Our Ref: 8201822101:IP
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Dear Angela,

RE: RESPONSE TO TRAFFIC MODEL AUDIT

Cardno (NSW/ACT) Pty Ltd (Cardno) was commissioned by Aoyuan International (Aoyuan) to undertaken a traffic and transport analysis to assess the impacts of the planned Chelsea Gardens residential development in Moss Vale, New South Wales. As part of this analysis, Cardno developed a microsimulation traffic model of the Moss Vale township including the development. The purpose of the model was to assess the impacts of the development on the surrounding road network and evaluate mitigation measures to accommodate the additional traffic demand.

The Aimsun Base Model was developed in 2018, using a combination of traffic data and TRACKS modelling outputs supplied by Wingecarribee Shire Council (Council). The Base Model was reviewed and endorsed by Transport for NSW (TfNSW) as fit-for-purpose in May 2019. Cardno issued a consolidated report covering the model development and future modelling results in September 2019.

Aoyuan has since consulted extensively with Council and TfNSW, and commissioned Cardno to develop numerous modelling scenarios requested throughout the process. These were requested to help evaluate network performance for the “with development” scenarios. This process was used to inform infrastructure upgrade requirements and included:

> An initial assessment of 2036 future year conditions

> A comprehensive staging assessment (including 2021, 2026, 2031 and 2036) evaluating combinations of land-use projections and infrastructure upgrade scenarios for each year

> A “Base Case + Chelsea Gardens” scenario and several iterations to test options to address network deficiencies (such as No Right Turn and signals at the Argyle Street / Arthur Street intersection)

> Subsequent technical memorandums, SIDRA modelling and response to various requests for clarification / additional outputs (eg SIDRA modelling)

All future-year modelling was developed based on the understanding there were no fundamental concerns with the methodology or findings outlined in the Base Model Development Report or in the model itself.

In late-2020, Council expressed a desire to independently verify the model outputs. Cardno presented the model assumptions and findings to a Council representative at a one-day workshop in November 2020. Subsequently, the model files and reporting were independently audited by Transport Modellers Alliance (TMA) on behalf of WSC. The comments were received by Aoyuan and Cardno in February 2021.

After this review was completed, Council advised that Stage 1 of the project did not have substantial traffic impacts, and that any modelling updates could be undertaken post determination of DA 20/0227 but prior to any approval of future detailed stages. A Traffic Impact Assessment (TIA) for Stage 1 was prepared and issued in April 2021 to help facilitate Stage 1 assessment and approval.

While the TMA audit identifies model changes that could be considered, these are not expected to fundamentally change the outcome of the investigations completed to date or the findings in relation to transport infrastructure requirements from the overall development. In the interest of assisting the project going forward into its next detailed subdivision stages, interim responses and recommendations on how to address each audit finding are attached to this letter. These traffic model updates should not preclude approval of DA 20/0227 for the Concept Masterplan and detailed Stage 1 subdivision.

Cardno's responses to the audit findings are tabulated as an attachment to this letter.

Yours sincerely,

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Audit item #	Audit item name	TMA comment	Severity	Cardno response
1	**Classified Intersection Count** 26 intersections have been surveyed on 30/08/2018, 7:30-9:30 in the morning peak and 15:00-18:00 in the afternoon peak.	• This time period is generally considered adequate for the analysis of a residential development, however: ○ The peak traffic conditions are expected to occur in relation to the school activity traffic which starts before 3:00pm. If the traffic survey had commenced at 2:30pm, this would have been better at identifying not just the impact from the school activity traffic but also the likely peak conditions on the network.	Medium	The data used to calibrate the model shows that the peak traffic volume occurs between 3:30pm and 4:30pm. While some locations might experience higher volumes and more congestion due to the school activity traffic (eg around the schools), the model is designed to replicate the network-wide peak hour (i.e. the highest traffic volume across the whole network). The data available does not show a peak at 3:00pm. The traffic volume recorded in this interval is considerably lower than subsequent intervals and the lowest until 5:15pm. Without data to support modelling a different time period, Cardno would not recommend changing this as the model may no longer be representative of the peak conditions. Recollecting survey data would require the model to be recalibrated to using 2021 as the base year.
2	**Travel Time Survey** The travel time survey is undertaken on 30/08/2018 at the Argyle Street corridor, between Yarrawa Road and King Road.	• The main corridor of the network has been covered, however, it is desirable if other arterial roads (Illawarra Highway / Yarrawa Road) can be surveyed for validation, given that these form key parts of alternative paths through the network. • Only one probe vehicle has been used to conduct the travel time survey. The actual peak of the road network is expected to be around 15:00 when the school traffic activities are highest. This is evident on travel time survey run 27 – the eastbound route required 6 minutes and 25 seconds to complete, while the other eastbound runs used less than 4 minutes to complete. An increased sample size or another day would be desirable to provide more information on the traffic conditions of Argyle Street, particularly around the school peak.	Minor	Most congestion in the model occurs on Argyle Street, making it the main route for validation. Although other routes could be included as well, they would not add much value to the validation as they would be mostly free-flowing. Cardno recommends to maintain the existing travel time route. If new surveys are undertaken, Cardno suggests to extract TomTom travel time data for this route to validate the model. Other routes can be included from the TomTom data if required.
3	**Origin Destination Survey** Section 6.1 of the Chelsea Gardens BMDR documents that the OD survey is used in the demand assumption.	• After discussion with Cardno it is apparent that the OD survey is incomplete and was not used in the process of demand development with models wholly dependent on TRACKS prior matrices. Base Model Development Report (BMDR) could be modified to reflect this.	Minor	Noted. The BMDR states that OD surveys were collected, however it does not clearly establish that they were not used. This will be updated in subsequent reporting.

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4	**SCATS Data (SCATS History File)** The SCATS data for the in intersection of Argyle Street / Kirkham Street was collected on 30 and 31 August 2018.	• This matches the date the traffic survey was conducted. However, the SCATS data of the mid-block crossing near Illawarra Highway / Waite Street has not been collected.	Minor	The crossing is only pedestrian-activated and was not observed to be activated frequently. However, Cardno suggests that it can be included in subsequent modelling. SCATS data to indicate historical activation frequency would be requested from Transport for NSW consistent with the calibration date.
5	**Survey Data Used and its Application**	• The traffic survey data indicates that the Friday traffic volumes are around 15 per cent higher than the Thursday used in the model assessments. • The traffic survey data indicates that the 2018 data has lower volumes than the traffic data collected in 2011. • This indicates that there could be seasonality impacts or traffic movements could be suppressed by the constrained capacity of Argyle Street. • Some peak spreading is evident, particularly at Argyle Street, southbound ATC data indicating a protracted period of congestion over several hours. • As traffic surveys only capture those vehicles that were able to pass through an intersection during the peak period, they do not potentially capture the actual demand which may be higher than the traffic volumes surveyed (particularly on approaches exhibiting substantial queueing).	Medium	Cardno does not recommend to change the modelled day to Friday without any evidence to substantiate that Fridays are busier than Thursdays. The tube counts provided are inconclusive as they show higher volumes on Friday than Thursday in one direction (northbound), but not in the other direction (southbound). The RMS guidelines were published in 2013 and have not been updated based on the latest research and industry best-practice. However, the most recent guidelines published in other states say that: • *"Data is generally collected from Tuesday to Thursday as it is considered representative of the network demand and is subject to reduced impact from weekend-related events." (VicRoads, 2019)* • *"Where possible, data collection should be avoided during Mondays and Fridays […] (Main Roads WA, 2018).* Cardno recommends to maintain the existing Thursday data as modelling a Friday is not recommended or common practice.
6	**Demand Development Process**	• Demand matrices are developed based on the 2018 traffic survey with 2016 TRACKS model providing the prior matrix for the demand adjustment process. • The heavy (HV) matrix from the TRACKS model is neglected, with heavy vehicles assumed to be a simple 5 per cent of the total traffic matrix pattern. As the HV matrix is typically expected to be aligned with the land-use and generally different to the car traffic pattern, this is not considered appropriate. • The iterative demand adjustment process documented is not evident in the Aimsun model provided.	Medium	Although the five per cent assumption may be coarse as a starting point, the matrices were adjusted to match survey volumes and the model attained acceptable calibration for heavy vehicles. Each iteration of the manual adjustment process was not saved, however the prior matrix development, OD adjustment and OD departure adjustment matrices have been saved in the model. This is generally standard practice as the number of iterations can be very high which tends to fill the model file with unrequired matrices. Cardno would provide greater clarify about the adjustment process in subsequent reporting.

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7	**Trip Length Distribution**	• The adjusted and profiled traffic demands in the Aimsun models indicate a substantial increase in short trips by 15 per cent over the original TRACKS demand model. • The modelling consultant has made changes to the trip distribution particularly between traffic loading from internal zones and external zones, however the need for this process to be undertaken has not been justified or at least documented.	Minor	Cardno would review the trip length distribution changes during the model update and adjust the matrices if required. This would also be documented in subsequent reporting.
8	**Model Setup**	• Demand matrices are developed based on the 2018 traffic survey with 2016 TRACKS model prior matrix. • The HV matrix from the TRACKS model is neglected and the assumption that the HV matrix is simply 5 per cent of the total traffic pattern is in error as the HV matrix is expected to be aligned with the land-use and would generally be different to the general traffic pattern. • The iterative demand adjustment process documented is not evident in the Aimsun model.	Medium	Refer to Response 6.
9	**Traffic Demand and Build-up** Six traffic demands have been prepared (three demands per peak period) with these mostly matching the demand development process described in Section 3.3 of the BMDR.	• The demand development process on Meso SRC (Step F of Figure 5) has no evidence of implementation in the models with no iterative assignments and demand adjustment provided on how they arrived at the GEH / travel time criteria has been met (as described in the BMDR).	Medium	The Meso SRC step was a misprint in the figure and not part of the calibration stage. This figure will be updated in subsequent reporting. More information on the calibration / demand adjustment procedure would be provided in the report.
10	**Path Assignment** The path assignment is built on Micro SRC in accordance with the traffic demand scenario described in Section 5.3.1.	• The microsimulation seed runs (Micro SRC) but it is using the path assignment files from the static assignment instead of the assignment file developed in Micro DUE.	Major	Noted. Although the static assignment paths were applied to the Micro SRC, as noted in the review, the path assignment is reasonable and meets the modelling guidelines. Cardno would update the path assignment used for the SRCs in the model update.
11	**Road / Lane / Section Type** Four Road Types have been included in the model.	• BMDR should document each of the individual road types and the reasoning on how these road types have been defined because each of them has different parameters such as capacity, lane change / turn parameters, give way model and volume delay functions.	Medium	Noted. Greater detail on the road types used would be provided in subsequent reporting.

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12	**Vehicle Type** Three vehicle classes are defined in the model: • Car • Truck • Bus. The default values from Aimsun for vehicle type parameters including vehicle dimensions, reaction times and driving behavior were used in the model.	• From the available ATC count, the vehicle length on light vehicle is compared against typical suburban arterial road. It is found that Moss Vale has a higher number of Class 2 vehicles (Ute), so vehicle length should be adjusted to fit the actual observation in Moss Vale instead of using a standard value. • All vehicle types apply with mean speed acceptance greater than one. This means that cars in the network are travelling on average 10 per cent faster than the posted speed limit. • Reaction time in the regional NSW township is expected to have a slower reaction time instead of applying the default reaction time. • The reaction time on heavy vehicle is 0.8 seconds in general instead of the 1.2 seconds as documented in the BMDR.	Medium	Cardno would use aerial photography from near the calibration date to measure vehicle lengths across the network. This would be used to derive a distribution of vehicle lengths that could be input into the model. The spacing between vehicles when stopped in queues could also be measured and included. It is generally best-practice to maintain the Aimsun default values unless there is sufficient evidence to warrant a change. If Council has any data to support slower reaction times and speed acceptance, these would be used in the model, otherwise the Aimsun defaults would be maintained.
13	**Signal Plan** One-hour signal plan is applied in the two-hours model for both AM and PM peak model, including warm-up periods.	• Cycle time matches to the SCATS history file collected. However, Phase C (Kirkham Street) approach is coded to allow pedestrians every cycle, which effectively prolongs Phase C from 20 seconds on average to 34 seconds. This artificially builds up delay on Argyle Street and traffic queueing instead of the models effectively reflecting traffic behaviour on site. • This discrepancy is also contrary to the RMS modelling guidelines as the signal timing applied exceeds 10 per cent of the average phase time on all phases within an hour. • Mid-block pedestrian crossing is missing in this model, consequently the platooning effects on Argyle Street during the peak hour, in particular the PM Peak, are not evident in the model. SCATS data should be provided to support the documentation stating that the pedestrian crossing is infrequently utilized during the modelling periods.	Major	This is due to the limitations of fixed signals in Aimsun. Pedestrian phases are run every cycle or not at all. Adjustments must be made to signal timings based on the number of pedestrian calls and minimum green requirements. Cardno would update the signals in the model to be vehicle-actuated so they react to the traffic demand in the same way that real signals operate. This would likely result in a closer correlation between the modelled and observed signal timings. Cardno would also obtain confirmation from Council / TMA that actuated signals would be maintained for the future-year scenarios. Refer to Response 4 for options regarding the signalised pedestrian crossing.

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14	**Public Transport Line** The PT line has included both local and regional bus services including the NSW TrainLink (approximately 20 different routes are included).	• All buses are coded with zero dwell time (therefore no friction is included between the bus and general traffic at bus stops). • No local school bus services are included. • There is no Public Transport Plan setup in Aimsun. Therefore, no PT service is included in any scenario.	Major	The number of buses is small. Zero dwell times is appropriate at most stops as the bus only stops on demand (unlikely to be at every stop). The impact of buses stopping would only be felt in the CBD area where separate bus bays are provided. Nevertheless, Cardno would update the model to include local school bus routes and dwell times at stops.
15	**Modelled Road Network** Posted speed limits appear to be matching the real condition.	• On-street parking on Argyle Street is removed, which effectively removes the friction on Argyle Street.	Medium	Friction from on-street parking can be included in microsimulation modelling, however, without detailed parking surveys including average duration of stay and turnover rates, this cannot be modelled accurately. Notwithstanding, Cardno would estimate turnover rates based on signposted parking restriction times, number of parking spaces available and travel time data along the route. These would be used to include periodic section incidents in the model along Argyle Street to model the friction of parking vehicles.
16	**Model Calibration** • GEH statistical network-wide calibration • Local driver behavior • Signal timings	• The town centre section of Argyle Street should be calibrated with core-area calibration criteria. • No u-turn calibration on all roundabouts including Argyle Street / Illawarra Highway (some 50 slow-moving vehicles not calibrated in the current PM Peak calibration). • No site visit has been undertaken (or evidence of site visit provided) to observe the actual on-road driving behavior for local behavior calibration. • Signal timing applied in the models do not calibrate to SCATS history data.	Major	Core-area calibration was not used due to the time constraints of delivering the model. U-turns are typically not included in the models as they generally result from vehicles missing turns, looking for parking, etc., which do not occur in the model. Nevertheless, Cardno would update the model calibration to include U-turns at surveyed roundabouts and include core-area calibration criteria. Cardno suggests the following core-area: • Argyle Street / Illawarra Highway / Suttor Road • Argyle Street between White Street and Waite Street • Spring Street underpass. Cardno has undertaken a site visit in March 2021 as part of the Stage 1 TIA. This will be used in the model update to calibrate local driving behavior. Refer to Response 13 for signal timing options.

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17	**Model Validation** Travel time validates under the RMS modelling guidelines	• Travel time is generally low across all directions in both peak periods indicating that the model is likely to be overestimating the available network capacity.	Medium	The model meets the RMS guidelines. All routes are within eight per cent of the observed data. The observed data shows more than eight per cent variation between runs. Some variation between the modelled and observed travel times is always to be expected because of variability and inherent error in using floating car/s to measure travel times. Cardno would ensure that following the model update, the RMS guidelines for travel time would remain satisfied. Adopting more stringent travel time criteria is not recommended because measuring travel times is not an exact science. They vary from day-to-day and even across the simulation period. For this reason, the RMS guidelines suggest that within 15 per cent is an acceptable result.
18	**Visual Inspection**	• A visual inspection of the model shows network coding appears to be appropriate. However, a minor coding issue observed at the Argyle Street / Illawarra Highway roundabout results in vehicles on the left turning lane not conflicting with vehicles in the roundabout, which overestimates the capacity of the roundabout.	Minor	The number of vehicles making this turn is minor and unlikely to coincide with vehicles making the right turn movement. Roundabout performance is based on the worst-performing movement which is not this left turn, so the impact is minimal. Nevertheless, Cardno would review all model behaviours in the model update to ensure they are as accurate as possible (factoring in the limitations of the software).
19	**Results Reporting**	• No intersection level of service (LoS) is included in any Aimsun modelling assessment. It is difficult to quantify intersection delay and impact as the result of the pre-Chelsea Gardens development and post-Chelsea Gardens development.	Major	Intersection LoS was calculated using SIDRA by request of Transport for NSW / Council. Aimsun LoS was previously reported but was removed to prevent confusion between the two methods. Intersection LoS can be extracted from the updated models and reported.
20	**Traffic Generation** Traffic generation rate of 0.84 trips/ dwelling is adopted.	• The traffic generation rate is considered to be on the lower side.	Minor	Traffic generation is from TRACKS. This rate (0.84) was back-calculated using the TRACKS demands. This figure was not adopted in calculating the future-year demands by Cardno.

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21	**Future Committed Infrastructure Assumptions** Section 3.2 of the Chelsea Gardens Traffic Study, Future Modelling report documents a few of the proposed infrastructure upgrades and Stage 1 Moss Vale Bypass have been assumed in some future scenarios.	• This committed infrastructure is proposed but might not necessarily be fully-developed. This infrastructure is proposed to support the development of the Moss Vale Enterprise Corridor.	Noted	This was previously raised by Council and removed from future-year modelling for the 2016 + CG scenario onwards.
22	**Spring Street** The assumption of the Spring Street railway underpass.	• There is no modelled capacity constraint at Spring Street railway underpass in various model scenarios. • The current traffic volumes (200 veh/hr) are expected to be close to its capacity.	Major	Applying an artificial capacity constraint to any portion of the network is not recommended in a dynamic simulation. The purpose of the dynamic simulation is to allow the simulated vehicles to react to congestion, delays, etc., within the simulation and choose their route choice. The underpass is modelled so that vehicles have to give way to each other, and includes the short storage-capacity on the western side of the railway line which sometimes causes vehicles to queue back through the underpass and block eastbound vehicles. When the underpass reaches capacity in the simulation, vehicles will reassign to other routes. The capacity is determined by the model based on available storage, queueing, travel time, etc. There is no evidence provided by TMA to suggest that 200 vehicles per hour is “close to capacity”. Applying this as a capacity constraint would cause vehicles to reassign once the route reaches 200 vehicles per hour, even if there is capacity available. Greater evidence of this number would need to be provided before it could be included in the model. Cardno suggests to use site-visit observations and video footage from surveys (if a resurvey is undertaken) to calibrate the drive behaviour, aggressiveness, etc. at this location in the model update.
23	**Chelsea Gardens Development Trip Assignment** Path assignment file: 2036 DUE – without Bypass has been reviewed.	• The traffic assignment from the Chelsea Gardens development has been assessed and appears to be appropriate. • 70-80 per cent of the traffic is routed on the main street (Argyle Street) while the remaining 20-30 per cent is rat-running on Kirkham Street and Elizabeth Street.	Noted	No action.

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24	**"2036 without Bypass" scenario** *(2016 + Chelsea Gardens_Arthur St signals.ang 2036 without bypass)*	• Based on the traffic demand and results, this appears to be the 2018 Base + Full Chelsea Gardens Development. • No Public Transport Plan is set up. • The filling structure should be revised so this will not be misunderstood.	Major	Once the Base Model is updated and approved, Cardno would liaise with TMA to address comments related to the future modelling.
25	**"2036 without Bypass" scenario** *(2016 + Chelsea Gardens_Arthur St signals.ang 2016 + CG Underpass)*	• 2016 + CG analysis is not clear on how it is developed. Aimsun demand appears to be sliced into a sub-area with a 12x12 matrix surrounding the Spring Street underpass. • All SIDRA (both isolated and network) models in the traffic study are not calibrated so the results might not be representative and realistic. For example, Lackey Street is only 40 metres west of Arthur Street, however the northbound queue at Arthur Street is always greater than 40 metres. Therefore, it is expected that Lackey Street traffic would be greatly impacted by the arrangement, but this is not shown in the SIDRA analysis. If comparing the result from the Aimsun model runs, the Aimsun model suggests the delay and traffic queueing is greater on Lackey Road.	Major	Once the Base Model is updated and approved, Cardno would liaise with TMA to address comments related to the future modelling.
26	**Modelling Presentation** *(8201822101_Chelsea Gardens Moss Vale Traffic Study_rev1.pdf)* All model results were graphically presented as speed plots, density plots and volume plots.	• All plots are graphically presented, however there is no quantitative measurable unit, such as intersection delays or travel time. VHT is numerically comparable between different scenarios. For example, the future modelling mentioned that in the 2036 Base scenario, Argyle Street is saturated without Chelsea Gardens development. However, it is undetermined that the actual travel time is increased from 2018 to 2036 base scenario and 2036 with Chelsea Gardens.	Minor	Once the Base Model is updated and approved, Cardno would liaise with TMA to address comments related to the future modelling.