The Traffic impact assessment of redevelopment of the Burnside village

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ABSTRACT

Shopping malls are crucial for a country's economy and have a significant socio-cultural impact on neighbouring areas. It is fair to say that shopping malls have a major impact on the local economy and culture, but they also generate jobs and revenue for the small companies located in and around the mall.

As South Australia's population and infrastructure expand, traffic congestion at signalised intersections is likely to rise. A Traffic Impact Study (TIS) was conducted to analyse the consequences of the Burnside Village redevelopment on signalised intersections in Adelaide. The implications on drivers, pedestrians, the economy, and the environment were all taken into consideration.

This research method has multiple steps to investigate traffic patterns in the studied region. To correctly estimate vehicle volume, the present road network was analysed using DIT data and on-site observations. The research then used trip generation estimates to determine how new construction influences traffic volume.

The impacts were evaluated using advanced techniques, namely SIDRA and AIMSUN. SIDRA primarily concentrated on analysing intersections, and its results were included into AIMSUN to simulate the entire traffic performance. The tools simulated the intersections and road network in the vicinity of the development site for different time periods: 2024 (current circumstances), 2025 (after redevelopment), future scenarios (10 years in the future), and an ideal solution.

The study included data collecting, model development with SIDRA and AIMSUN, calibration, validation, and recommendation of the optimal approach. The ideas for minimising traffic consequences include establishing a lane on Portrush Road and Greenhill Road in TS088 and increasing the cycle time from 130s to 150s. These changes are intended to improve road system performance and optimise traffic signal settings, resulting in greater traffic efficiency and general community well-being. The data and conclusions will be useful for future development initiatives and research in transportation engineering.

DECLARATION

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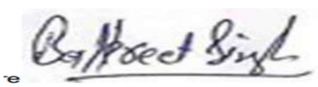
2. and the research within will not be submitted for any other future degree or diploma without the permission of Flinders University; and
3. to the best of my knowledge and belief, does not contain any material previously published or written by another person except where due reference is made in the text.

Signature of student.......  ....

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Print name of Principal Supervisor.............. Dr Nicholas Holyoak......................................

Date...

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LIST OF ABBREVATIONS

TS088 Intersection of Portrush road and Greenhill Road

TS229 Intersection of Portrush road and Cator Street

DIT Department of Infrastructure and Transport

LOS Level of service

GLFA Gross leasable floor area

Co2 Carbon dioxide

SF Saturation Flow

TAM Tactical Adelaide model

INTRODUCTION

Project Background

Shopping malls and retail business are critical components of metropolitan economies, with considerable direct and indirect impacts on employment, income creation, and GDP contribution. This project is the traffic impact study of the redevelopment of the Burnside village, which is developing in its sixth stage and the reconstruction is expected to be finished in 2025. The shopping centre is located in Southeast region, in the suburb of Glenside and it is less than 7km far from the Adelaide CBD. Burnside Village is situated along four roads: Green Hill Road, Portrush Road, Sydney Street, and Cator Street.

The shopping complex features over 100 fashion businesses and groceries, with plans to add an additional 80+ stores throughout the remodel. The renovation project will have new access points, a cinema complex, five floors of office space, and 560 more parking spaces. The remodelling of the retail complex is projected to attract more customers, tourists, and workers, leading to increased visitor rates. This increased traffic demand could create higher traffic congestion levels surrounding the village, and it might increase the queue length at main roads. The increasing volume of traffic might have a negative impact on the environment, such as noise pollution and air pollution, and it could have an influence on the quality of life for those that reside nearby. These concerns could not be ignored.

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Figure 1Case Study location.

This project report presents a detailed Traffic impact Study (TIS) to examine the influence of the future transportation system on traffic conditions. This investigation also requires the design of solutions that would be applicable under all future situations. The solutions need to adapt to the current limits of the road network, without making major changes to existing intersections and road widths. At the same time, it should ensure efficient traffic flow and address important factors such as pedestrian and vehicle safety, and reduced emissions, particularly during peak periods.

As the basis for finding solutions for growing traffic, the research requires gathering a variety of data necessary to predict future situations. The major content of this study is the identification of all relevant stakeholders, including direct and indirect stakeholders and the gathering of detailed information from each of them. The next step is to do a literature review to find out how other projects have utilised technologies like SIDRA and AIMSUN in comparable circumstances.

The current traffic flow on road connection surrounding the shopping centre varies between 30,000 and 40,000 vehicles per day. After the redevelopment of Burnside village, however, a significant number of vehicles is expected to go through this region. The additional traffic will influence the flow of vehicles on Portrush Road and Greenhill Road. Three major intersections that have been significantly impacted by the new development include the intersection of Portrush Road and Greenhill Road, the T Junction of Greenhill Road and Sydney Street, and the T junction of Portrush Road and Cator Street. Additionally, it will also influence vehicles travelling on the M1 highway and in the CBD, as Portrush Road serves as a connection between the city and the M1.

Project Aims and Objectives

According on the literature study and research gap analysis, research must be performed. A set of goals are established to overcome knowledge gaps and improve outcomes. The major objective of the research is to ensure that the current safety and service quality requirements are not affected.

The objectives of this research are outlined below:

1. Create a microscopic traffic model for the purposes of analysing model scenarios.
2. Determine the impact of new development on traffic in the region.
3. Investigate the impact on key parameters such as delay time, LOS, travel speed and emissions etc.
4. Assess if the present road network can accommodate increased traffic.
5. Propose recommendations for reducing negative effects of traffic.

Project Scope

The scope of this project is chiefly determined by the aims and objectives, and it also assesses the future model's viability with respect to delay time, travel time, and environmental impact. The assessment's scope is decided by the volume of traffic generated by the proposed development and its potential impact on the road network. For this project's traffic impact study, the AUSTROADS guidelines are the most significant ones.

The paper is structured into seven chapters, each of which is further divided into parts and subsections. First chapter provides introduction, background of the study area and location, scope, and objectives of the research. In second chapter, the literature review presents information on the connection between land use and transport, the redevelopment of Burnside village, the impact of redevelopment, simulation modelling, transportation evaluation, and modelling.

In third chapter, the methodology and specifications used for modelling the intersections are explained. The modelling is done using the SIDRA and AIMSUN microsimulation tools. This chapter covers data collection, modelling, calibration, and validation of the model.

Fourth chapter provides the results and analysis including delays, travel speed, CO_2 emission and Level of Service (LOS).

Fifth chapter provides discussion section of the thesis, sixth chapter presents the conclusion, and seventh chapter depicts the future work.

LITERATURE REVIEW

The traffic impact assessment is based on the redevelopment of Burnside Village. The Burnside Village is currently in its sixth stage of development, which will include the addition of 80 new stores and new building covers 38,850 square metres. There will also be around 560 free undercover parking spaces and EV charging stations. The construction of shopping centre is expected to complete in next year 2025. (village, 2024) Multiple new enterprises in the leisure, food and drinks, home & lifestyle, and health/wellness sectors are launching in the Burnside village, which will attract fresh consumers and therefore result in increased traffic in the surrounding area. (RCP, 2024) It is essential to examine the public transportation system in the research region throughout this literature analysis, as it significantly affects the amount of traffic. In this specific region, buses are the only type of public transportation, therefore leading to the probability of an increasing number of vehicles.

Emission variables are frequently linked to average speed, and researchers typically employ average speed as a metric to assess traffic performance. When congestion causes the average speed of vehicles to drop below 45 mph on a motorway, there is an increase in CO_2 emissions. Increased vehicle usage leads to elevated levels of CO2 emissions due to extended periods of time spent on the road. Thus, in this situation, programmes aimed at alleviating congestion will immediately decrease the amount of CO2 emissions (Boriboonsomsin, 2009). In Mumbai metropolitan region, the 51% increase in transit time during congested conditions may account for a substantial portion of the 53% increase in CO2 emissions (Shashank Bharadwaj, 2017). In 2012, road transport was responsible for 84% of the 91 million metric tonnes of carbon dioxide equivalents (CO2) emitted by Australia's transportation industry (Australia, 2013).

SIDRA is an advanced micro-analytical assessment tool that utilises lane-based traffic and vehicle drive cycle models. Experts in traffic design, operations, and planning employ this widely used software to assess intersection and network capacity, level of service, and performance. AIMSUN is a highly efficient microsimulation tool that assists urban planners in the management of transportation by facilitating traffic analysis and optimisation. Its predictive and simulation analytics facilitate decision-making and comprehension of network performance (SIDRA, n.d.).

Modern transportation networks are so complicated that direct testing is not an option. These days, effective traffic control is achieved using traffic flow models. Based on the findings, computer simulations are a great tool for planning and executing road improvements, intersection management, and automated traffic control systems. Since the development of computers, traffic simulation models—which often use automated ways to assess traffic effects—have become indispensable. (huo Huang 1, 2020)

Microscopic simulation is a highly accurate method that accurately reproduces the actions of individual vehicles, considering many elements such as the speed of the driver, lane changes, turning patterns, and specific features of each vehicle, such as size, weight, and acceleration rate. This approach is employed to assess the consequences of alterations to the road network or traffic flow, as well as concerns related to congestion and safety. (Li, 2019) It is frequently used to simulate intricate road networks, such as crossroads and roundabouts. Studies has conducted using microscopic simulation to examine how road and roundabout designs impact traffic flow and safety (Mohammadian, 2018).

The shopping centre growth affects neighbourhood traffic patterns in Istanbul, Turkey. The study examines traffic volumes at an Istanbul retail mall before, during, and after its 2014 opening using continuous traffic data from the Istanbul Municipality Research Centre (Arian, 4, April - 2021). Linear regression analysis shows considerable local traffic growth, especially at peak hours, underscoring the necessity for efficient traffic management. The study emphasises the relevance of Traffic Impact Analysis (TIA) in understanding how such changes affect road networks and the usefulness of using socioeconomic, demographic, and land use data to enhance traffic generation estimates. Traffic analysis is essential for urban development since the study found that careful design and planning managed traffic effects. In contrast, Anil Minhansa, Nazir Huzairy Zaki, and Rakesh Belwal (2013) examine TIA in Skudai Town, Malaysia, during fast urban growth. The proposed Tesco Hypermarket on a crucial junction is expected to cause severe congestion by 2025 with a V/C ratio of 1.740, an average delay of 1092.1 seconds, and LOS F. They improve dramatically once a flyover is built, demonstrating the relevance of infrastructural changes. This research also emphasises the need of knowing how urban expansions influence traffic and road networks, especially in economically and educationally growing areas. The researchers use Trip Rate Analysis and Regression Analysis to show that socioeconomic and demographic characteristics improve traffic predictions. Existing trip generating instructions may be inaccurate, thus the study recommends regression-based estimations (Anil Minhansa, 2013). Both studies emphasise the need of TIA in controlling new development traffic impacts.

The study by (Kalubowila, 2023) examines the impact of the Festival Plaza Tower's new large-scale development in Adelaide's CBD on nearby signalized intersections and pedestrian crossings, considering its effects on drivers, pedestrians, the economy, and the environment through a traffic impact study (TIS). Given that approximately 78% of South Australia's population resides in Adelaide's densely populated CBD and relies heavily on automobile transportation for social and cultural needs, the interaction between land use and transportation is significant (Rodrigue, Comtois, and Slack, 2020). The research (Kalubowila, 2023) indicates that by 2035, anticipated delay times can be reduced to 39 seconds, and the level of service can be improved to LOS D with proposed improvements such as extending slip lanes and lanes. The optimal solution proposed could potentially save $2.5 million annually, representing a 33.5% reduction in total annual costs, showcasing the solution's effectiveness. However, in the worst-case scenario of 2035, CO_2 levels are expected to rise by 57% compared to the baseline year. The proposed optimal solution has the potential to reduce CO_2 emissions by 0.3 million kilograms per year, amounting to a 24.9% reduction. The research aims to provide optimal recommendations to mitigate the adverse effects of traffic and enhance road performance, focusing on improving the road network and traffic signal settings to boost traffic efficiency and overall community well-being.

METHODOLOGY

A Traffic Impact Assessment assists in reducing the adverse effects that the planned development may have on the surrounding. It ensures that the transportation network can manage the expected increase in traffic. After the Burnside village is redeveloped, it is expected that there will be excessive congestion on Portrush road and Greenhill Road. An analysis was conducted to analyse the impact of the recent development on three main intersections during peak periods. The analysis focused on evaluating delays, travel speed, emissions, and level of service. These intersections are remarkably close to the shopping centre(shown in figure 2). (GoogleMaps, 2024)

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Figure 2 Three Intersection impacted by development.

The modelling procedure utilised in this study was conducted using two different software applications, such as SIDRA and AIMSUN. The software applications were chosen based on their strengths and capabilities in managing a wide range of traffic management strategies (SIDRA, n.d.). The research project started with an in-depth examination of existing information and a review of relevant literature. The data collecting approach involved conducting a DIT data collection and field survey. Field surveys were conducted to gather data, which included recording the number of vehicles, the length of queues, and saturation flow. These collected data used for modelling the intersection in SIDRA and AIMSUN.

The ITE Trip Generation Manual database, specifically the Guide to Traffic Generating Developments, was used to forecast the number of trips that will be generated following the redevelopment of the Burnside village (Transport Planning Section, 2002). Eventually, it shows potential solutions for minimising delays, and emissions, while improving the general conditions of traffic flow and speed, after the use of SIDRA and AIMSUN software for modelling.

Flow Chart of the research:

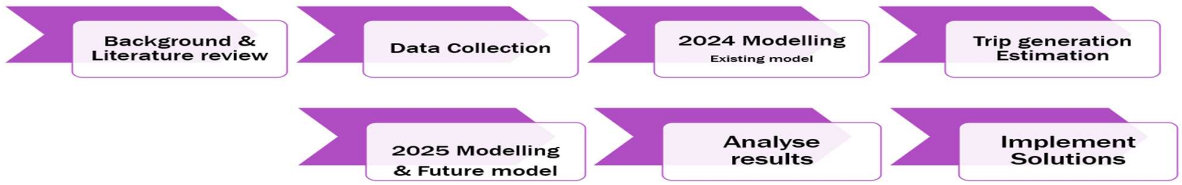


Figure 3 Flow Chart of the research.

In general, the research methodology (shown in figure 3) employed a thorough and comprehensive approach to modelling by examining the effects of Burnside village redevelopment, such as delays and emissions, in consideration of the development's peak-time location. The method was carried out to evaluate the efficacy of Greenhill Road and Portrush Road both before and after to the completion of the project. A traffic impact study for the Burnside village development was done, and it came up with several possible options, such as improving the roads and changing the traffic lights.

Data Collection:

Data was collected from two sources: the Department of Infrastructure and Transport (DIT) and the Sydney Coordinated Adaptive Traffic System (SCATS). Initially, there were intersection drawings available for TS088 and TS229 in SCATS, providing vital information regarding their geometry and structure. During the week of November 20-26, 2023, SCATS counts were collected using the Sydney Coordinated Adaptive Traffic System. We collect and analyse the traffic volume data for these two intersections. For the third intersection Greenhill Road/ Sydney Street, SCATS data was not available, so we must do field survey for the intersection.
The Tactical Adelaide Model (TAM) Guidelines identify weekday morning peak hours as 8:00-9:00 AM and weekday evening peak hours as 5:00-6:00 PM. But in this research, we were doing traffic impact assessment of the shopping centre which usually opens at 9 AM and closes at 5 PM, so that why I chose peak time for this project was 9:00-10:00 AM and evening peak 4:00-5:00 PM (guidlines, n.d.). Initially at the site, I have selected the location for the camera to record video, from where I can watch each lane of the intersection. So, I had selected two location points for each intersection and recorded two videos of 15 Minutes for every intersection, between 9-10AM and 4-5PM(showen in figure 4). I have done these video recordings and vehicles counts between 7-19, March 2024. After the recording of videos, I watched each video and counted both heavy and light vehicles passing in each direction. The field study produced an important dataset with a diverse range of crucial indicators. The data collected included both light and heavy vehicle volumes, which offered insights

into the sorts and amounts of cars passing through the intersections. I have compared these manual data with SCATS data, which were probably same, so I preferred to choose data recorded by myself.

Figure 4 Video recording and manual data count.

In general, the data collection process from DIT and SCATS, as well as the site visit, was an essential aspect of this project (DIT, 2024). It provided vital information about the intersection's geometry, traffic volume, and other relevant parameters. This information was necessary to develop a precise and accurate simulation model using the SIDRA software.

SIDRA modelling for existing model 2024:

SIDRA is an advanced micro-analytical tool that is utilised to assess the operational efficiency of intersections and develop various intersection designs. Applications involve signalised intersection and network timing calculations, level of service evaluation, performance analysis, and assessment of intersection and network capacity.

Geometry:

The process of Sidra modelling consists of several distinct stages. Initially, I have included intersection data, which consists of details such as the name of the road and the distance to the approach, as image shown in the Appendices. After that, the different intersections provided "MOVEMENT DEFINITIONS" such vehicle classifications and approach motions. After that, I adjusted the intersection's geometry—including Lane Configuration and Lane Disciplines—to produce an existing base model of Intersections TS088, TS229, and Greenhill/Sydney St. that reflects present scenario, as image shown in appendices. I removed pedestrian and bicycle lanes as well. The primary goal was to make sure that the observed intersection geometry precisely matched the present SIDRA.

Saturation Flow:

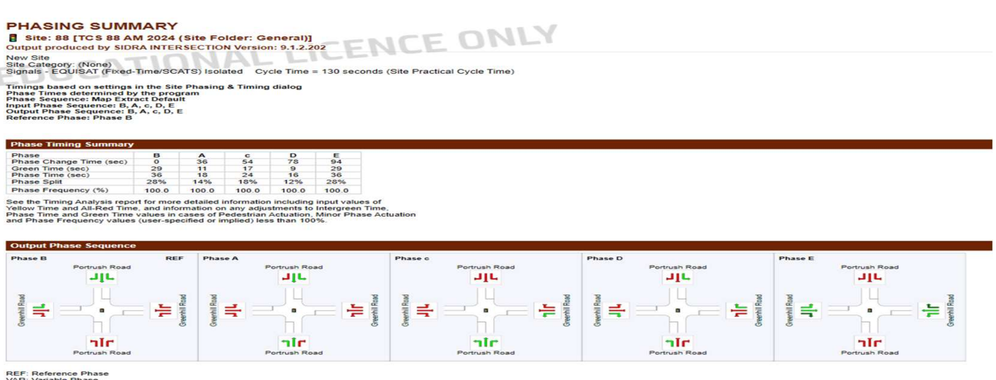
The saturation flow refers to the maximum rate at which a continuous stream of vehicles may pass through a fixed green signal, usually measured in vehicles per hour or PCUs per hour. I have used JCT Tools, which is a mobile application for measuring the saturation flow for each lane of all three intersections, images are attached to appendices.

Volumes:

Traffic volume is a crucial step for the modelling, in this I have updated the counted vehicles (HV & LV) for each lane direction for all three intersections. In this I particularly specify the percentage of heavy vehicles.

Phasing and Timing:

A vital component of traffic study was the optimisation of signal phasing and timing. To configure the phasing and timing parameters in the SIDRA programme, Input is required for several parameters including cycle time, phase and sequence data, and green times for each phase of the signal. I have used 130 seconds cycle time as given by DIT. The optimisation of signal timing and phasing was one of the key components of traffic analysis. In the SIDRA programme, to adjust the time and phasing, input a number of parameters for each phase of the signal shown below in figure 5 regarding Intersection TS088. These parameters include cycle duration, phase and sequence data, and green times. Input five phases, each having a unique phase split of 28%, 14%, 18%, 12%, and 28% for phases B, A, C, D, and E, respectively. In addition, the programme offered timing and phasing visualisations of the signals, which helped me comprehend how various adjustments influenced traffic flow (shown in figure5).


PHASING SUMMARY
Site: 88 [TCS 88 AM 2024 (Site Folder: General)]
Output produced by SIDRA INTERSECTION Version: 9.1.2.202
New Site
Site Category: (None)
Signals - EQUISAT (Fixed-Time/SCATS) Isolated Cycle Time = 130 seconds (Site Practical Cycle Time)

Timings based on settings in the Site Phasing & Timing dialog
Phase Times determined by the program
Phase Sequence: Map Extract Default
Input Phase Sequence: B, A, c, D, E
Output Phase Sequence: B, A, c, D, E
Reference Phase: Phase B

Phase Timing Summary

Phase	B	A	c	D	E
Phase Change Time (sec)	0	36	54	78	94
Green Time (sec)	29	11	17	9	29
Phase Time (sec)	36	18	24	16	36
Phase Split	28%	14%	18%	12%	28%
Phase Frequency (%)	100.0	100.0	100.0	100.0	100.0

See the Timing Analysis report for more detailed information including input values of Yellow Time and All-Red Time, and information on any adjustments to Intergreen Time, Phase Time and Green Time values in cases of Pedestrian Actuation, Minor Phase Actuation and Phase Frequency values (user-specified or implied) less than 100%.

Figure 5 Phasing summary.

SIDRA Model Calibration and validation:

The modelling process required significant calibration during the project's traffic analysis to make sure that the simulation reflected real-world traffic conditions precisely. To calibrate traffic simulations, the Avg Back of Queue (dis) method was used within the SIDRA software. It showed me the queue length of 355m for intersection TS088, which is quite like real site experience. For other two intersections (both AM &PM peak hours), I used the same pattern to validate the model.

Calibration with Saturation flow: Initially, saturation flow (SF) was measured with JCT tools for each movement of an intersection for the five times, and got the avg. SF, SIDRA gave output SF. With calculations shown in table 1, I have got similar value of SF as measured with manual JCT tools at site. Thus, the model is well calibrated & validated, and I follow the pattern for all intersections.

Table 1 Basic saturation flow calibration

Index	Green Time	Full Dmd PCU	Full Dmd Time	Saturation Flow	Timestamp
1	53	14	27.73	1817	14 March 2024 9:02:32 am
2	57	15.5	32.64	1710	14 March 2024 9:05:00 am
3	54	13	28.37	1649	14 March 2024 9:07:29 am
4	56	14	39.69	1270	14 March 2024 9:09:59 am
5	57	13	28.38	1649	14 March 2024 9:12:29 am
		A	**Average SF**	**1619**	
		B	Sidra Output SF	1920	
		A/B		0.843229167	
		C	Sidra Basic SF	1950	
		C*A/B	New Sidra Basic SF	1644.296875	
		D	New Sidra Output SF	1619	

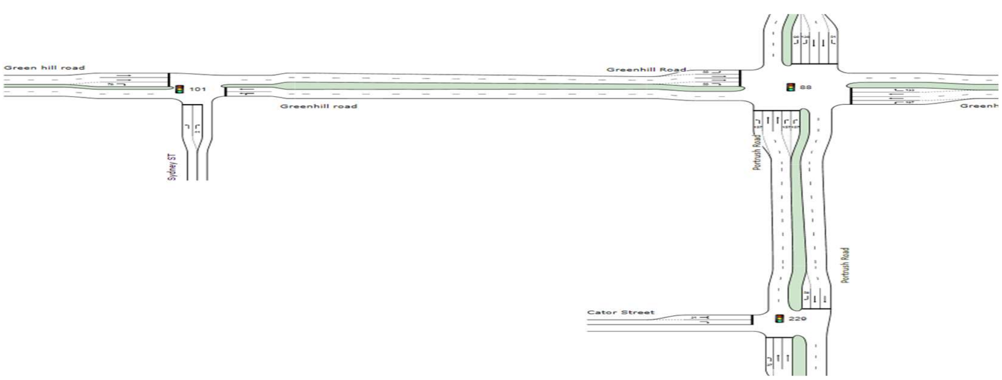


Figure 6 Network of three intersections.

Trip generation Estimation

Trip generation rates, which represent the number of trips created by a land use type, are used to assess traffic impact. The redevelopment of the Burnside village will lead to new trips. New trip generation estimates are needed for SIDRA and AIMSUN's future models to assess traffic impact. ITE Trip Generation Manuals (Guide to Traffic Generating Developments – updated traffic surveys, August 2013) were utilised for estimating the number of trips that were made. I have calculated the trips with two methods:

Method 1:

. V(P)= 20 A(S) + 51 A(F) + 155 A(SS)+ 22 A(OM) (vehicles trips per 1000m2)

Where:

- A(S): Slow Trade gross leasable floor area includes major department stores.
- A(F): Faster Trade GLFA- includes discount department stores i.e., K-mart, Target etc.
- A(SM): Supermarket GLFA- include stores such as large fruit markets.
- A(SS): Specialty shops, secondary retail GLFA, A(OM): office, medical centre, business offices

In this method, gross leasable floor area is divided according to the use such as large fruit market, offices etc. Then these distributed areas put in the formula given, and we got the number of trips as shown in the table 2.

Table 2 Trip generation values

Total Area	38850 sqm
Gross leasable floor area	29138 sqm
A(S) (50%)	14568
A(F) (17%)	4953
A(SM) (17%)	4953
A(SS) (8%)	2331
A(OM) (8%)	2331
V(P) (Vehicles)	1470.186

Method 2:

In this method, I have identified the range of GLFA and selected day (Thursday) and calculated the vehicles with peak hour generation rate. The data displayed in the table 3 are from the 2011 revised survey.

Table 3 Peak Hour Generation Rate (vehicles per 100m2 GLFA)

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Table 4 Trip generation values 2

Total Area	38850sqm
Gross leasable floor area	29138sqm
Total trips (v/h)	1719.14

Using these two methods, I have obtained new trip values of 1470 and 1719, respectively. I have selected the highest values for trips to use in modelling scenarios after the development of the Burnside village.

SIDRA Modelling after the development 2025:

After the new trip generation, we have distributed the new vehicles to the possible lanes going in and out to the Burnside village for both AM and PM peak hours, as we can see in the figure 7.

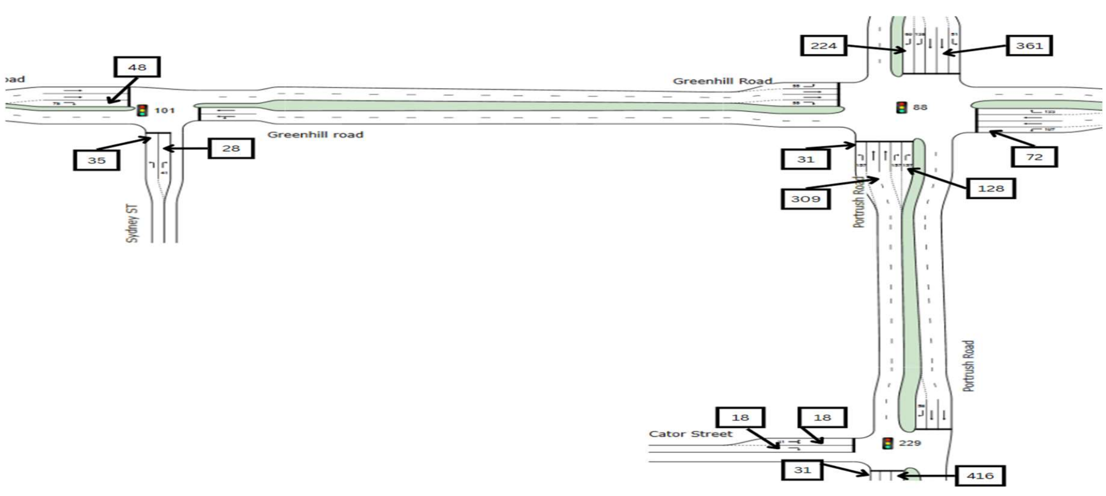

Figure 7 New trips distribution (AM)

The modelling of these three intersections with added new trips during both AM and PM peak hours found that delays were longer, CO2 emissions were greater, the Level of Service (LOS) got worse, and travel speeds decreased. Then I have developed more model with optimum solutions such as increasing cycle time, adding extra lanes. After these models with revised results, I have done modelling for the future, such as model 2034, model 2035, and upgraded model 2035. The results of all these scenarios are discussed in the result chapter.

AIMSUN Modelling:

AIMSUN was a powerful programme for simulating traffic. It let you make detailed models of traffic networks, try different situations, and look at the results (Aimsun, n.d.), and flow chart of the software shown in figure 8.

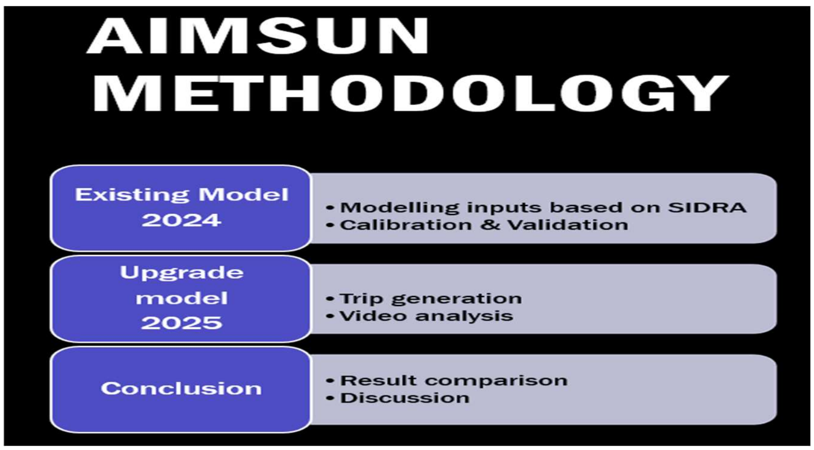

Figure 8 AIMSUN Methodology

In AIMSUN, I have model one intersection TS088 for the AM peak hour. Initially, the Network Geometry was established by importing the road network and adjusting the road geometry, as done in the SIDRA model. This process involves making changes to the number of lanes, intersection alignment, turning motions, lane discipline, stop-lines, and turn priority. Afterwards, the Traffic Demand, Control Plan, and Master Control Plan were properly specified. Then OD matrix have done with counted traffic volume. By following all steps, existing model 2024 has done, and calibration was done as per guidelines, which states that GEH statistic for individual flow should be below 5.0, mean GEH is also 1.39<1.5, and R2 =0.9938 as shown in figure 9.

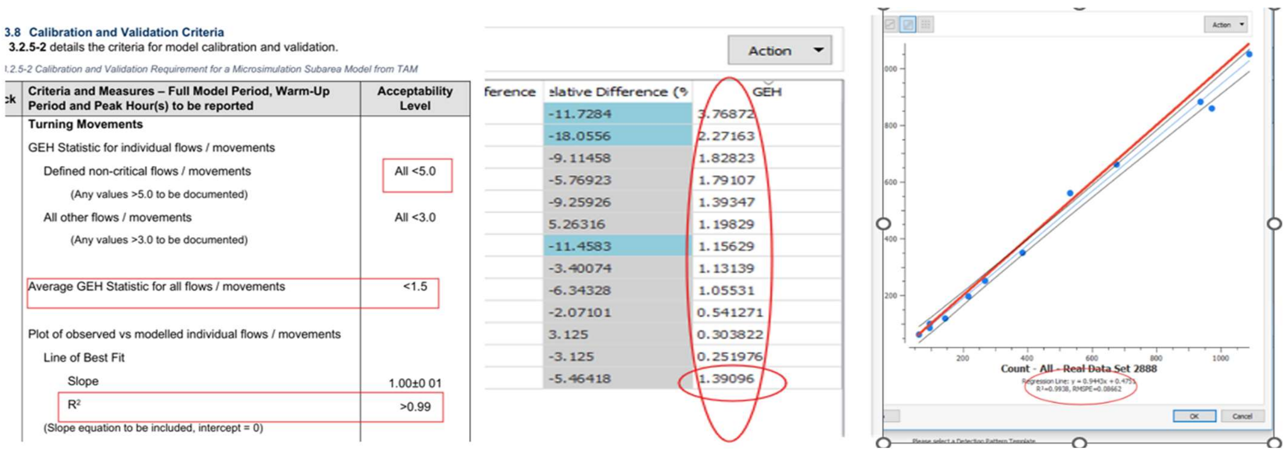

Figure 9 AIMSUN model calibration

Following the calibration of the model, I produced a model for the year 2025 with a higher traffic volume (with trip generation). Subsequently, I developed an upgraded version of the model (upgrade 2025) that includes optimal solutions to assess the visualization of vehicles.

RESULTS AND ANALYSIS

This chapter will describe the results derived from two distinct methodologies, specifically the microsimulation AIMSUN model and the SIDRA Intersection evaluation. These techniques were used to examine the impacts of the redevelopment of Burnside village on the traffic flow of Portrush and Greenhill Road. The outcomes derived from these two approaches will be used to measure the traffic impact according to multiple measures, including Level of Service (LOS), travel speed, queue length, emissions, and delay.

Delay time and LOS:

Level of service (LOS) is a metric used to assess the efficiency and effectiveness of an intersection. The level of service of a signalised intersection is determined by calculating the average total delay experienced by all vehicles passing through the intersection. Vehicle delay can be used to measure driver suffering, frustration, and wasted travel time.

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Figure 10 Criteria of LOS for signalized intersections (Austroads, 2017).

The control delay is quantified using numerous factors to assess the amount of time that all vehicles must wait in the approach lane of the intersection. Delay refers to the extra amount of time it takes for a vehicle to travel compared to the normal travel time. The delay experienced by the average vehicle can be directly related to a level of service (LOS) as shown in figure 10.

The figure 11 showed delay time and LOS for each side of movement for the existing model.

Figure 12 shows that delay time has increased in model 2025 than existing model 2024. I have updated the intersection by adding extra lane in Portrush road and Greenhill Road and increased the cycle time as shown in images. Hence, I have got better delay time and LOS in upgraded model 2025. Also, the values of LOS get better with upgraded model.

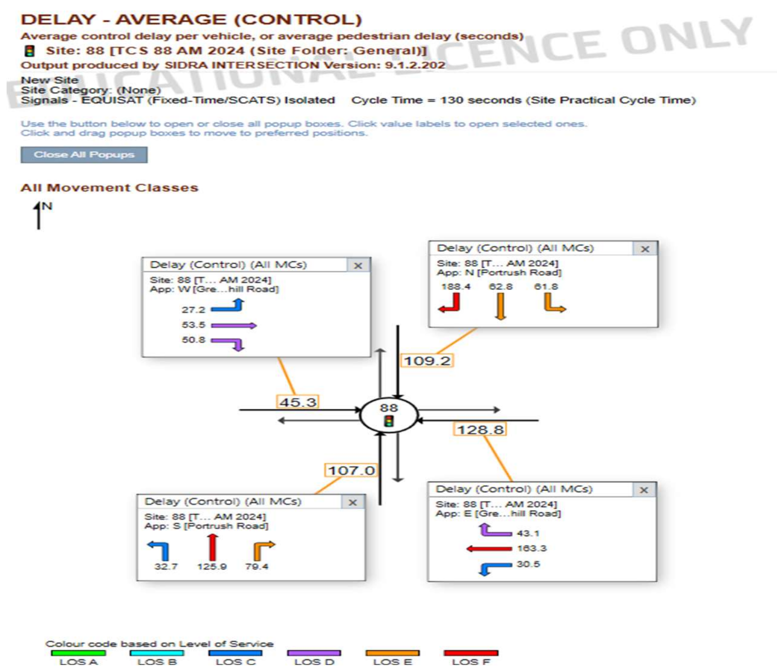

Figure 11 TS088 (AM) 2024 Delay & LOS

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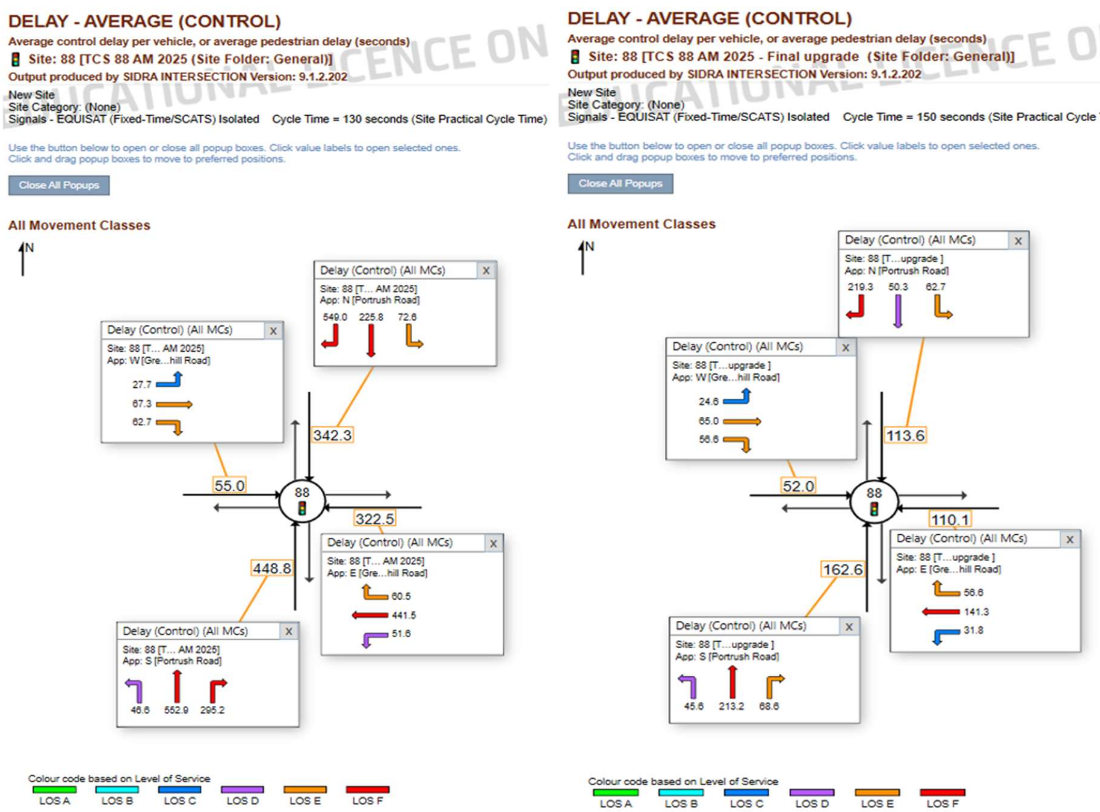

Figure 12 LOS vs Delay 2025 & upgraded 2025.

TS229, Portrush road and Cator Street

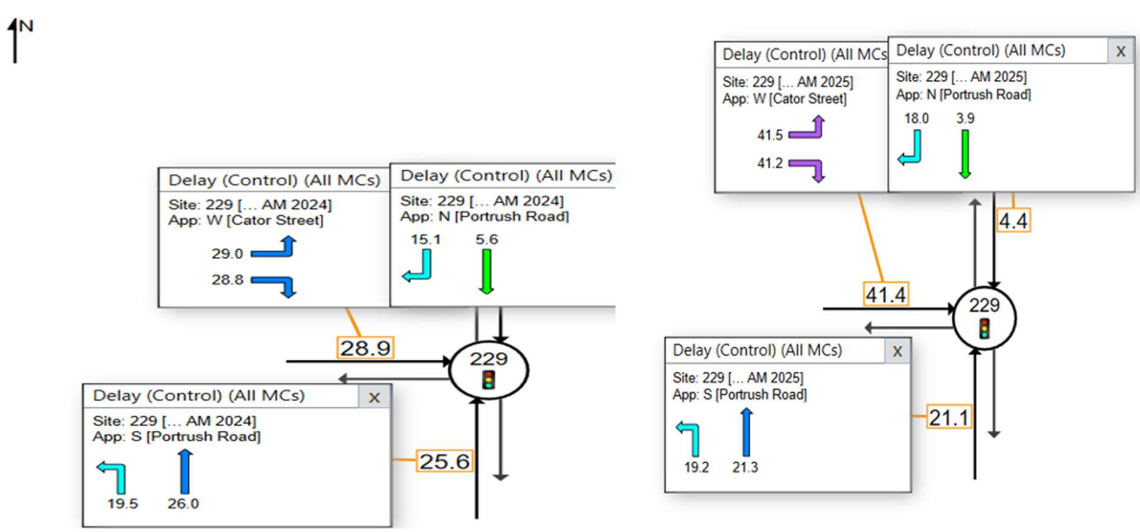

Figure 13 LOS vs delay 2024 & 2025.

In TS229, LOS of all movements are ranges between A to C of before and after the development, which is quite acceptable for the traffic flow, and also there is minor rise in delay time, So there is no need of any further upgradation in the intersection.

Emissions:

The presence of road network delays and traffic congestion contributes to several environmental problems. The rise in fuel consumption and the release of dangerous pollutants caused by new development negatively impact environment. The levels of carbon dioxide emissions are steadily and noticeably rising daily.

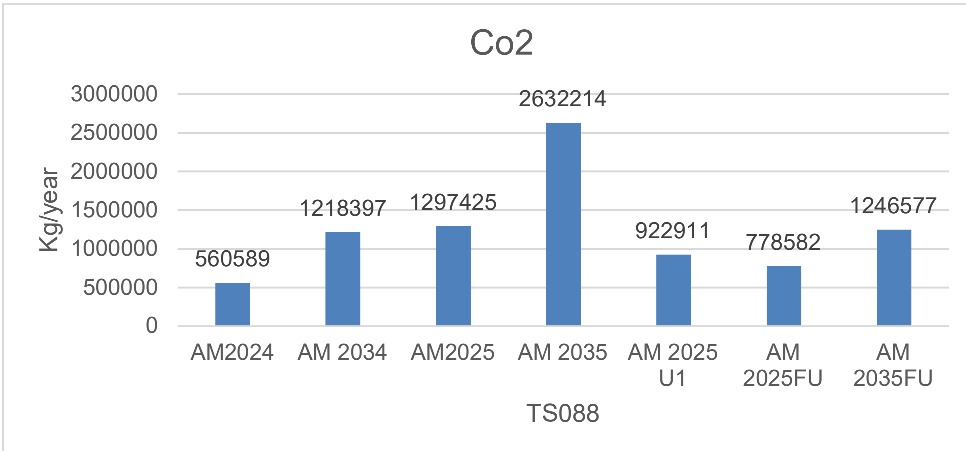

Figure 14 CO2 emission vs scenarios.

Figure 14 shows a 131% rise in CO_2 levels in 2025 compared to 2024. The amount of carbon dioxide is projected to reach its peak in model 2035, although it is significantly reduced by 52% with the upgraded model (2035FU).

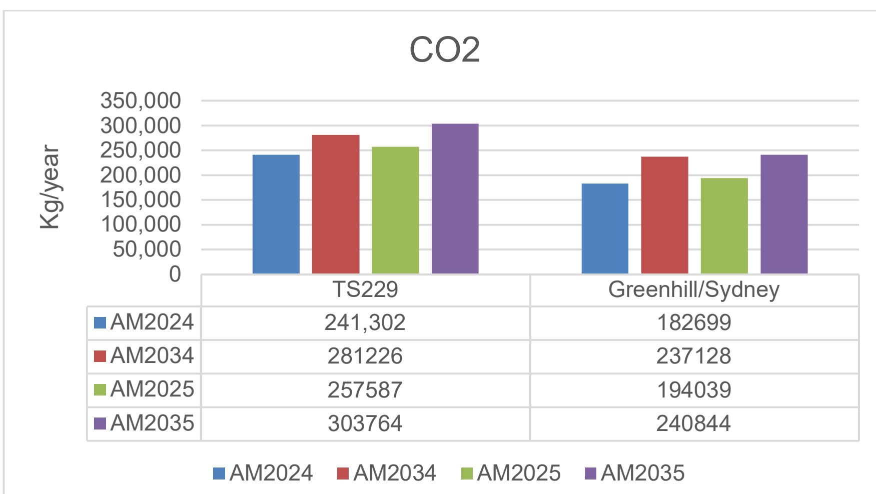

Figure 15 CO2 vs scenarios.

Figure 15 shows the CO_2 level of TS229 which ranges between 0.2M to 0.3M Kg/Y, and for intersection of Greenhill road and Sydney Street, it ranges between 0.15 to 0.25M Kg/Y for all the scenarios.

These value ranges are for 10 year future, and these values are lower than compared to the other intersection TS088.

Annual Intersection performance of network:

Intersection Performance - Annual Values			
Performance Measure	**Vehicles:**	**All MCs**	**Persons**
Demand Flows (Total)	veh/y	2,488,320	2,985,985 pers/y
Arrival Flows (Total)	veh/y	2,488,320	
Delay (Total)	veh-h/y	69,777	83,732 pers-h/y
Effective Stops (Total)	veh/y	2,909,656	3,491,587 pers/y
Travel Distance (Total)	veh-km/y	731,486	877,784 pers-km/y
Travel Time (Total)	veh-h/y	78,349	94,018 pers-h/y
Cost (Total)	$/y	3,307,040	3,307,040 $/y
Fuel Consumption (Total)	L/y	221,966	
Carbon Dioxide (Total)	kg/y	525,294	
Hydrocarbons (Total)	kg/y	60	
Carbon Monoxide (Total)	kg/y	492	
NOx (Total)	kg/y	1,027	

Figure 16 intersection performance 2024.

Figure 16 shows the annual values for delay, travel time, cost, fuel consumption and emission for existing model 2024.

Intersection Performance - Annual Values			
Performance Measure	**Vehicles:**	**All MCs**	**Persons**
Demand Flows (Total)	veh/y	2,999,899	3,599,879 pers/y
Arrival Flows (Total)	veh/y	2,873,798	
Delay (Total)	veh-h/y	175,031	210,037 pers-h/y
Effective Stops (Total)	veh/y	4,295,148	5,154,178 pers/y
Travel Distance (Total)	veh-km/y	828,304	993,965 pers-km/y
Travel Time (Total)	veh-h/y	174,018	208,821 pers-h/y
Cost (Total)	$/y	7,037,193	7,037,193 $/y
Fuel Consumption (Total)	L/y	378,943	
Carbon Dioxide (Total)	kg/y	896,719	
Hydrocarbons (Total)	kg/y	113	
Carbon Monoxide (Total)	kg/y	829	
NOx (Total)	kg/y	1,594	

Figure 17 annual intersection performance 2025.

In figure 17, I have noted that after the development, there is a significant rise in the delay by 150%, fuel consumption by 70%, and the cost by 112%.

Intersection Performance - Annual Values			
Performance Measure	**Vehicles:**	**All MCs**	**Persons**
Demand Flows (Total)	veh/y	2,999,899	3,599,879 pers/y
Arrival Flows (Total)	veh/y	2,999,899	
Delay (Total)	veh-h/y	92,076	110,491 pers-h/y
Effective Stops (Total)	veh/y	3,285,101	3,942,122 pers/y
Travel Distance (Total)	veh-km/y	1,290,392	1,548,470 pers-km/y
Travel Time (Total)	veh-h/y	108,664	130,396 pers-h/y
Cost (Total)	$/y	4,575,739	4,575,739 $/y
Fuel Consumption (Total)	L/y	303,823	
Carbon Dioxide (Total)	kg/y	719,256	
Hydrocarbons (Total)	kg/y	80	
Carbon Monoxide (Total)	kg/y	692	
NOx (Total)	kg/y	1,405	

Figure 18 Annual intersection performance upgrade 2025.

Figure 18 showed the values of upgraded model with optimum solutions. After upgradation, delay decreased by 47%, fuel consumption by 20% and the cost by 35%.

Travel Speed

Travel speed is a basic feature of transportation, and increasing the speed is seen as beneficial. The advantage of an increase in speed is often evaluated based on the actual value of the time saved during travel.

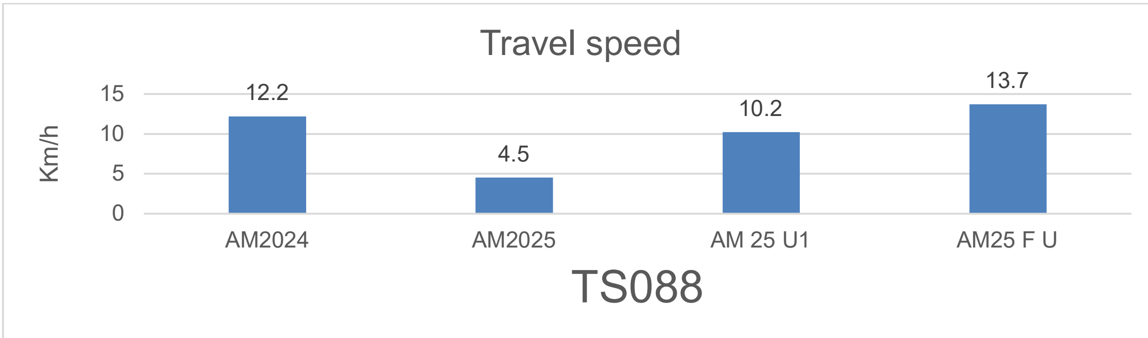

Figure 19 Travel speed vs scenarios.

Figure 19 illustrates the travel speed at intersection TS088 for the present model 2024, which is recorded at 12.2km/h. However, in the next version, 2025, the travel speed reduced by 4.5km/h due to an increase in traffic volume, which is expected to generate traffic congestion on road. Afterwards, the speed increased to 13.7km/h with upgrading the intersection with optimal solutions i.e. added lanes and increased cycle time.

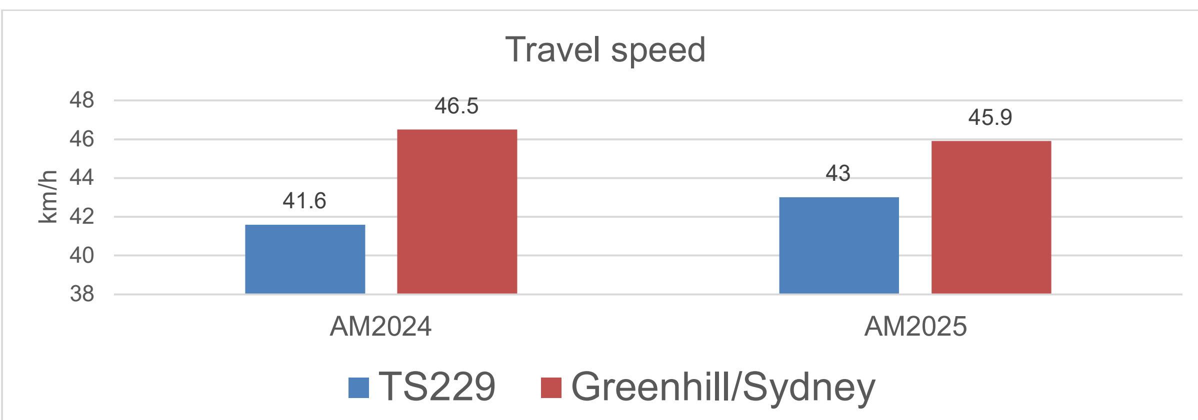

Figure 20 Travel speed vs scenarios.

Figure 20 shows travel speed for two intersections TS229 and Greenhill/Sydney of before and after the development models. This result shows that there is slight variation of travel speed before and after the development, which is acceptable for traffic. Thus, there is no need of any further upgradation in these two intersections.

AIMSUN Results:

The AIMSUN data was used for visualising the movement of vehicles and the durations of queues, enabling a deeper understanding of the operation of the intersection.

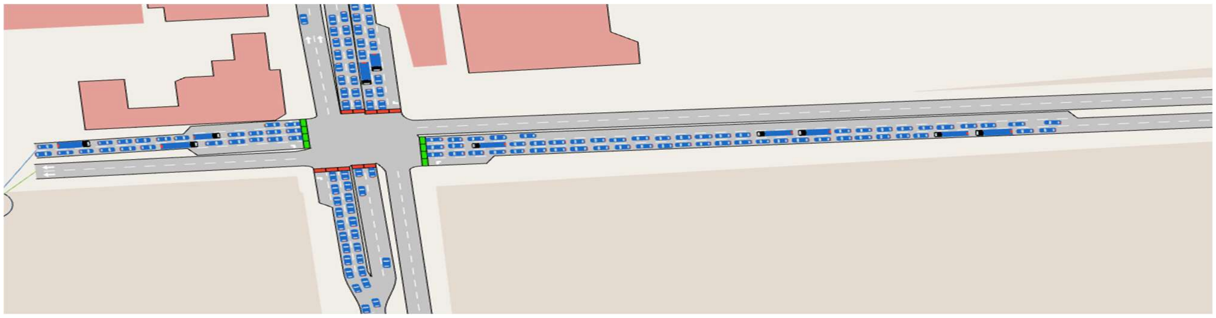

Figure 21 queue length in model 2025.

Figure 21 shows the queue length of intersection TS088 after the development.

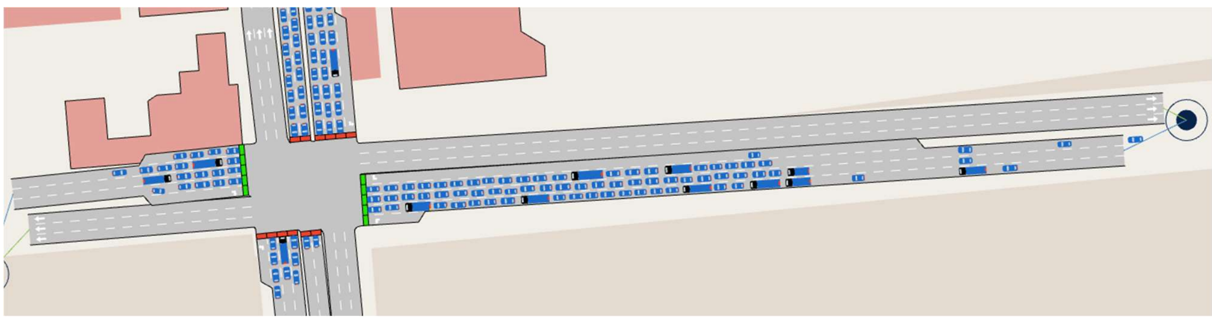

Figure 22 Queue length in upgraded model 2025.

In figure 22, I observed that queue length has decreased by 20% with the upgraded optimum solutions.

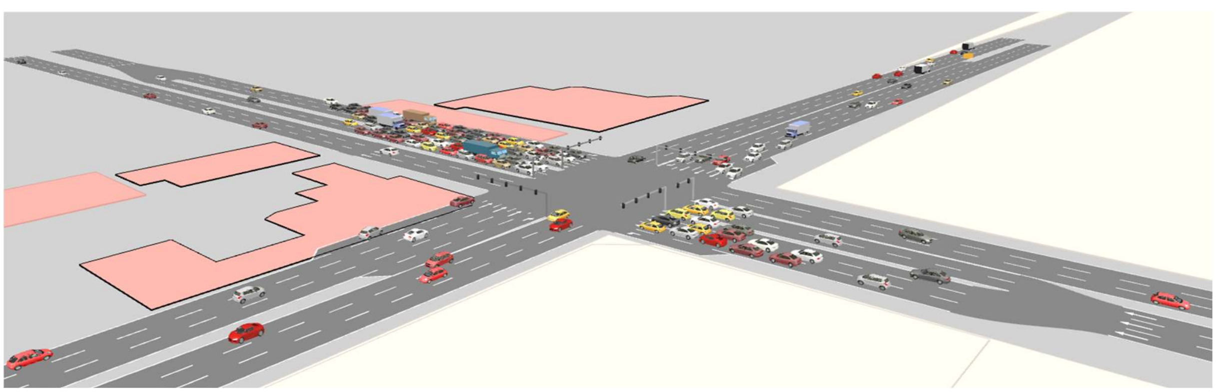

Figure 23 3D visualization.

Figure 23 shows the 3D visualization of the intersection TS088.

In this chapter, I have presented the result only for the AM peak hour because of limited space. The results for the PM and other intersections could be found in the appendices.

DISCUSSION

The primary objective of this study project is to do a Traffic Impact Study (TIS) to find out how a new development might affect the nearby road network and how well the road network works overall. The effects on signalised crossings, the business, and the environment are looked at in the study. The study uses SIDRA and AIMSUN modelling to look at the current state in 2024, the end of the reconstruction in 2025, and models that predict what will happen over the next ten years.
Several assumptions were made in the process of evaluating trip generation rates and conducting modelling using the SIDRA and AIMSUN software. These assumptions may potentially affect the validity of the recommendations.
The redevelopment of Burnside village is projected to increase 1719 trips by 2025, raising concerns about its impact on congestion. The intersection of TS088 is expected to have substantial difficulties due to the rise in traffic demand, requiring the establishment of an effective plan to avoid congestion and delays. The proposed solutions for these issues include road upgrades and signal phasing adjustments. These actions improved the delays at the intersection.
There was a 47% drop in CO_2 emissions and a 32% gain in travel speed with the proposed optimum solution for the intersection TS088. Also, it has a significant reduction of 52% in delay times. The goal is to maintain a credible, functioning, and environmentally friendly transportation infrastructure that meets the demands of the growing community while minimising negative environmental impacts.

Based on the findings of (Kalubowila, 2023), a detailed comparison has been conducted between two studies performed in the same city, focusing on Festive Plaza Tower and Burnside Village Shopping Centre. Both buildings fall under similar categories, allowing for a meaningful analysis of traffic performance metrics such as Delay Time , Level of Service (LOS) and emissions.

The Delay Time, which measures the average time vehicles are delayed at an intersection or along a roadway, showed notable improvements in both studies. In the 2023 baseline study, the average delay time was 33.2 seconds. Projections for the 2035 future model indicate an improvement to 28.2 seconds. My study further examined a particularly congested lane of Burnside village, where the delay time was significantly reduced from 448 seconds (existing) to 162 seconds (upgraded) by 2025 for future models. This reduction was achieved through infrastructure enhancements, such as adding lanes and extending slip lanes.

The Level of Service (LOS) is a qualitative measure used to describe the operational conditions of traffic flow, ranging from LOS A (free flow) to LOS F (over-capacity). In the existing study, the LOS for Festive Plaza Tower in Adelaide CBD improved from LOS F (the worst level, indicating highly congested conditions) to LOS D (which signifies improved but still suboptimal conditions). The Burnside Village study yielded similar results under heavy traffic conditions, with LOS D improving to LOS C for certain turns, indicating a shift from congested to more manageable conditions. However, heavily congested roads in both studies remained at LOS F, although their delay times saw some improvement.

In terms of environmental impact, both studies reported significant reductions in carbon dioxide emissions. The Festive Plaza Tower study documented a reduction of 0.3 million kg/year in CO_2 emissions. Similarly, the Burnside Village study showed a reduction of 0.5 million kg/year. These reductions are attributed to improved traffic flow and reduced idling times, which contribute to lower overall emissions.

In conclusion, the comparison of these studies highlights substantial improvements in both delay times and LOS, as well as notable reductions in carbon dioxide emissions. The findings underscore the effectiveness of infrastructure enhancements and traffic management strategies in improving urban traffic conditions and reducing environmental impact.

CONCLUSION

The Burnside village is a large new development, and this research intends to look at how it has affected signalised intersections. Drivers, pedestrians, the economy, and the environment were all examined through a thorough Traffic Impact Study. This analysis illustrates the negative impacts of redeveloping Burnside village on the nearby roads and intersections. It was noted that the redevelopment of shopping centre will cause traffic delays and higher levels of congestion. This congestion results in decreased rates of traffic flow, lower speeds, and limited mobility for travellers. In this project, there are several key steps followed to study the impact of traffic in the study area. Initially, I assessed the traffic volumes by SCATS and field survey and afterwards increased traffic volume has assumed by trip generation manual. SIDRA and AIMSUN, advanced computer tools, were used to assess the impact of those modifications. These computer programmes examine infrastructure capacity and traffic flow, providing valuable insights into road system performance.

SIDRA specifically focused on intersection performance, and the AIMSUN showed the cleared visualization of road system performance.

The study used SIDRA and AIMSUN software to simulate intersections and the local road network at peak hours (AM & PM) for four different scenarios: 2024 (existing model), 2025 (post-redevelopment of Burnside Village), 10 years in the future, and an ideal solution model. The study included data collection, modelling, calibration, validation, and recommendation of an optimal development alternative. The Traffic Impact Study (TIS) was conducted to assess the potential effects of the Burnside village redevelopment on the nearby road network and environment. The study revealed a significant rise in delays, level of service (LOS), carbon dioxide (CO_2) emissions, and a fall in travel speed because of the development. The major purpose was to give optimal suggestions to reduce traffic effects and improve road performance, with an emphasis on enhancing the road network and traffic signal settings to increase traffic efficiency and residential well-being.

The proposed optimal solution for intersection TS088 resulted in significant improvements across several key metrics. Specifically, there was a 47% reduction in CO_2 emissions, from 1.2 million kg/year to approximately 636,000 kg/year. Travel speed increased by 32%, rising from an average of 15 km/h to 19.8 km/h. Delay times saw a dramatic reduction of 52%, decreasing from an average of 120 seconds to 57.6 seconds per vehicle.

FUTURE WORKS

The purpose of this research is to conduct a Traffic Impact Study (TIS) to assess the possible consequences of redevelopment of Burnside Village on the local road network, and environment. The data gathered from this study will be a significant resource for future development initiatives and research in transportation engineering.

Furthermore, I've seen a significant percentage of heavy vehicles on the Portrush road, so we could create a separate lane for heavy vehicles in the future to improve traffic flow. To reduce traffic congestion, consider integrating smart transportation technologies such as electric cars, driverless cars, traffic control systems, and ride-sharing services.

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APPENDICES

Data Collection

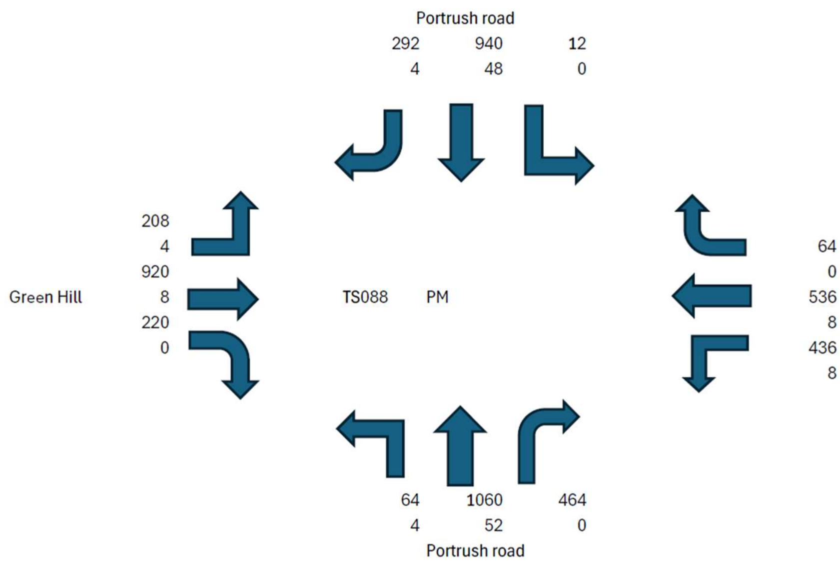


Figure 24 Manual data PM of TS088

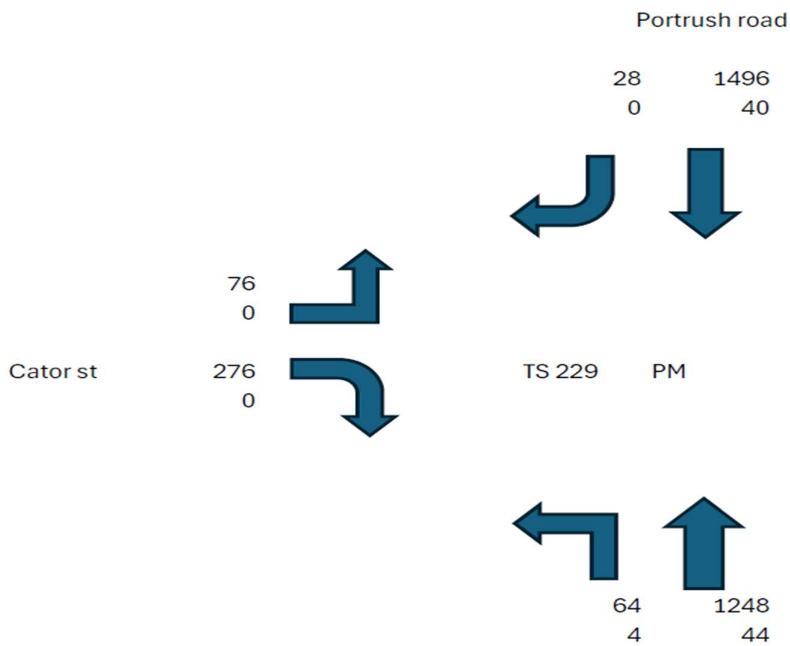


Figure 25 Manual data for PM of TS229

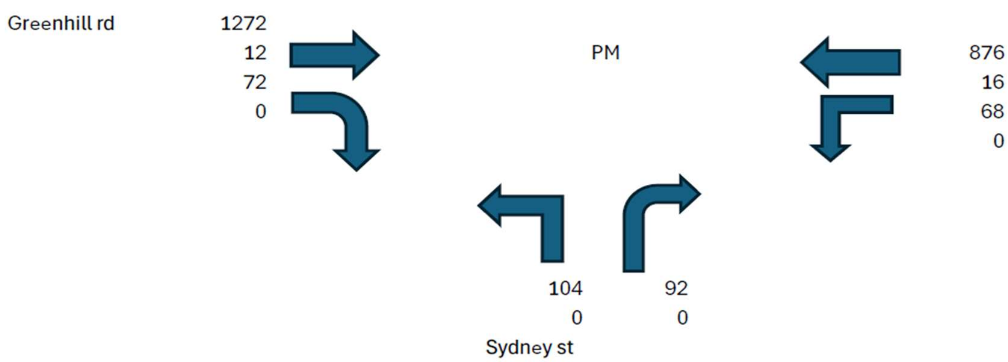


Figure 26 Manual data count for PM Greenhill/Sydney st

Figure 27 Traffic volume Locationsamapviewer

SIDRA Modeling

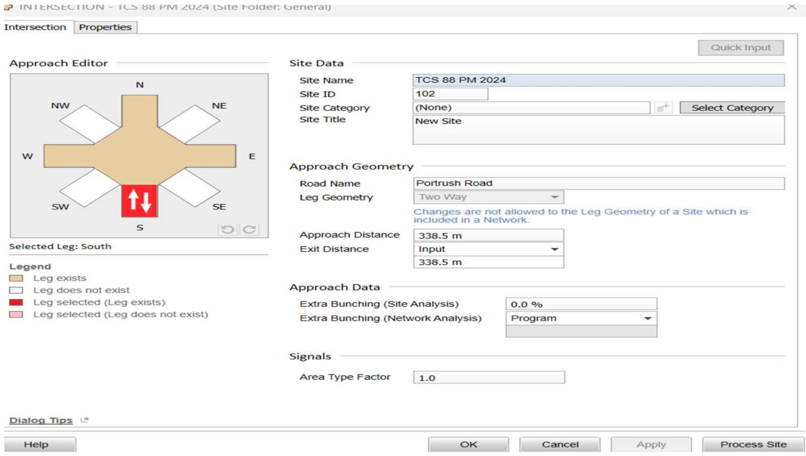


Figure 28 Intersection TS088

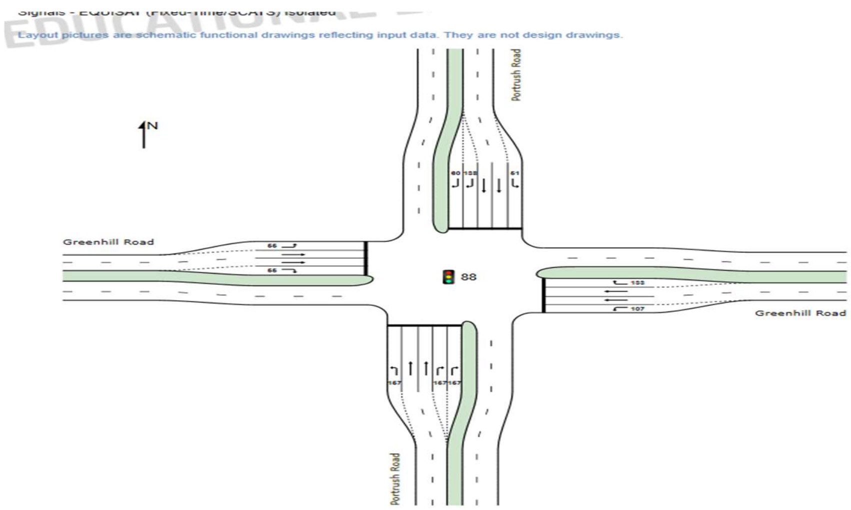


Figure 29 lane geometry of TS088.

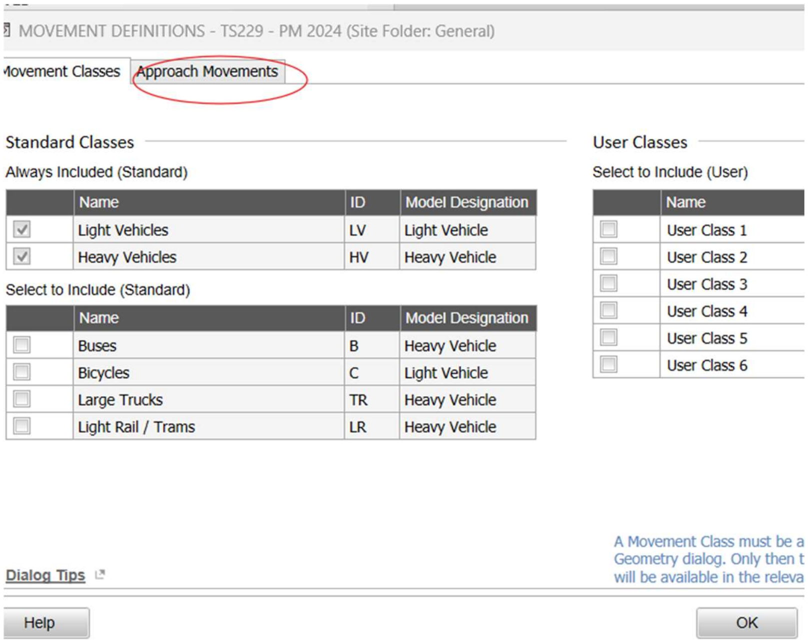


Figure 30 lane movements.

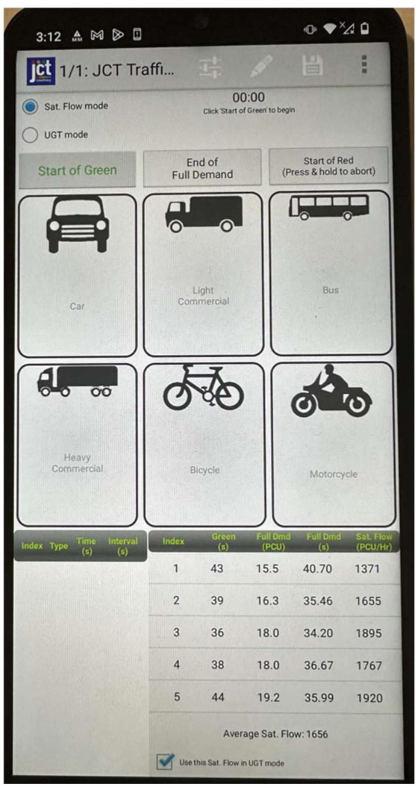


Figure 31 Saturation flow TS088 Northbound

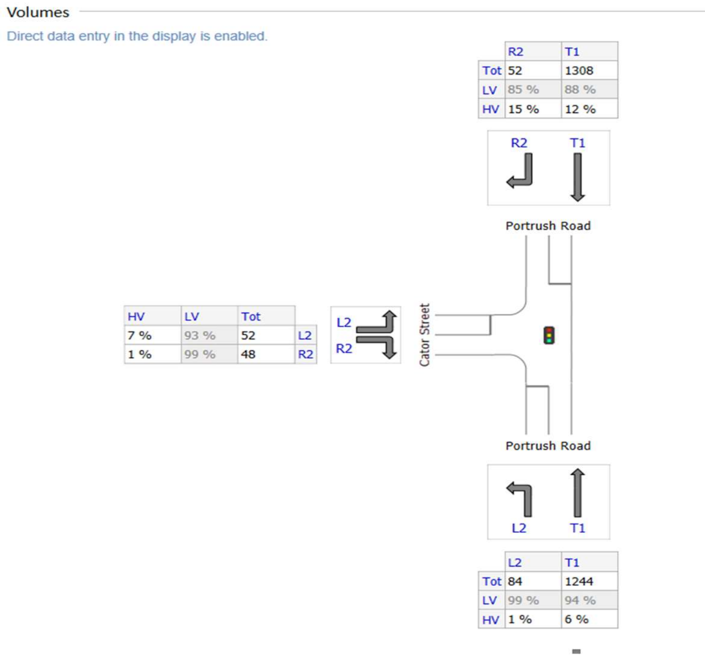


Figure 32 volume data TS229.

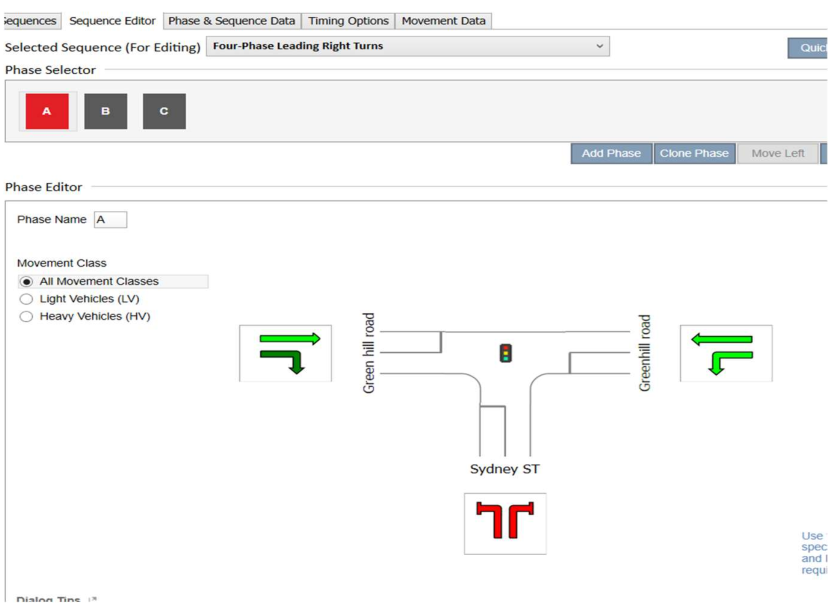


Figure 33 Phasing and timing of Greenhill/Sydney Street.

RESULTS

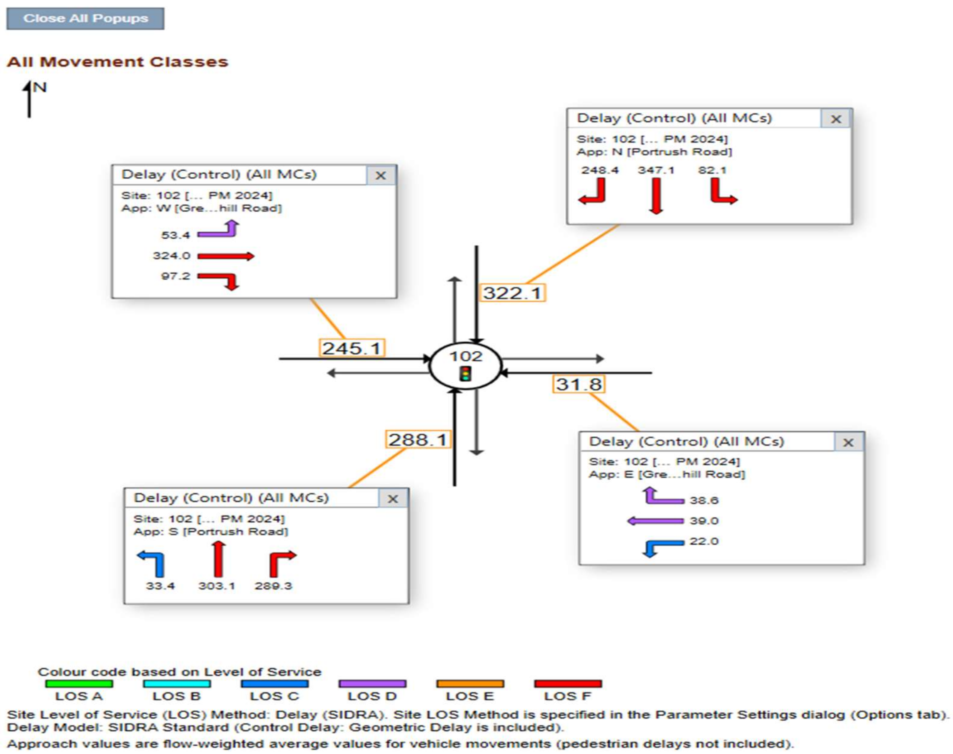


Figure 34 LOS and delay of TS088 PM model 2024.

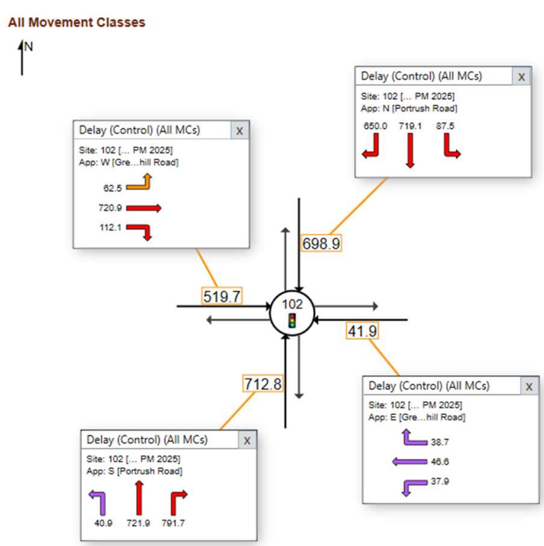


Figure 35 LOS and delay of TS088 PM model 2025.

All Movement Classes

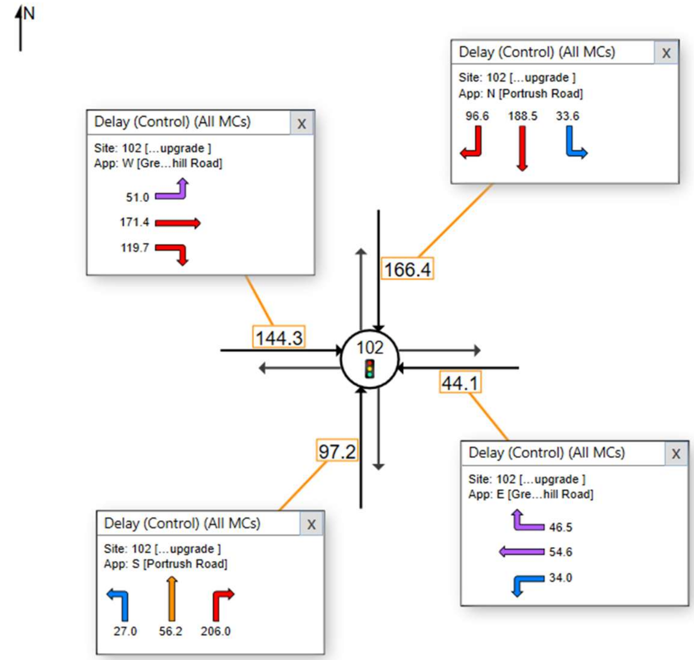


Figure 36 LOS and delay of TS088 PM upgraded model 2025.

Intersection Performance - Hourly Values			
Performance Measure	**Vehicles:**	**All MCs**	**Persons**
Travel Speed (Average)	km/h	6.3	6.3 km/h
Travel Distance (Total)	veh-km/h	2346.7	2816.0 pers-km/h
Travel Time (Total)	veh-h/h	374.2	449.0 pers-h/h
Desired Speed	km/h	60.0	
Speed Efficiency		0.10	
Travel Time Index		0.05	
Congestion Coefficient		9.57	
Demand Flows (Total)	veh/h	5352	6422 pers/h
Arrival Flows (Total)	veh/h	5352	
Percent Heavy Vehicles (Demand)	%	2.7	
Percent Heavy Vehicles (Arrivals)	%	2.7	
Degree of Saturation		1.144	
Practical Spare Capacity	%	-21.3	
Effective Intersection Capacity	veh/h	4678	
Control Delay (Total)	veh-h/h	349.42	419.30 pers-h/h
Control Delay (Average)	sec	235.0	235.0 sec
Control Delay (Worst Lane by MC)	sec	362.1	
Control Delay (Worst Movement by MC)	sec	347.1	347.1 sec
Geometric Delay (Average)	sec	1.9	
Stop-Line Delay (Average)	sec	233.2	
Idling Time (Average)	sec	207.5	
Intersection Level of Service (LOS)		LOS F	
95% Back of Queue - Veh (Worst Lane)	veh	91.5	
95% Back of Queue - Dist (Worst Lane)	m	667.6	
Ave. Que Storage Ratio (Worst Lane)		2.51	
Effective Stops (Total)	veh/h	9647	11577 pers/h
Effective Stop Rate		1.80	1.80
Proportion Queued		0.95	0.95
Performance Index		882.2	882.2
Cost (Total)	$/h	15046.04	15046.04 $/h
Fuel Consumption (Total)	L/h	783.2	
Carbon Dioxide (Total)	kg/h	1849.8	
Hydrocarbons (Total)	kg/h	0.223	
Carbon Monoxide (Total)	kg/h	1.66	
NOx (Total)	kg/h	2.305	

Figure 37 Intersection summary of Model PM2024 (TS088)

Intersection Performance - Hourly Values			
Performance Measure	**Vehicles:**	**All MCs**	**Persons**
Travel Speed (Average)	km/h	2.9	2.9 km/h
Travel Distance (Total)	veh-km/h	2887.8	3465.4 pers-km/h
Travel Time (Total)	veh-h/h	991.7	1190.0 pers-h/h
Desired Speed	km/h	60.0	
Speed Efficiency		0.05	
Travel Time Index		0.00	
Congestion Coefficient		10.00	
Demand Flows (Total)	veh/h	6441	7729 pers/h
Arrival Flows (Total)	veh/h	6441	
Percent Heavy Vehicles (Demand)	%	2.9	
Percent Heavy Vehicles (Arrivals)	%	2.9	
Degree of Saturation		1.393	
Practical Spare Capacity	%	-35.4	
Effective Intersection Capacity	veh/h	4624	
Control Delay (Total)	veh-h/h	973.27	1167.93 pers-h/h
Control Delay (Average)	sec	544.0	544.0 sec
Control Delay (Worst Lane by MC)	sec	800.2	
Control Delay (Worst Movement by MC)	sec	791.7	791.7 sec
Geometric Delay (Average)	sec	1.9	
Stop-Line Delay (Average)	sec	542.1	
Idling Time (Average)	sec	498.7	
Intersection Level of Service (LOS)		LOS F	
95% Back of Queue - Veh (Worst Lane)	veh	200.4	
95% Back of Queue - Dist (Worst Lane)	m	1462.9	
Ave. Que Storage Ratio (Worst Lane)		5.17	
Effective Stops (Total)	veh/h	18166	21799 pers/h
Effective Stop Rate		2.82	2.82
Proportion Queued		0.98	0.98
Performance Index		1974.8	1974.8
Cost (Total)	$/h	38915.03	38915.03 $/h
Fuel Consumption (Total)	L/h	1719.4	
Carbon Dioxide (Total)	kg/h	4059.6	
Hydrocarbons (Total)	kg/h	0.526	
Carbon Monoxide (Total)	kg/h	3.46	
NOx (Total)	kg/h	4.621	

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).

Figure 38 Intersection summary of Model PM2025 (TS088)

Intersection Performance - Hourly Values			
Performance Measure	**Vehicles:**	**All MCs**	**Persons**
Travel Speed (Average)	km/h	13.6	13.6 km/h
Travel Distance (Total)	veh-km/h	3518.4	4222.1 pers-km/h
Travel Time (Total)	veh-h/h	258.0	309.6 pers-h/h
Desired Speed	km/h	60.0	
Speed Efficiency		0.23	
Travel Time Index		1.41	
Congestion Coefficient		4.40	
Demand Flows (Total)	veh/h	6441	7729 pers/h
Arrival Flows (Total)	veh/h	6441	
Percent Heavy Vehicles (Demand)	%	2.9	
Percent Heavy Vehicles (Arrivals)	%	2.9	
Degree of Saturation		1.069	
Practical Spare Capacity	%	-15.8	
Effective Intersection Capacity	veh/h	6027	
Control Delay (Total)	veh-h/h	206.88	248.26 pers-h/h
Control Delay (Average)	sec	115.6	115.6 sec
Control Delay (Worst Lane by MC)	sec	223.1	
Control Delay (Worst Movement by MC)	sec	206.0	206.0 sec
Geometric Delay (Average)	sec	1.9	
Stop-Line Delay (Average)	sec	113.7	
Idling Time (Average)	sec	100.5	
Intersection Level of Service (LOS)		LOS F	
95% Back of Queue - Veh (Worst Lane)	veh	76.7	
95% Back of Queue - Dist (Worst Lane)	m	559.6	
Ave. Que Storage Ratio (Worst Lane)		1.60	
Effective Stops (Total)	veh/h	7686	9223 pers/h
Effective Stop Rate		1.19	1.19
Proportion Queued		0.97	0.97
Performance Index		637.8	637.8
Cost (Total)	$/h	10758.28	10758.28 $/h
Fuel Consumption (Total)	L/h	682.0	
Carbon Dioxide (Total)	kg/h	1611.5	
Hydrocarbons (Total)	kg/h	0.174	
Carbon Monoxide (Total)	kg/h	1.54	
NOx (Total)	kg/h	2.156	

Figure 39 Intersection summary of upgraded model 2025 (TS088)

INTERSECTION SUMMARY

Site: 102 [TS229 - PM 2024 (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.2.202

New Site
Site Category: (None)
Signals - EQUISAT (Fixed-Time/SCATS) Isolated   Cycle Time = 60 seconds (Site Practical Cycle Time)

Intersection Performance - Hourly Values

Performance Measure	Vehicles:	All MCs	Persons
Travel Speed (Average)	km/h	40.5	40.5 km/h
Travel Distance (Total)	veh-km/h	1918.9	2302.7 pers-km/h
Travel Time (Total)	veh-h/h	47.4	56.8 pers-h/h
Desired Speed	km/h	60.0	
Speed Efficiency		0.68	
Travel Time Index		6.39	
Congestion Coefficient		1.48	
Demand Flows (Total)	veh/h	3276	3931 pers/h
Arrival Flows (Total)	veh/h	3276	
Percent Heavy Vehicles (Demand)	%	2.8	
Percent Heavy Vehicles (Arrivals)	%	2.8	
Degree of Saturation		0.841	
Practical Spare Capacity	%	7.1	
Effective Intersection Capacity	veh/h	3897	
Control Delay (Total)	veh-h/h	16.19	19.43 pers-h/h
Control Delay (Average)	sec	17.8	17.8 sec
Control Delay (Worst Lane by MC)	sec	38.5	
Control Delay (Worst Movement by MC)	sec	38.5	38.5 sec
Geometric Delay (Average)	sec	0.8	
Stop-Line Delay (Average)	sec	17.0	
Idling Time (Average)	sec	11.1	
Intersection Level of Service (LOS)		LOS B	
95% Back of Queue - Veh (Worst Lane)	veh	21.2	
95% Back of Queue - Dist (Worst Lane)	m	151.9	
Ave. Que Storage Ratio (Worst Lane)		0.60	
Effective Stops (Total)	veh/h	2598	3117 pers/h
Effective Stop Rate		0.79	0.79
Proportion Queued		0.80	0.80
Performance Index		120.7	120.7
Cost (Total)	$/h	2234.21	2234.21 $/h
Fuel Consumption (Total)	L/h	221.2	
Carbon Dioxide (Total)	kg/h	523.4	
Hydrocarbons (Total)	kg/h	0.047	
Carbon Monoxide (Total)	kg/h	0.56	

Figure 40 Intersection summary PM TS229 Model 2024

INTERSECTION SUMMARY

Site: 102 [TS229 - PM 2025 (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.2.202

New Site
Site Category: (None)
Signals - EQUISAT (Fixed-Time/SCATS) Isolated   Cycle Time = 130 seconds (Site Practical Cycle Time)

Intersection Performance - Hourly Values

Performance Measure	Vehicles:	All MCs	Persons
Travel Speed (Average)	km/h	30.9	30.9 km/h
Travel Distance (Total)	veh-km/h	2191.1	2629.4 pers-km/h
Travel Time (Total)	veh-h/h	70.9	85.0 pers-h/h
Desired Speed	km/h	60.0	
Speed Efficiency		0.52	
Travel Time Index		4.62	
Congestion Coefficient		1.94	
Demand Flows (Total)	veh/h	3819	4583 pers/h
Arrival Flows (Total)	veh/h	3819	
Percent Heavy Vehicles (Demand)	%	2.8	
Percent Heavy Vehicles (Arrivals)	%	2.8	
Degree of Saturation		0.902	
Practical Spare Capacity	%	-0.2	
Effective Intersection Capacity	veh/h	4233	
Control Delay (Total)	veh-h/h	42.38	50.85 pers-h/h
Control Delay (Average)	sec	39.9	39.9 sec
Control Delay (Worst Lane by MC)	sec	95.3	
Control Delay (Worst Movement by MC)	sec	95.3	95.3 sec
Geometric Delay (Average)	sec	0.9	
Stop-Line Delay (Average)	sec	39.1	
Idling Time (Average)	sec	26.8	
Intersection Level of Service (LOS)		LOS D	
95% Back of Queue - Veh (Worst Lane)	veh	57.6	
95% Back of Queue - Dist (Worst Lane)	m	413.5	
Ave. Que Storage Ratio (Worst Lane)		1.62	
Effective Stops (Total)	veh/h	3121	3745 pers/h
Effective Stop Rate		0.82	0.82
Proportion Queued		0.83	0.83
Performance Index		245.2	245.2
Cost (Total)	$/h	3198.93	3198.93 $/h
Fuel Consumption (Total)	L/h	277.9	
Carbon Dioxide (Total)	kg/h	657.4	
Hydrocarbons (Total)	kg/h	0.061	
Carbon Monoxide (Total)	kg/h	0.69	

Figure 41 Intersection summary PM TS229 Model 2025

INTERSECTION SUMMARY

Site: 101 [PM 2024 Greenhill/sydney st (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.2.202

New Site
Site Category: (None)
Signals - EQUISAT (Fixed-Time/SCATS) Isolated   Cycle Time = 50 seconds (Site Practical Cycle Time)

Intersection Performance - Hourly Values

Performance Measure	Vehicles:	All MCs	Persons
Travel Speed (Average)	km/h	46.1	46.1 km/h
Travel Distance (Total)	veh-km/h	1569.9	1883.9 pers-km/h
Travel Time (Total)	veh-h/h	34.1	40.9 pers-h/h
Desired Speed	km/h	60.0	
Speed Efficiency		0.77	
Travel Time Index		7.42	
Congestion Coefficient		1.30	
Demand Flows (Total)	veh/h	2244	2693 pers/h
Arrival Flows (Total)	veh/h	2244	
Percent Heavy Vehicles (Demand)	%	1.3	
Percent Heavy Vehicles (Arrivals)	%	1.3	
Degree of Saturation		0.628	
Practical Spare Capacity	%	43.2	
Effective Intersection Capacity	veh/h	3572	
Control Delay (Total)	veh-h/h	7.54	9.05 pers-h/h
Control Delay (Average)	sec	12.1	12.1 sec
Control Delay (Worst Lane by MC)	sec	29.0	
Control Delay (Worst Movement by MC)	sec	29.0	29.0 sec
Geometric Delay (Average)	sec	1.3	
Stop-Line Delay (Average)	sec	10.8	
Idling Time (Average)	sec	7.5	
Intersection Level of Service (LOS)		LOS B	
95% Back of Queue - Veh (Worst Lane)	veh	8.5	
95% Back of Queue - Dist (Worst Lane)	m	60.8	
Ave. Que Storage Ratio (Worst Lane)		0.28	
Effective Stops (Total)	veh/h	1461	1753 pers/h
Effective Stop Rate		0.65	0.65
Proportion Queued		0.74	0.74
Performance Index		80.6	80.6
Cost (Total)	$/h	1580.98	1580.98 $/h
Fuel Consumption (Total)	L/h	149.2	
Carbon Dioxide (Total)	kg/h	351.9	
Hydrocarbons (Total)	kg/h	0.031	
Carbon Monoxide (Total)	kg/h	0.40	

Figure 42 Intersection summary PM 2024, Greenhill/Sydney Street

INTERSECTION SUMMARY

Site: 101 [PM 2025 Greenhill/sydney st - (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.2.202

New Site
Site Category: (None)
Signals - EQUISAT (Fixed-Time/SCATS) Isolated   Cycle Time = 50 seconds (Site Practical Cycle Time)

Intersection Performance - Hourly Values

Performance Measure	Vehicles:	All MCs	Persons
Travel Speed (Average)	km/h	45.1	45.1 km/h
Travel Distance (Total)	veh-km/h	1647.7	1977.3 pers-km/h
Travel Time (Total)	veh-h/h	36.5	43.8 pers-h/h
Desired Speed	km/h	60.0	
Speed Efficiency		0.75	
Travel Time Index		7.24	
Congestion Coefficient		1.33	
Demand Flows (Total)	veh/h	2331	2797 pers/h
Arrival Flows (Total)	veh/h	2331	
Percent Heavy Vehicles (Demand)	%	1.3	
Percent Heavy Vehicles (Arrivals)	%	1.3	
Degree of Saturation		0.663	
Practical Spare Capacity	%	35.7	
Effective Intersection Capacity	veh/h	3515	
Control Delay (Total)	veh-h/h	8.63	10.36 pers-h/h
Control Delay (Average)	sec	13.3	13.3 sec
Control Delay (Worst Lane by MC)	sec	28.4	
Control Delay (Worst Movement by MC)	sec	28.4	28.4 sec
Geometric Delay (Average)	sec	1.4	
Stop-Line Delay (Average)	sec	11.9	
Idling Time (Average)	sec	8.3	
Intersection Level of Service (LOS)		LOS B	
95% Back of Queue - Veh (Worst Lane)	veh	9.0	
95% Back of Queue - Dist (Worst Lane)	m	64.3	
Ave. Que Storage Ratio (Worst Lane)		0.29	
Effective Stops (Total)	veh/h	1597	1917 pers/h
Effective Stop Rate		0.69	0.69
Proportion Queued		0.78	0.78
Performance Index		87.7	87.7
Cost (Total)	$/h	1691.89	1691.89 $/h
Fuel Consumption (Total)	L/h	158.9	
Carbon Dioxide (Total)	kg/h	374.8	
Hydrocarbons (Total)	kg/h	0.033	
Carbon Monoxide (Total)	kg/h	0.42	

Figure 43 Intersection summary PM 2025, Greenhill/Sydney street

SITE GRAPHS - Demand (Design Life) Analysis

Site: 88 [TCS 88 AM 2034 (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.2.202

New Site
Site Category: (None)
Signals - EQUISAT (Fixed-Time/SCATS) Isolated   Cycle Time = 130 seconds (Site Practical Cycle Time)
Design Life Analysis (Final Year): Results for 10 years

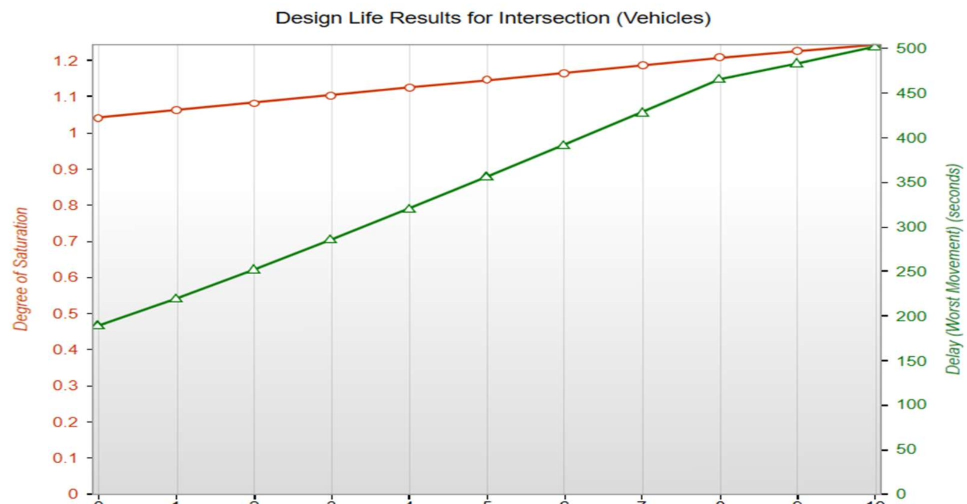


Figure 44 Future demand analysis AM2034 (TS088)

SITE GRAPHS - Demand (Design Life) Analysis

Site: 102 [TCS 88 PM 2034 (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.2.202

New Site
Site Category: (None)
Signals - EQUISAT (Fixed-Time/SCATS) Isolated   Cycle Time = 130 seconds (Site Practical Cycle Time)
Design Life Analysis (Final Year): Results for 10 years

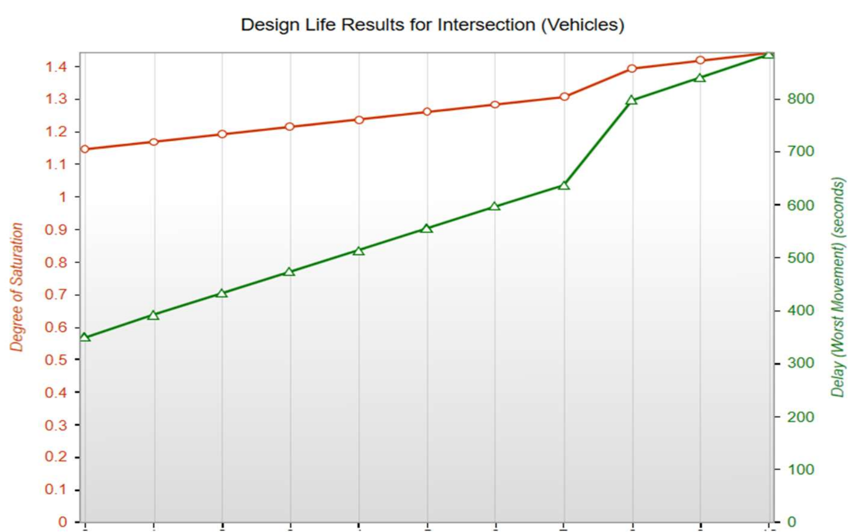


Figure 45 Future demand analysis PM2034 (TS088)

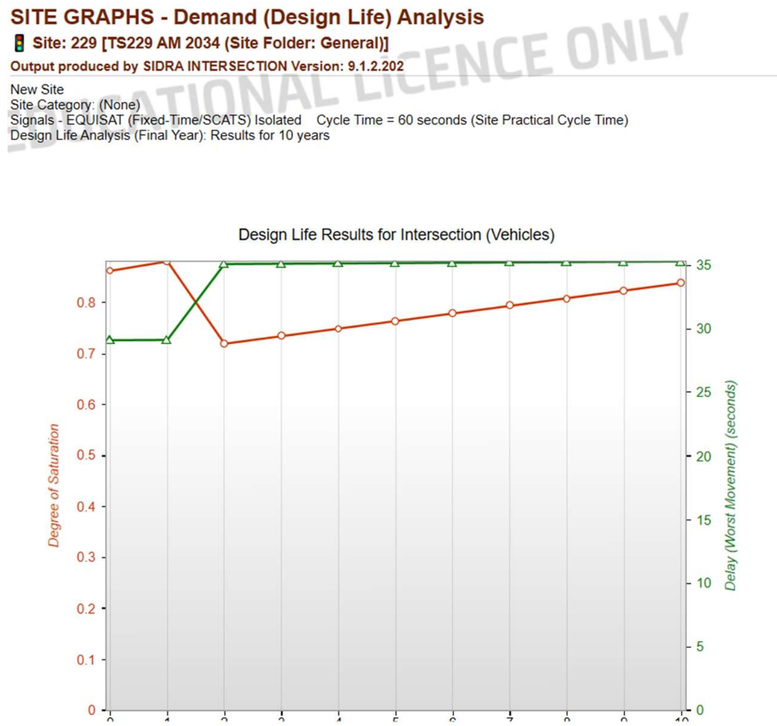


Figure 46 Future demand analysis AM2034 (TS229)

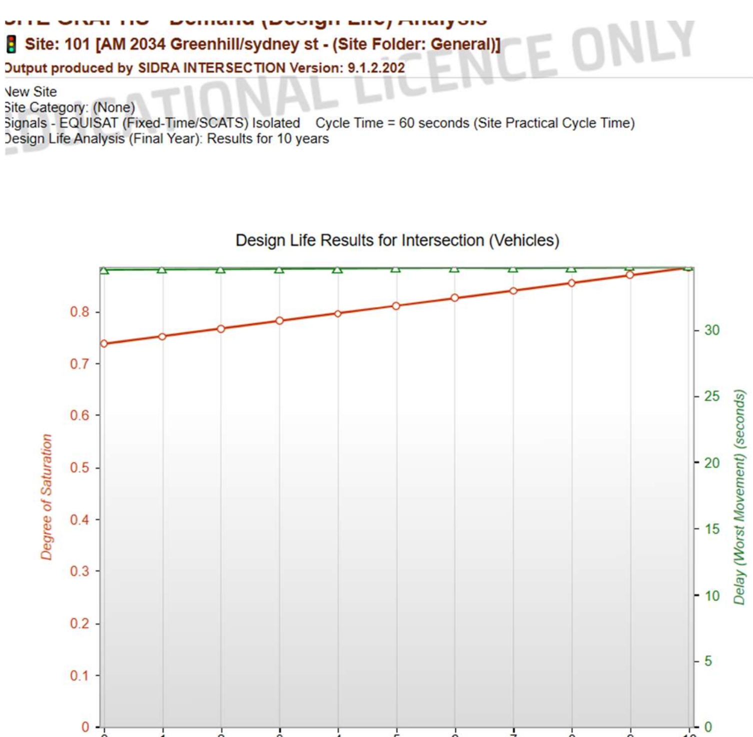


Figure 47 Demand analysis AM2034 of Greenhill/Sydney street

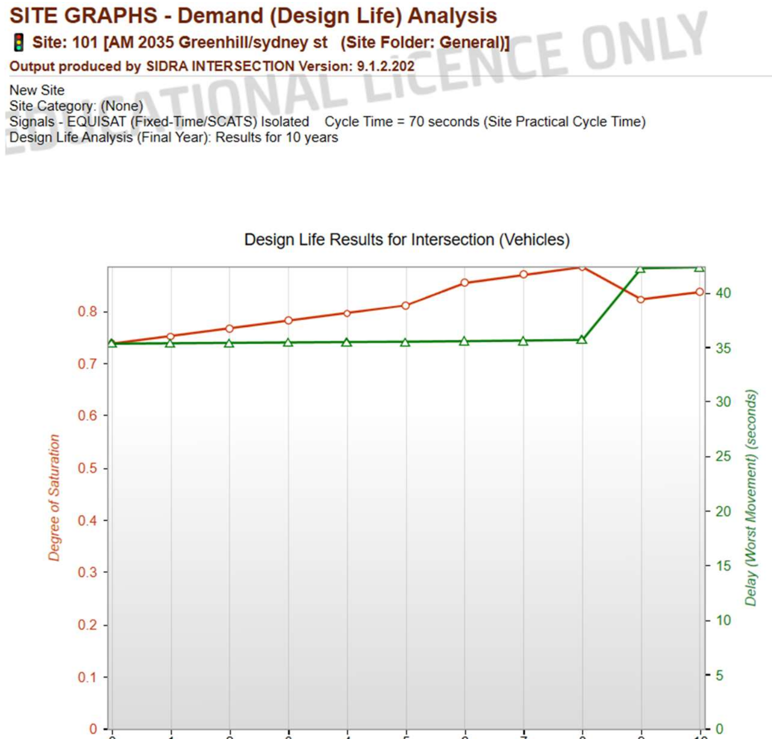


Figure 48 Demand analysis AM2035 of Greenhill/Sydney street

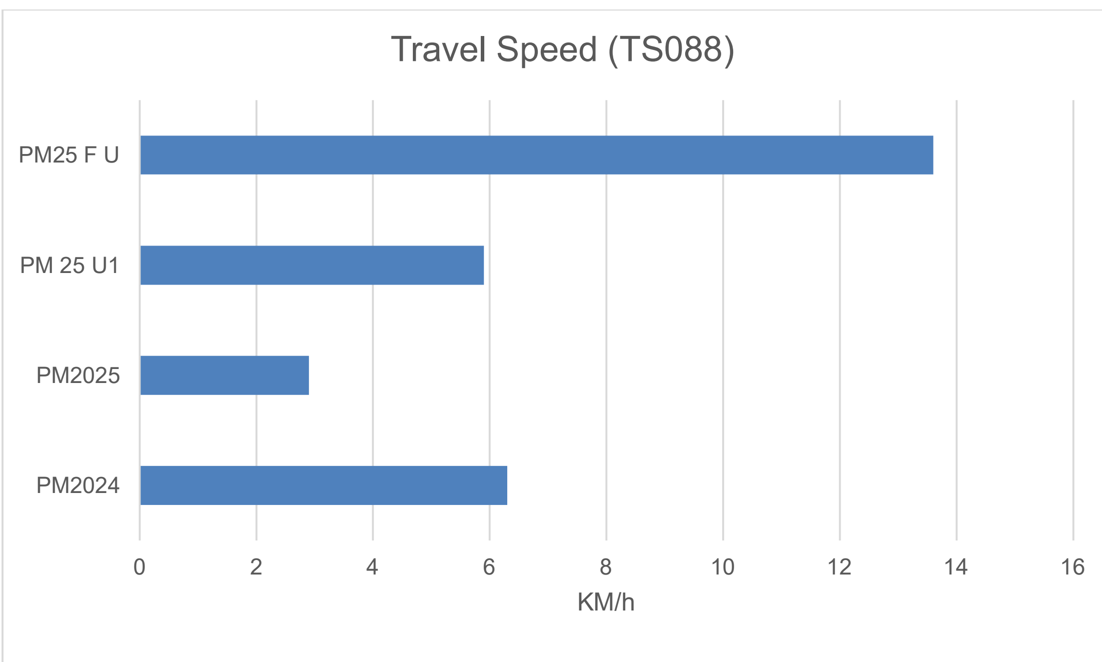


Figure 49 Travel speed PM TS088

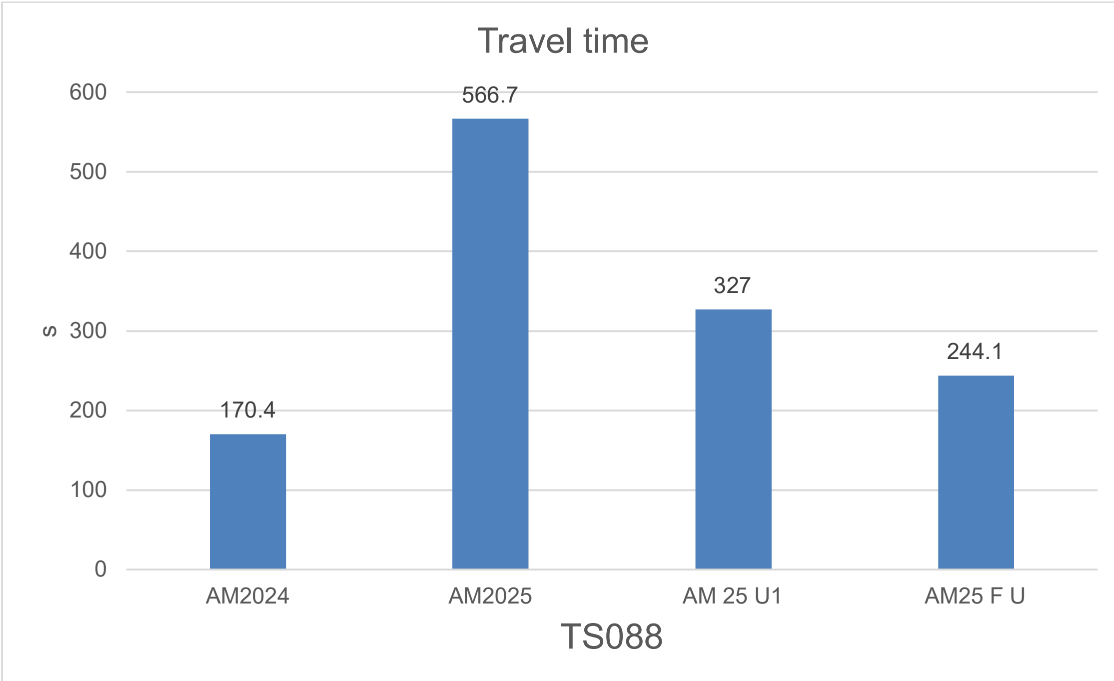


Figure 50 Travel time of TS088 AM

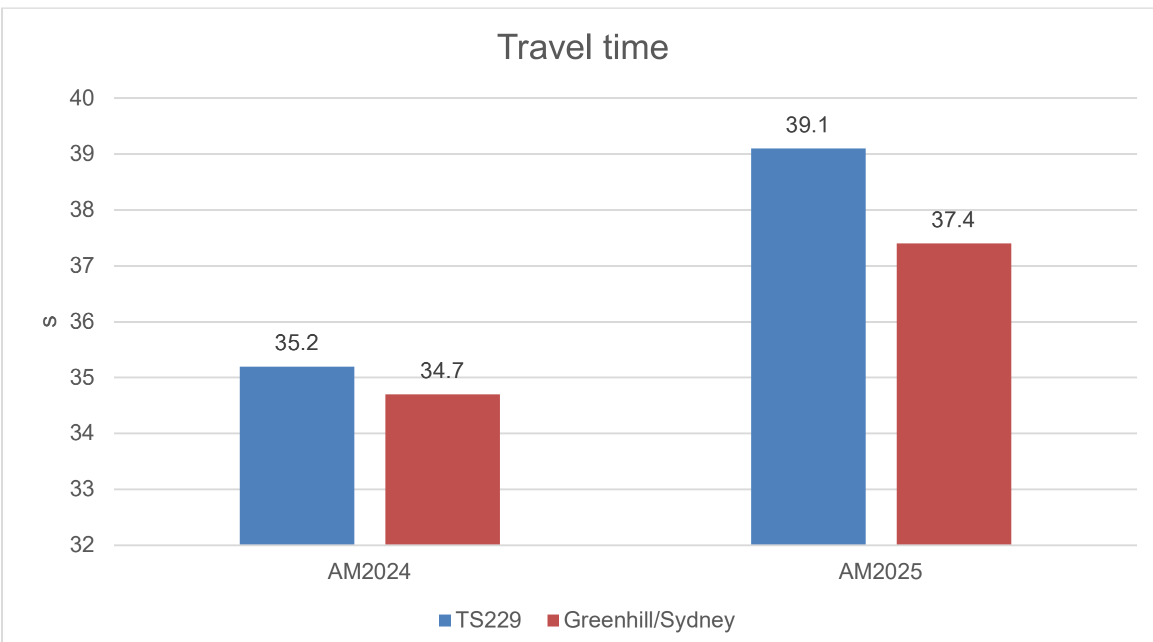
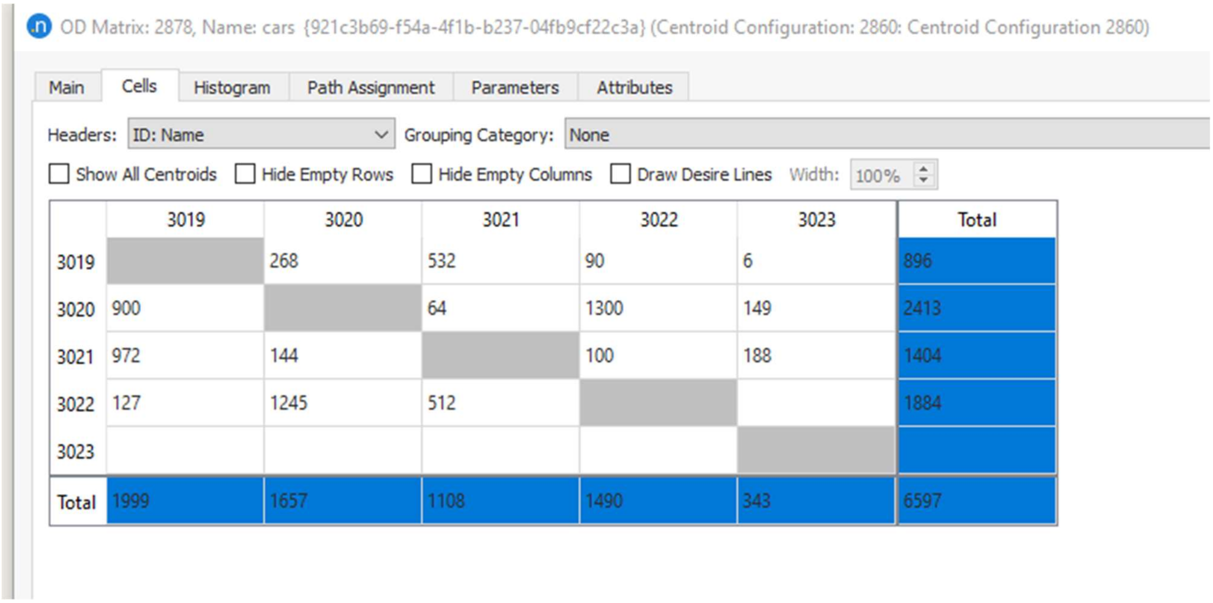


Figure 51 Travel time of TS229 and Greenhill/sydney AM

AIMSUN



	3019	3020	3021	3022	3023	Total
3019		268	532	90	6	896
3020	900		64	1300	149	2413
3021	972	144		100	188	1404
3022	127	1245	512			1884
3023						
Total	1999	1657	1108	1490	343	6597

Figure 52 OD matrix (traffic volume count)

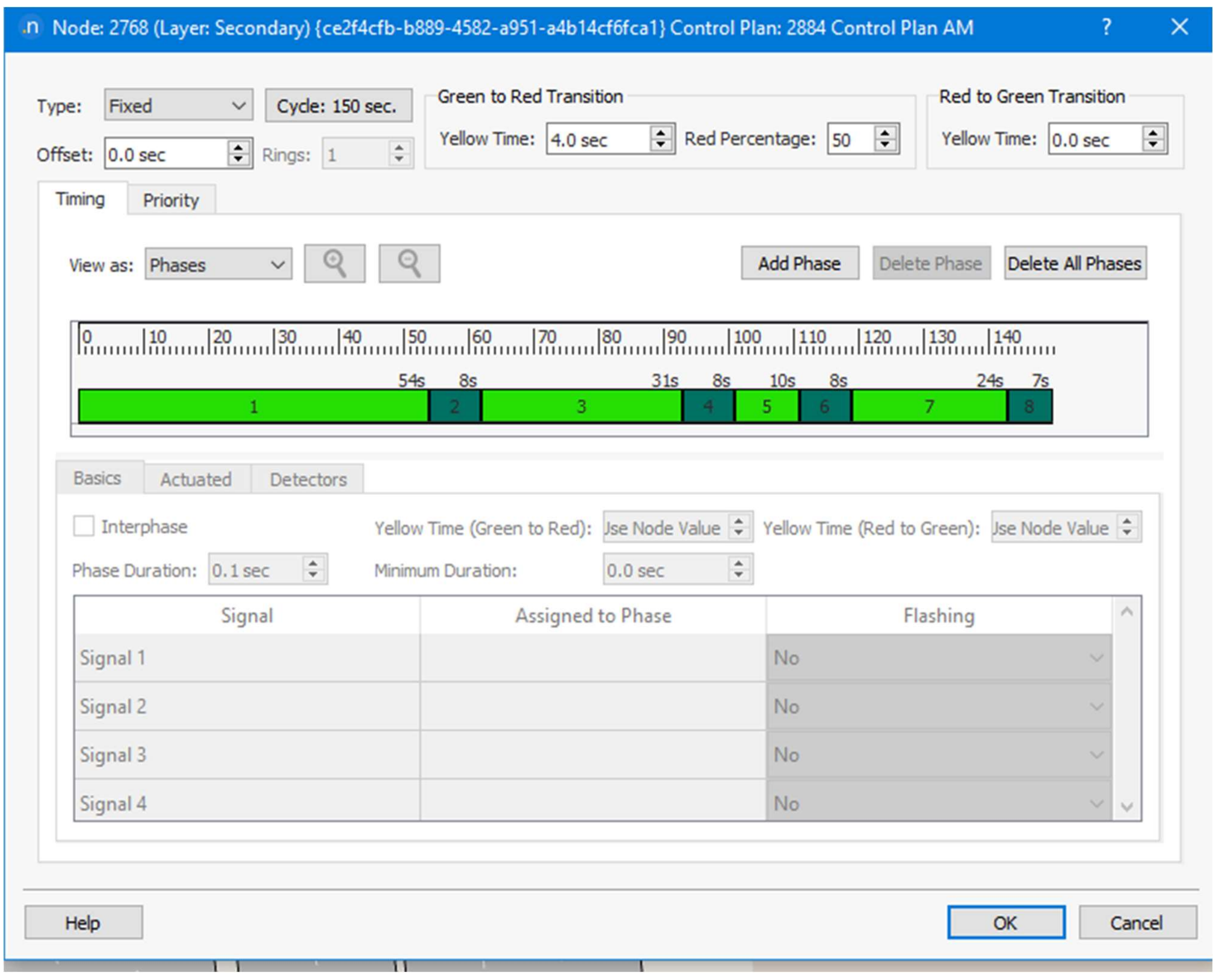


Figure 53 Phasing in AIMSUN