarification required as to why this is missing from only this turn.	***Issue CE1*** *The clear adherence values have been included at this location.*	**The auditor notes that a number of locations have had *Clear exit adherence* removed in the latest version of the model. Clarification is required why these have been removed, as the auditor believes that their removal is incorrect (yellow boxes are observed on the ground at these locations).** ***Issue CE1*** This parameter is still missing at this location.	Further actions: **Model updates and clarifications required** Risk: **Medium**

Review Aspect	Auditor Comments	*Model Developer Comments*	Further Auditor Comments	Further Action Required / Risk
	Issue CE2 All movements at Node 22 appear to have this parameter set to 80 except the right-turn movement from Link 5:22 to Link 22:44. Clarification required as to why this is missing from only this turn. ***Issue CE3*** Clarification required regarding the use of a value of 50 at Nodes 328, 333 and 1178, which is inconsistent with the more frequently used modelled value of 80. ***Issue CE4*** Taking cognisance of the fact the yellow box is located on the northbound carriageway only at Node 475, clarification required why the southbound ahead movement has Clear exit adherence set to 80. Furthermore, clarification would be useful regarding the right-turn from Link 437:475 to Link 475:477 – it is noted this has a Clear exit adherence set to 50, which is	***Issue CE2*** *The clear adherence values have been included at this location.* ***Issue CE3*** *A review of adherence values used will be carried out.* ***Issue CE4*** *Since the model was issued to Jacobs in February, this has been corrected.*	***Issue CE2*** This has not been done; instead, this is an example of one of the junctions referred to above that has had their *Clear exit adherence* values removed since the previous issue of the model. ***Issue CE3*** The auditor notes this parameter has been removed at these locations. However, this appears to be incorrect – these locations require a *Clear exit adherence* value, as these areas represent yellow boxes on the ground. ***Issue CE4*** There are missing *Clear exit adherence* values at the following locations: ▪ Left turn from Link 4203:475 to Link 475:477 ▪ Right turn from Link 437:475 to Link 475:477	

Review Aspect	Auditor Comments	*Model Developer Comments*	Further Auditor Comments	Further Action Required / Risk
	inconsistent with the value of 80 used for other movements at this node.		Furthermore, there is a *Clear exit adherence* value (at the adjacent junction) for the right-turn from Link 475:437 to Link 437:436 that should not be there (no yellow box is observed on the ground).	
Detectors	The positioning of detectors in the model has been reviewed. ***Issue DE1*** Detectors appear to be missing from the model. Clarification required if scripts are used and if these obviate the need for detectors.	***Issue DE1*** There are no scripts or detectors in the model.	***Issue DE1*** The auditor suggests that a number of junctions within Aberdeen are likely to operate using a detection system. These are known to improve capacity at locations where they are used and help to balance queueing on each approach. Clarification would be useful regarding if any consideration has been given to the use of detectors and, if so, the reason(s) for their exclusion.	Further actions: **Clarification required** Risk: **Low**
Scripts	It is assumed that a number of signalised junctions require scripts to operate.			Further actions: **Clarification required**

Review Aspect	Auditor Comments	*Model Developer Comments*	Further Auditor Comments	Further Action Required / Risk
	Issue SC1 Scripts appear to be missing from the model. Clarification required if scripts comprise part of the model and, if so, it is suggested that these are also reviewed as part of this assessment.	***Issue SC1*** There are no scripts or detectors in the model.	***Issue SC1*** The auditor's response to this relates to that given for Detectors. Please see response to *Issue DE1* (above).	Risk: **Low**
Demand Matrices	There are four demand sets in the model: ▪ Set 1: *AM* – 0700-1000 ▪ Set 2: *IP* – 1000-1600 ▪ Set 3: *PM* – 1600-1900 ▪ Set 4: *Warm Up* – 0630-0700 Each demand set comprises two matrices split by vehicle type: ▪ Matrix 1 – Car, Taxi and LGV ▪ Matrix 2 – MGV, HGV and Coach The auditor notes that the 2019 base matrices have been developed using a combination of the following: ▪ 2012 base model matrices for the AM and PM peak time periods; ▪ Aberdeen Sub Area Model (ASAM14) 2019 Reference Case matrices; ▪ 2019 traffic count data; and ▪ Land-use estimates (from TRICS).			Further actions: **Clarification and data required** Risk: **Low**

Review Aspect	Auditor Comments	*Model Developer Comments*	Further Auditor Comments	Further Action Required / Risk
	It is noted that, to estimate trip ends, traffic count survey data was used where possible. In cases where no data was available, trip rate estimates have been derived from TRICS. The auditor is satisfied with this approach. ASAM14 has been used to develop the trip distribution, in conjunction with ANPR surveys the 2012 base matrices. For this audit, the demand matrices have been exported to CSV and interrogated. A review of the following was undertaken for each matrix within each demand set: ▪ Total matrix size; ▪ Top 10 largest row and columns sense check; ▪ Top 10 largest individual cell total O-D sense check; and ▪ Relative size of Matrix 1 ('lights') and Matrix 2 ('heavies') in each time period. It is anticipated that any significant anomalies within the trip matrices would be captured by the above review. The key findings from this review are set out below. **Trip Matrix Size** The AM, IP and PM 'light' vehicle (Car, Taxi and LGV) matrix totals are 75,722, 157,741 and 92,601 respectively. The relative size of these matrices appears to be logical, although the six-hour IP matrix is noted to have more than			

Review Aspect	Auditor Comments	*Model Developer Comments*	Further Auditor Comments	Further Action Required / Risk
	double the number of trips as the three-hour AM matrix, therefore indicates a higher average hourly number of trips across the time period. The auditor suggests this is close to the upper limit of acceptability for a city centre model, as it would, broadly speaking, be anticipated that the AM and PM matrices would contain more trips per hour than the IP matrix. The AM, IP and PM 'heavy' vehicle (MGV, HGV and Coach) matrix totals are 3,772, 7,320 and 2,730 respectively. The relative size of these matrices appears to be logical, with the largest and smallest average hourly number of trips occurring in the AM and PM peaks respectively (PM is expected to be low for freight traffic broadly speaking). The amount of 'heavy' traffic as a proportion of total traffic is 4.7%, 4.4% and 2.9% in the AM, IP and PM time periods respectively. Based on the above percentages, the relative size of the 'light' and 'heavy' traffic appears reasonable. A lower PM percentage of 'heavy' traffic compared to the other time periods is anticipated. **Largest Origins and Destinations** A review of the zones that indicate the largest trip matrix origin and destination totals has been undertaken. The purpose of this was to help assess if the network locations			

Review Aspect	Auditor Comments	*Model Developer Comments*	Further Auditor Comments	Further Action Required / Risk
	where a significant volume of traffic arrives and departs are logical. The analysis indicates that the zones with the most origin trips are: ▪ **AM** – Zone 1,029 (A92 Southbound) ▪ **IP** – Zone 1,008 (Garthdee Retail Park, ASDA Bridge of Dee superstore) ▪ **PM** – Zone 1,008 (Garthdee Retail Park, ASDA Bridge of Dee superstore) The analysis indicates that the zones with the most destination trips are: ▪ **AM** – Zone 1,027 (A96 Northbound) ▪ **IP** – Zone 1,008 (Retail Park, ASDA Superstore) ▪ **PM** – Zone 1,029 (A92 Northbound) Further to the above, the ten zones with the largest number of origin and destination trips were checked, for each time period, and the auditor is satisfied these appear to be logical. **Largest Individual Cells** The ten origin-destination zone pairs with the largest number of trips were checked, for each time period, and the auditor is satisfied these appear to be logical.			

Review Aspect	Auditor Comments	*Model Developer Comments*	Further Auditor Comments	Further Action Required / Risk
	Issue DM1 The auditor notes that, as the purpose of the model is to assess a LEZ, it would be beneficial to have the demand matrices disaggregated by fuel type. Clarification required if this has been considered and, if so, why this hasn't been implemented. ***Issue DM2*** It is noted that no Trip Length Distribution (TLD) data has been included in the Model Development Report. The auditor suggests it would be useful for this information to be made available.			
Matrix Estimation	Matrix Estimation (ME) was undertaken using Paramics Discovery's built-in ME procedure. Four sets of inputs were required for the process: a set of demand matrices, a Routing file, a Survey file and a Constraints file. It is noted that the volume of trips in the post-ME matrices is higher than the prior matrices for all time periods. Furthermore, the vehicle type proportions of the overall model changed slightly in the AM and PM peak. Overall, the demand set for each time period (i.e. the combined size (number of trips) of Matrix 1 and 2) increased by 10%, 21% and 13% for the AM, IP and PM respectively. It is noted that the IP increase is quite significant, although within the bounds of acceptability.			Further actions: **Consider data review** Risk: Medium

Review Aspect	Auditor Comments	*Model Developer Comments*	Further Auditor Comments	Further Action Required / Risk
	Matrix 2 (MGV, HGV and Coach) increased by 44%, 48% and 84% in the AM, IP and PM respectively. These are considered to be significant increases, in particular the PM peak has almost doubled from 1,484 to 2,730 trips during ME. Consideration should be given to reviewing the prior matrices due to this significant change.			
Unreleased Demand	Following a full 12 hour model assignment, during which all time periods were assigned, no unreleased vehicles were noted.			Further actions: **None** Risk: **None**
Vehicle Type Proportions	The vehicle type proportions used for each demand set have been checked to ensure they are logical. It is noted that the vehicle type proportion varies by time period. This is considered logical and it is assumed this is based on the data outlined in Section 6.1.1 of the Model Development Report. The vehicle type proportions used in the model appear to be acceptable.			Further actions: **None** Risk: **None**
Profiles	Profiles control how much of each matrix will be released onto the network within a given (usually five minute) time period.			Further actions: **None**

Review Aspect	Auditor Comments	*Model Developer Comments*	Further Auditor Comments	Further Action Required / Risk
	It is acknowledged that observed turn count data and car park data was used to define Profiles for each time period. A total of 54, 50 and 50 Profiles have been applied in the AM, IP and PM peak respectively. The Profiles in the model have been reviewed to ensure that each Profile releases vehicles during the correct time interval. A general check of the shape of the Profile curve for each Profile has been undertaken and appear to be acceptable.			Risk: **None**
Profile Assignment	Each origin-destination movement (in each time period) has a Profile assigned to it which determines the traffic release pattern through the time period. The Profile Assignment for all matrices and time periods has been reviewed. It is observed that number of modelled zones that represent car parks have been assigned a different Profile from ordinary zones. These have been checked to ensure they have been applied appropriately, and the auditor is satisfied this is the case. It is noted that separate sets of Profiles have been developed and applied for 'light' vehicles and 'heavy' vehicles. The correct application of Profiles for each vehicle type has been reviewed.			Further actions: **Clarifications required** Risk: **Low**

Review Aspect	Auditor Comments	*Model Developer Comments*	Further Auditor Comments	Further Action Required / Risk
	Issue PA1 There are a number of zones (e.g. Zone 1001-1002, 1008, 1013) which have a 'General Heavy' Profile applied to their origin (row) in the matrix for 'heavy' vehicles. However, for 'light' vehicles, a zone-specific Profile is used instead of the 'General Light' Profile. Clarification required on the inconsistency between the use of Profiles by vehicle type. ***Issue PA2*** It is noted that there is an inconsistency between the use of 'general' Profiles and zone-specific Profiles between time periods for a number of zones. For example, Zone 1003 uses a zone-specific Profile in the AM peak, and it uses a 'General Heavy' Profile in the PM peak. Clarification required on this consistency. ***Issue PA3*** The auditor notes that Zone 93 (Quay area) uses a different Profile to the surrounding zones (both geographically and numerically). This Profile is particularly peaky, and it is assumed this is to reflect the variable nature of traffic flow departing the quay. Clarification required.			
Model Settings	**Simulation** The model uses two time steps per second, which is considered appropriate.			Further actions: **None**

Review Aspect	Auditor Comments	*Model Developer Comments*	Further Auditor Comments	Further Action Required / Risk
	Vehicle Release The model uses the *Precise* release type; P*reserve link choice* is disabled. These are the default settings and are considered appropriate. **Vehicle Behaviour** The *Mean headway* represents the time between vehicles travelling in the network. The model uses a *Mean headway* value of one second. This is the default setting and is considered appropriate. The *Minimum gap* represents the distance left between vehicles when below a crawl speed. The *Minimum gap* value used in the model is two metres. This is the default setting and is considered appropriate. The *Aggression* and *Awareness* distributions used in the model have been set as per the default settings. This is considered appropriate unless there is sufficient evidence to suggest these should be modified. The *Overtaking levels* used in the model for Urban and Highway links have both been set to *Medium*. These are considered appropriate unless there is sufficient evidence to suggest these should be modified.			Risk: **None**
Perturbation	The *Perturbation* value is the maximum percentage increase in the lowest route cost (from origin to destination zone)			Further actions:

Review Aspect	Auditor Comments	*Model Developer Comments*	Further Auditor Comments	Further Action Required / Risk
	perceived by a vehicle in the network. A *Perturbation* value of 5% has been applied to every vehicle type in the model. This is considered appropriate.			**None** Risk: **None**
Familiarity	The *Familiarity* value is the percentage of drivers who respond to dynamic feedback. *Familiar* drivers perceive no difference between the cost of major and minor links, whilst an *unfamiliar* driver will perceive minor links to have twice the cost of major links (and do not respond to dynamic feedback). The *Familiarity* values used in the model for each vehicle type have been reviewed. Appropriate values for familiarity are considered to be within the range 30-70% for Car / LGV and 0-40% for OGV / Coach. The following *Familiarity* values have been used ▪ Taxi – 85% ▪ Car / LGV – 50% ▪ MGV / Coach – 25% ▪ HGV – 15% The above values are considered acceptable.			Further actions: **None** Risk: **None**
Dynamic assignment	Dynamic assignment has been enabled in the model. The *interval* at which *familiar* drivers will re-calculate their routes (based on an assessment of the optimum route to			Further actions: **None**

Review Aspect	Auditor Comments	*Model Developer Comments*	Further Auditor Comments	Further Action Required / Risk
	their destination) has been set at two minutes. This is the default setting and is considered appropriate. A S*moothing factor* that modifies the route calculation cost has been set at 0.5. This is the default setting and is considered appropriate.			Risk: **None**
Generalised Cost Parameters	The Generalised Cost Equation (GCE) combines together the time taken, distance travelled, and any toll fees paid, with each of these multiplied by a coefficient, to calculate an overall cost for any given journey. The GCE has been set individually for each vehicle type in the model. Each GCE has been reviewed. ***Issue GP1*** The Car vehicle type has the same coefficient values as the MGV vehicle type (Time=0.6, Distance=0.4); however, it is anticipated that Car would place a lower proportion of the weighting on distance relative to MGV. The Car vehicle type places a heavier proportion of the weighting on distance than the LGV vehicle type (Time=0.7, Distance=0.3). Again, it is anticipated that Car would place a lower proportion of the weighting on distance relative to LGV. The coefficients applied to the LGV and MGV vehicle types place a heavier proportion of the weighting on time rather than distance. This is considered inappropriate, as freight			Further actions: **Consider updates** Risk: **Medium**

Review Aspect	Auditor Comments	*Model Developer Comments*	Further Auditor Comments	Further Action Required / Risk
	traffic is generally considered to place a higher importance on the distance travelled. Clarification required on the derivation of the GCE.			
Hazard Overrides	*Hazard overrides* facilitate the modification of vehicle lane behaviour when it is found the default behaviour is not representative of observed conditions. It is noted that *Hazard Overrides* have been used in 25 locations. These have been reviewed and appear to be acceptable.			Further actions: **None** Risk: **None**
Signpost Distance	The *Signpost Distance* affects vehicle lane behaviour approaching the node. The default *Signpost distance* is 250m on Urban links. It is noted that 11 nodes have had their *Signpost distance* modified. These have been reviewed and the modifications appear acceptable.			Further actions: **None** Risk: **None**
Screenlines	There are 64 screenlines assessed in the model validation process. The auditor notes this is a very high number of screenlines (as does the developer in the Model Development Report). The auditor is content with the level of detail strived for in the model development process.			Further actions: **None** Risk: **None**

Review Aspect	Auditor Comments	*Model Developer Comments*	Further Auditor Comments	Further Action Required / Risk
Overall Calibration	**Screenlines** The relevant WebTAG acceptability guidance states that 'all or nearly all screenlines' should have observed and modelled flows within 5% of each other. The auditor notes that, depending on time period, between 63% and 81% of screenlines across the model achieved the 5% WebTAG criterion. Furthermore, it is noted that all screenlines are within 15% of the acceptability criterion, and the auditor acknowledges that the 5% criterion is widely regarded as an ambitious target for large, complex models. **Link and Turn Flows** The relevant WebTAG acceptability guidance states that at least 85% of flows must meet the following criteria (vph = vehicles per hour): ▪ Flows within 100vph for flows of less than 700vph. ▪ Flows within 15% for flows of 700-2,700vph. ▪ Flows within 400vph for flows of more than 2,700vph The link and turn flow calibration data provided in the Model Development Report indicates that the model demonstrates a good overall level of link flow calibration. The auditor is satisfied with the link and turn calibration.			Further actions: **Data required** Risk: Low

Review Aspect	Auditor Comments	*Model Developer Comments*	Further Auditor Comments	Further Action Required / Risk
	Issue CL1 Although the overall level of calibration appears to be acceptable, the Model Development Report does not contain full calibration (and validation) datasets. This means it has not been possible to check the level of calibration at individual locations. It is suggested that this data is added to the Model Development Report.			
Journey Time Validation	The relevant WebTAG acceptability guidance states that the modelled times along routes should be within 15% of observed data (or one minute, if higher than 15%) for at least 85% of cases. The auditor notes that the data used for journey time validation was collated using INRIX Roadway Analytics, and that the observed data used from INRIX is based upon floating vehicle data. The data sources for this include smart phones and in-vehicle GPS; this is considered to provide a robust observed dataset with an excellent sample size. There are 16 journey time routes in the model for each direction, providing a total of 32 routes for validation in each time period. The auditor notes that 88%, 100% and 91% of routes comply with relevant WebTAG criteria for the AM, IP and PM time periods respectively.			Further actions: **Clarifications required** Risk: **Low**

Review Aspect	Auditor Comments	*Model Developer Comments*	Further Auditor Comments	Further Action Required / Risk
	Overall, this is considered to be an excellent level of journey time validation in all three time periods. ***Issue JT1*** In the AM peak, it is noted that traffic on Route 5 EB is approximately 30% (over two minutes) faster in the model compared with observed data. This is a major route into the model representing the A96 Auchmill Road. Clarification required why this route is so much faster in the model. Furthermore, it is suggested that a review of improvements to this route be considered. ***Issue JT2*** The auditor notes that modelled traffic on Route 11 WB takes approximately five minutes in both the AM and PM time periods. However, the observed data suggests traffic in the PM peak is around 75% slower than in the AM peak (4m 44s vs 8m 21s according to the Model Development Report). Clarification required regarding which section of this route appears to be experiencing delay in the PM peak, and why this delay appears to have not been replicated in the model.			
Queue Lengths	There is no specific WebTAG criteria to facilitate the validation of queue lengths; however, a review of how well modelled and survey queue lengths correlate has been undertaken.			Further actions: **More data need**

Review Aspect	Auditor Comments	*Model Developer Comments*	Further Auditor Comments	Further Action Required / Risk
	It is noted that queue length surveys were undertaken at 28 locations. ***Issue QL1*** Although surveys were undertaken at 28 locations, queue length validation graphs have been provided in Appendix B of the Model Development Report for only four locations. It is, therefore, not possible for the auditor to confirm if the queue lengths at the other locations are acceptable. ***Issue QL2*** In the Model Development Report, the queue length reported in Figure 21 of Appendix B (Mugiemoss Road at Haudagain) indicates the modelled queue is significantly longer than the observed queue at approximately 0800-0845. It is not possible to determine from the Model Development Report if this corridor has too much traffic in the AM peak compared to the observed data. It is suggested that a review of the traffic flows and queuing be undertaken on this corridor in the AM peak. ***Issue QL3*** The queue length reported in Figure 22 of Appendix B (Great Western Road (East) at Haudagain) indicates the			**Data review required** **Clarification required** Risk: **Medium**

Review Aspect	Auditor Comments	*Model Developer Comments*	Further Auditor Comments	Further Action Required / Risk
	modelled queue is significantly longer than the observed queue at approximately 1730-1800. It is not possible to determine from the Model Development Report if this corridor has too much traffic in the PM peak compared to the observed data. It is suggested that a review of the traffic flows and queuing be undertaken on this corridor in the PM peak. ***Issue QL4*** The queue length reported in Figure 23 of Appendix B (Bridge of Dee at Great Southern Road) indicates the modelled queue is significantly longer than the observed queue at approximately 0800-0900. It is not possible to determine from the Model Development Report if this corridor has too much traffic in the AM peak compared to the observed data. It is suggested that a review of the traffic flows and queuing be undertaken on this corridor in the PM peak. ***Issue QL5*** It is not clear from the text in Section 7.7 of the Model Development Report, or from the graphs in Appendix B, if the queue lengths reported are 'average' or 'maximum' queues. Clarification required.			

Review Aspect	Auditor Comments	*Model Developer Comments*	Further Auditor Comments	Further Action Required / Risk
Model Assignment Warnings	During model assignment, Paramics flag up any warnings or errors, for which the model was checked. ***Issue MW1*** When running the Paramics model, a number of warnings appear: ▪ 'There are no suitable release or arrival links in Zone 211' ▪ There are no suitable release or arrival links in Zone 212' ▪ There are no suitable release or arrival links in Zone 213' ▪ There are no suitable release or arrival links in Zone 214' These are noted to be isolated zones. It is suggested these be removed from the model. ***Issue MW2*** Clarification required why there are no suitable release or arrival links for zone 211,212, 213 and 214.			Further actions: **Clarification required** Risk: **Low**

2.3 Public Transport Coding Review

Table 2.2 Public Transport Coding Review

Review Aspect	Auditor Comments	Model Developer Comments	Further Auditor Comments	Further Action Required
Bus Lanes	A review of the location of all modelled bus lanes has been undertaken. ***Issue BL1*** Clarification required regarding the positioning of a bus lane on Link 2520:2521. Observations from street-level mapping suggest no bus lane should be provided at this location.	***Issue BL1*** *The extra lane has been included at this location to allow vehicles to pass a dwelling bus. This matches observed behaviours.*	***Issue BL1*** This is acceptable.	Further actions: **None** Risk: **None**
Bus Stops	A review of the location of all modelled bus stops has been undertaken. All bus stop locations appear to be acceptable.			Further actions: **None** Risk: **None**
Bus Routes and Services	A review of the location of all modelled bus routes and services has been undertaken. It is noted that PT Routes and Services have been added, and each Route has been correctly assigned to the correct Service (Routes are Services have been numbered identically).			Further actions: **None** Risk: **None**

Review Aspect	Auditor Comments	Model Developer Comments	Further Auditor Comments	Further Action Required
	A Schedule has been added to each Service. These are numbered to be consistent with the Service (and Route) number, and it has been checked this has been done correctly. Where possible, the service scheduling has been checked against information from various online data sources and appears appropriate. It is noted that multiple routes for each line number have been created to model the effect of part-routing, as well as to replicate the effects of services leaving and re-entering the modelled area. The path through the network applied to each route has been cross-checked against information from various online data sources. It is noted that different routes with the same line number have different stopping patterns. Where possible, this was verified using online data sources. The coding of the PT routes and services in the model appear acceptable.			

3. Summary

A detailed review of the Aberdeen City Centre Paramics base model initially indicated a number of issues relating to the model network coding. Most of the issues identified were considered minor in nature, and these were reviewed and addressed by the developer.

Subsequently, a final version of the base model was received and audited. A number of additional comments have been provided by the auditor for the developer to address.

In general, the network coding within the Paramics model is to a very high standard.

The main issues that require a review by the developer are:

- Network structure;
- Traffic signals;
- Visibilities;
- Generalised cost parameters;
- Gap acceptance parameters; and
- Queue length data.

Detailed signal plan information was not available for this assessment; therefore, a limited review of signalised junctions has been undertaken. A further review will be undertaken following the receipt of the required data.

From this assessment, the 2019 base Paramics model is considered to be acceptable for its intended purpose (LEZ modelling and forecasting), and it appears to be consistent with the information contained within the Model Development Report.