Assessment of transportation network performance using SCATS and Micro simulation techniques

A thesis presented by

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Submitted to the College of Science and Engineering in partial fulfilment of the requirements for the degree of Master of Engineering (Civil) at Flinders University – Adelaide Australia

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Declaration

I certify that this work does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

Visarg Patel

Acknowledgment

I would like to thank you to mu supervisor Dr. Nicholas Holyoak for continuous support in research work and giving appropriate guidance for work and, I would like to thank you to Branko Stazic for technical support and, I would like to thank the department and my classmate who also support me to complete the thesis in appropriate way.

Executive Summary

This research paper comprises a detailed literature review that analyses the transmit networks used in different metropolitan cities, mainly airport cities. Furthermore, proper traffic management on the highways, fewer carbon emissions, and financial advancement also play a vital role in maintaining the required network connectivity. Apart from this, different stimulation techniques are also used to inspect the impact due to accident. Adelaide's current transportation network efficiency and various factors affecting it in compliance with efficient transport micro-simulation factors and latent statistic is also studied to have proper insight about the feasibility of transport network innovations in Adelaide's metropolitan cities. This section will conclude with a discussion of the gap in the research and how the findings of this research paper will contribute to the current body of knowledge uniquely. Most of the literature review comprises the techniques and methods which aid to minimise the unfavourable events of the incidents used in SIDRA microsimulation approaches.

The transport department based in Adelaide mainly evaluates the major transport projects with the help of a macro-level strategic model, i.e., MASTEM (Metropolitan Adelaide Strategic Transport Evaluation Model). Despite its numerous advantages, it cannot simulate and monitor the vehicle movements individually as it can be easily carried out by microsimulation.

As a result, there is currently no microsimulation model of the investigation region capable of providing a complete assessment of all network components (like individual intersection operation).

Computer simulation is a valuable tool that aid to create and monitor the motorway and its connectivity networks in a feasible way

The primary purpose of this study to analyse the impact of non-recurring incidents in Adelaide. Moreover, no article or research paper has mentioned the impact of non-recurring incidents in Adelaide. Therefore, the research will contribute to the current body of knowledge.

The secondary purpose of this research paper is to use microsimulation which is used to identify the effects of lane blocking, incident location, and time duration. It is evident that using a microscopic model of a roadway network is quite beneficial as it is a cost-friendly and secure technique to analyse the effects of incidents. Apart from this, macrostimulation does not require field or laboratory-based testing.

The tertiary purpose of this research paper is to examine the impact of greenhouse gases (CO_2 emissions), weight reduction, and detailed analyses of the different factors affecting the transport design metrics of lane obstruction, incident location, and its time duration.

The quaternary purpose of this research paper is to use SCATS technology in a significant incident which aid to find a proper SIDRA technique while doing qualitative cost-benefit analysis.

Lastly, this research paper performs a sensitivity analysis of all the findings of the modelling techniques, which aids to identify the long-term effects of unpredictable events.

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1. Introduction

1.1 Project Background

Several critical routes in Adelaide's metropolitan arterial road network have been showing increasing congestion levels. Majority of the vehicle delays can be attributed to traffic congestion at signalised intersections which represent the road network bottleneck locations. Most of the signalised intersections have either reached the capacity during peak periods or are close to approaching it. Increased traffic congestion results in serious adverse impacts, such as increased costs, fuel consumption and emissions. This has forced the Government to focus efforts towards tackling the road congestion problem, ensuring that traffic keeps flowing without serious breakdowns, thereby making commuters reach destinations sooner. An Audit Report carried out on Australian Infrastructure in 2015 has suggested that delay costs will keep increasing for the urban transportation network in Adelaide with an estimated potential wastage in 2031 amounting to $4 Billion. In the key routes, the problem of traffic congestion is not restricted only to the peak periods, but impacts public transport, freight traffic and businesses all through the day. Another report on Congestion and Reliability by Austroads has pointed out that the operational performance of road traffic network has a strong influence on the productivity and liveability of the cities.

One of the key Adelaide metropolitan routes that is experiencing increased traffic congestion levels due to expansion of Adelaide Airport will be focus of this study. The study routes and the location of signalised intersections is shown in the image below. Performance of major signalised intersections between City and the Airport will be evaluated and optimised using the intersection optimising software and microsimulation techniques.

Figure 1: Study area for six intersections.

The above image reflects the study area for this project starting from the Airport Road to Mile End along the Sir Donald Bradman drive. For these intersections, SCATS data has been collected that included vehicle counts and signal phasing data. In addition, on-site surveys were conducted to supplement SCATS data as needed (e.g., some traffic lanes were not covered by SCATS detectors). The analysis of the existing condition has been done using SIDRA and AIMSUN software to provide various solutions for the reliable traffic flow, at the individual intersection locations as well as for the entire study route.

1.2. Project Overview:

The main aim of the project is focussed towards improving the performance of the road network by providing simulated environments that address all possible congestion scenarios. The focus is towards understanding various congestion patterns. A workflow is developed depending on SCATS data and demonstrating the same for the selected area and intersections. Pre-generated scenarios will be made use of for building and demonstrating scenarios for better understanding of congestion patterns. The projects consider current traffic infrastructure, using SCATS along with other important data including databases for vehicular registration; data on fleet vehicles along with models analysing travel demands.

1.3 Reasons for The City to Airport and The Airport Future Extension Plans

Since privatization, Adelaide Airport has grown to become a major transportation centre, transporting passengers can go to all locations over South Australia, broadly and universally. The rise of air terminal urban communities has been expanded with air transport for business travel and merchandise shipment expanded quickly during past several decades. Airport cities are major monetary centre points showing over the previous decade's considerable development and benefits. Hotels are an essential part of the airport’s amenities as they raise revenue. Lodgings are a fundamental piece of the air terminal's conveniences as they raise income. However, the period of growth toward an air terminal city has proven to be difficult, as air terminals around the world have failed miserably. Problems such as traffic congestion, road damage, mishaps including trucks, and pollution are some of the things that should be managed. Improvement around air terminals has heightened with the development in traveller traffic and considering the availability and agglomeration benefits of an air terminal situated area. The quickly changing part of capital city airports has placed demands on surrounding infrastructure. After the air terminal was privatized in 1998, Adelaide Airport, as the transportation hub to Adelaide and South Australia, has seen a sharp increase in passenger traffic. Because of the airport's connection to the area of the city, detailed planning and discussion are necessary to maintain Adelaide's transportation management, which is a serious issue, while also ensuring that the airport's services are not disrupted.

Airport-cantered metropolitan improvement accepts distinctive spatial signs, as per geological scale and the development of business exercises at the air terminal. As businesses cluster further outward (primarily along connecting transportation corridors), more extensive improvement models occur like the aerotropolis (air terminal coordinated metropolitan economic region), the airport corridor and the airport city. Accordingly, a future masterplan for Airport ought to consider transport management vision which will control congestion, improve travel times and be better for the climate. Considering the expansion in number of daily trips to and from the airport, a balance between private vehicle uses and different source of transport requires shift with greater choice and flexibility. It is necessary to make plans for a potential rapid transportation system and underground system neighbouring to the airport. Visitors, corporation, and staff traffic would be separated by a new road network. All modes of transportation, including cars, taxis, bus, pedestrians, and cyclists, will be accommodated by a ring road system. An 'avenue' for pedestrians and cyclists would connect the terminal to the surrounding area.

1.4 Sidra and Microsimulation

SIDRA is the most utilized intersection modelling software and can automatically eliminate phases from the phase plan if a more viable intersection operation results. When the default values are used, it is adjusted according to Australian conditions since it was built in Australia. It is a model utilized for execution assessment of crossing points and traffic circles. It can deal with various kinds of crossing points and designs plans. As the driver conduct and vehicle qualities shift by area, likewise, the kind of vehicles is diverse in various nations. There are three stages for ensuring model correctness namely validation, verification, and calibration. the correct issue is considered, and verification ensures it is done the correct way which is performed by the model developer. Finally, the performance produced by the model is compared to the actual observations during calibration. The aim of model calibration is to keep the difference between model performance and observations as small as possible. In most cases, the simulation is validated with standard calibration parameter values, and the comparison is made to the results.

Microsimulation models have become increasingly complex in recent years, and their use in transport planning and design has grown substantially. Microsimulation is the secondary modelling method of individual traffic flow for measuring the traffic efficiency of highway and road frameworks, transit, and walkers. However, since microsimulation can be a task that is resource-intensive and has time-constraints, adhering to certain core values for this type of research can help you obtain a cost-effective microsimulation investigation.

The ability to recognize the tool's limitations to make sure that it correctly reflects the traffic operations hypothesis is critical for proper use. Affirm that it very well will be used with the intent, criteria, and scope of work, and that it can and will be used to answer the question asked. Try not to utilize microsimulation if adequate resources and time are not accessible. Misapplication can compromise validity and become a source of controversy or dispute. For good microsimulation model performance, reliable data is essential. Further calibration of any microsimulation model to local conditions is pivotal.

1.5 What is SCATS and Why to be Used?

Two level order adaptive traffic management systems are used by Sydney Coordinated Adaptive Traffic System to monitor the traffic risk management. The SCATS system is a flexible system for organizing traffic management scheduling on the lane. It is used to improve traffic control efficiency by reducing exemptions, venture times, and the number of stations. Several applications, including SCATS Access, SCATS Traffic Reporter, and SCATS File Downloader, can extract information for demonstrating from the SCATS system. A real-time dynamic traffic control system adjusts signal timings in real-time. (For example, process durations, stage parts and balances) because of variety in rush hour is a primary module of SCATS.

Traffic control is typically conducted at two levels: strategic and tactical, with individual servers at each cross-section handling control. Considering traffic demand, it regulates and oversees the allocation of green times to phases, allowing phases to be extended, terminated, or skipped. The aim of this research is to coordinate traffic out and about to reduce congestion at the given intersections in Adelaide city. The study's intent is to use SCATS and micro-simulation to evaluate and track traffic on the road, which will necessitate the design of a SCATS micro-simulation model to examine vehicle space and time management. The attempted study's expected outcomes include a traffic management software evaluation using

SCATS and a microsimulation model validation. Evaluation of the management of traffic is expounded through SCATS and micro-simulation by totalling and detaching road corridors, Incorporation of GPS for expanding mapping capacities of vehicle-to-vehicle communications, expanding accessibility of information services by organizing through screening and information assessment, and determining situations showed by utilizing SCATS street traffic. It is inferring that cutting-edge research is carried out by combining SCATS parameters with micro-simulation techniques to control optimization in traffic control systems.

Transport Simulation Systems, based in Barcelona, Spain, developed and promotes AIMSUN, a widely used business transport modelling platform. AIMSUN has two components that allow for complex simulations: a microscopic simulator and a mesoscopic simulator. They can deal with a variety of traffic networks, including metropolitan regions, highways, ring roads, arterials, and any combination among these. The software was used to confirm the Sidra results, especially because the model was not fully calibrated due to traffic being affected by Pandemic. It was also used to visualize vehicle movements and confirm the Sidra results for the sites that needed major upgrades and to get the results based on a range of different vehicle physical and kinematics parameters rather than an average vehicle modelling as deployed in Sidra. Slightly better intersection performance can be seen in AIMSUN as it describes model building and results and not modelling pedestrians. It is culminating that AIMSUN has advantages in terms of user-friendliness when it comes to building networks and setting parameters. It is fundamental that the SCATS objects such as signals and detectors correspond with the AIMSUN objects to ensure correct connection between AIMSUN and SCATS.

1.6 Expected Results

The expected results from this project include:

- Determining acceptable aggregation levels for the SCATS data; in lines with pre-existing research on this subject.
- Aggregation and isolation of SCATS data for the Adelaide City Council and the planned intersections.
- Developing a mapping tool that can be an augmentation on existing mapping capabilities.
- Determination SIDRA Scenario.

- Reduce the Delays and LOS for all intersection by adding lane or providing bridge or tunnel
- Understanding all the perspective scenarios pertaining to traffic congestion and testing and evaluating possible solutions.

2. Literature Review

The thesis' literature review investigated transit networks in various cities and their potential communal paybacks, such as relief from congested highways, reduced carbon emissions, and financial advancement. In addition, some well-established approaches for mitigating accident impacts using simulation technology will be investigated. In addition, differing details about the efficiency of Adelaide's current transportation network, as well as numerous efficient transport micro-simulation factors, reaffirmed the latent statistic in conducting this study into the practicability of transport network innovations in Adelaide's metropolitan cities. This section will end with a comment about the void in the literature and how the analysis in this study will add to the existing body of information in a specific way.

2.1 Traffic Management in metropolitan cities globally and Adelaide city

Traffic management has become a major concern in cities during the last few decades, affecting not only people's daily lives but also healthy societal and economic growth. Air pollution, travel time, economic costs increase because of the increase in traffic congestion (Ferguson, 1990). Governmental bodies attempting to track and address traffic congestion, but the challenge is difficult due to the current issues; traffic jams is difficult to estimate. The dynamic and interconnected nature of traffic congestion reflects its complexity. Traffic congestion can spread from a congested road segment to neighbouring road segments, according to (Bauza, Gozalvez, & Sanchez-Soriano, 2010) Completely automated traffic congestion analysis is difficult to accomplish due to these complexities. Though the traffic management scenario and congestion analysis has been restricted only to Adelaide; the replication of this model can prove useful for evaluating and solving traffic issues in other metropolitan cities globally.
The main drawback of the common transportation root is the high level of road traffic produced by individual cars on access roads, the high degree of interaction with other traffic, and the resulting good standard of parking facilities needed at the airport (Casey, Zhao, Kumar, &

Soga, 2020). When traffic congestion or slow-moving traffic flows occur along access routes, this common mode of transportation may become unreliable. Since airline access by car uses the same general surface transportation system as other modes of transportation, it is susceptible to delays caused by traffic not related to the airport Parking near some major airports is sometimes so costly that most long-term parkers are forced to use less demanding remote parking beyond the airport's borders, which is another major source of traffic jam.

Adelaide Airport is located west of the Adelaide City Centre in the City of West Torrens. It is situated on Commonwealth-owned land that has been leased to AAL to manage the airport in compliance with the Airports Act of 1996. It was founded in 1991 and is bordered on the north by Sir Donald Bradman Drive and the Anna Meares Bike Path (Kivits & Sawang, 2021). The Adelaide Airport and its related businesses occupy nearly the entire area of the suburb. On the western side of the suburb, also there is the Harbor Street shopping centre. The task of allowing passengers and tourists to conveniently travel to and from Adelaide Airport is growing, as the airport handles millions of passengers per year, with numbers rising by about 5% annually. With 19% of passengers taking taxis, this aspect can have a significant effect on traffic movement across the airport as well as the convenience with which passengers can fly from and to the airport. Furthermore, caused by mechanical payment collection issues related to poor weather or user error, there is a shortage of taxis, causing traffic congestion and passengers waiting too long than usual for taxis as reported by (Abduljabbar, Dia, Liyanage, & Bagloee, 2019).

Austroads, the pinnacle association of Australasian Road transport and traffic networks, has released a Congestion and Reliability Review to measure levels and consider major reasons behind traffic congestion across big cities in Australia and New Zealand. Since congestion efficiency is inversely proportional to population density, the largest cities, such as Sydney and Melbourne, perform the worst overall. Adelaide has the slowest average speed in the country. According to the study, although weekday morning and midday peaks in Sydney experience time lags of up to 40%, travelling during weekends also leads to severe traffic, with delays of up to 30% at the mid-day peak. The next step was to conduct an econometric study to gain insight into the factors that influence network efficiency. Congestion is caused by a variety of factors in each area, including accidents, scheduled activities, and weather. The study suggests that road and transportation authority’s invest in a variety of strategies, including coordinated landscape and transportation planning and low-cost, high-benefit-to-cost-ratio innovations including automated ramp metering and traffic signal optimization.

According to (Maalsen, Burgoyne, & Tomitsch, 2018), Adelaide and Cisco are collaborating to perceive how Internet of Things tech can help reduce traffic jams. They are investing for urban areas stage to check whether information and sensors can be utilized to diminish normal city-living issues like traffic congestion and check the attainability of arising advancements like autonomous vehicles.

In Australia's major cities, public transportation normally accounts for 5-8 percent of travel needs. According to the International Association of Public Transportation, if public transportation is to make a meaningful contribution to addressing urban congestion issues, its consumption rate must rise to at least 12% to 20% in the medium to long term. The Association stated in a 2003 report to the Senate and House Standing Committee on Environment and Heritage investigation into Low Carbon that a significant reason for the lack of participation in the provision of public transportation is the lack of federal transportation policy support (Kash & Hidalgo, 2014).

2.2 Impacts from traffic Congestion

A large amount of traffic congestion can be ascribed to non-repeating episodes, which is characterized by just like an impermanent and sudden decrease in limit because of occurrences like accidents, vehicle breakdowns and roadworks, where the street limit is the most extreme possible traffic stream on a specific roadway when all paths are being used (Anjum, et al., 2019). While repeating traffic refers to the aftereffect of there being deficient limit on a street to support traffic demand consistently, particularly in peak periods (Moyano, Stępniak, Moya-Gómez, & García-Palomares, 2021). Enormous extents of traffic congestion can be attributed to significant traffic incidents, and these non-repeating occurrences bring about huge effects on society. Primarily, these impacts can be categorized into monetary and ecological ramifications.

As per a survey, the time people spend stuck in a traffic jam in Australia costs them compensation in the form of missed work hours and high transport costs. As per a new study by the Council of Australian Governments on the cost of traffic congestion and pollution from transportation, the monetary cost of traffic congestion in Sydney is projected to be $7.8 billion, with emissions costing an additional $1 billion (Kazancoglu, Ozbiltekin-Pala, & Ozkan-Ozen, 2021). Private heavy vehicles accounted for 60% of emissions, compared to 14% for light vehicles, 18% for public transit, and 0.3 percent for motorcycles.

2.2.1 Economic Impacts

Not only there are significant delays induced by roadway incidents, the monetary expense and effect on the climate as an immediate aftereffect of this is likewise a significant subject of exploration. The cost of delay is categorized into three parts: holding time, vehicle running expenses, and associated expenses such as emissions. As per (Mu & Yamamoto, 2019), the cost levied on society is significant when all aspects of an incident involving congestion, collisions, and environmental emissions are considered. This assertion proven by the fact that, in Australia alone, the avoidable costs of congestion in all capital cities during the financial year were projected to be around $16.5 billion (Aminu & Pearse, 2018). In the city of Adelaide, South Australia, it was assessed that the absolute expense of street car accidents alone caused an expense of $1.165 billion to the economy, comparable to 2.32% of the states complete GDP, due to numerous factors such as the roads quality, secure infrastructure and the distance the crashes occur from trauma care facilities (Retallack & Ostendorf, 2020).The climate is diversely influenced by distinctive transport modes and it is significant that to internalize external costs, one has to differentiate between these modes and analyse the different aspects. External costs that arise due to the environmental impact are increased travel time, vehicle maintenance and additional fuel costs due to traffic.

2.2.2 Ecological Impacts

In Australia, the transportation sector accounted for 14% of the country's total pollution, with road traffic accounting for nearly 90% of that (Bharadwaj, Ballare, & Chandel, 2017). A case analysis of vehicles travelling on the Monash Freeway in Melbourne showed that 95 percent of these emissions are CO_2 (Jabbar & Dia, 2019). To place certain figures in context, Australia's carbon emissions in 2012 totalled 91 million tonnes of CO_2 equivalents (CO_2e), with transportation sector accounting for 84 percent of this total (Kinnear, Rose, & Rolfe, 2015). Note that CO_2e is a unit of measurement for the volume of carbon dioxide that has an equal impact on global warming as compared to other greenhouse gases. In view of the negative consequences of traffic accidents, a study conducted in Orange County, California by (Boarnet & Chalermpong, 2001), found that the average road traffic collision (non-recurring incident) culminated in a rise of 398.4kilogrammes Carbon footprint.

Transportation's exposure to greenhouse gas emissions should not be overlooked, as automobiles accounted for more than 23% of total Greenhouse gas emissions, while road transportation accounted for roughly 87 percent of total transportation carbon emissions. (Leighty, Ogden, & Yang, 2012). As none of the past reviews focused on the environmental implications of road and traffic, (Costin, Adibfar, Hu, & Chen, 2018) reviewed major studies focusing mainly on model architectural issues. In view of the negative effects of major collisions, vehicle engines become less effective during congested environments, increasing the rate of exhaust emissions (Reyna, Chester, Ahn, & Fraser, 2015). In Australia, the transportation sector is responsible for 14 percent of the country's net outflows, with road transportation accounting for approximately 90% of the above. Of these emanations, it was found from a contextual analysis of transport outflows in Australia in 2012 added up to 91Mt of CO_2 counterparts (CO_2e), with 84 percent of this due to street transportation (CO_2e is a unit used to measure of carbon dioxide that would proportionally affect environmental change. It was further tracked down that the normal street accident brought about an increment of 398.4kg of CO_2 outflows in an investigation directed in Orange County and California (Bharadwaj, Ballare, & Chandel, 2017).

Over 100 countries have ratified the Paris Agreement, which aims to stabilize GHG concentrations at an optimum level while also anticipating negative consequences. The aim of this agreement is to set a global warming limit of 2 degrees Celsius, which must be at least half of 1990 levels (Held & and Roger, 2018). As a result, the Australian government has set a target for the economy of Australia to reduce emissions by 80 percent by 2050 compared to 2000 levels (Graham, Gargett, Evans, & Cosgrove, 2012). Further to achieve the target by 2050 of reducing 80% of emission as set by Australian Government, changes in the transportation industry should be implemented to achieve the reduction in number of private vehicles on roads. The Government of South Australia's three-decade Future Plan for Greater Adelaide is assisting it in becoming the world's first carbon-neutral capital, thanks to a zero-emission transport system. (Sotani, 2018).

2.3 Computer Simulation as an Analytical Tool in Traffic Management

The substantial and complex traffic frameworks that exist today are not manageable to experimentation control. Thus, it is virtually essential to control traffic through digital simulation of traffic flow at a near-optimum level. Computer simulation analysis can only make analytical decisions concerning road improvement, kind of intersection control, and the feasibility of mechanized traffic control (Gao, Huang, Xie, Xiong, & Du, 2020). Traffic simulation models came into application since computer technology evolved. Various techniques for assessing incident impacts are utilizing a mechanized traffic simulation approach. The development of effective transportation strategies turns into the most difficult assignment for the transport authority. Recent advancements in computer technology and particularly the technique of computer traffic simulation offer another compelling path for testing plausible solutions preceding their execution (Vehlken, 2020). Computer simulation of transportation systems, includes mathematical modelling of transportation networks by developing models utilizing different computer software for predicting, planning, and designing operational aspects of transportation frameworks (Boukerche & Wang, 2020). Generally, there are various degrees of detail that can be accomplished in rush hour traffic analyses using traffic simulation models that are categorized as microscopic, macroscopic, and mesoscopic models (San José, Pérez, & Gonzalez-Barras, 2021). While these modelling methods are viewed in terms of a limited sample of study areas, the level of the complexity and the detail that can be derived from the models' results grows. Computational simulation is also used to research strategy schemes, network operational execution, and transportation facilities for different modes of transportation. This will assist both private and public bodies in liaising with one another.

Traffic analysis using computer modelling has several benefits in terms of network efficiency, cost-effectiveness, and security, as well as removing necessity on-site traffic flow assessments. Traffic mismanagement at global scale, leads to the interaction between each controller as offsets, for maintenance of smooth stream of traffic flow. As Offsets rely upon traffic volume and congestion they must be set as a trade-off of various time demands or probably, they should be changed to react to actual demands through on-line control (Hu & Smith, 2020). Secondly, traffic flow can be considered as a framework control issue as well as a framework plan issue. The framework comprises of the road network and other relevant aspects of road limit like road width, block length, street parking permits and the impact of business and private turn of events (Komninos, 2021). As the traffic engineer has limited control over the system design parameters, however his goal is to make suggestions dependent on significant information about choices to be made by other city authorities (Alsrehin, Klaib, & Magableh, 2019). Thus, he ought to have the option to anticipate the impact of road changes and populace shifts on traffic flow using computer simulation.

In Australia, transport authorities have long used computer software to simulate traffic control processes (Alsrehin, Klaib, & Magableh, 2019). Existing systems, such as various GPS tracking systems split by the operator's organization and distributed by the operator. Trans Perth's recently released ‘real time arrivals' capability, which tracks rail and bus arrival times, is an illustration of this; taxi GPS monitoring systems exist as well but are often shared solely with the taxi operator (Heyns & Van Jaarsveld, 2017). Getting access to existing public transportation and taxi GPS data is required to integrate each of these distinct interfaces to better visualize the position of cars and people. Additionally, sensors can be put to track pedestrian activity at crossings by detecting the presence of neighbouring smart cards. Transport authorities may acquire a better understanding of current demand and construct better estimates of future demand by merging these numerous interfaces, which will considerably benefit in transportation planning (Aminu & Pearse, 2018).

The automobile sector is rising at the same rate as big data. The rapid progress of information and communications technologies have ushered in a revolution in transportation planning and operations, as well as other sectors of it. Australia has yet to fully realize the huge possibilities of Big Data. Small data from sensors put expressly for congestion control is used by Australian cities to develop congestion control systems. ‘Big Data can help Main Roads better understand how the transportation system is currently being utilized, match available capacity to changing demand, and manage its assets through data from the vehicles themselves,' according to the Intelligent Transport Systems Master Plan (Abduljabbar, Dia, Liyanage, & Bagloee, 2019). The proposal emphasizes intelligent infrastructure, smart vehicles, and information services, and believes that managed motorways may increase efficiency by 27% during peak hours.

There are several approaches to use Big Data to aid in traffic management, including the alleviation of existing traffic congestion using real-time data. Many cities across the world are using real-time data from several sources (such as traffic lights, vehicle counters, social media streams, Surveillance streams, and so on) to control traffic congestion, however this is still considered an application of small data. Other method is to prevent traffic congestion by predictive approaches, in which Big Data allows prognostic algorithms to combine real-time data with historical data sets on commuter behaviours and favorited routes to enable for predictive traffic management. Another method is to develop complex public transportation routings, in which Big Data generates high-resolution data that may be utilized to create public transportation demand maps, resulting in better resource allocation. Although work in this area is still in its early stages, various writers have published research in this field (Alsrehin, Klaib, & Magableh, 2019).

Although Big Data can give critical information for evaluating, planning, and improving transportation systems, the fact that such a large volume of data necessitates many forms of data analysis and processing is a major obstacle. Because there is so much data available, software and programs that can filter through it and focus on the main elements of the data that will offer critical inputs into transportation forecast patterns must be developed. However, due to the volume of data, variety of data, and frequent changes, integrating, visualizing, analysing, and responding to inquiries is a difficult task (Abduljabbar, Dia, Liyanage, & Bagloee, 2019). Present data analytics systems have limited analysis capabilities and reaction times of several minutes, which makes real-time data analytics impossible. In-memory computing algorithms have recently been discovered to attain far higher efficiency, with processing rates of around one second. Several IT firms are active in this subject, and researchers are now working on it.

2.4 Assessment of Transportation Network Performance Using SIDRA and Micro Simulation Techniques.

Why microsimulation

Although transport department is utilizing a macro-level strategic model namely MASTEM (Metropolitan Adelaide Strategic Transport Evaluation Model) to assess significant transport projects in Adelaide, however it is not equipped for simulating and displaying individual vehicle movements as it can be done by microsimulation. Consequently, there is no microsimulation model of the investigation region at present that can provide a detailed assessment of all the network parts such as individual intersection operation.

Simulation models have indeed been widely utilized to test the efficiency of various traffic infrastructure and management techniques for effective and sustainable transportation frameworks. Microsimulation model calibration and validation is one of the most important factors in ensuring that the models accurately represent local conditions. According to (Hong, Chen, & Wu, 2020), the ability to create comprehensive traffic systems that can record the movements of individual vehicles and driver behaviours, as well as traffic management through multimodal shifts, is achieved using microsimulation modelling. As previously mentioned, macroscopic simulation results in an undervaluation of vehicular emission on an expressway; however, microscopic article examines the effect of individual vehicle acceleration and braking on pollution, resulting in a more precise calculation of ecological impact (Kim, Lee, Shin, & Park, 2020). Furthermore, where information on the behaviour of individual vehicles is needed, (Schweizer, Poliziani, Rupi, Morgano, & Magi, 2021), suggest that a microsimulation modelling approach is the most appropriate. This claim is supported by (Dabiri & Heaslip, 2018) who describe microsimulation as the most effective method for evaluating the network-wide effects of traffic occurrences and possible relief solutions in a network.

The simulation technique of the movement of individual vehicles in a rush hour gridlock framework, has long been utilized for traffic analysis however the collaboration between data advancements and traffic designing has empowered another age of microsimulation model that is presently accessible for street and transport managers for analysing complex traffic operations (Dashora, Sudhagar, & Marietta, 2020). These applications often include complex, congested situations that are usually outside the reach of traditional analytical or macroscopic modelling procedures. Microsimulation packages now provide functions ranging from perception to the later advancement of emulating the operation of a signal control system. Even though microsimulation can give the expert important data on the performance of the current transportation framework and expected upgrades, nonetheless, it can likewise be a tedious and asset escalated action (Dabiri & Heaslip, 2018). The way to acquiring a savvy microsimulation examination is to observe certain core values for this kind of investigation for example utilizing appropriate tool, using microsimulation analysis when it is required, understanding the limitations of the tool and ensuring its precision in addressing the traffic tasks hypothesis (Farrag, El-Hansali, Yasar, Shakshuki, & Malik, 2020).

The vehicular movement through a road network is tracked in a microsimulation model after some time at a short time frame interval of a fraction of a second (Manser, Becker, Hörl, & Axhausen, 2020). It is possible to simulate the vehicular interaction in detail under the influence of a control measure in this way. Even though this technique is useful for a broad range of applications, it does necessitate. Random number generators are included, and the calibration of these models requires more effort. It is relatively more difficult to optimize parameters such as signal settings when compared with an analytical model like SIDRA. A microsimulation model may also be an important component of a hybrid simulation method that combines a comprehensive microscopic simulation of certain important elements of a model (for example, intersection operations) with analytical models (e.g., speed-flow relations for traffic assignment) (Gulhan, Özuysal, & Ceylan, 2020). This process, also identified as mesoscopic simulation, adds more information to a model that is used mostly for assignments. It is also possible to link a microsimulation model to a real-time signal monitoring system like SCATS.

Although total amount of green time available to movements is important, it is not sufficient to achieve good validation using the observed queue lengths for instance, the ability to extend and terminate phases with traffic responsive signals tends to improve the queue length estimates in microsimulation models. In countries like Australia and New Zealand, the performance of signalized intersections is overwhelmingly assessed utilizing microscopic SIDRA Intersection software (Leleisa & Quezon, 2018). A research examined at Beijing drivers' various modes of transportation, that had been used to quantify carbon emissions from frequent travelers. The results from the model revealed that under the integrated effects of improving public transportation, energy conservation enhancement, and electricity powered vehicle growth, carbon emissions in everyday commute can be lowered by 43 percent in Beijing annually (Tu, et al., 2019).

Microsimulation can conceivably offer advantages over traditional traffic examination strategies in three zones in particular clarity, precision, and adaptability (Vehlken, 2020). Where the aim of achieving consistency in the traffic management context is to characterize the representation of the graphical user interface used to oversee traffic operations. Improving network conduct for detecting network congestion is not difficult. Network traffic precision is achieved by studying the complexities of vehicle intersections (Jena, Patro, Dutta, & Bhuyan, 2020). For routing changes, a viable option in terms of vehicle speed control can be considered. Adaptability is evaluated by keeping up vehicle actuated signal, reliance of interest and facilities, queue management, priorities of public transport, traffic circle signals, and grouping vehicle type. Normally, the process for the development and the application of a microsimulation model to a particular traffic investigation issue comprises of seven significant errands to be specific, identification of Study Purpose, Scope, and Approach, Data Collection and Preparation, Base Model Development, Error Checking, Calibration, Alternatives Analysis and Final Report and Technical Documentation (Maheshwary, Bhattacharyya, Maitra, & Boltze, 2020).

The model used for determining transportation limits and other performance measures is the micro analytical model SIDRA Intersection developed in Australia by Akcelik and Associates (Mfinanga, 2017). With up to eight methodologies, this application will investigate a variety of intersections, including signalized, unsignalized, and roundabout intersections. (Mfinanga, 2017). SIDRA's versatility allows it to analysis both continuous flow and merging scenarios, allowing it to quantify not only limit and other execution-related steps directly from the traffic system, but also fuel utilizations and operational costs. Being the most used single intersection modelling software, SIDRA can automatically eliminate phases from the phase plan if a more effective intersection activity result (Dumba, 2017). Undertaking alternative evaluation in a single intersection environment can have significant time and cost saving benefits. By modifying the environment factor, the model can turn out to be more (having lower capacity) or less restricted (having higher capacity). The climatic factor can be considered as a set of factors that encompass all about the roundabout's environment, such as the type of construction, visibility, level, velocity, driver responsiveness and assertiveness, percentage of pedestrians and heavy vehicles, and parking near the major intersection (Mfinanga, 2017). A recent study assessed the benefits of modelling traffic signals with traffic responsive framework and were more clearly shown at individual intersection level (Guo, Li, & Ban, 2019). Modelling of individual vehicles at signalized crossing points presents additional intricacy as the dynamics of queue formation at the stop line depends on the arrival rates, discharge flow rates and the amount of green time accessible to explicit movements. In any case, it means that in specific circumstances modelling traffic signals by approximating certain highlights of versatile SCATS frameworks can improve the authenticity and precision of results.

Another research has made use of multiple video camera recorders for capturing turning movement of vehicles at roundabouts along with vehicle queue progression at the approaches of these roundabouts. These video records can help in accurately counting of the vehicles present in these queues for every minute so that peak hour traffic determination can be done. Software packages like SIDRA, VISSIM and RODEL have been used for estimating several performance-oriented criteria including queue length, capacity, delay and the same can be compared with field data that has been collected. The study has proved that VISSIM and SIDRA generally have a tendency of underestimating queue lengths and delays, particularly during the congestion scenarios. RODEL, on the other hand, overestimates queue lengths and delays during congestion analysis (Chen & Lee, 2016).

Contingent upon the degree of collection, a couple of strategies can be utilized in SIDRA to model and measure its capacity and performance in traffic circles, where lack of empirical acceptance method that considers both impacts from driver response and geometry. As the basis of SIDRA is a lane-by-lane analysis method, hence for lane blockage and capacity constraint, network model in sidra intersection, is an iterative process (Demir, 2020)**.** Sidra intersection utilizes a transportation network wide iterative technique to find solution that changes these negating impacts. The two essential components of the model are profoundly intuitive with restricting impacts. Sidra intersection uses a network-wide iterative process to discover a solution that balances these restricting impacts namely- Reverse spread of congestion and capacity constraint are common to all intersection types, Importance of back of queue model and path-based likelihood of blockage, Use of Special Movement Classes for intently dispersed intersections and Signal coordination model (Lane-based second-by-second company model) as a component of signal offsets (Demir, 2020).

On one hand, there are environmental variables that have a positive impact on traffic, such as high perceivability, a limited number of pedestrians, fast response times of drivers, low numbers of heavy automobiles and parking vehicles on pathways (Yao, Shen, Liu, Jiang, & Yang, 2019). In such situations, the climatic factor should be reduced, resulting in increased power. Then again, circumstances like poor visibility, substantial volumes, long response times of drivers and large number of heavy automobiles have negative impacts on the limit. Therefore, environment factor should be higher, this will lead to lower capacity. As modification in the environment aspects causes a change in the follow-up headway for the dominant lane at zero circulating flow which eventually leads to adjustment at all circulating flows. Thus, the environment factor can be set to 1 by default, which is also an accepted value in Australia. (Simsekoglu & Klöckner, 2019) studies in Norway have shown that 1.1 is a better accepted value of environment factor for Norwegian conditions.

2.5 Assessment of Transportation Network Performance Using SCATS

The Sydney Coordinated Adaptive Traffic System (SCATS), a traffic control mechanism for monitoring and managing congestion, is the most widely used strategy for minimizing occurrence impacts (Cuena, Hernández, & Molina, 1995). SCATS estimates traffic flows and volumes using inductive loop sensors on the road surface, and they capture the data automatically. These techniques are normally used over signal crossings to count every vehicle and their movement direction.

The NSW Department of Main Roads created SCATS, an intelligent transportation system, in the 1970s. (Wey, 2000). Since then, the framework capacity and application have been improved and upgraded with the emergence of new advancements. Fixed time control does not adequately reflect SCATS controlled operations, especially when the controller's phases frequency is unstable, pedestrian volumes are relatively low, and traffic flows and arrival patterns are deviant (Essa & Sayed, 2020). As a result, fixed time signals are not recommended for microsimulation modelling of SCATS-controlled adaptive traffic signals although, they are acceptable in microsimulation if there is high-level strategic planning assessment. The utilization of SCATS tools in simulation models has exhibited certain benefits in congested traffic networks. In the advancement of traffic models, their need for application should be considered against the additional resources and costs requirement to include their functionalities. So far, only microscopic simulation models have been connected to SCATS applications.

It additionally implies that adjacent intersections affect each other’s operation, the way SCATS is set up and works to improve the general traffic conditions additionally implies that adjacent intersections influence each other's operations (Do, Vu, Vo, & Liu, 2019). This effect is a very dynamic in nature and from one cycle to another. The commercially available software can consider the effect of versatile framework only to a limited degree. Though this limitation can slightly be recovered by making better improving presumptions about some essential parameters for individual intersections, however it requires detailed information of SCATS system and regional/local settings. Accordingly, many traffic considers overlook to see the value in this and treat intersections as confined during assessment. One of the common errors for example is training the software to advance process duration for less important intersections which underestimates the delay for minor roads and right turns. The present circumstance frequently makes the difference between the assumptions in the traffic analysis and the original performance when authorizing another traffic signal. It was additionally found in some rush hour gridlock studies that overlook the order between the SCATS sub-frameworks regardless of whether the tool utilized for the evaluation requires this as a significant contribution for setting up the model (e.g., LINSIG). As indicated by (Lertworawanich & Unhasut, 2021) with the most recent coming of microsimulation with SCATS it is it is currently conceivable to measure a cycle-by-cycle premise of postponement, queue length, number of stops, volume, and process duration length at all signalized crossing points in the model. By interpreting charts delivered from high resolution parameter measurement the paper explains the connection between signalized sites and measures the impact linked intersections have on each other in both off-peak and congested conditions.

AIMSUN is a known commercial micro-simulation software which is often utilized in the transportation research field, developed, and marketed by Transport Simulation Systems situated in Barcelona, Spain (Cartenì, De Guglielmo, & Pascale, 2018). The microscopic and mesoscopic simulators are AIMSUN parts that enable dynamic simulations. (Braud, et al., 2021). They can manage distinctive traffic networks namely expressways, interstates, ring streets, arterials, and any combination thereof. They also assist their users in presenting simulations of traffic design or traffic control solutions. AIMSUN is distinguished by its incredibly fast simulations and its ability to combine dynamic and static traffic tasks with microscopic, mesoscopic, and hybrid simulations in a solo software package.

Simulation scenario is a set of parameters of simulation that characterises the experiment and four kinds of data namely- network descriptions, map of the area, details of the number lanes for each section, possible turning movement for every junction, speed limits for every section and detectors is the information input needed by AIMSUN Dynamic test simulators (Braud, et al., 2021). To ensure right association among AIMSUN and SCATS, fundamental that the SCATS tools such as signals and detectors correspond with the AIMSUN tools, certain guidelines should be followed for instance, each SCATS intersection should be represented in AIMSUN as one SCATS type regulator, one SCATS intersection can be addressed by at least one AIMSUN intersections, all crossing points that address one SCATS intersection should addressed utilizing associations between its SCATS regulator and the related AIMSUN crossing points (Braud, et al., 2021). Each SCATS detector should be modelled as one relating AIMSUN detector and should have count and occupancy as estimating abilities, though, logical detectors distinguish public transport vehicles and are related with one physical detector and a set of public transport lines.

2.6 Developing an Efficient Traffic Control System to Alleviate Traffic Congestion in Adelaide.

Consistently, people everywhere in the world make use of transportation systems to reach their desired location. A requirement for a compelling and versatile framework emerges, with the consistently expanding traffic volume. It is imperative for the people who plan traffic to have an efficient traffic analysis tool to construct the feasibility of a transportation system and use its full capability. Most traffic analysis tools are used to analyse plans for the existing and future transportation systems, which can provide a stronger base for the process of decision-making by evaluating and comparing potential alternatives. Several different tools are available to choose from depending on the user's interests (Vajjarapu, Verma, & Allirani, 2020).

Cities all over the world are struggling with how to transport a diverse mobile population as the cost and inconvenience of road congestion rises. The rising cost of fuel, the need to minimise greenhouse emissions, and governments dealing with the demands for speculation from all sectors create a difficult transportation policy climate. As other leading cities, Sydney confronts similar transport issues, it should be able to compete with other cities of the world as well as domestically, to attract and retain business while remaining competitive (Bendall & Brooks, 2011). A significant factor in this regard is the efficient transportation of both people and goods in a region. The ability to derive additional benefits from traffic management systems structures for metropolitan arterial road systems is less apparent, partially because Australian jurisdictions are already using these technologies and reaping substantial productivity and efficiency gains (McLeod & Curtis, 2020). However, by applying a network management approach to the implementation of both arterial road and motorway management tools and access management steps, some benefits can still be realized.

Via specific techniques such as signalling motorway entrances to monitor the pace at which vehicles merge with the main motorway traffic stream, Traffic Management Systems can reduce the number of accidents and severity of congestion on motorways and arterial links. Prioritizing those types of vehicles, such as buses and trucks, for entry to the highway, Changing the lane speeds at both metered and unmetered on-ramps where queues can delay special groups of vehicles, adjusting lane speeds assisted by variable message signs; Limiting those types of passengers to designated lanes. supported by variable message signs; at both metered on-ramps and unmetered ramps where queues may delay the special classes of vehicles; Restricting certain classes of passengers to explicit lanes. Improvement in Australia’s response to overseeing development in urban congestion costs, including on national urban corridors, is justified and attainable; both financially and ecologically (McLeod & Curtis, 2020). There is a chance to deliver the next phase of traffic management reforms and strengthen Australia's congestion management capabilities. Infrastructure and management enhancements should be regarded as mutually reinforcing elements of approaches to providing, managing, and pricing transportation infrastructure to increase the efficiency of urban transportation networks.

The strategy to ramping up that is gradual and consistent Australia's strategy to traffic congestion management is likely to be the most effective (Anjum, et al., 2019). This will be variable and evolve as the conditions on each urban Auslink route change. It will entail rigorous monitoring to ensure that new measures are introduced or updated as needed in response to changes in demand, as well as building on demonstrable accomplishments. More critically, past subjectively based surveys have not tended to the situations identified with overwhelming struggles in bi-directional non-path based heterogeneous traffic conditions. Besides, past displaying endeavours have focused principally on backside crashes in path based homogeneous traffic conditions, which win in created nations. Considering the developing interest and headway of the intrinsic capacity of recreation models to address different alternatives of street offices and to assess their wellbeing before execution, the paper proposed a system that can be utilized to foster traffic security simulation models and assess security during overwhelming moves in two-path bi-directional traffic conditions in non-industrial nations (Kim, Lee, Shin, & Park, 2020).

Appropriate combinations of initiatives can improve the interaction of national corridors with surrounding networks, passenger and freight systems, and the management of local, cross-urban, and through-urban traffic flows. Strong land use planning decisions, integrated infrastructure planning and development, and other congestion management techniques are examples of these (Ferguson, 1990).

For increased traffic density, decisions on spatial and temporal priority basis would be crucial. Evidence indicate that suitable pricing mechanisms could play an essential role in traffic and congestion control as part of a larger strategy. Ex-ante and ex-post reviews of congestion control methods in Australia are scarce. Also, there are significant gaps in data and performance statistics relating to traffic congestion. These flaws must be addressed to objectively assess how specific measurements and bigger policies are progressing, as well as the gains they are making. This is necessary to ensure that successful congestion control initiatives are carried out (Bauza, Gozalvez, & Sanchez-Soriano, 2010).

The collection and utilisation of real-time data on traffic patterns via proper surveillance equipment is critical for incorporating "intelligence" into infrastructure and enhancing the reliability and efficiency of national corridors. Enhanced use of proper traffic management methods, incorporated into systems capable of actively managing a full corridor or network in real time, offers a cost-effective chance to obtain large advances in infrastructure and transportation productivity, corporate efficiency, reliability, and community benefits in the short to medium term. This is particularly true when it comes to systems that are directed at motorway performance (Boukerche & Wang, 2020).

On urban arterial roadways, gains can also be realised by adopting traffic management systems on a whole-of-corridor/network basis. A crucial challenge is to make explicit policy and management decisions concerning time-based priority access to specific routes where economically warranted, such as to better productivity vehicles, to ensure that infrastructure is utilised to its full economic potential.

On current infrastructure that is of a suitable design to support ongoing monitoring, traffic management solutions can bring great efficiency, reliability, and productivity advantages, according to international and Australian experience (Kockelman, et al., 2017). The possible impact of such measures on access roads to the motorway and other urban roads in the near area of the actively managed roadway, as well as the possibility to shift the congestion averted on the highway to these surrounding roads, must be considered when applying these measures on a route basis.

This underlines the importance of evaluating their deployment on a corridor and network level rather than a route-by-route basis, with the option of incorporating priority access for high-productivity vehicles. Adding information throughout the entire metropolitan road network, like the traffic management and performance monitoring tools used on highways, will make operational and strategic management at the corridor and network levels better in the future. Performance appraisals can deliver real-time reporting of travel times and conditions for all kinds of transportation. Travelers will be able to make informed decisions regarding their preferred mode and time of travel with the use of such real-time information (Dabiri & Heaslip, 2018).

When paired with other congestion control techniques, effective integrated land use and transportation planning can make a major contribution to the performance of transportation networks. While land use planning is a technique for achieving transportation goals such as reducing congestion, it is a long-term technique with progressive results. There are several successful examples of integrated planning in Australia, according to the assessment of the integrated land use and transportation planning commission (Kockelman, et al., 2017). However, there are enough examples of roadblocks to efficient integrated planning to demonstrate that better planning processes and implementation are possible to alleviate urban congestion.

2.7 The Airport Future Extension Plans Considering Traffic Management System

Airports had been planned as part of urban areas since the beginning of avionics. conventionally, airport planners plan air terminals and urban planners plan urban communities and never the twain will meet. With the advent of the airport city, the requirement for a coordinated approach to airport and regional planning has never been more prominent. This polarization between urban planners and airport planners is forestalling numerous air terminals making a fruitful transition from airport-to-airport city. The initial step to better acknowledge the planning problem faced by current airport and urban planners is to perceive the more noteworthy spatial impact of an airport city over a conventional airport (Kockelman, et al., 2017). From a substantial metropolitan perspective, they are arising as significant sub-regional activity centres with developing intricacy of land use, framework, transport, ecological effects and implications. Due to these changes, airport impacts presently pose significant challenges for both airport administrators and the encompassing metropolitan and provincial climate. In Australia, issues that are currently confronted include: ecological impacts and resource exploitation; identified with transport restricted congestion, disengagement of planning procedures; and land-use conflicts and competition between airports and encompassing metropolitan regions.

With the rising demographics and anticipated rise in demand for air borne travel benefits, the requirement for efficient and effective transportation on land for connectivity to our airports is obvious. Movement of air travellers via our airports of the capital city are expected to grow rapidly over the coming 20 years, according to predictions. As per estimates, (Prentice & Kadan, 2019), movements of air passenger through the eight capital city airports in Australia will expand by 4.2% annually in previous decade, which recommends exponential rise from 98.3 million to 235 million in the coming decade. Over the course of the following 20 years, Brisbane and Perth Airports are required to have the enhanced passenger growth rates of capital city airports by 4.9 per cent and 4.7 per cent individually.

Adelaide Airport is the fifth biggest airport in Australia by passenger traffic, which exceeded 6.8 million passengers a decade ago and is projected to grow by 3.5 percent to 14.1 million passengers in the next two decades. A major part of land transport comprises of private car for going to Adelaide Airport, which accounts for 20% of total mode share, with parked private vehicles accounting for 42% of total share. Cabs are estimated to make up the majority private vehicle pick-up and drop-off use, accounting for up to 27% of journeys, while bus mode share is about 6%, with 4% for public transportation buses and 2% for shuttles. The existing dependence on private cars and taxicabs to reach Adelaide Airport places a premium on making improvements to the airport's infrastructure. (Gössling, Hanna, Higham, Cohen, & Hopkins, 2019). Adelaide Airport's primary focus is on creating an accessible internal access system and parking facilities for all modes of transportation. At a distance, the emphasis is on enhancing connectivity to existing modes of transportation and providing public and active transportation options.

Land transportation planning is a recent formal requirement of the Airports Act. Sydney, Melbourne, Perth, Adelaide, and Canberra are the only airport cities that have established a transport infrastructure plan11, with Melbourne and Adelaide publishing their first Land Transport Plans in 2009. The Coordinated Transport and Landscape Plan would eventually incorporate the transport system in Adelaide, and the government of South Australia's 30 Years Plan for Greater Adelaide would provide considerable legitimacy based on this report (Heyns & Van Jaarsveld, 2017).

To gain a better understanding of the cities' productive potential, Australian airport authorities and respective governments of the states will need to be responsive to rising demand for air travel by providing quality land transportation and appropriate alternatives for public transportation that are competitive in terms of price, travel times and quality. Adelaide has been taking actions to turn into a smart city for a couple of years now. To maintain a competitive advantage, the transportation system needs to be investigated for all potential operational scenarios to provide the best service to passengers when serving the most appealing destinations, specifically in metropolitan city networks. Furthermore, a framework should be affordable to all members of the network, regardless of their income status, and available at a fair rate for both the operator and the consumer.

Literature Review summary and the Research gap identified

Several conclusions can be taken from the literature and research discussed in this chapter. To begin with, there is a serious problem with traffic congestion and the environmental and financial consequences that it brings. It is obvious that the main areas of research and road network improvements should be major signalised intersections along arterial routes since most vehicle delays occur at those locations. One of the routes identified that has experienced increased traffic volumes due to recent Adelaide Airport expansion, such as new airlines starting operations, increased number of domestic and international flights, new hotel built, expansion of parking garages, etc. Although transport department is utilizing a macro-level strategic model namely MASTEM (Metropolitan Adelaide Strategic Transport Evaluation Model) to assess significant transport projects in Adelaide, it is not equipped for simulating and displaying individual vehicle movements and it does not have intersection optimisation module. The detailed traffic performance can only be assessed using special intersection evaluation tools such as Sidra and the microsimulation software. Two software packages that will be used in this study, Sidra and AIMSUN, are packages that are exclusively used in Adelaide by the Department of Infrastructure and Transport (DIT). Since, there is no microsimulation model of the investigation region at present that can provide a detailed examination of all the network parts such as individual intersection operation, models of the entire route will be developed and utilised in the study.

Computer simulation is an effective tool that may be used to simulate motorway and arterial road networks in a secure and cost-effective mode to measure the effects of traffic events (Alsrehin, Klaib, & Magableh, 2019). According to the existing corpus of research that has used this method, the microsimulation automobile following model is the most preferred instrument for assessing these impacts.

The research's first goal is to investigate the effects of non-recurring incidents in Adelaide. It is obvious from the literature that evaluating the effects of major non-recurring incidents has a lot of merit. This goal will address the problem that there is no published work of this kind for Adelaide, so the research will add to the current body of knowledge.

The secondary goal of this thesis is to use microsimulation to determine the impacts of lane blocking, incident location, and duration. Furthermore, lane blockage, incident duration, capacity reduction, and incident generated delay were found as the most influential factors in generating a major event in the literature.

The third goal is to quantify the monetary impact, CO2 emissions, capacity reduction, and other essential transport design metrics of lane obstruction, incident location, and duration. Lane obstruction and the associated capacity reduction have been identified as the most influential criteria in worsening financial costs and car emissions, according to the literature. As a result, this goal will entail accurately assessing incident impacts using key variables described in the literature, as well as significant transport technical factors like queues, delays, and transit speeds.

The literature review devotes a major portion of its time to developing and analysing methods for decreasing the negative effects of incidents by utilizing SIDRA microsimulation approaches. The thesis study's fourth goal is to employ SCATS technology to a critical incident to identify an appropriate SIDRA approach while qualitatively analysing cost-benefit analysis. A major incident will be found by testing numerous distinct event scenarios and locations throughout the network before applying strategies from a rapid emergency response plan to determine the most effective means of reducing incident consequences.

3. Methodology

AIMSUN software was used to build the microsimulation model. This model was utilized to analyse the various performance indicators. Since the microsimulation models do not optimize the traffic lights there was a need for SIDRA modelling to be conducted for all the signalized intersection. In mobility simulation, a series of future models were created to validate various performance indicators. The SCATS system is used to run an adaptive system for traffic congestion scheduling on the lane. Vehicle transmission rate and idle time were found to be delayed because of automation in the vehicle management system. SCATS parameters were used to conduct a more advanced study.

Since SCATS do not contain data for unsignalized intersections additional manual count survey was performed. The SCATS system was used to run an adaptive approach for traffic congestion planning on the lane. Installing traffic simulator, SCATS, and other tools creates a validation setup. SCATS was used to determine simulation of vehicles road tracker, setting of the routes, defining the maximum queue length, organization of traffic density, delay in traffic, coordination in speed, simulation of time management strategy, arrangement of personalized connection for management level of service, and estimation of changes in environment. Collected data is used in microsimulation models to calibrate the results for initial existing model. The concept of a graphical user interface to control traffic operations provides clarity in the traffic management framework. Interlinking of roads is needed for coordination between virtual vehicles to improve road safety. The calibration system's efficiency improves by coordinating four parameters: network interpretation, calibration power, and calibration demand. Multiple databases store duplicate data from the vehicle management programme, potentially posing a security risk.

The design of a traffic management plan would aid in reducing the time it takes to transport covid-19 Pandemic patients to the hospital. A strategic action plan was developed for coordinating vehicle traffic on the highway, including vehicle alignment based on registration and categorization. Predicting and transitioning arrival times aids in the systematic management of traffic congestion. For better communication between public transportation, two-wheelers, four-wheelers, heavy vehicles, and pedestrians, a relationship between us interval, road capability, queuing, and distance should be established. Passengers' satisfaction levels are improved when travel time is reduced. To reduce the detrimental impact of intersections, corridor-based intersection designs were investigated. Vehicle-to-vehicle contact, which predicts their GPS position, aids in traffic scheduling by establishing a timeline. Time dependence improves the system's validity and consistency.

3.1 Study area

The literature review has revealed that one of the major arterial routes, Adelaide CBD to Airport, is experiencing high levels of traffic congestions currently and this has a potential to become even worse following the major Airport expansions and future traffic volume increase. To assess these impacts and recommend the best traffic management solutions, the SIDRA software was used and possible solution for six intersections were investigated. Following intersections, it has been designed in SIDRA.

1. Sir Donald Bradman Dr and Airport Road (TS163)
2. Sir Donald Bradman Dr and Marion Road (TS60)
3. Sir Donald Bradman Dr and Bagot Avenue (TS187)
4. Sir Donald Bradman Dr and South Road (TS061)
5. Sir Donald Bradman Dr and James Congdon Dr (TS062)
6. Sir Donald Bradman Dr and West Terrace (TS3044)

Figure 2 Study map

4. Data collection and analysis

The SCATS data that included traffic counts, intersection drawings, signal phasing, and SCATS Operation sheets were obtained from DIT and used in the traffic analysis and building of the traffic models of the existing scenarios. Due to certain data limitations, additional surveys were conducted onsite.

4.1 SCATS data for TS163

Vehicle counts are collected and stored by SCATS system automatically in 5-minute intervals for each loop detector. This data was obtained from DIT and the latest datasets that Flinders University has in his database was used in this study. Data was analysed for one weekday in 2017 for all the signalised intersections in the study area as shown in tables and graphs below.

		Detector	1	2	3	4	5	6	7	8	9	10
2017-09-22T07:35:00	163		17	21	17	30	43	18	15	19	28	30
2017-09-22T07:40:00	163		20	18	10	29	39	13	24	14	33	33
2017-09-22T07:45:00	163		8	16	10	30	29	9	7	11	56	67
2017-09-22T07:50:00	163		11	21	6	45	44	12	20	9	28	42
2017-09-22T07:55:00	163		12	18	10	46	47	24	27	15	27	27
2017-09-22T08:00:00	163		18	21	4	30	41	8	22	13	38	38
2017-09-22T08:05:00	163		8	12	13	31	38	12	18	9	38	49
2017-09-22T08:10:00	163		20	21	10	38	50	10	21	10	31	35
2017-09-22T08:15:00	163		10	12	6	21	32	10	26	11	48	50
2017-09-22T08:20:00	163		16	16	10	39	42	14	22	7	30	30
2017-09-22T08:25:00	163		22	23	9	32	37	14	24	8	25	26
2017-09-22T08:30:00	163		13	22	8	27	36	10	19	9	34	41
			175	221	113	398	478	154	245	135	416	468
				396			876			380		884

Table 1: SCATS Data for TS163

Figure 3: SCATS images showing detector locations.

Above figure shows that detector location at the intersection TS163 so it counts how many vehicles are going through an intersection. These lane traffic volumes were used in determining the peak time for the designing as shown in the following graph. The graph shows the busiest AM and PM peak times that were selected for traffic modelling.

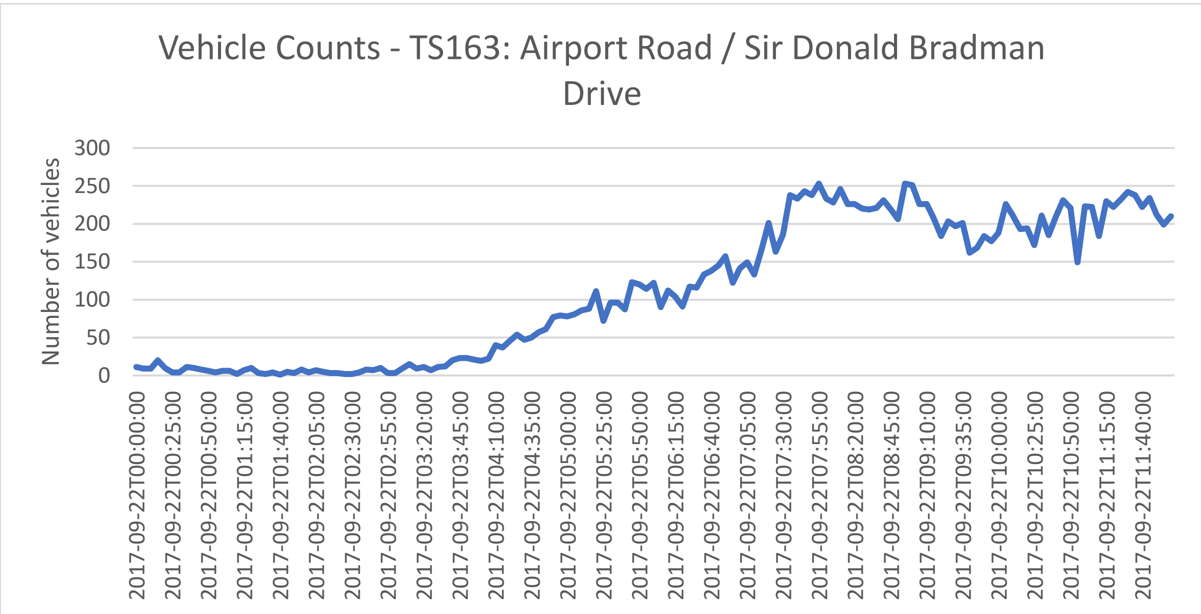


Figure 4 Vehicle Counts - TS163: Airport Road and Sir Donald Bradman Drive

So, from above graph It shows that peak time in the morning is 7:30 to 8:30 AM based on the traffic Counts. Detector counts analysed and turning movements developed for input into Sidra. For example, detector 1 and 2 counts represent total number of through vehicles from West approach.

Figure 5: DPTI's Map for Traffic Estimation

Number of Cars and heavy vehicles are taken in consideration of design modelling and heavy vehicle percentage is used from DPTI's map and pedestrian volume is taken as 50 defaults. (Location SA Viewer)

Table 1: Car traffic projections for Australian cities

City	2002			2020			Percent change
	Car VKT/ Person (000)	Popul (a) (000)	Car (b) VKT(m)	Car (c) VKT/ Person (000)	Popul (a) (000)	Car VKT(m)	2002-2020
Sydney	7.035	4207.5	29,600	7.858	4999.0	39300	+33%
Melbourne	8.089	35556.8	28,770	9.035	4058.4	36700	+28%
Brisbane	6.903	1681.8	11,610	7.711	2188.0	16,900	+46%
Adelaide	7.474	1111.9	8,310	8.348	1170.4	9,800	+18%
Perth	7.163	1430.9	10,250	8.001	1798.1	14,400	+41%
Hobart	7.155	193.0	1,381	7.992	187.7	1500	+9%
Darwin	6.041	93.2	563	6.748	127.2	860	+53%
Canberra	8.962	318.0	2,850	10.011	354.9	3,550	+25%

Figure 6: Traffic growth in Australian cities

Above figure is shows that the traffic growth from 2002 to 2020 for metropolitan cities in Australia so for the Adelaide from 2002 to 2020 it increases 18% so it increases 1% per year in Adelaide so I took 1% for the future traffic data analysis (Department of transport and regional service bureau of Transport and regional economics)

For intersections TS163 shared lane survey is missing so I manually went there for the surveys during peak time from 7:30 to 8:30 and took 15-minute interwall each approach and then I use this data in SIDRA modelling.

Figure 7 Manual Counting from SW approach

Figure 8 Manual Counting from East Approach

Figure 7 shows that, there is one left turning moment to the west approach and there is no detector for that line, so it manually counted the vehicles taking left on the west approach for 15 min interval.

Also, Figure 8 shows similar as the figure 7 it shows that there is left turning moment on the southeast approach and no detector for that lane, so vehicle counted for 15 minutes interval.

Figure 9 Manual Counting from NE approach

Figure 10 Manual Counting from West approach

Also figure 9 and 10 show the similar as above figures and it shows that for the left turning moment no detector for that moment, so it manually counted for 15 minutes interval for each approach.

Manual Count data is following for 7:30 to 8:30 AM

Approach	North – East			East	South- West			West
Turn	Left	Through	Right	Left	Left	Through	Right	Left
Count	94	37	20	101	7	19	38	46

Table 2 Manual Count Data

Above table shows the manual counting of vehicle for the left turning moment for each approach and it counted between 7.30 to 8.30 and given 15 minutes interval for each approach.

4.2 Model Calibration and Validation

Lane usage calibrated (e.g., TS163 East approach through lanes) to match the real-life lane usage.

Figure 11 SCATS Image for TS163

Manual turning counts do not require calibration in Sidra since they are input as a traffic demand, and they are the exact values from the real-life surveys. Phase sequences, right turn operations, integrin times (yellow and all red) used as per SCATS Operation Sheets provided by Department of Infrastructure and Transport (DIT)

Phase times averaged across time modelled. An example is given below,

```
Tuesday 05-September-2017 07:41 SS  13M+ PL 3.4  PV  47.4 CL  130 -5 RL 118' SA 209 DS 120
 Int   SA/LK    PH  PT!  DS  VO  VK!  DS  VO  VK!  DS  VO  VK!  DS  VO  VK! ADS
  163 S 189     2  39!  85  16  16!  79  15  17!   -        -!   -        -!   69
  163 S 190     1  39!  31   6   6!  47   9  10!   -        -!   -        -!   47
  163 S 191 ^    6  14!  52   3   4!   -        -!   -        -!   -        -!   42
  163 S 192 ^'   5  14!  97   6   7!   -        -!   -        -!   -        -!   62
  163 S 193     D  43!  65  16  15!  16   4   4!   -        -!   -        -!   56
  163 S 194     E  24> 111  12  14> 106  12  14!   -        -!   -        -!   92
  163 L  79  '   2  39!  85  16  16!  79  15  17!   -        -!   -        -!  780
  163 L  80  '   1  39!  31   6   6!  47   9  10!   -        -!   -        -!  500
A=<30>  B=1  C=1  D=34  E=25  F=11 |
```

Figure 12 Phase Timing

This type of phasing data is given for every signal phasing cycle, and it needed to be averaged across the entire modelling period. Phase data is given as a percentage of Cycle Length, and it needed to be converted before input into Sidra.

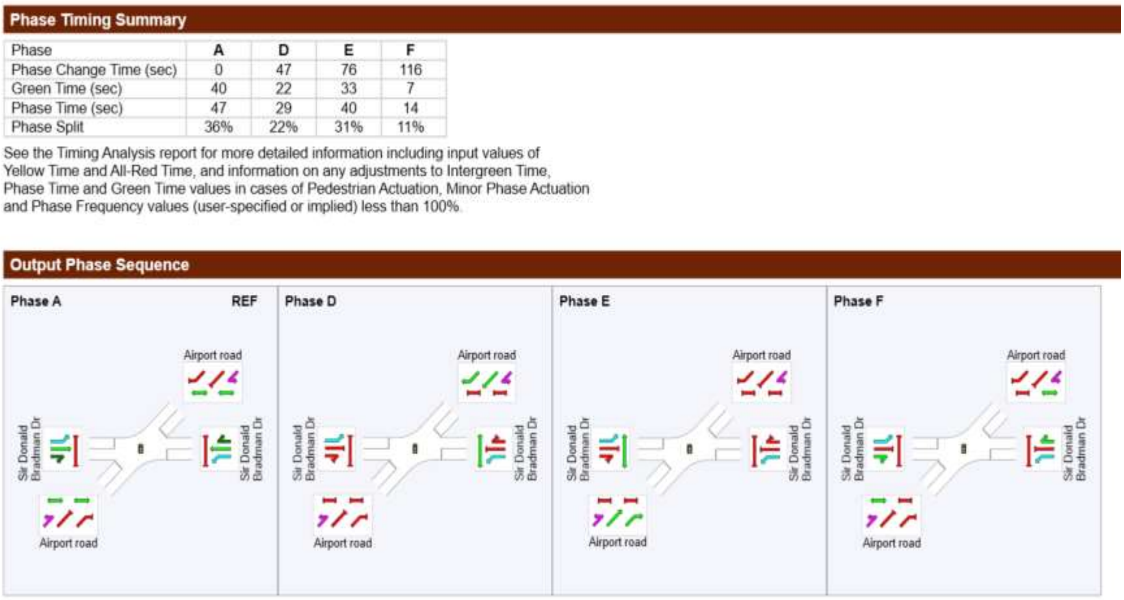
Phase value of 1 indicates that the phase is skipped (not used) in that cycle.

Phasing summary for TS163 is given below

TS163	A	D	E	F	Total	CL
%	36	22	31	11	100	130
seconds	47	29	40	14	130	

Table 3 Phase Summary

Above table shows that the phasing summary for TS163 for four phase A, D, E, F in percentage and second for each phase and cycle time is 130 Second is considered.


Phase Timing Summary

Phase	A	D	E	F
Phase Change Time (sec)	0	47	76	116
Green Time (sec)	40	22	33	7
Phase Time (sec)	47	29	40	14
Phase Split	36%	22%	31%	11%

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 13 Phase time summary and output sequence

Above figure shows that the phase timing summary and output phase sequence for the TS163 phase time summary shows that phase change time, green time, phase time and split time for each phase and bottom part shows that the output phase sequence for A, D, E, F phase. The model was optimized to always improve congestion level for TS163.

Other calibration and validation parameters, such as vehicle queue lengths and the travel times were not calibrated due to traffic being affected by Covid-19.

5. Sidra software Modelling

This section contains information about step of SIDRA modelling and how to create geometry in SIDRA software. After, collection of data from DPTI and imports the map in SIDRA software or also manually we can create the existing geometry according to the drawing and putting all data in it.

Process of Creation of existing geometry by using map extract tools is following.

Figure 14 Map Extract button

The button with red circle is representing as map extract tool in SIDRA intersection it helps to build site by using open street map file data and this tool create following sites.

- Signalised intersection.
- Sign- controlled intersection.
- roundabouts.

Map extract tool is not helpful to crate single point interchange and midblock pedestrian crossing (Signalised and unsignalized) due to the restriction applied to these kinds of sites.

Figure 15 Map extract dialog

Above figure shows that on the left side there is open new map button and right-side search location, and user guide tool shows in figure and all the sites are represented in red rectangle.

5.1 Loading map process

For the loading of sites, you must obtain a map file. The map extract file accepts two file (PBF) and (OSM XML) (.osm) and this file downloaded from OpenStreetMap website. Now, on top right side click on the open new map and select map file from it once the site displayed then search the road or place name by using search location tool and red rectangle automatically provide the information about road or place name and when you find your site then click on the red rectangle which automatically create geometry of the intersection which shows in following image.

Figure 16 Selected Geometry from SIDRA extract tool

From above figure, it shows that geometry is created for the intersection and red rectangle gives information about intersection and road or name of place and once you click on that it creates geometry of the existing intersection.

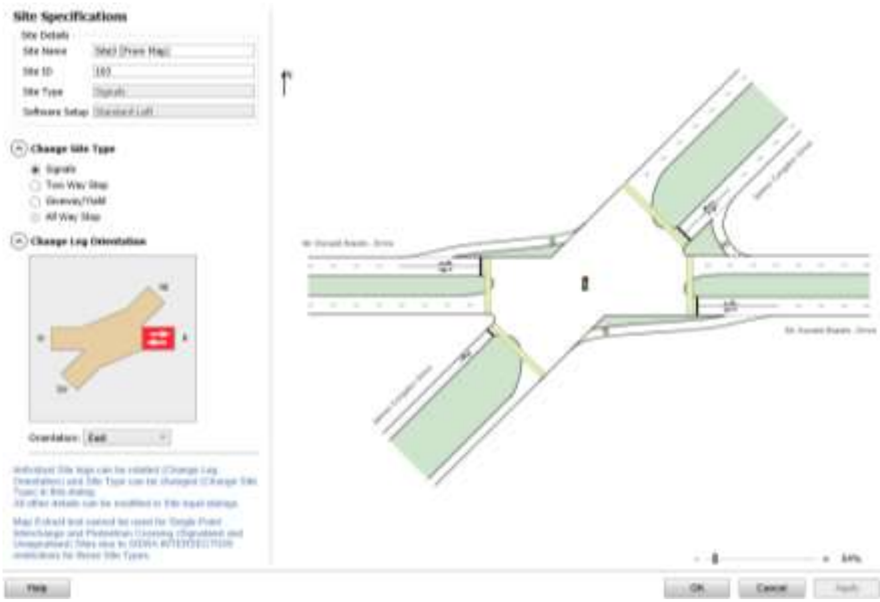


Figure 17 Existing Geometry

After clicking on import tool, once it creates this geometry it not necessary it is same as drawing image therefore by using change site type and change leg orientation option which available in preview dialog. It also shows that the site specification where we create site name, site ID, Site type, and software setup and change site type option shows the information about signals, two-way stop, giveaway/yield and the change leg orientation option show the information about orientation, and we can adjust orientation from this option After all the adjustment made just click on the import into SIDRA intersection.

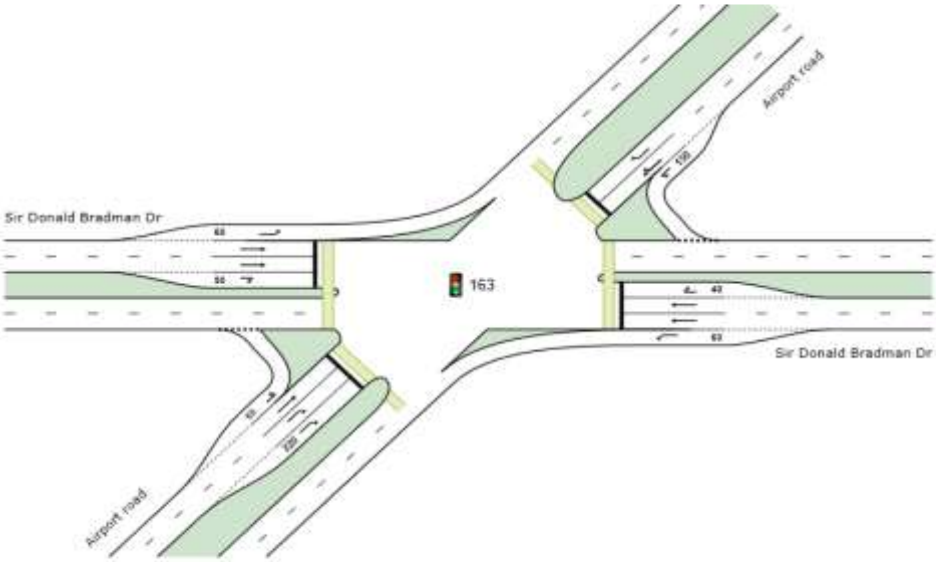


Figure 18 Adjusted Existing geometry of the TS163

Above figure shows that final geometry is created by making adjustment in change or adding leg and on all approach and make it according to the drawing of the TS163.

5.2 Modelling step for SIDRA Software

Sidra software modelling step is following.

Figure 19 Sidra Site Modelling steps summary

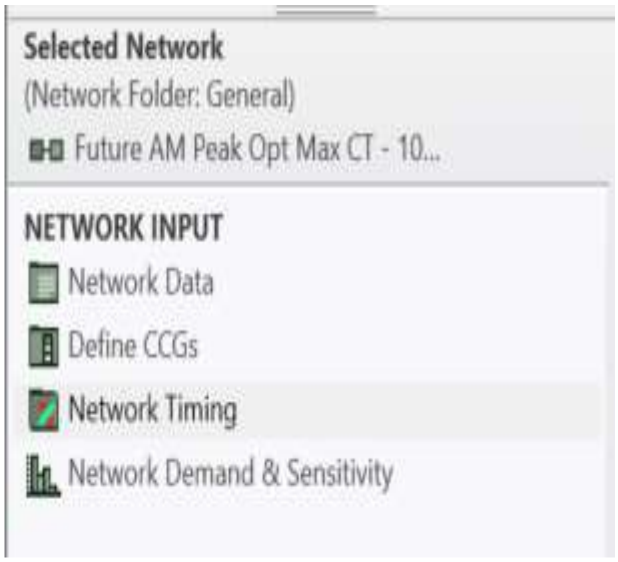


Figure 20 Sidra Network and Route Modelling Steps

INTERSECTION

Intersection Dialog part of data input contains the following:

A Site description (Name, ID, and Title) An “Approach Editor” to select an intersection leg and specify existing approaches, their names and leg geometry (e.g., two-way lag, one-way approach, one-way exit, and no leg).

MOVEMENT DEFINITIONS

Movement Definitions Dialog part of data input contains the following movement classes data:

- Six standard and two user defined movement classes.
- Model designation can be either Light vehicle or Heavy vehicle.
- Pedestrians will be specified at a later stage.
- Select only light and heavy vehicles.
- Select buses if your intersection has a bus lane.

LANE GEOMETRY

- Selecting the method to be edited is the first stage in Lane Geometry definition. This is done under the dialog's "Approach selector" section.
- Using the buttons beneath the "Lane editor" dialog area, you can add approach and exit lanes, strip (median) islands, and delete lanes.
- Values should be specified as illustrated on the attached Intersection drawings. Geometry data that is missing (e.g., short lane length) should be filled up.

PEDESTRIAN

Pedestrian part of data input contains the following:

- No pedestrian crossing on some approaches
- Staged crossing. This option is only available if strip island is specified for a particular approach.
- Full crossing
- Slip lane crossing. This option is only available for signalised slip lanes.
- Diagonal crossing. Only one diagonal crossing is specified for the whole intersection. All other types can be specified for each approach.

VOLUMES

Vehicle volumes are specified as an Origin-destination (OD) matrix for each movement class. There are three options available when specifying light (LV) and heavy (HV) vehicles:

The first one is named "Separate". This option allows vehicle volume specifications for both vehicle types separately. The second option labelled "Total & %" allows the specification of HV as a proportion of total vehicle volumes. The third option labelled "Total & Vehicle" allows for the separate specification of HV and the total vehicle volume. If this option is selected, the LV volumes will be calculated based on total and HV volumes.

PRIORITIES

Movement priorities are specified by OD movements, and they apply to each movement classes for a particular OD movement.

GAP ACCEPTANCE

gap acceptance data is split into two parts:

- The first part is "Gap acceptance data" and it can only be set for Opposed movements
- The second part is "Settings".

VEHICLE MOVEMENT

Vehicle Movement Data dialog is split into three parts, as follows:

- Path Data
- Calibration
- Signals

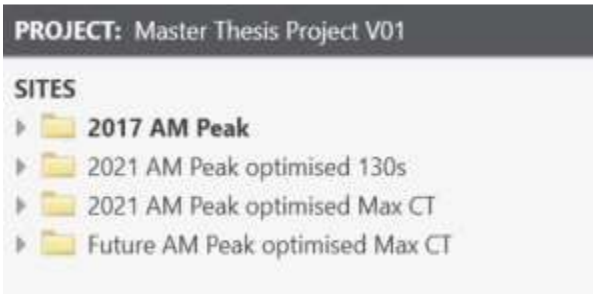


Figure 21 Sidra Scenarios modelled for site

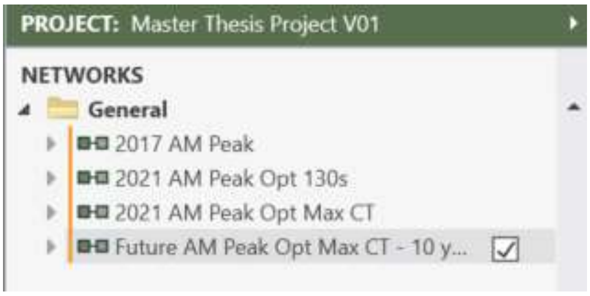


Figure 22 Sidra Scenarios modelled for network

From above image, we can see that above scenarios are designed for all intersection.

From above figure, these scenarios designed for all intersection. 2017 AM peak is designed for the existing geometry and 2021 AM peak for optimised cycle time (130s) and 2021 AM peak for maximum cycle time and future (for 2031) AM peak for optimised cycle time. And compare all the scenario to each other and taken best scenario for the design which is discussed in the result and analysis section.

6. Sidra results and analysis

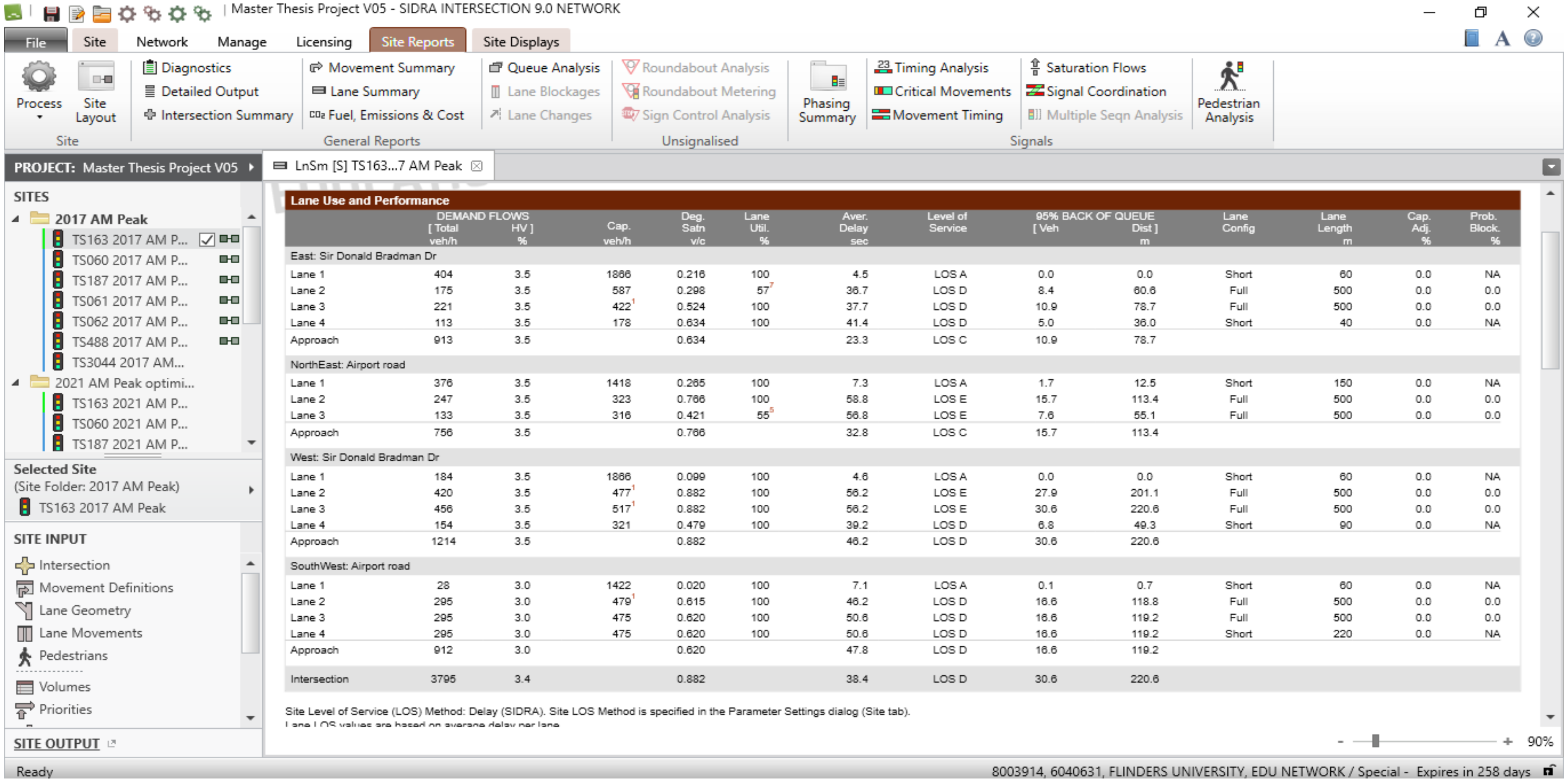
Sidra modelling was conducted, and key traffic performance indicators were generated that included the vehicle delays, travel times, queue lengths, fuel consumption, emissions, economic cost, etc. This was done for all the scenarios investigated and the final scenario comparison was performed. The analysis was performed on the individual intersection's performance as well as the network wide performance.

Following the data entry steps, the following results were obtained from SIDRA Software.

The lane summary table shows you labels what data it represents, for example, it gives vehicle queues, delays LOS, etc. for each lane.

Lane summary for all scenario is following.

6.1 Lane Summary for intersection TS163

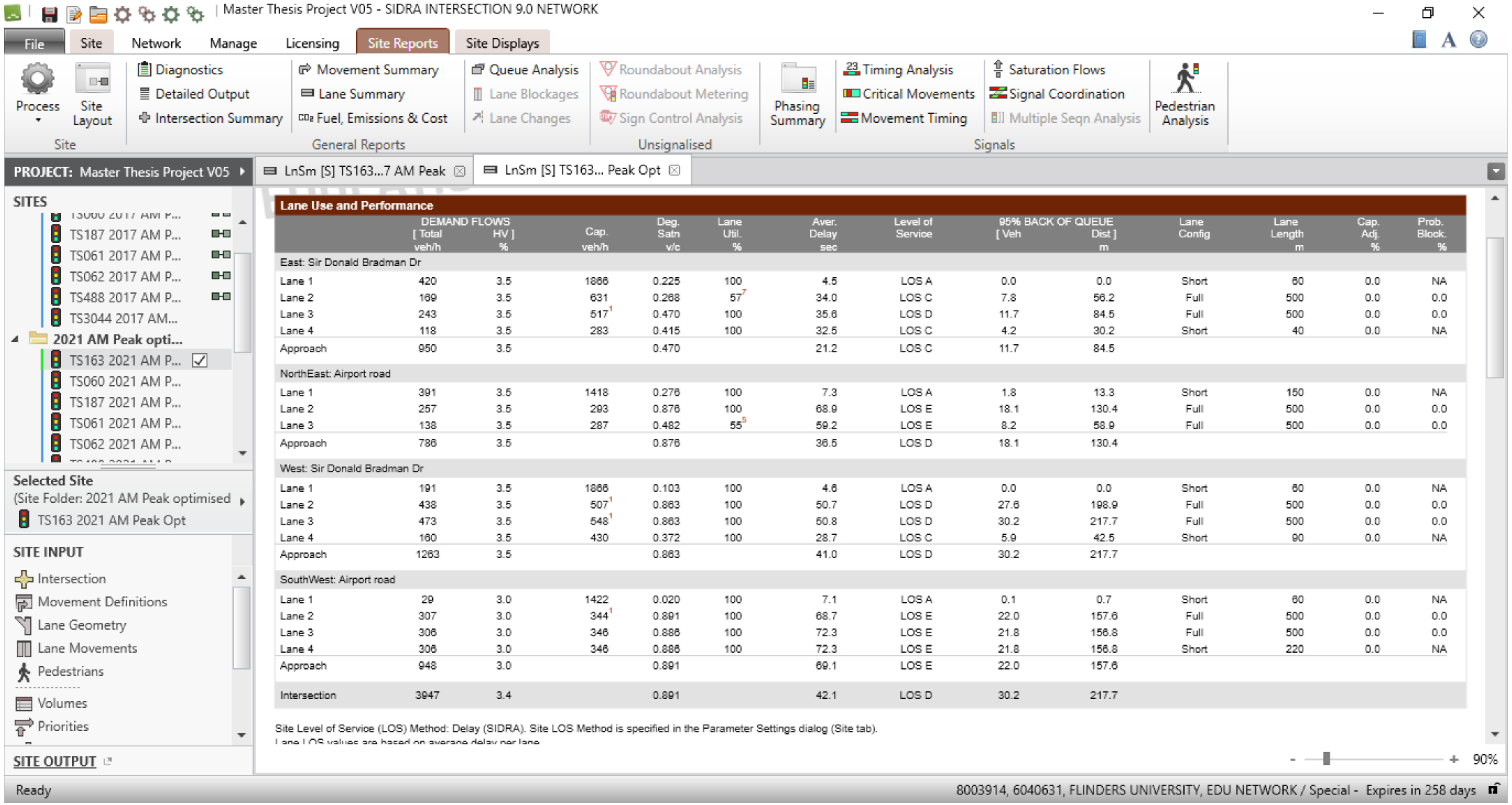


	DEMAND FLOWS [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
East: Sir Donald Bradman Dr													
Lane 1	404	3.5	1866	0.216	100	4.5	LOS A	0.0	0.0	Short	60	0.0	NA
Lane 2	175	3.5	587	0.298	57[7]	36.7	LOS D	8.4	60.6	Full	500	0.0	0.0
Lane 3	221	3.5	422[1]	0.524	100	37.7	LOS D	10.9	78.7	Full	500	0.0	0.0
Lane 4	113	3.5	178	0.634	100	41.4	LOS D	5.0	36.0	Short	40	0.0	NA
Approach	913	3.5		0.634		23.3	LOS C	10.9	78.7				
NorthEast: Airport road													
Lane 1	376	3.5	1418	0.265	100	7.3	LOS A	1.7	12.5	Short	150	0.0	NA
Lane 2	247	3.5	323	0.766	100	58.8	LOS E	15.7	113.4	Full	500	0.0	0.0
Lane 3	133	3.5	316	0.421	55[5]	56.8	LOS E	7.6	55.1	Full	500	0.0	0.0
Approach	756	3.5		0.766		32.8	LOS C	15.7	113.4				
West: Sir Donald Bradman Dr													
Lane 1	184	3.5	1866	0.099	100	4.6	LOS A	0.0	0.0	Short	60	0.0	NA
Lane 2	420	3.5	477[1]	0.882	100	56.2	LOS E	27.9	201.1	Full	500	0.0	0.0
Lane 3	456	3.5	517[1]	0.882	100	56.2	LOS E	30.6	220.6	Full	500	0.0	0.0
Lane 4	154	3.5	321	0.479	100	39.2	LOS D	6.8	49.3	Short	90	0.0	NA
Approach	1214	3.5		0.882		46.2	LOS D	30.6	220.6				
SouthWest: Airport road													
Lane 1	28	3.0	1422	0.020	100	7.1	LOS A	0.1	0.7	Short	60	0.0	NA
Lane 2	295	3.0	479[1]	0.615	100	46.2	LOS D	16.6	118.8	Full	500	0.0	0.0
Lane 3	295	3.0	475	0.620	100	50.6	LOS D	16.6	119.2	Full	500	0.0	0.0
Lane 4	295	3.0	475	0.620	100	50.6	LOS D	16.6	119.2	Short	220	0.0	NA
Approach	912	3.0		0.620		47.8	LOS D	16.6	119.2				
Intersection	3795	3.4		0.882		38.4	LOS D	30.6	220.6				

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

Figure 23 Lane Summary for existing condition for intersection TS163

Figure 23 it shows average intersection delays of 38.4 seconds per vehicle, although some lanes are experiencing average vehicle delays of more than 50 seconds. And average level of service for the existing condition was D with 30.6 vehicle



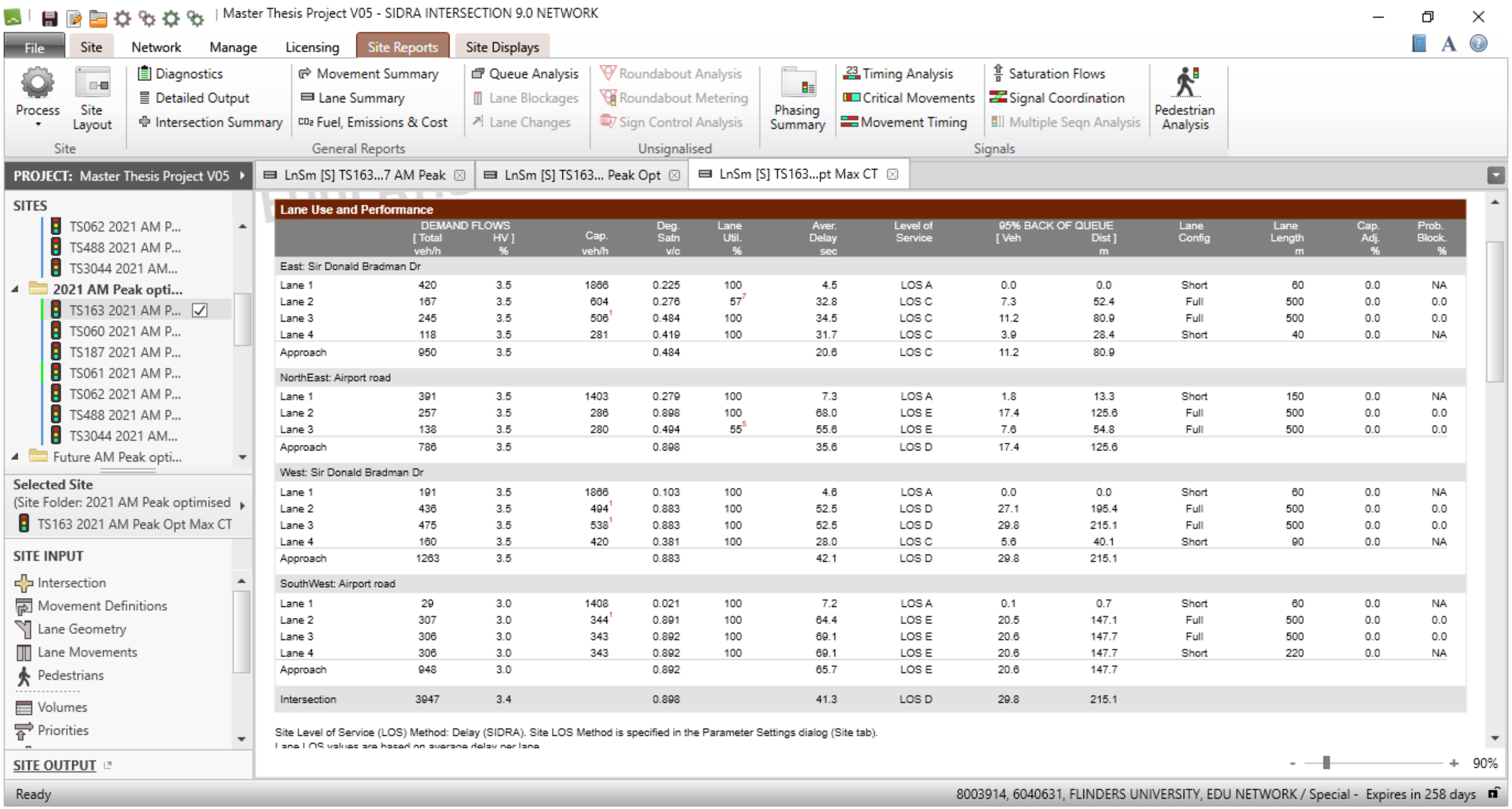
Lane Use and Performance

	DEMAND FLOWS [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
East: Sir Donald Bradman Dr													
Lane 1	420	3.5	1866	0.225	100	4.5	LOS A	0.0	0.0	Short	60	0.0	NA
Lane 2	169	3.5	631	0.268	57 [7]	34.0	LOS C	7.8	56.2	Full	500	0.0	0.0
Lane 3	243	3.5	517 [1]	0.470	100	35.6	LOS D	11.7	84.5	Full	500	0.0	0.0
Lane 4	118	3.5	283	0.415	100	32.5	LOS C	4.2	30.2	Short	40	0.0	NA
Approach	950	3.5		0.470		21.2	LOS C	11.7	84.5				
NorthEast: Airport road													
Lane 1	391	3.5	1418	0.276	100	7.3	LOS A	1.8	13.3	Short	150	0.0	NA
Lane 2	257	3.5	293	0.876	100	68.9	LOS E	18.1	130.4	Full	500	0.0	0.0
Lane 3	138	3.5	287	0.482	55 [5]	59.2	LOS E	8.2	58.9	Full	500	0.0	0.0
Approach	786	3.5		0.876		36.5	LOS D	18.1	130.4				
West: Sir Donald Bradman Dr													
Lane 1	191	3.5	1866	0.103	100	4.6	LOS A	0.0	0.0	Short	60	0.0	NA
Lane 2	438	3.5	507 [1]	0.863	100	50.7	LOS D	27.6	198.9	Full	500	0.0	0.0
Lane 3	473	3.5	548 [1]	0.863	100	50.8	LOS D	30.2	217.7	Full	500	0.0	0.0
Lane 4	160	3.5	430	0.372	100	28.7	LOS C	5.9	42.5	Short	90	0.0	NA
Approach	1263	3.5		0.863		41.0	LOS D	30.2	217.7				
SouthWest: Airport road													
Lane 1	29	3.0	1422	0.020	100	7.1	LOS A	0.1	0.7	Short	60	0.0	NA
Lane 2	307	3.0	344 [1]	0.891	100	68.7	LOS E	22.0	157.6	Full	500	0.0	0.0
Lane 3	306	3.0	346	0.886	100	72.3	LOS E	21.8	156.8	Full	500	0.0	0.0
Lane 4	306	3.0	346	0.886	100	72.3	LOS E	21.8	156.8	Short	220	0.0	NA
Approach	948	3.0		0.891		69.1	LOS E	22.0	157.6				
Intersection	3947	3.4		0.891		42.1	LOS D	30.2	217.7				

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

Figure 24 Lane summary for 2021 optimized cycle time for intersection TS163

Figure 24 it shows average intersection delays for current condition is 42.1 seconds per vehicle, although some lanes are experiencing average vehicle delays of more than 60 seconds. Also, it shows that from the southwest side average delay and delays for each lane is very high and more than 60 second per vehicle.

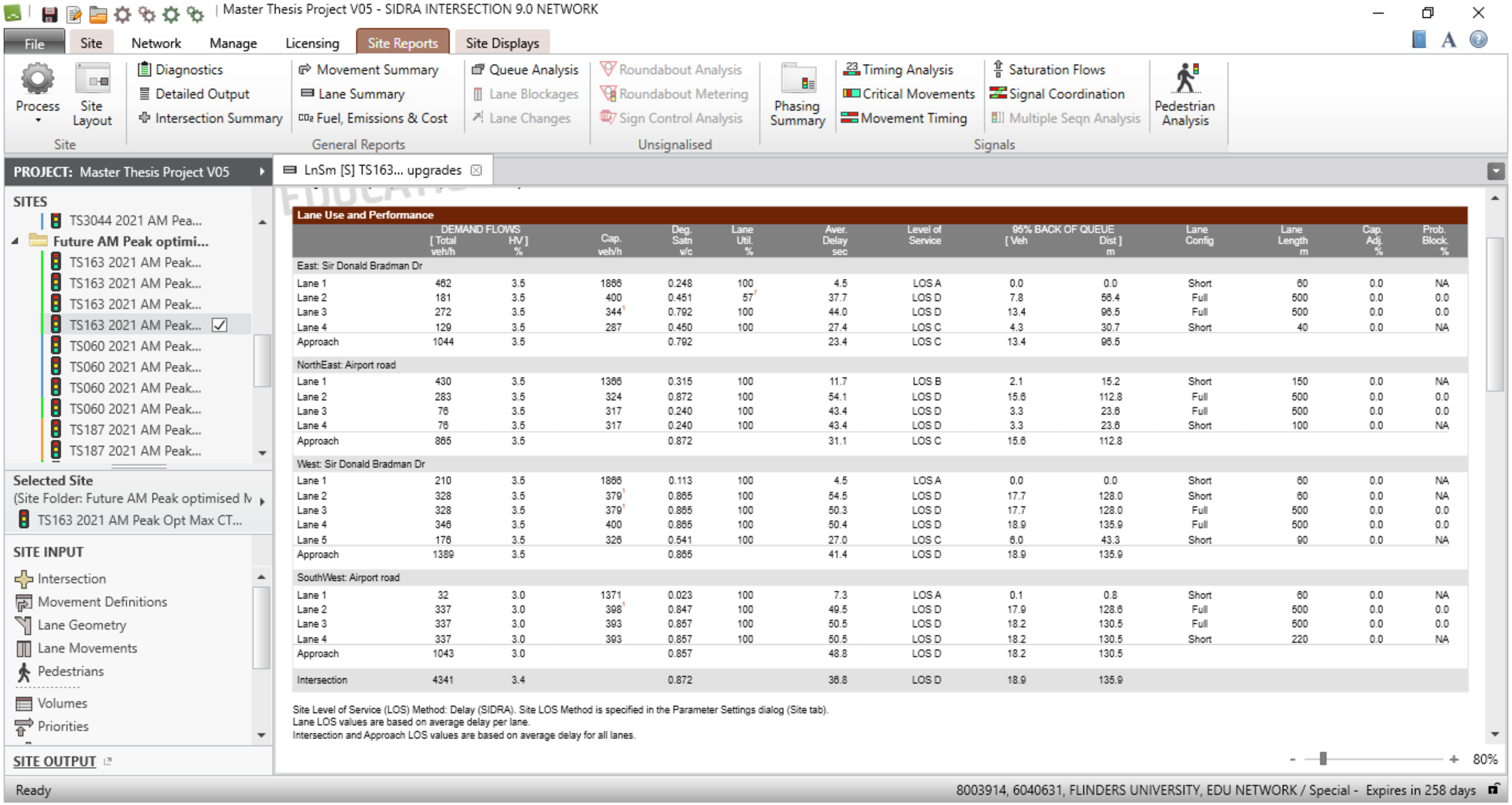


Lane Use and Performance	DEMAND FLOWS [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
East: Sir Donald Bradman Dr													
Lane 1	420	3.5	1866	0.225	100	4.5	LOS A	0.0	0.0	Short	60	0.0	NA
Lane 2	167	3.5	604	0.276	57[7]	32.8	LOS C	7.3	52.4	Full	500	0.0	0.0
Lane 3	245	3.5	506[1]	0.484	100	34.5	LOS C	11.2	80.9	Full	500	0.0	0.0
Lane 4	118	3.5	281	0.419	100	31.7	LOS C	3.9	28.4	Short	40	0.0	NA
Approach	950	3.5		0.484		20.6	LOS C	11.2	80.9				
NorthEast: Airport road													
Lane 1	391	3.5	1403	0.279	100	7.3	LOS A	1.8	13.3	Short	150	0.0	NA
Lane 2	257	3.5	286	0.898	100	68.0	LOS E	17.4	125.6	Full	500	0.0	0.0
Lane 3	138	3.5	280	0.494	55[5]	55.6	LOS E	7.6	54.8	Full	500	0.0	0.0
Approach	786	3.5		0.898		35.6	LOS D	17.4	125.6				
West: Sir Donald Bradman Dr													
Lane 1	191	3.5	1866	0.103	100	4.6	LOS A	0.0	0.0	Short	60	0.0	NA
Lane 2	436	3.5	494[1]	0.883	100	52.5	LOS D	27.1	195.4	Full	500	0.0	0.0
Lane 3	475	3.5	538[1]	0.883	100	52.5	LOS D	29.8	215.1	Full	500	0.0	0.0
Lane 4	160	3.5	420	0.381	100	28.0	LOS C	5.6	40.1	Short	90	0.0	NA
Approach	1263	3.5		0.883		42.1	LOS D	29.8	215.1				
SouthWest: Airport road													
Lane 1	29	3.0	1408	0.021	100	7.2	LOS A	0.1	0.7	Short	60	0.0	NA
Lane 2	307	3.0	344[1]	0.891	100	64.4	LOS E	20.5	147.1	Full	500	0.0	0.0
Lane 3	306	3.0	343	0.892	100	69.1	LOS E	20.6	147.7	Full	500	0.0	0.0
Lane 4	306	3.0	343	0.892	100	69.1	LOS E	20.6	147.7	Short	220	0.0	NA
Approach	948	3.0		0.892		65.7	LOS E	20.6	147.7				
Intersection	3947	3.4		0.898		41.3	LOS D	29.8	215.1				

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

Figure 25 lane summary for 2021 MAX Cycle time for intersection TS163

Above figure shows that for the maximum cycle time Delays is 41.3 vehicle per second is quite similar with optimized cycle time and some lanes have more than 60 vehicle per second especially in south-west side.



Lane Use and Performance	DEMAND FLOWS [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
East: Sir Donald Bradman Dr													
Lane 1	462	3.5	1866	0.248	100	4.5	LOS A	0.0	0.0	Short	60	0.0	NA
Lane 2	181	3.5	400	0.451	57[7]	37.7	LOS D	7.8	56.4	Full	500	0.0	0.0
Lane 3	272	3.5	344[1]	0.792	100	44.0	LOS D	13.4	96.5	Full	500	0.0	0.0
Lane 4	129	3.5	287	0.450	100	27.4	LOS C	4.3	30.7	Short	40	0.0	NA
Approach	1044	3.5		0.792		23.4	LOS C	13.4	96.5				
NorthEast: Airport road													
Lane 1	430	3.5	1366	0.315	100	11.7	LOS B	2.1	15.2	Short	150	0.0	NA
Lane 2	283	3.5	324	0.872	100	54.1	LOS D	15.6	112.8	Full	500	0.0	0.0
Lane 3	76	3.5	317	0.240	100	43.4	LOS D	3.3	23.6	Full	500	0.0	0.0
Lane 4	76	3.5	317	0.240	100	43.4	LOS D	3.3	23.6	Short	100	0.0	NA
Approach	865	3.5		0.872		31.1	LOS C	15.6	112.8				
West: Sir Donald Bradman Dr													
Lane 1	210	3.5	1866	0.113	100	4.5	LOS A	0.0	0.0	Short	60	0.0	NA
Lane 2	328	3.5	379[1]	0.865	100	54.5	LOS D	17.7	128.0	Short	60	0.0	NA
Lane 3	328	3.5	379[1]	0.865	100	50.3	LOS D	17.7	128.0	Full	500	0.0	0.0
Lane 4	346	3.5	400	0.865	100	50.4	LOS D	18.9	135.9	Full	500	0.0	0.0
Lane 5	176	3.5	326	0.541	100	27.0	LOS C	6.0	43.3	Short	90	0.0	NA
Approach	1389	3.5		0.865		41.4	LOS D	18.9	135.9				
SouthWest: Airport road													
Lane 1	32	3.0	1371	0.023	100	7.3	LOS A	0.1	0.8	Short	60	0.0	NA
Lane 2	337	3.0	398[1]	0.847	100	49.5	LOS D	17.9	128.6	Full	500	0.0	0.0
Lane 3	337	3.0	393	0.857	100	50.5	LOS D	18.2	130.5	Full	500	0.0	0.0
Lane 4	337	3.0	393	0.857	100	50.5	LOS D	18.2	130.5	Short	220	0.0	NA
Approach	1043	3.0		0.857		48.8	LOS D	18.2	130.5				
Intersection	4341	3.4		0.872		36.8	LOS D	18.9	135.9				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.

Figure 26 lane summary for 10 years upgrade for intersection TS163

Form above figure it shows that average delays is decreased as compared to current scenario and which is 30.5 vehicle per second, and it decreased for individual lane as well because of adding new lane for the future design

6.2 Delays each scenario from SIDRA Result

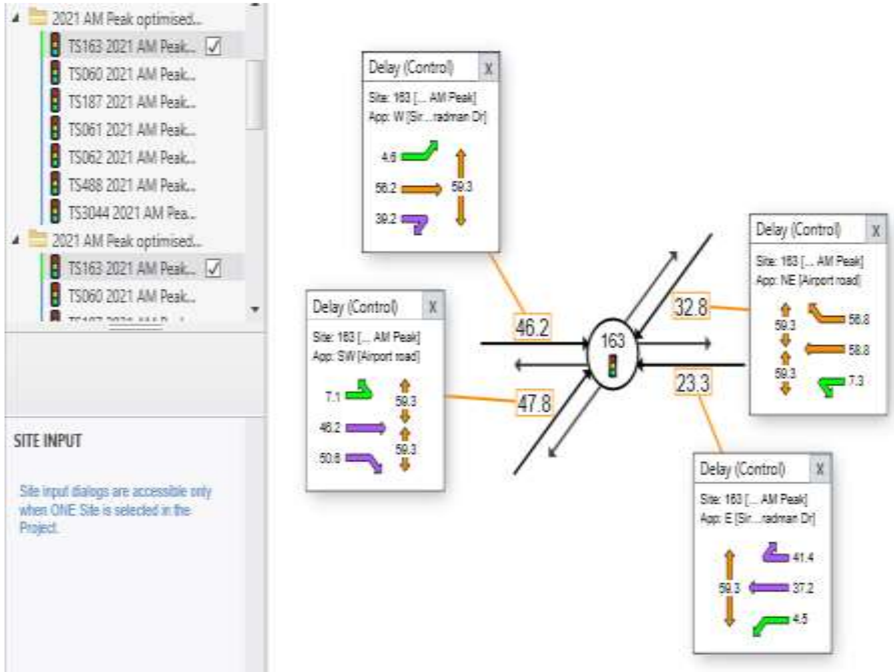


Figure 27 Delay for existing condition in 2017

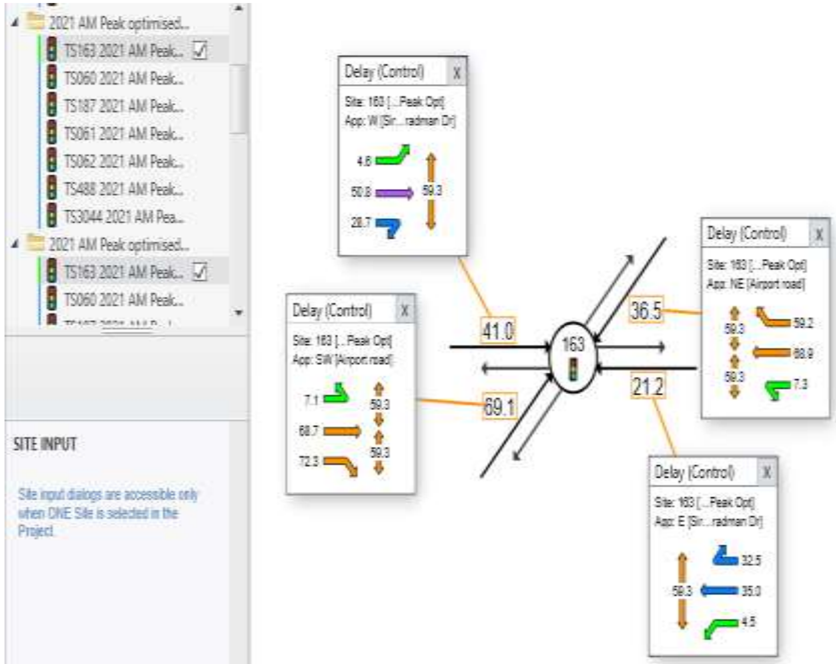


Figure 28 Delay in 2021 for optimized cycle time

From above figure it shows that average delays from southwest side is increased as compared to the current condition and rest of other approach have quite similar delays as compared to the current condition of optimized cycle time

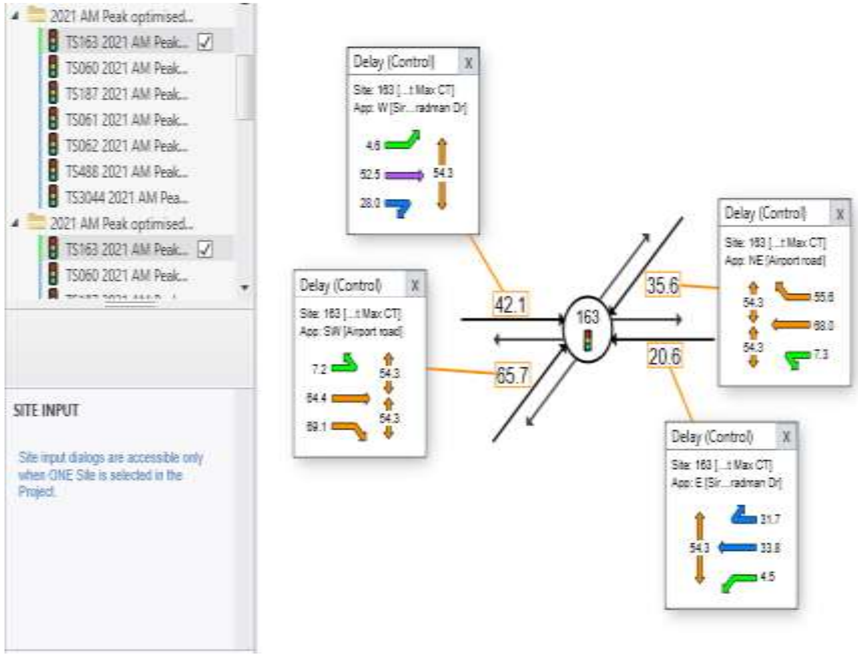


Figure 29 Delays in 2021 for maximum cycle time

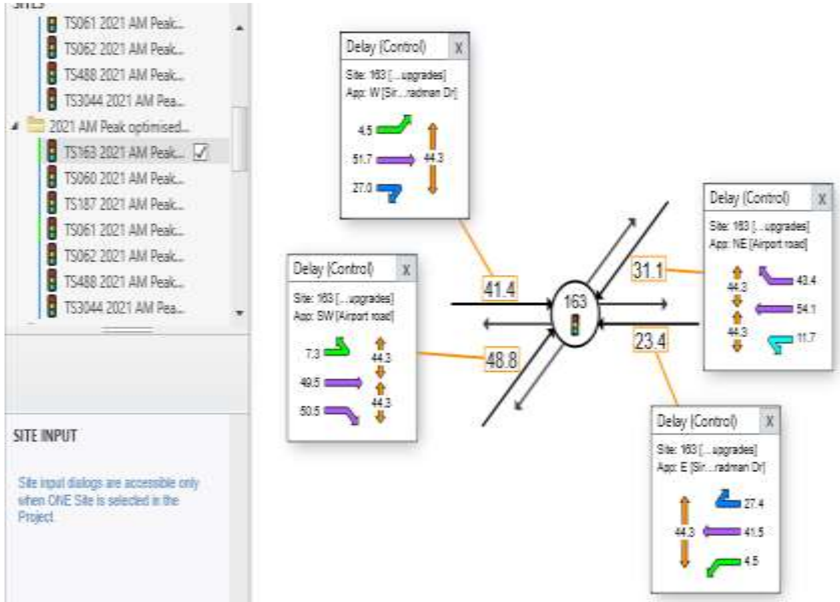


Figure 30 Delays for 10-year upgrade

Figure 29 shows that if the cycle time is maximum still there is no more change from south-west approach it quite similar for the other approach as well as compared to existing 2017 delays.

Figure 30 shows that average delays from South-west side is 48.8 vehicle per second which is less that existing and 2021 delays and also it decreased for other approach as well because for the 2031 model add three right turning lanes to the east approach.

6.3 Level of Service for intersection TS163 (Sir Donald Bradman Dr and Airport Road)

From the table it shows that if the delays are between 55 to 80 seconds it shows that LOS is E and if the delays is more than 80 second it shows that level of service is very worst, and which is represent as F and if the delays is 10 second or less than that then LOS is A it means that LOS is good and flow of vehicle continuous and if the level of service is between 10 to 20 than LOS is B and if it Between 20 to 35 then LOS is C and LOS denoted D if delays between 35 to 55.

Level of Service	Control delay per vehicle in seconds (d)		
	Signals	"SIDRA Roundabout LOS" method (1)	Sign Control
A	$d \le 10$	$d \le 10$	$d \le 10$
B	$10 < d \le 20$	$10 < d \le 20$	$10 < d \le 15$
C	$20 < d \le 35$	$20 < d \le 35$	$15 < d \le 25$
D	$35 < d \le 55$	$35 < d \le 50$	$25 < d \le 35$
E	$55 < d \le 80$	$50 < d \le 70$	$35 < d \le 50$
F	$80 < d$	$70 < d$	$50 < d$

Table 4 Method of level of service based on delays only (SIDRA user's guide 2020)

Level of service for each scenario is following.

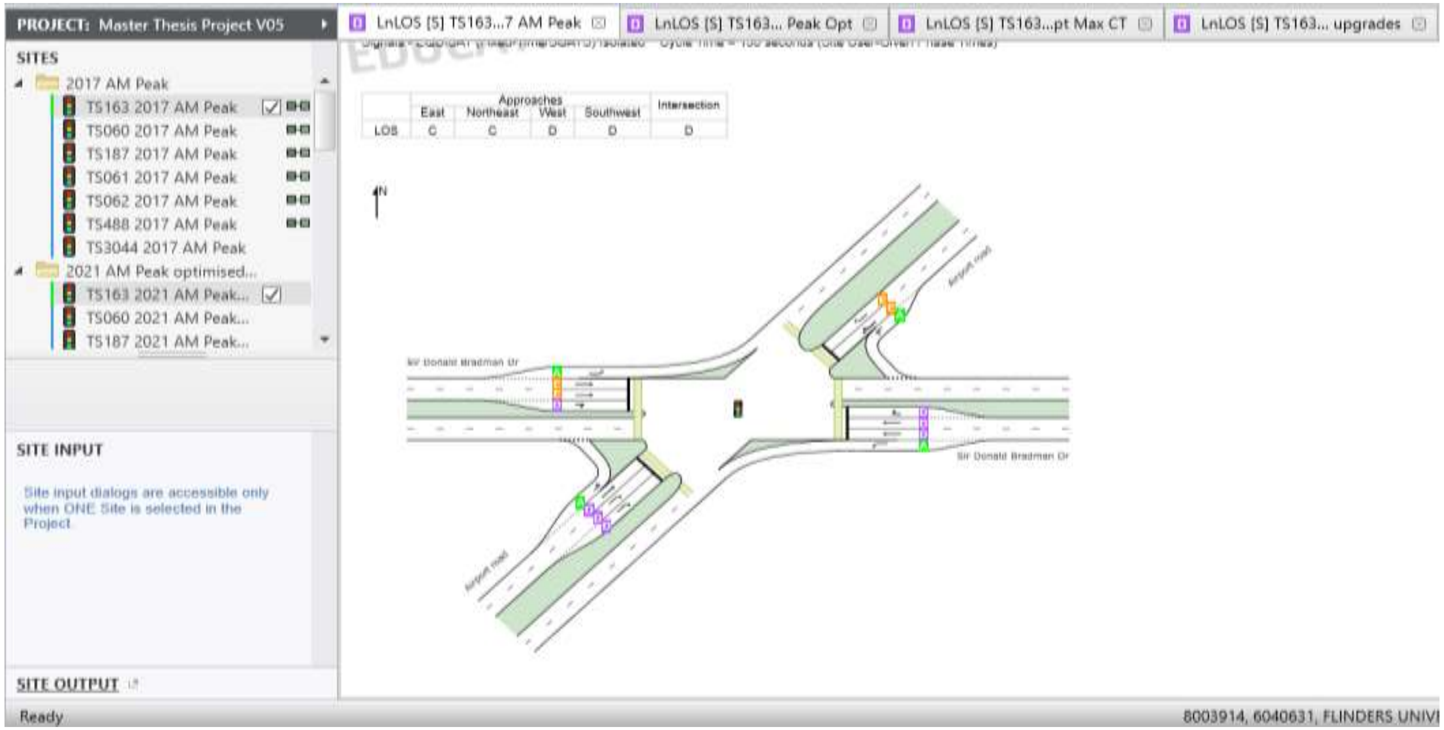


Figure 31 Level of service for existing condition 2017

Figure 31 shows that level of service for all approach it shows that LOS for south-west approach was D and for west and north-east approach LOS is F and LOS for east approach in D for the existing condition (2017) for intersection TS163

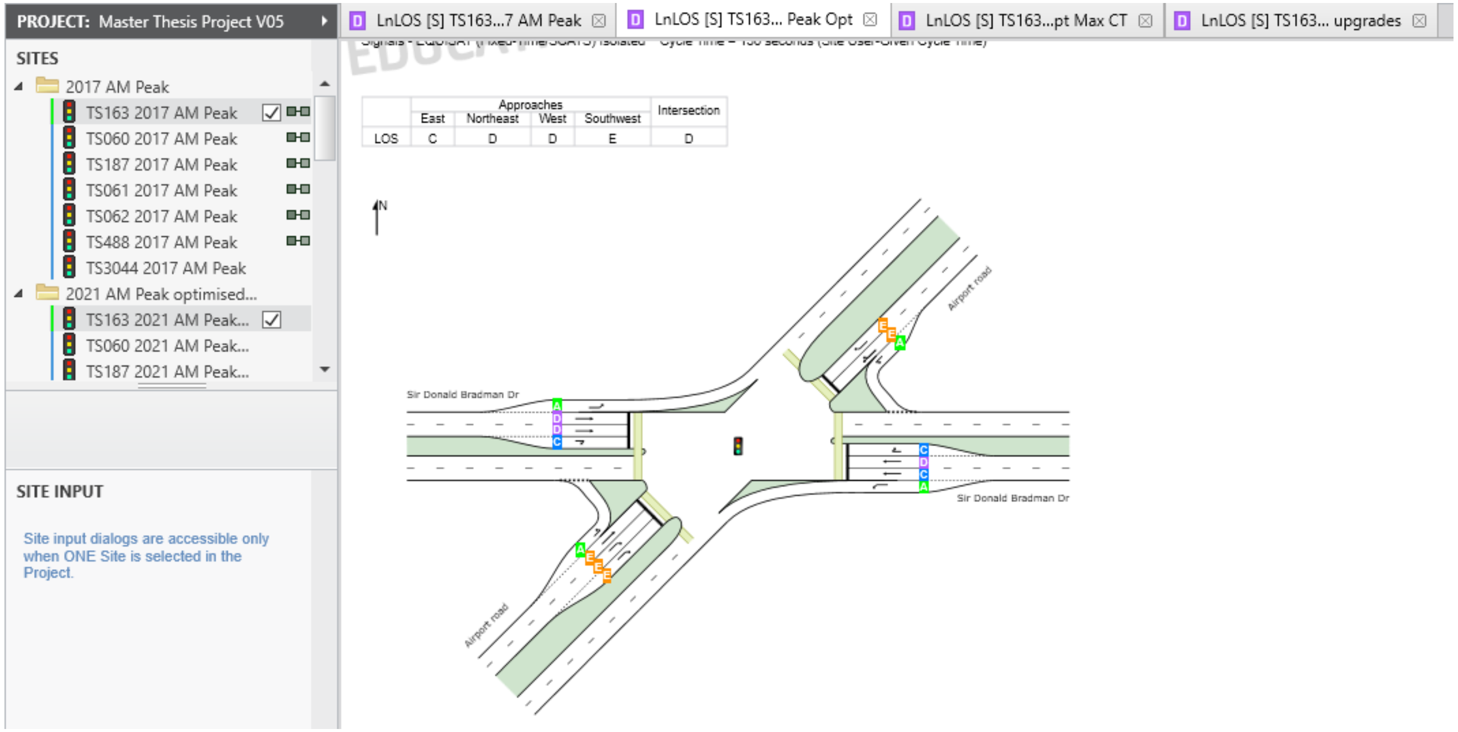


Figure 32 Level of service for 2021 for optimized cycle time

Above figure shows that the level of service is E for South-west approach and north-east approach which is worst as compared to scenario of 2017 for TS163 and for west approach LOS is D and for east approach its C and D for optimized cycle time for 2021.

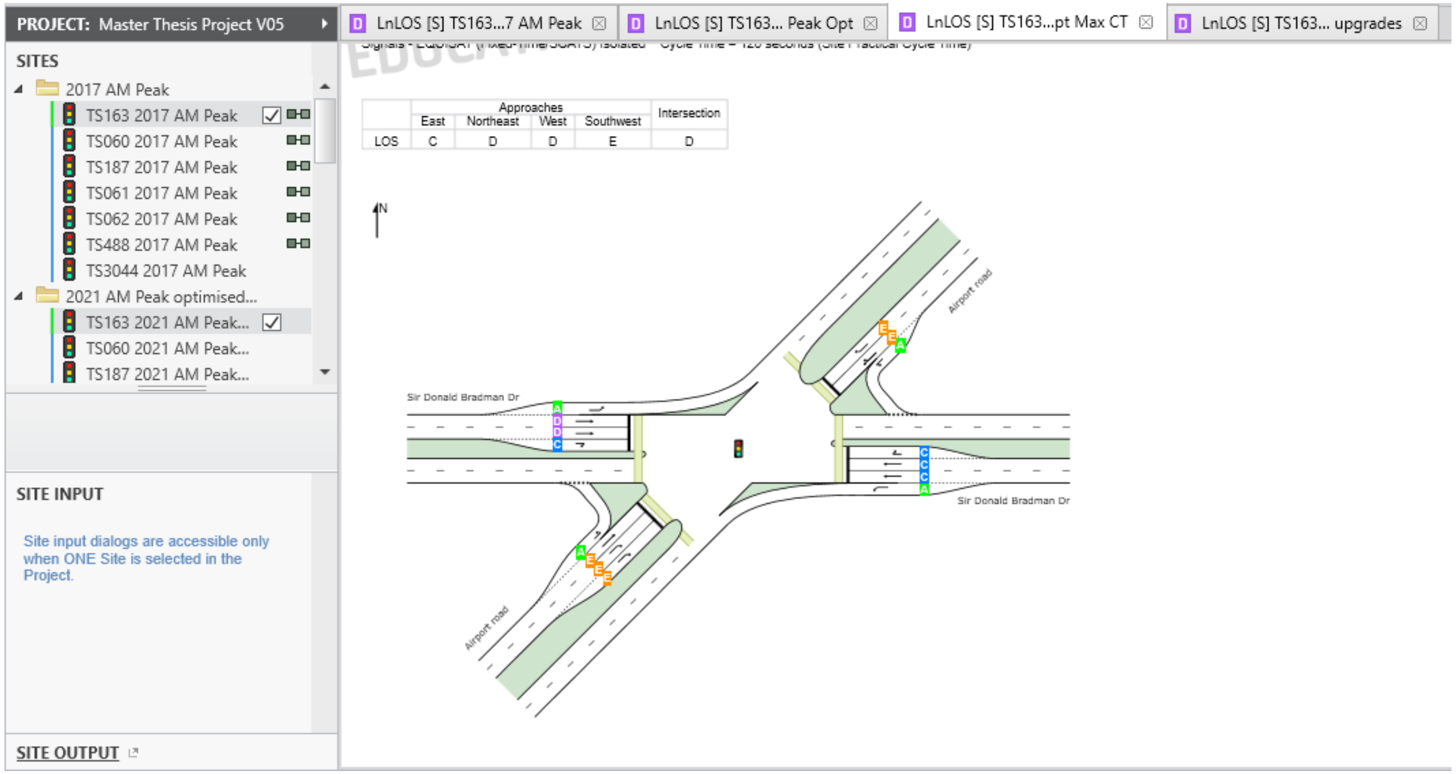


Figure 33 Level of service for 2021 MAX cycle time

From above figure it shows that LOS from south-west and North-East side is E and for the maximum cycle time which is similar to optimized cycle time and LOS for west approach is D and for east approach is C which is improved as compared to optimized cycle time in 2021 for Intersection TS163

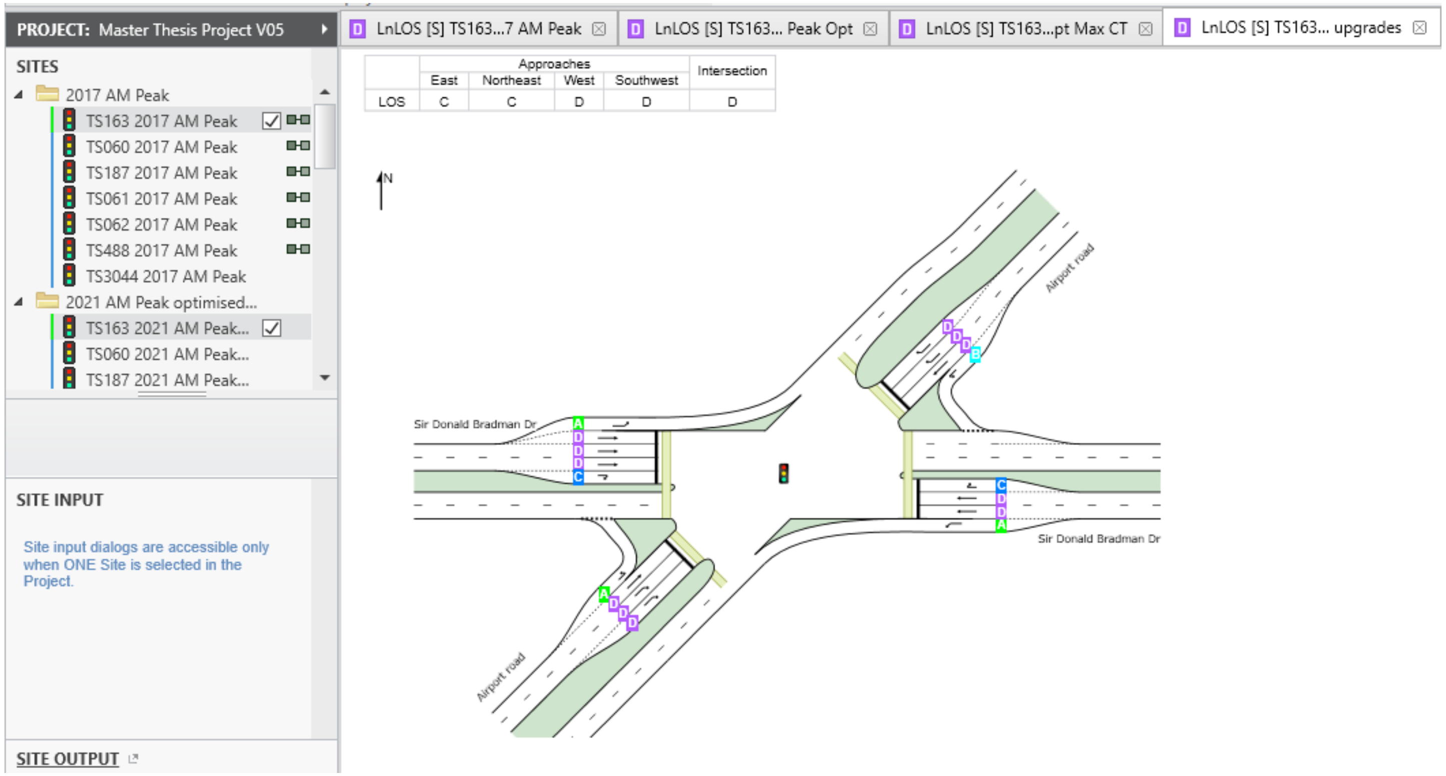


Figure 34 Level of service for 10-year upgrade

From above images it shows that level of service in existing condition is very worst in each approach but in future upgrade intersection it shows that level of service for all approach is improved especially for south-west and north-east approach LOS is E in 2021 and it will improve from E to D for the future model in 2031 for

7. Microsimulation

Reasons for AIMSUN:

Along with the Department of Infrastructure and Transport in South Australia, the AIMSUN microsimulation software is a most widely accepted and used software for traffic analysis around the world. (AIMSUN user's guide,2021).

To confirm the Sidra results, especially because the model was not fully calibrated due to traffic being affected by Covid-19.

To visualise vehicle movements (2D and 3D) and confirm the Sidra results for the sites that needed major upgrades.

Figure 35 AIMSUN result for TS163

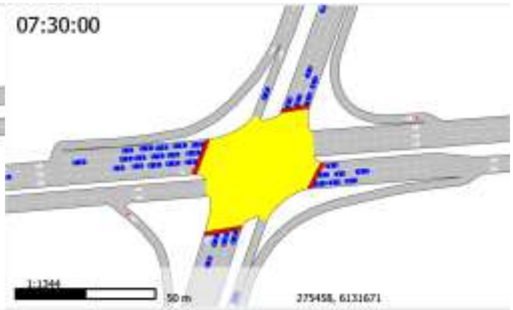


Figure 36 AIMSUN Result for TS163

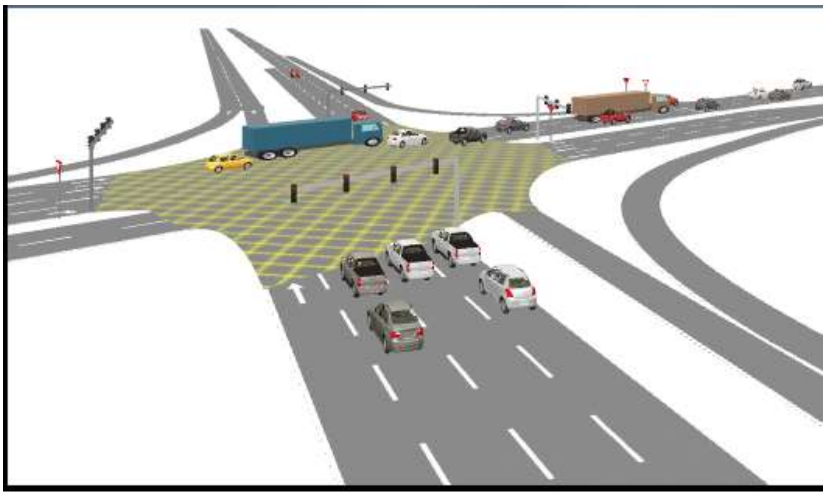


Figure 37 3D View of TS163

To get the results based on a range of different vehicle physical and kinematics parameters rather than an average vehicle modelling as deployed in Sidra. Slightly better intersection performance due to AIMSUN not modelling pedestrians.

TS163 is only designed in AIMSUN because for the design of each intersection lots of DATA required and it require origin-destination matrix.

8. Discussion of result

From above image it shows that four scenario is designed for each intersection.

Figure 38 SIDRA Scenario Description

LOS for all four Scenario.

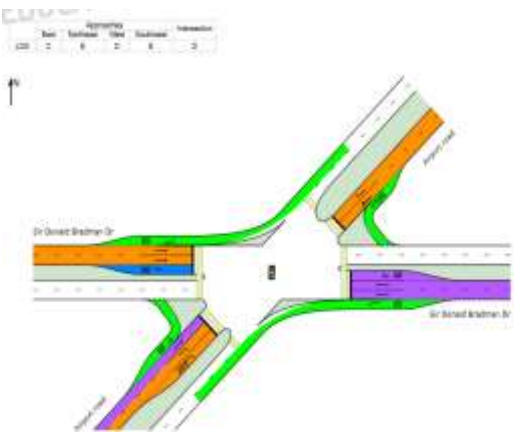


Figure 39 TS163 2021 optimize MAX cycle time

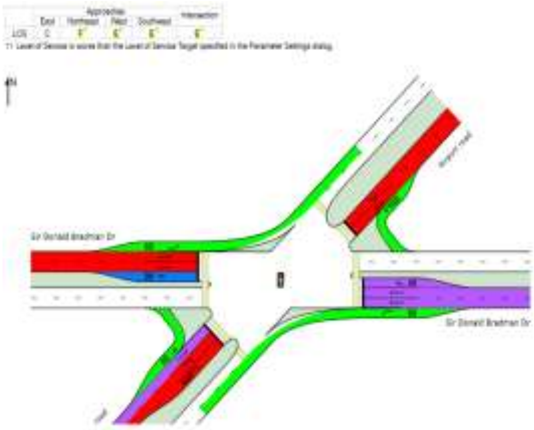


Figure 40 TS163 2021 optimize MAX cycle time - 10 years upgrade

Figure 41 TS163 2021 optimize MAX cycle time – Upgrade

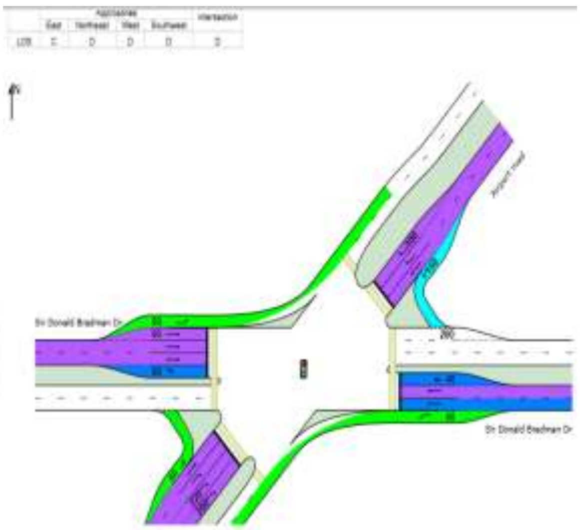


Figure 42 TS163 2021 optimize MAX cycle time- 10 Years upgrade

Therefore, it is very clear from above four scenarios, LOS in Scenario 1 and 2 is E and F and LOS for the 10 years upgrade   for maximum cycle time is improving and it convert from E to D or C.

Therefore, Scenario 4 is the best scenario for the future upgrade.

After, All the data analysis and putting all data in SIDRA software and selecting best scenario it shows that delays in existing condition (2017) is very high and also it become higher in current condition (2021) but delays for the future upgrade in 2031 is decreased because from the figure it shows that there is two right turning moment to the east approach in exiting condition and in future condition three right turning moment to the east approach it means one extra lane is added to the south west approach therefore delays is reduced. Delays in 2017 for TS163 for southwest approach was 55.5 second and delays for the future will be 45.4 second as per SIDRA model

Figure 43 Geometry of existing condition (2017) for TS163

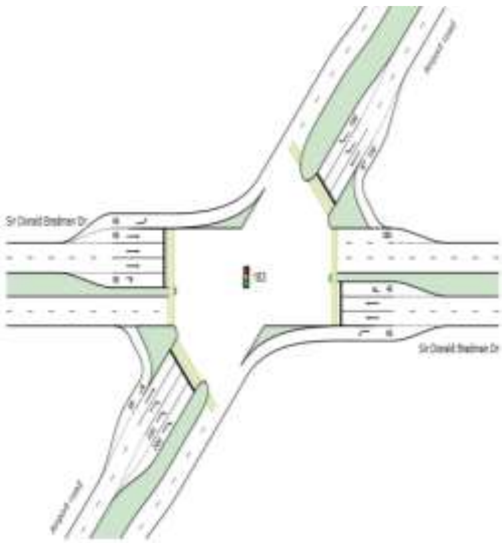


Figure 44 Geometry of future condition (2031) for TS163

In existing condition, for the west approach there is two straight moments where in the future one extra lane is added in the west approach therefore delays are improved. For the northeast approach in 2017 there is one right turning and one shared lane and for the future model it shows that two separate lane added, and one straight moment added in future design.

Figure 45 LOS for TS163 in 2017

Figure 46 LOS for TS163 in 2021

From above figure it clearly shows that LOS for southwest and northeast approach was E and after adding lane in 2031 intersection design the LOS is improving and it will be C or D.

Result From AIMSUN software

Time Series	Value	Standard Deviation	Units
Delay Time - All	34.85	31.66	sec/km
Flow - All	3536.31	N/A	veh/h
Fuel Consumption - All	0	N/A	l
IEM Emission - All - CO2	808067.4	N/A	g
IEM Emission - All - NOx	1230.69	N/A	g
IEM Emission - All - PM	130.52	N/A	g
IEM Emission - All - VOC	1292.65	N/A	g
Input Count - All	3727	N/A	veh
Mean Queue - All	27.38	N/A	veh
Number of Stops - All	0.07	N/A	#/veh/km
Speed - All	38.43	11.15	km/h
Total Distance Travelled - All	3901.2	N/A	km
Total Number of Stops - All	2589	N/A	
Total Travel Time - All	111.57	N/A	h
Travel Time - All	102.71	32.31	sec/km

Table 5 AIMSUN Result for Intersection 163(Existing 2017)

Time Series	Value	Standard Deviation	Units
Delay Time - All	36.9	31.52	sec/km
Flow - All	4062.46	N/A	veh/h
Fuel Consumption - All	0	N/A	l
IEM Emission - CO2 - All	960096.7	N/A	g
IEM Emission - NOx - All	1462.07	N/A	g
IEM Emission - PM - All	169.46	N/A	g
IEM Emission - VOC - All	1509.14	N/A	g
Input Count - All	4298	N/A	veh
Mean Queue - All	32.14	N/A	veh
Number of Stops - All	0.08	N/A	#/veh/km
Speed - All	37.49	10.53	km/h
Total Distance Travelled - All	4482.31	N/A	km
Total Number of Stops - All	3300	N/A	
Total Travel Time - All	130.57	N/A	h
Travel Time - All	104.59	31.91	sec/km

Table 6 AIMSUN Result for Intersection 163(Future 2031)

Table 4 and 5 shows that AIMSUN result comparisons between existing intersection 2017 and future intersection 2031.

9. Conclusion

The research was conducted with the aim of analysing transmit networks for different metropolitan cities in Australia, particularly those having major airports. It studied congestions in traffic with reference to scenarios. This was a deviation from standard practices, which only analysed management of traffic based on recurring events and not consider the impact of non-recurring incidents, which cause the biggest impact on traffic. The paper also has made use of micro simulation as a technique to identify the effects that are caused, when one or more lanes in a motorway, gets closed due to such unplanned events. It establishes microsimulation to be a secure and cost friendly technique for analysis of such incidents and providing useful perspectives. The environmental concerns caused by congestions has also been addressed in this study and this is in lines with the commitment of the Australian Government to ensure sustainability in all its practices.

The research shows that non-recurring incidents should be incorporated in the realms of traffic management and the system should make use of the simulated data for planning alternatives, whenever such incidents take place. This strategy should lead to developing further the arterial roads that connect to the major motorways that are under efficient traffic management systems, so that they can be used for removal of congestions due to non-recurring incidents. This will not only help in reducing congestion and its associated economic costs but also make transportation environment-friendly, as congestions have been found to increase emissions.

SCATS data is useful to analysis of existing condition and design of intersection by suing SIDRA software it shows that Delays and LOS is very worst in almost all intersection and for the upgrade like providing extra lane or building bridge or tunnel as per cost economic and reduce the traffic congestion at intersection and providing reliable traffic flow during peak time of given intersection.

As per the result from SIDRA software Scenario 4 is the best scenario for the design of intersection TS163 because LOS and Delay is improving compared to all other scenarios.

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Appendix A SCATS Drawing

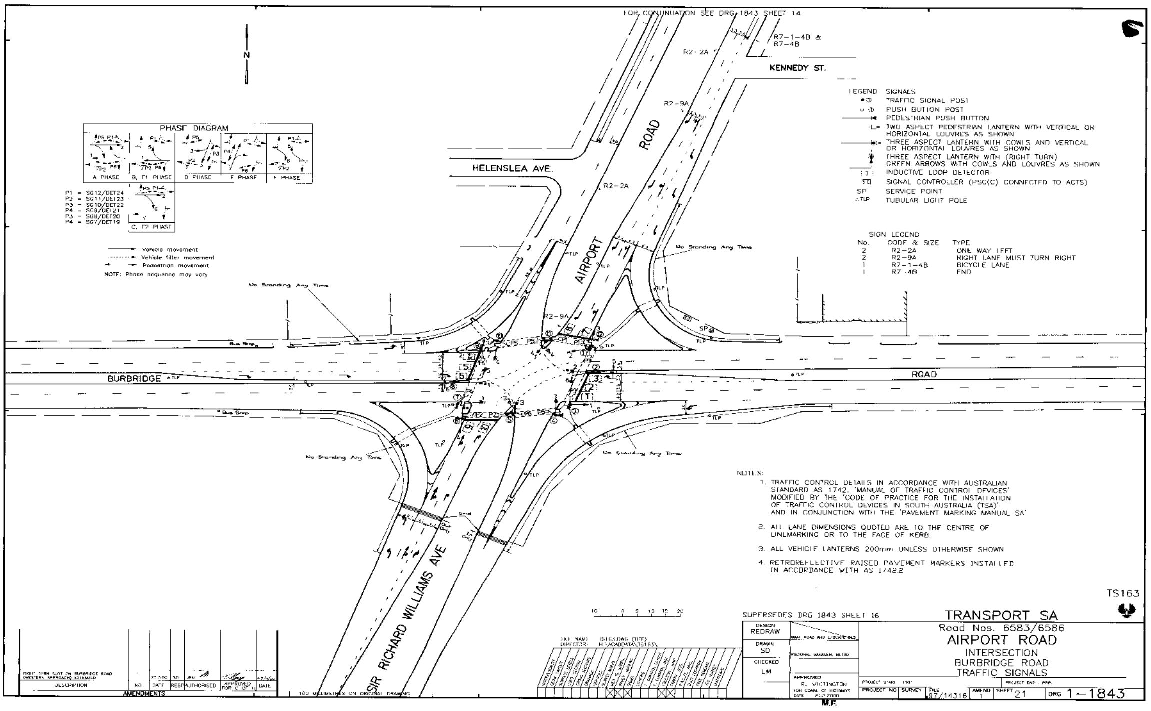

Figure 47 SCATS Drawing for TS 163

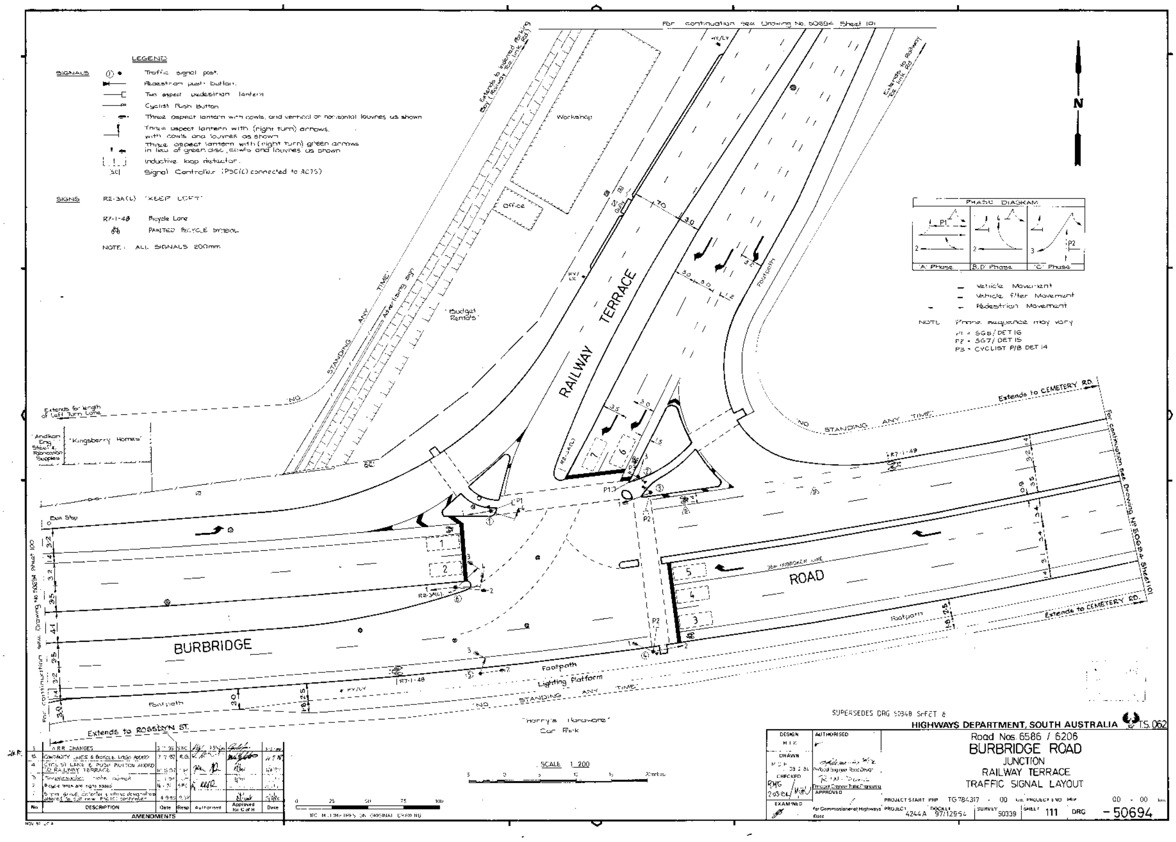

Figure 48 SCATS Drawing for TS 062

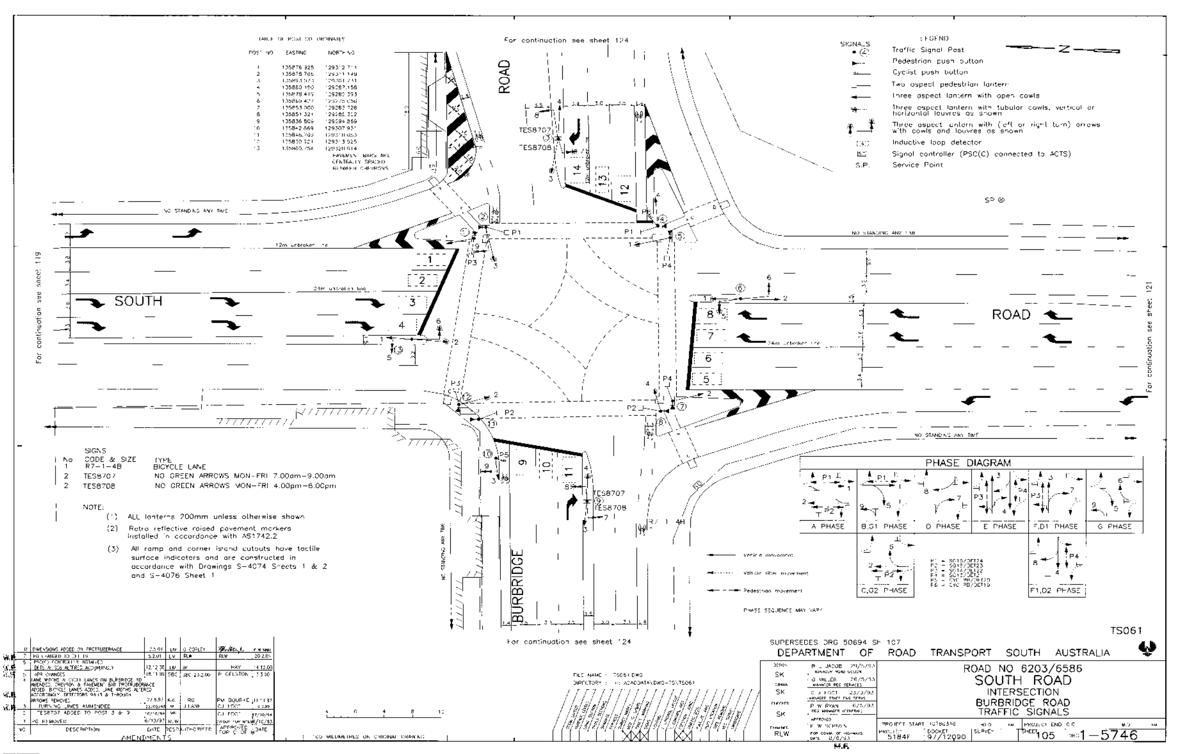

Figure 49 SCATS Drawing for TS061

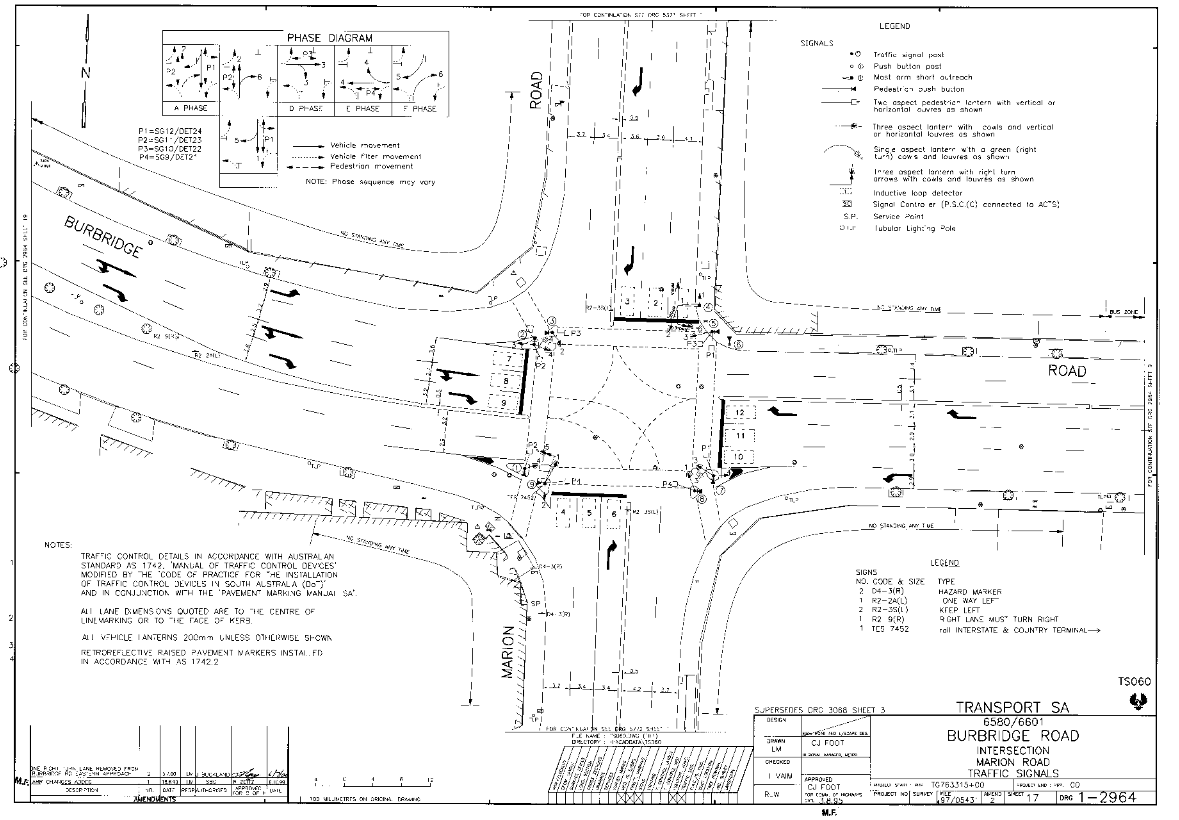

Figure 50 SCATS Drawing for TS060

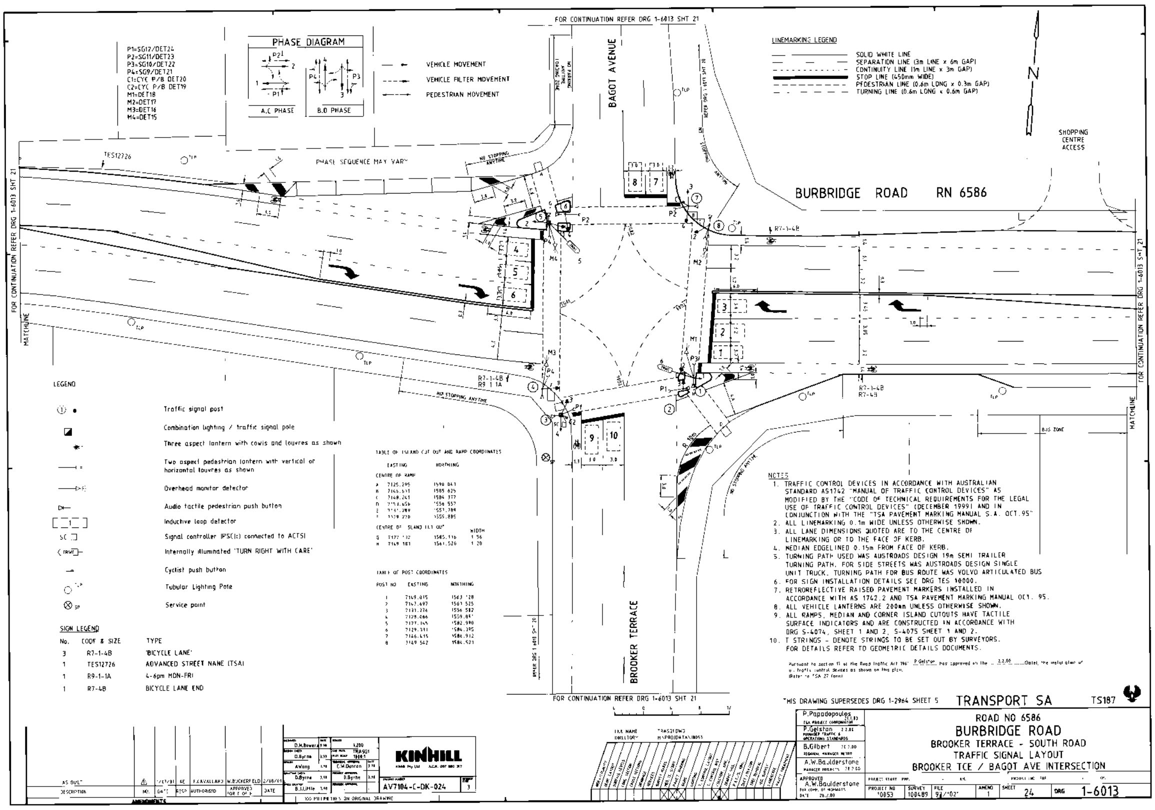

Figure 51 SCATS Drawing for TS187

Appendix B SIDRA Software result Delays
TS60

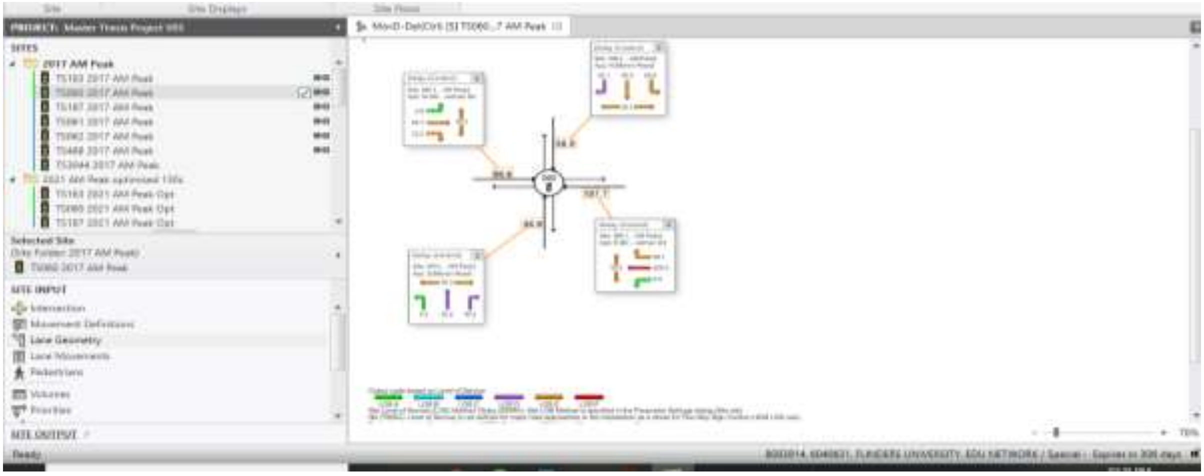

Figure 52 delay for 2017

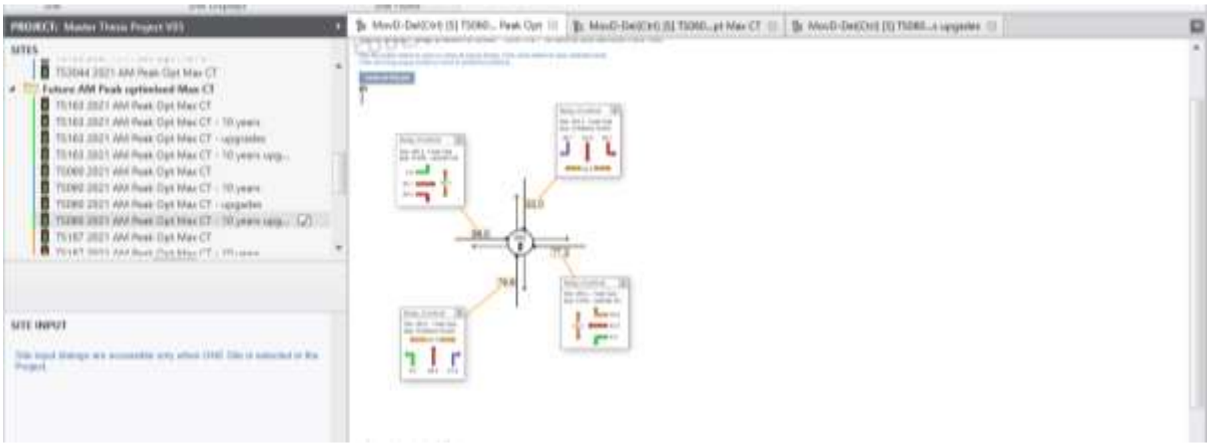

Figure 53 delay for 2021 optimized cycle time

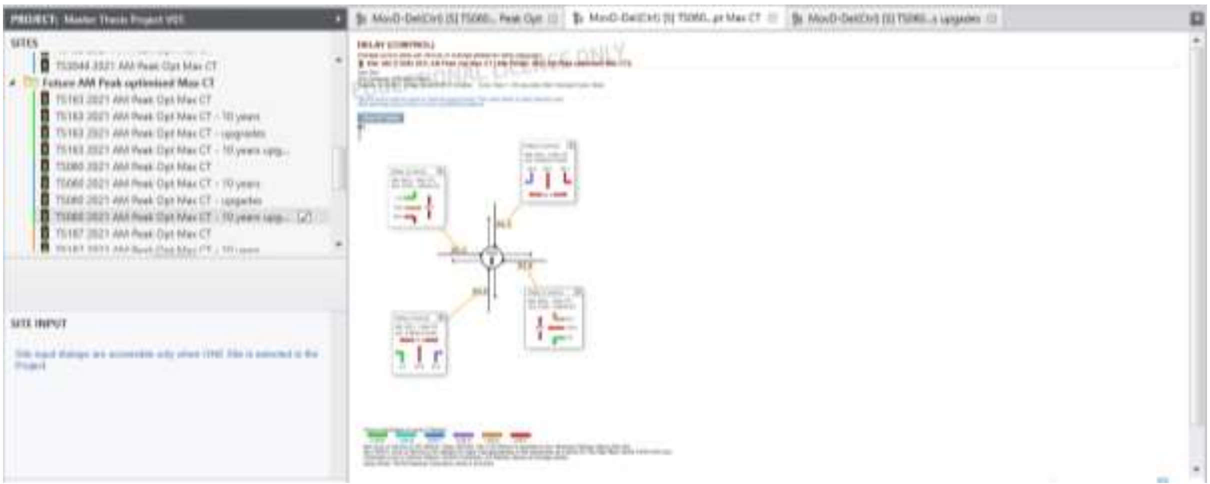

Figure 54 delay for 2021 Max cycle time

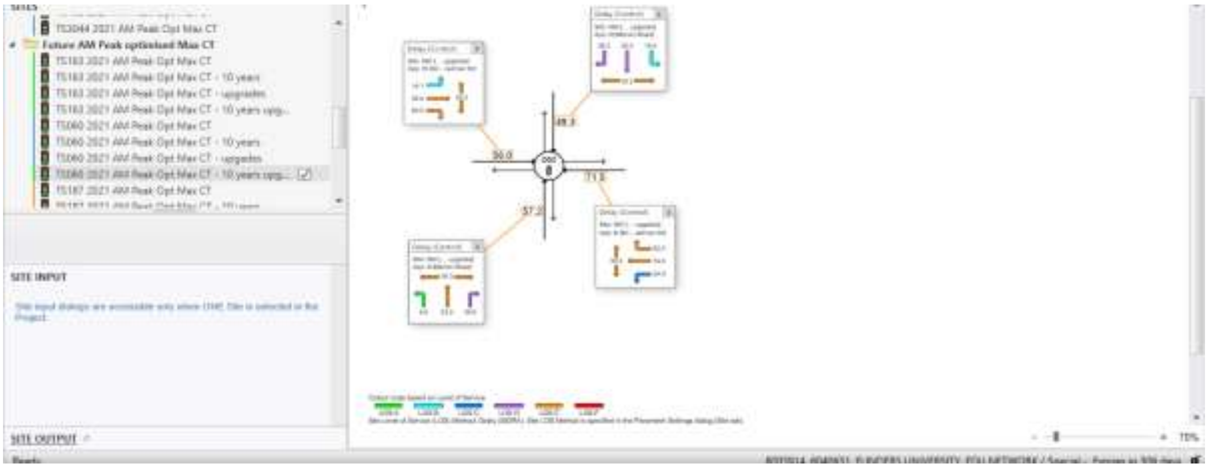

Figure 55 delay for upgrade 10 year

TS187

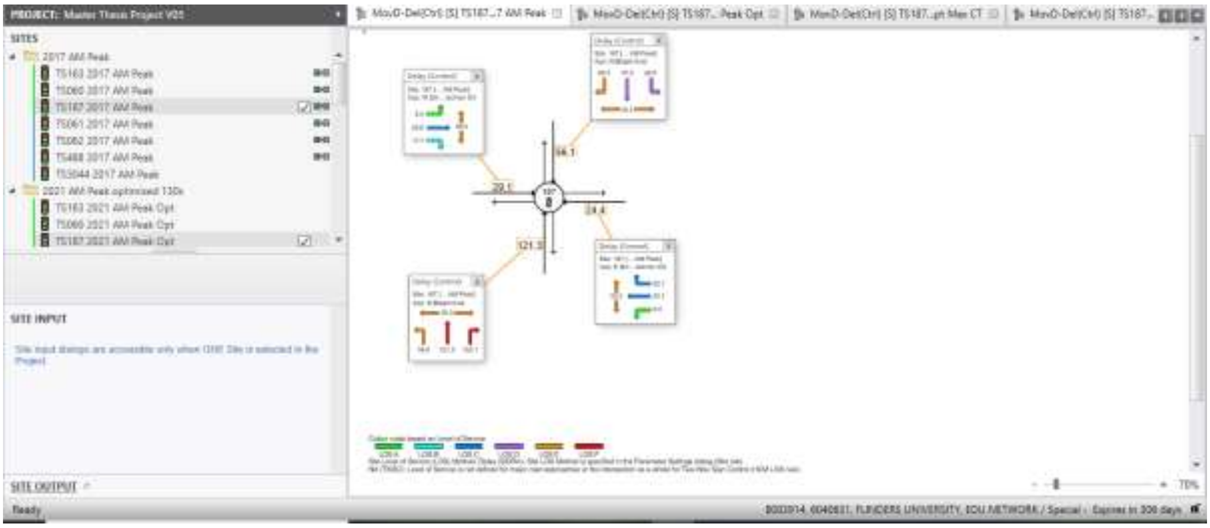

Figure 56 delay for 2017

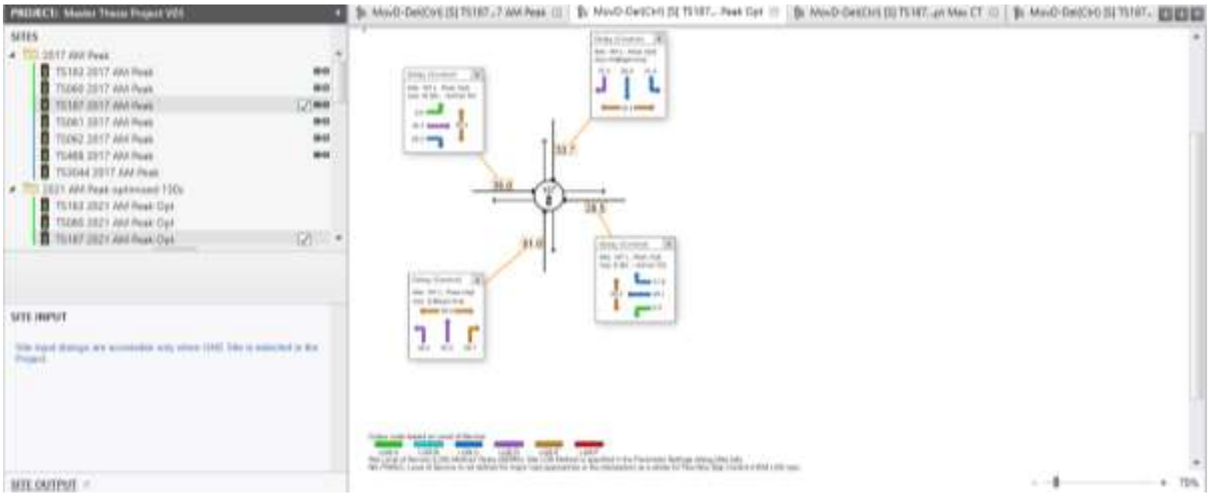

Figure 57 delay for 2021 optimized cycle time

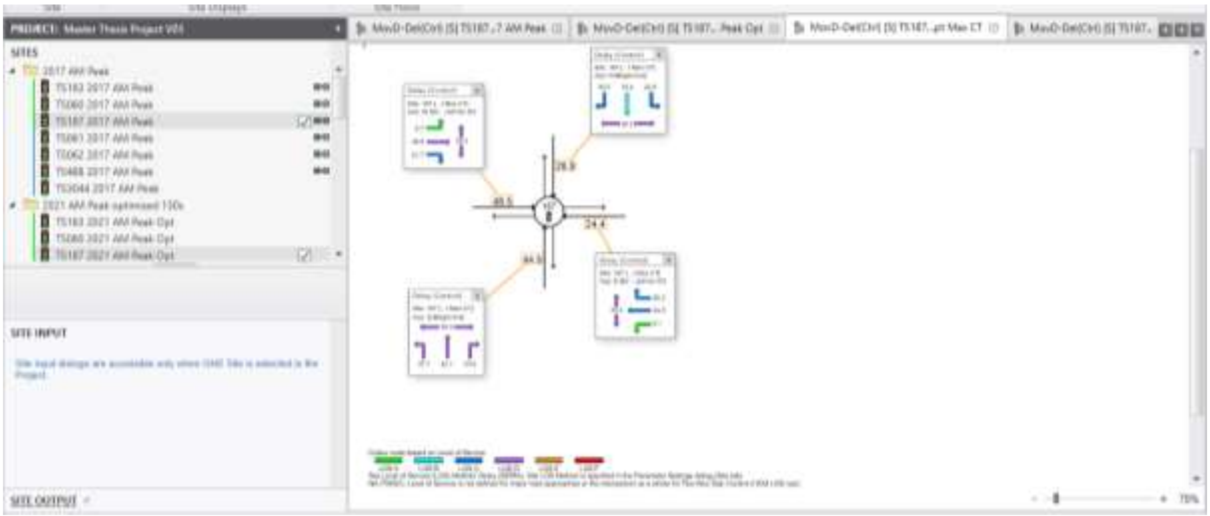

Figure 58 delay for 2021 MAX cycle time

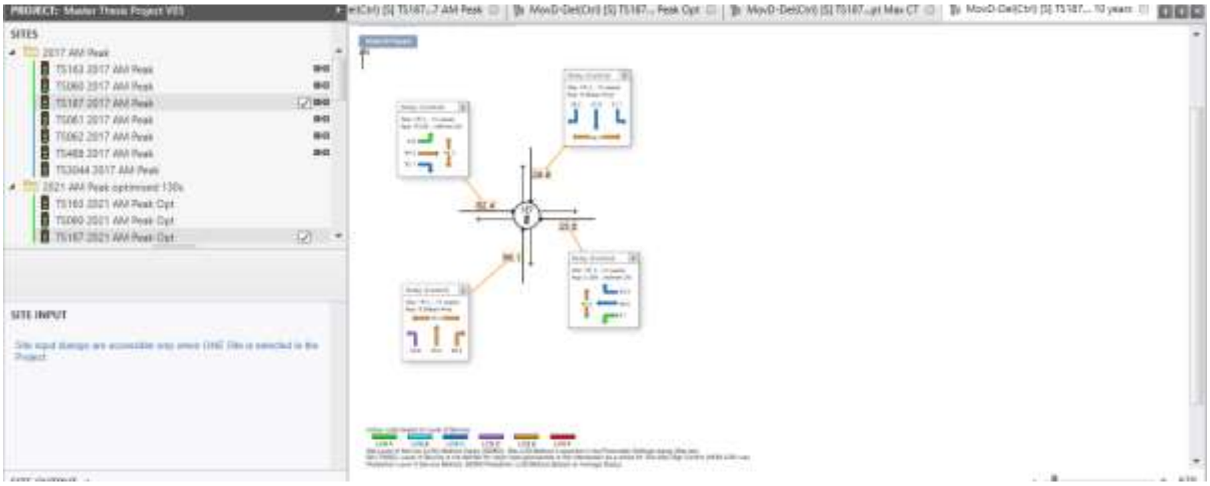

Figure 59 delay for 10 years upgrade

TS061

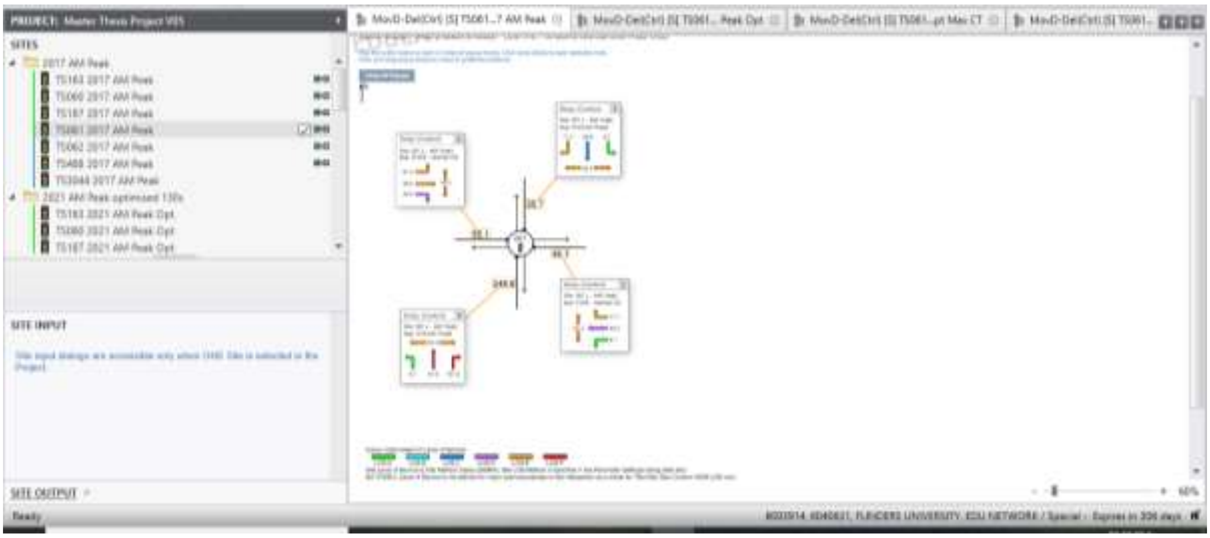

Figure 60 delay for 2017

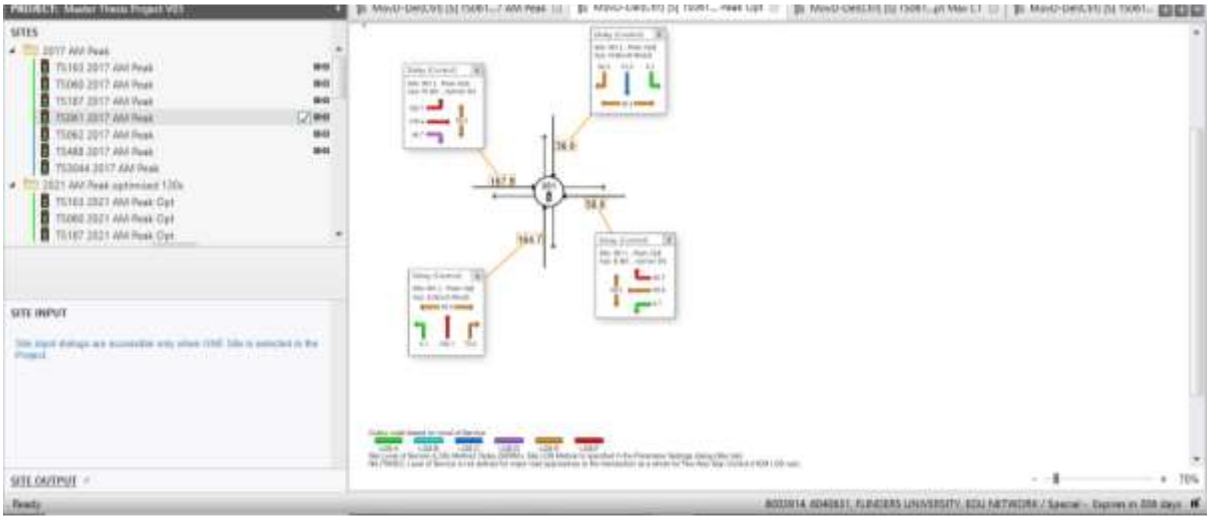

Figure 61 delay for 2021 optimized cycle time

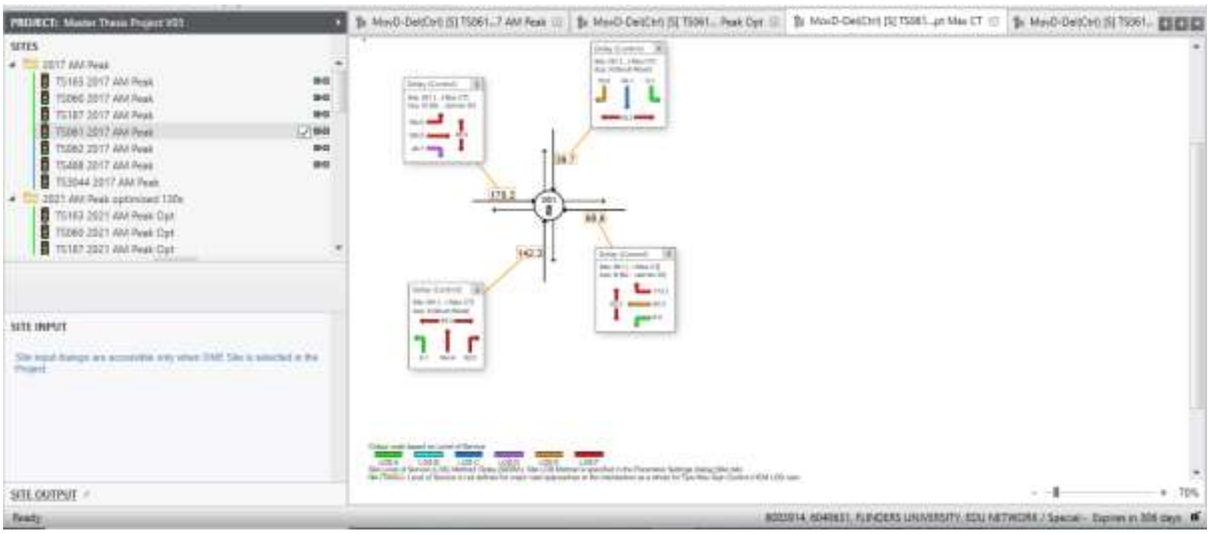

Figure 62 delay for 2021 MAX cycle time

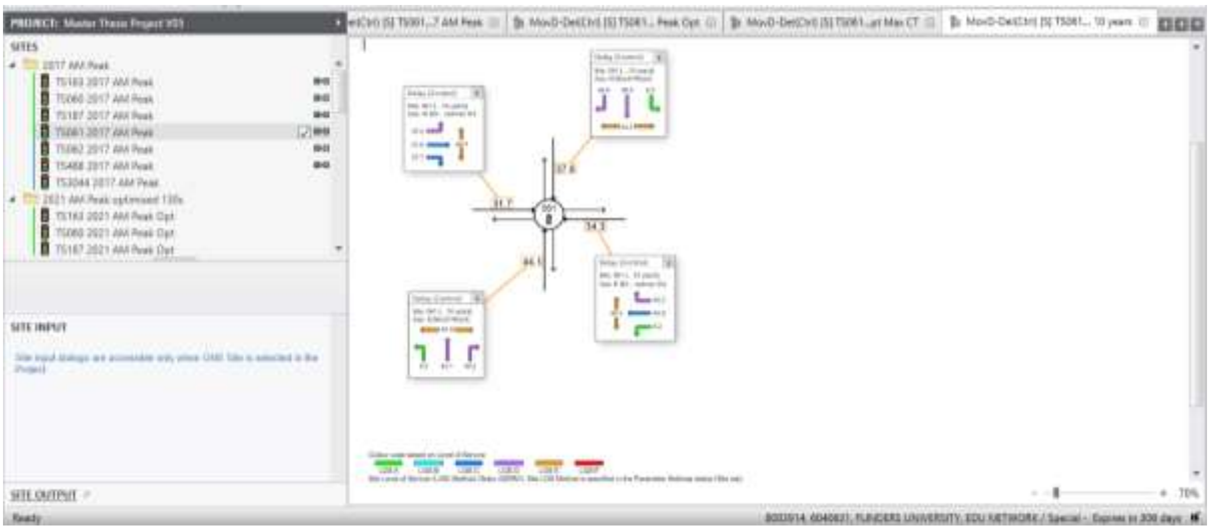

Figure 63 delay for 10 years upgrade

TS062

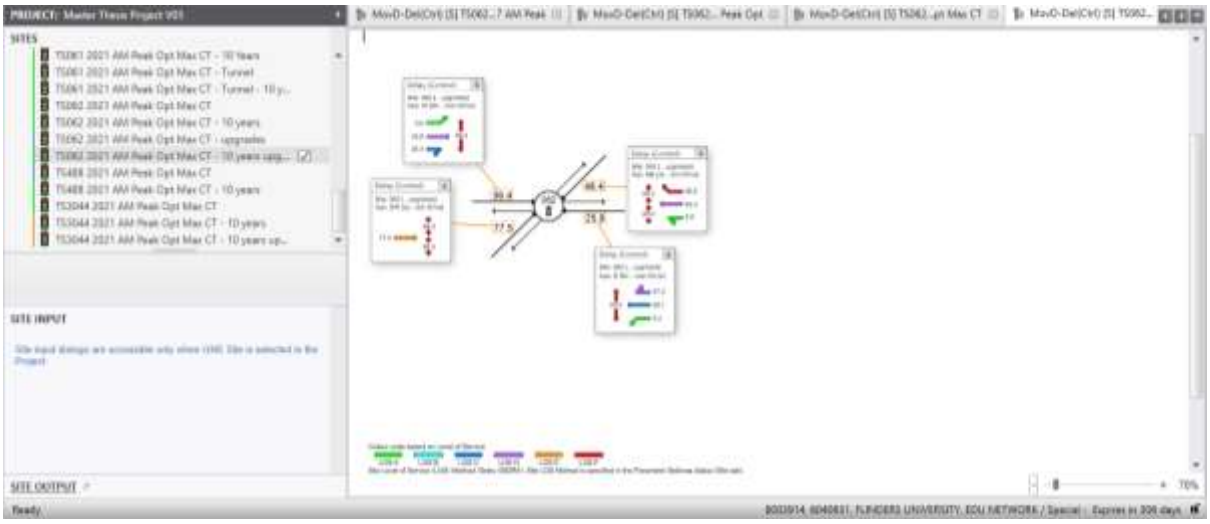

Figure 64 Delays for TS062 for 2017

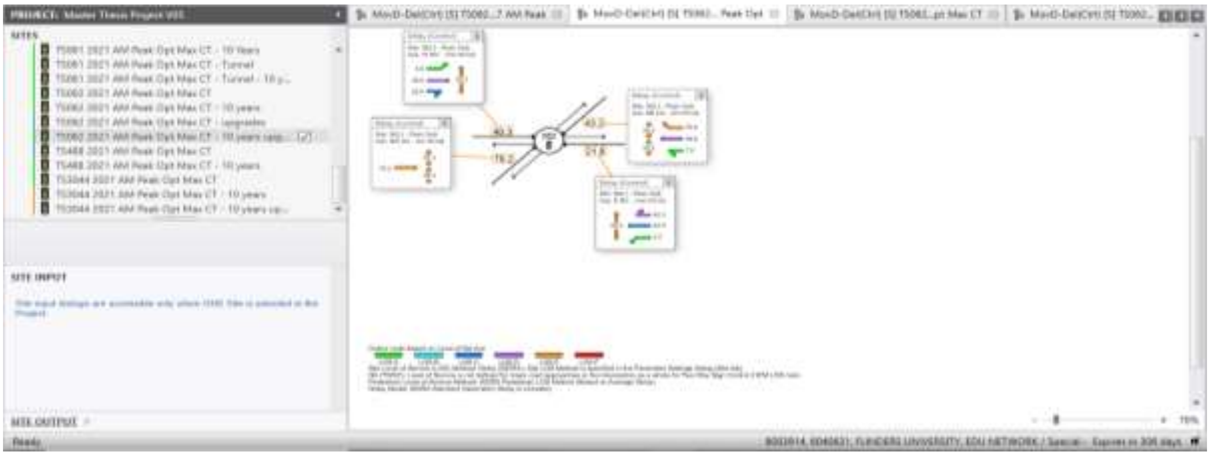

Figure 65 Delays for 2021 optimized cycle time

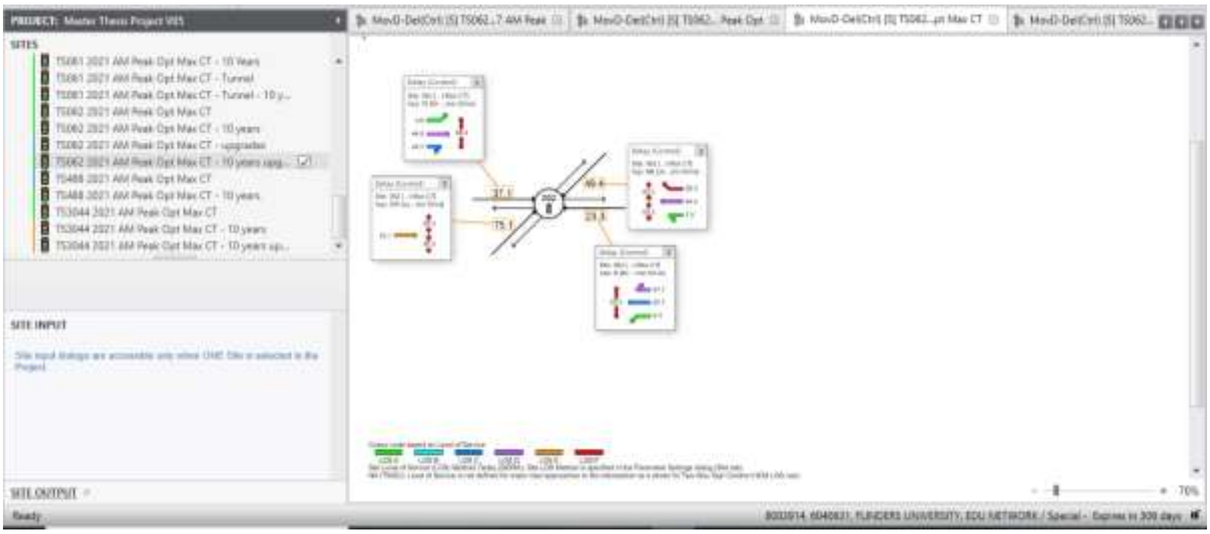

Figure 66 delays for 2021 MAZ cycle time

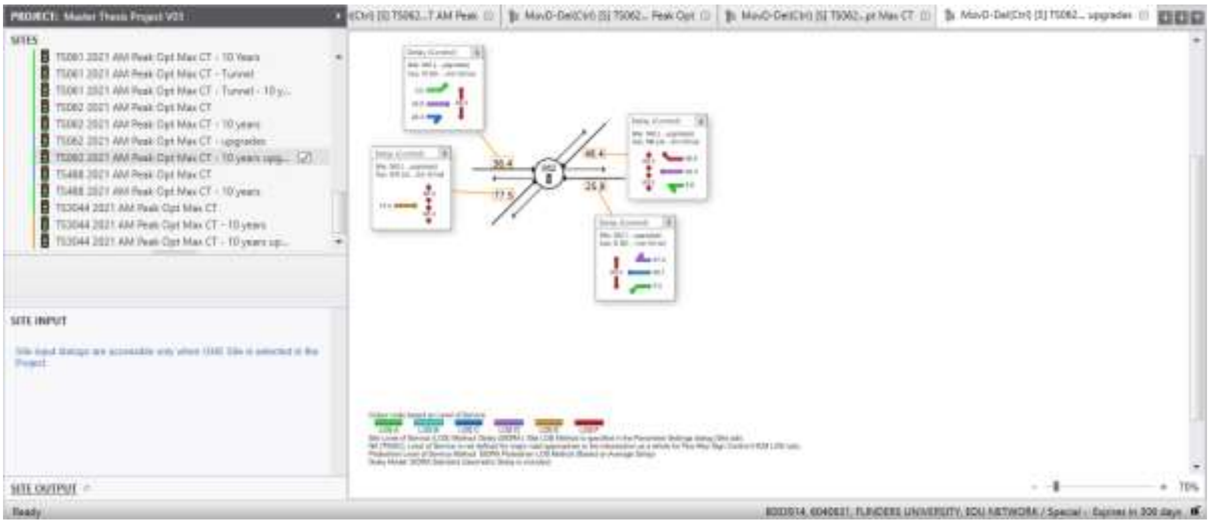

Figure 67 Delays for future upgrade

TS3044

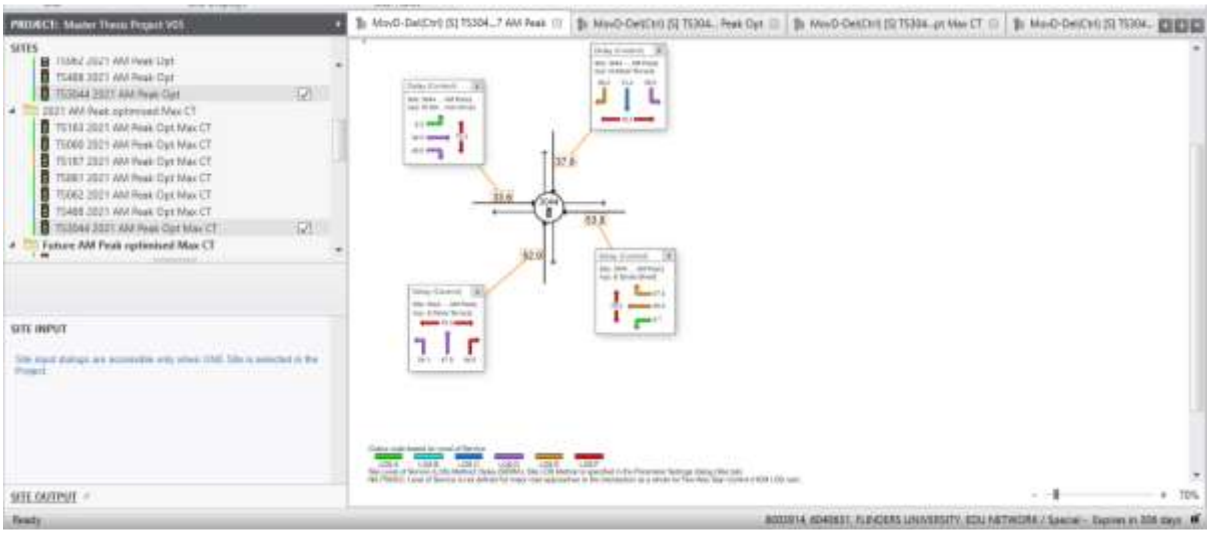

Figure 68 Delays for 2017

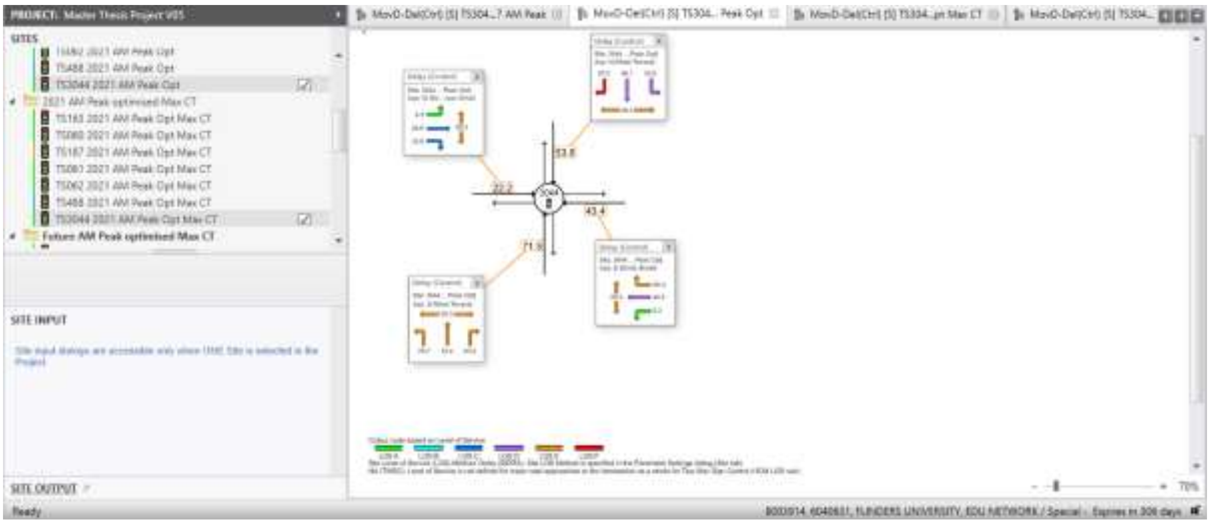

Figure 69 delays for 2021 optimized cycle time

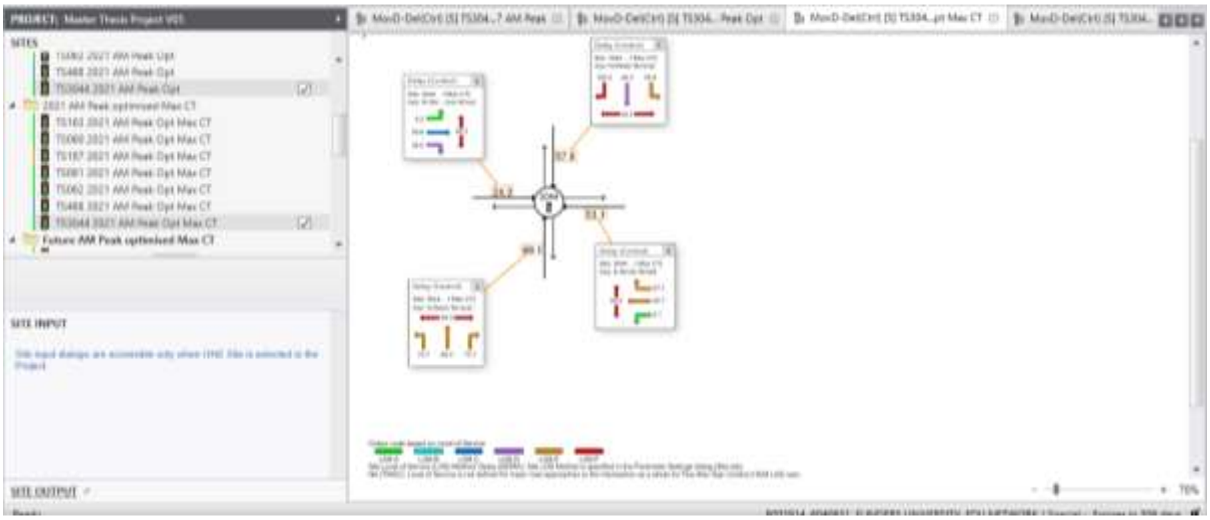

Figure 70 Delays for 2021 MAX cycle time

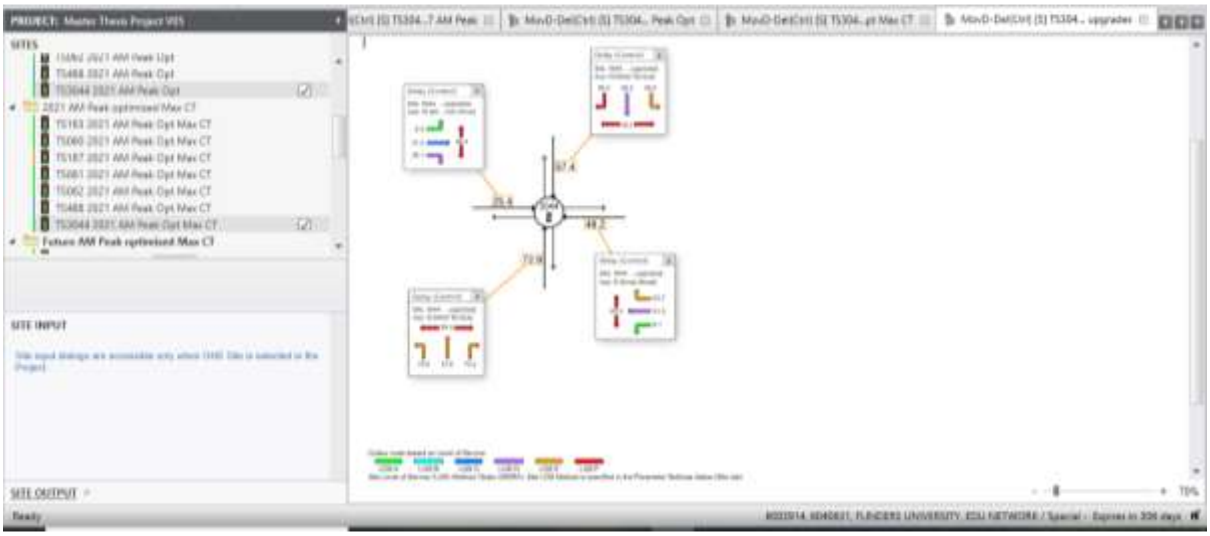

Figure 71 Delays for 10 years upgrade

Appendix C SIDRA Software result Level of service
TS060

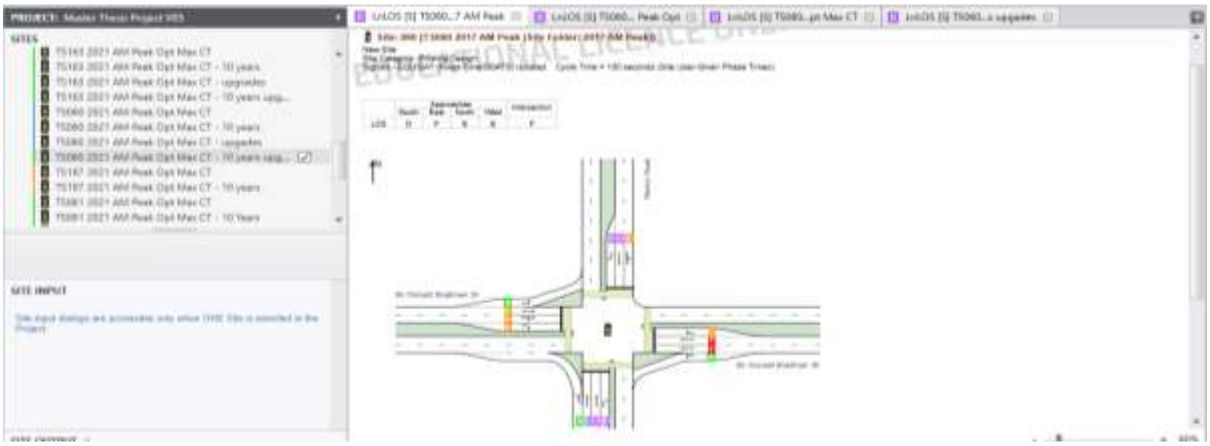

Figure 72 LOS for 2017

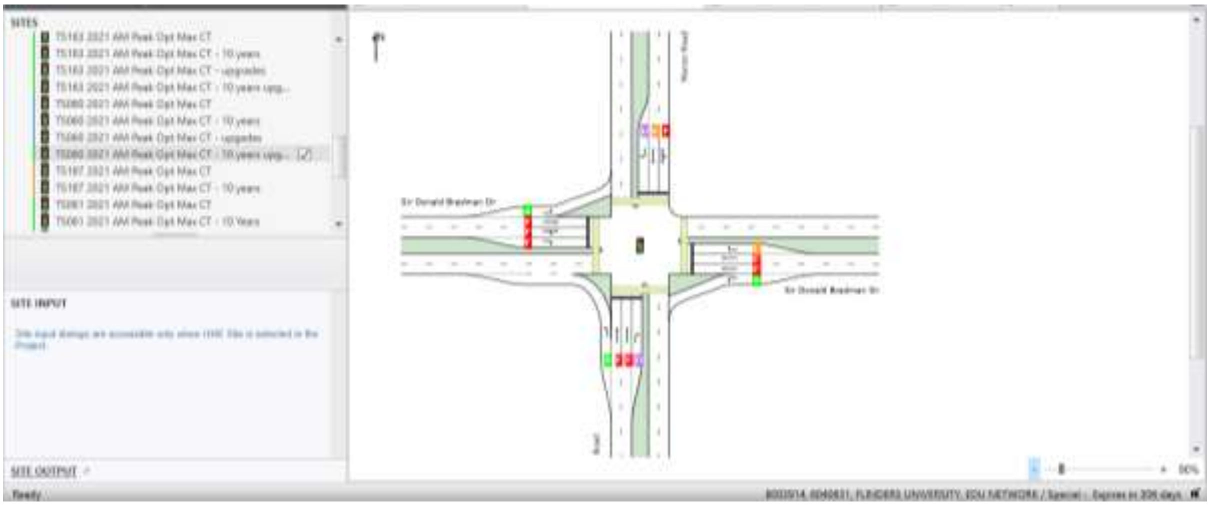

Figure 73 LOS for 2021 optimized cycle time

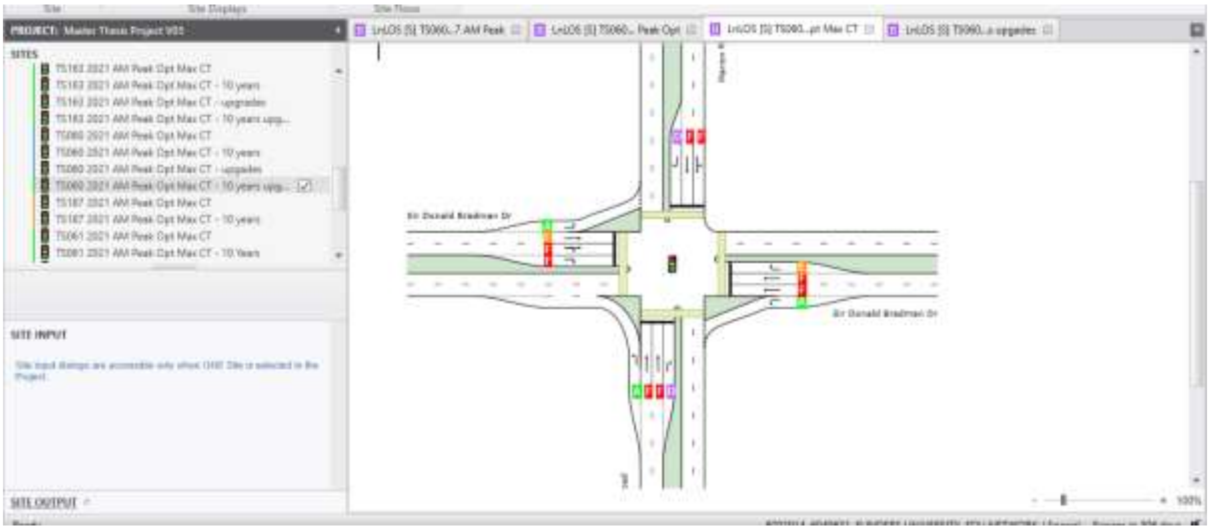

Figure 74 LOS for 2021 Max cycle time

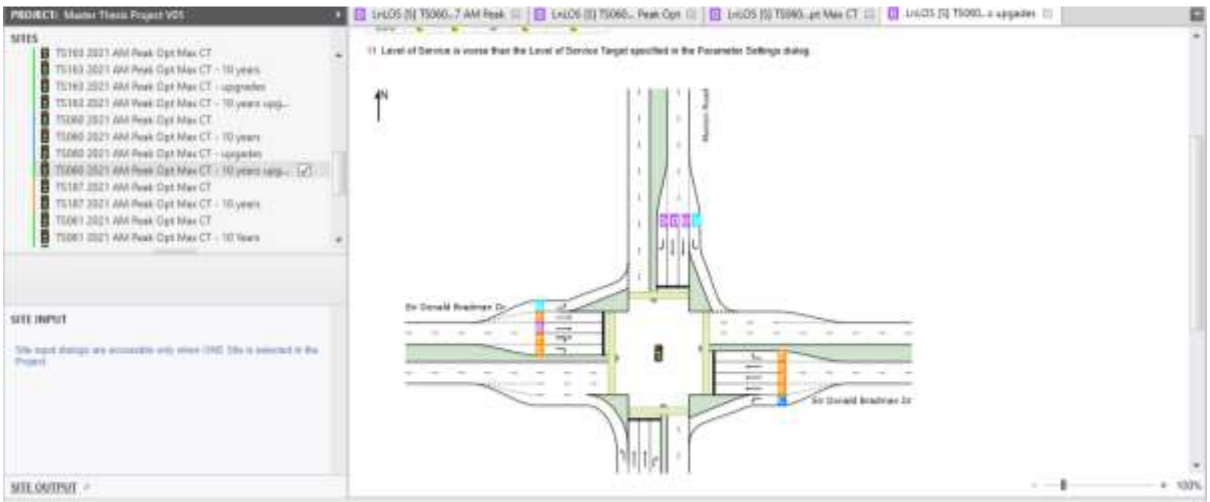

Figure 75 LOS for 10 years upgrade

TS187

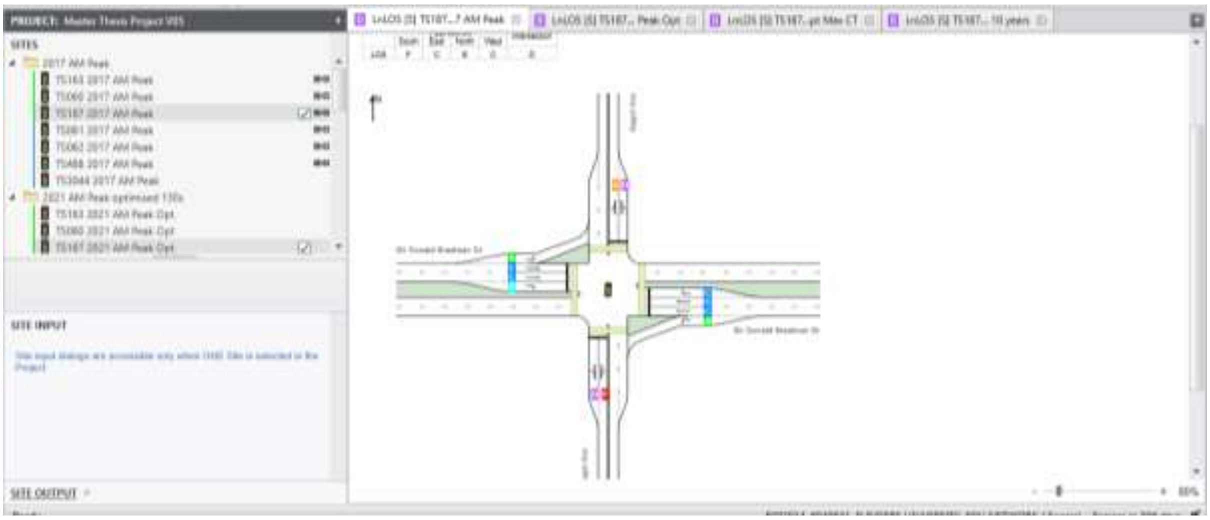

Figure 76 LOS for 2017

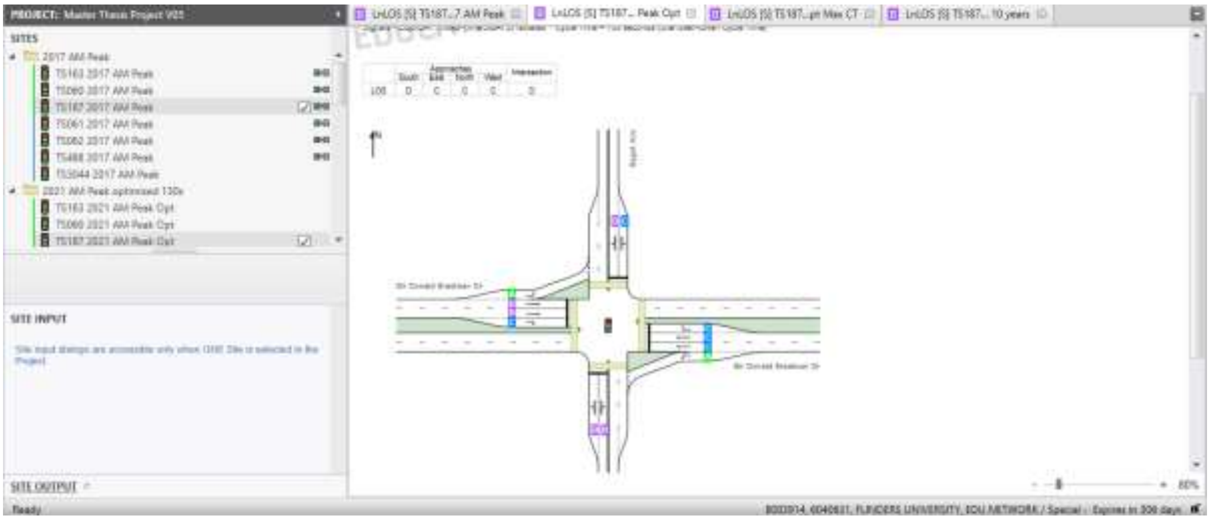

Figure 77 LOS for 2021 optimized cycle time

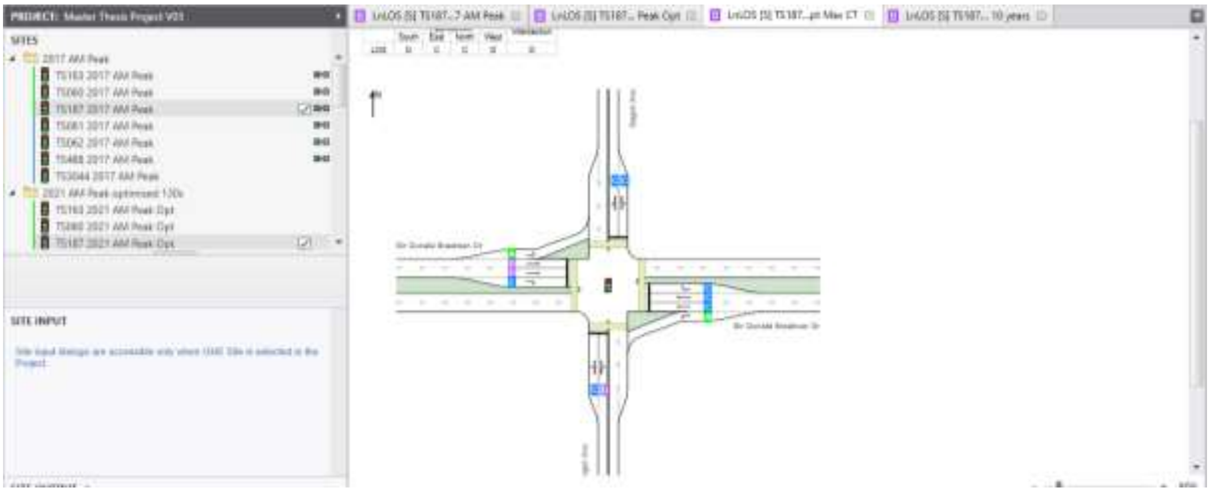

Figure 78 LOS for 2021 MAX cycle time

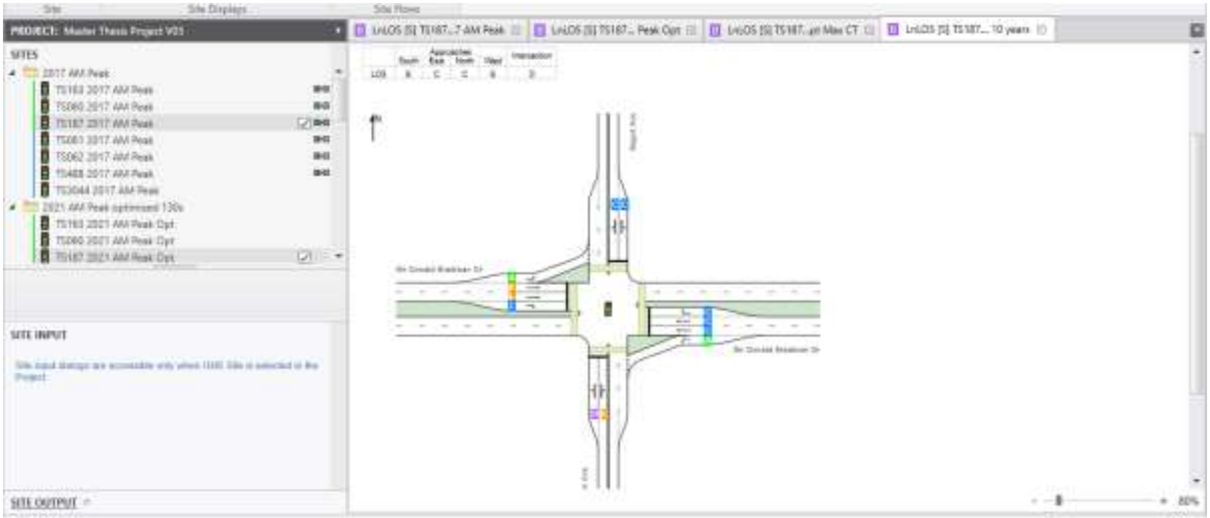

Figure 79 LOS for 10 years upgrade

TS061

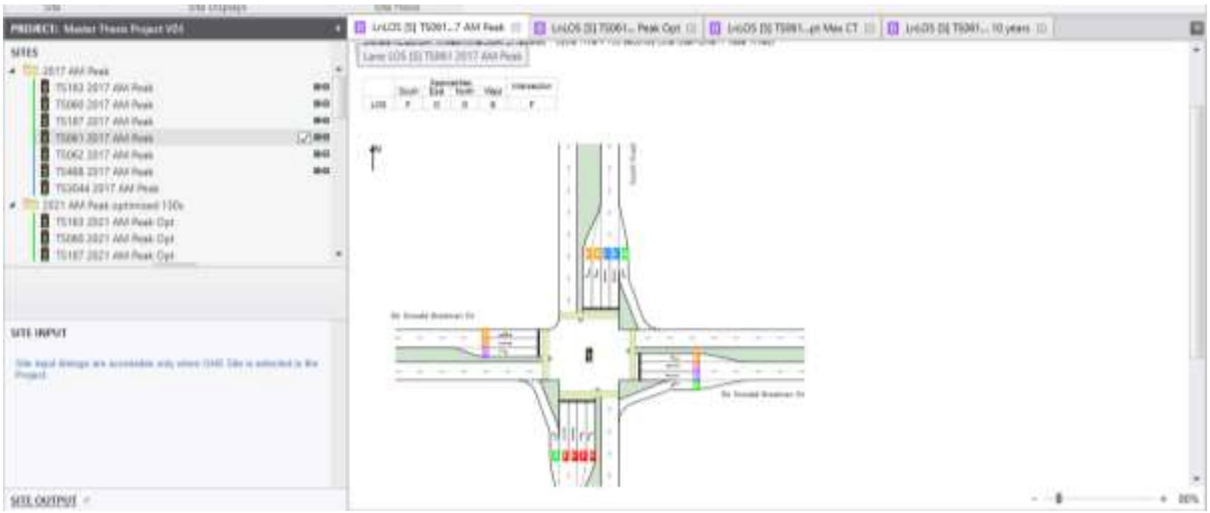

Figure 80 LOS for 2017

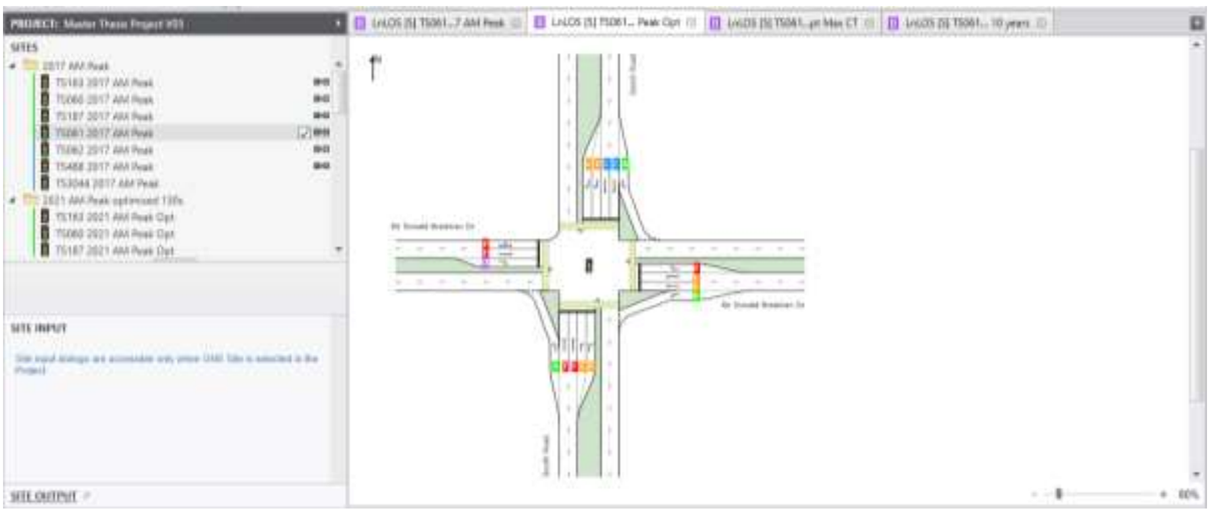

Figure 81 LOL for 2021 optimized cycle time

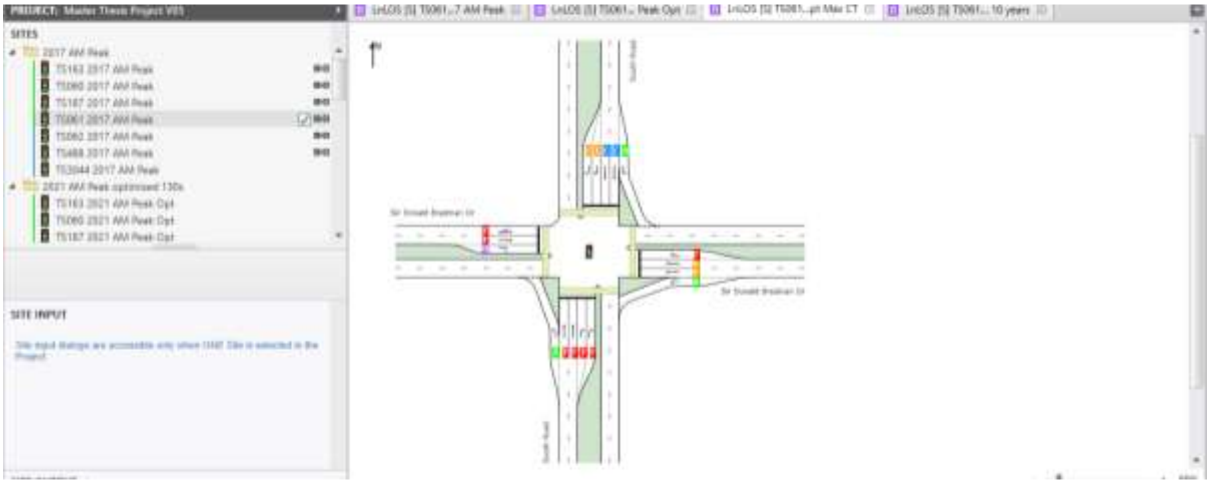

Figure 82 LOS for 2021 MAX cycle time

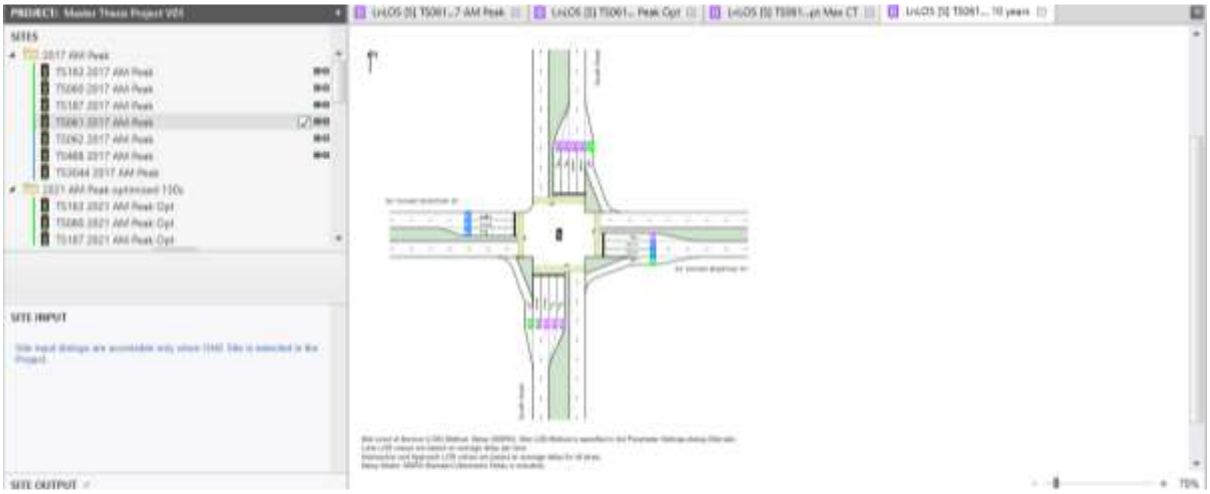

Figure 83 LOS for 10 years upgrade

TS62

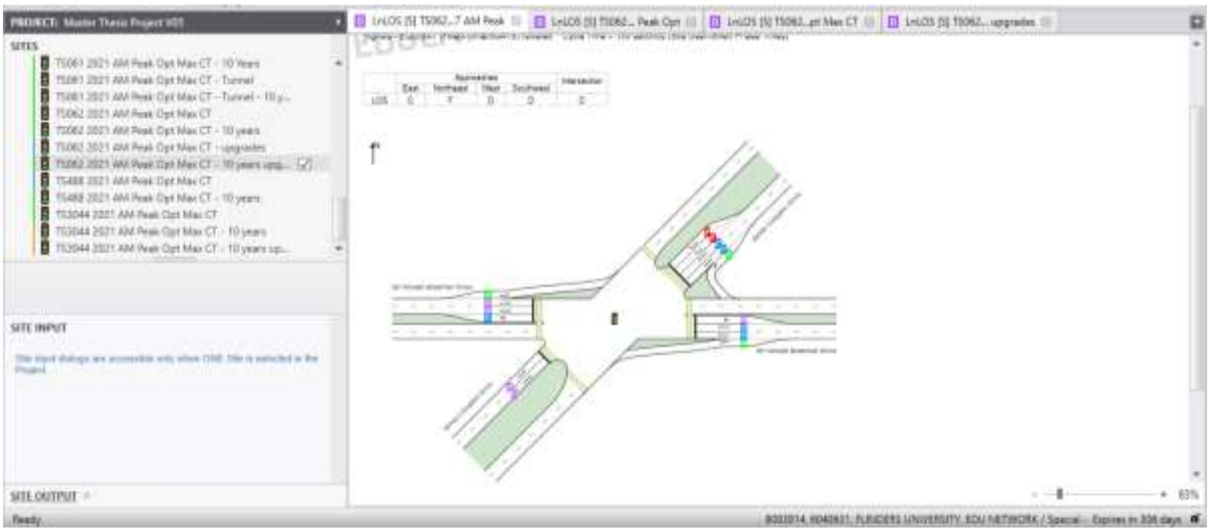

Figure 84 LOS for 2017

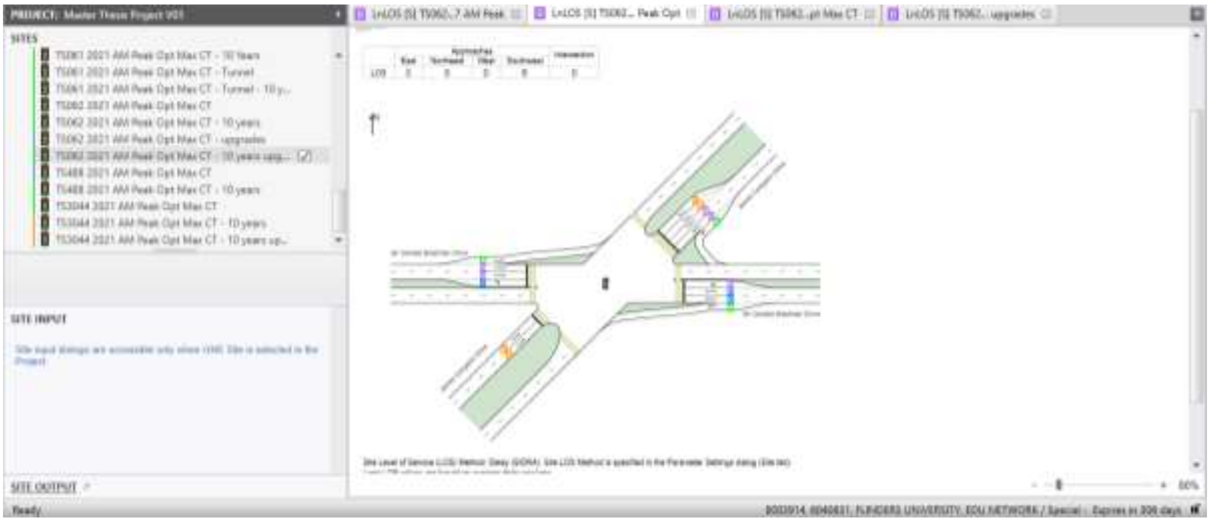

Figure 85 LOS for 2021 optimized cycle time

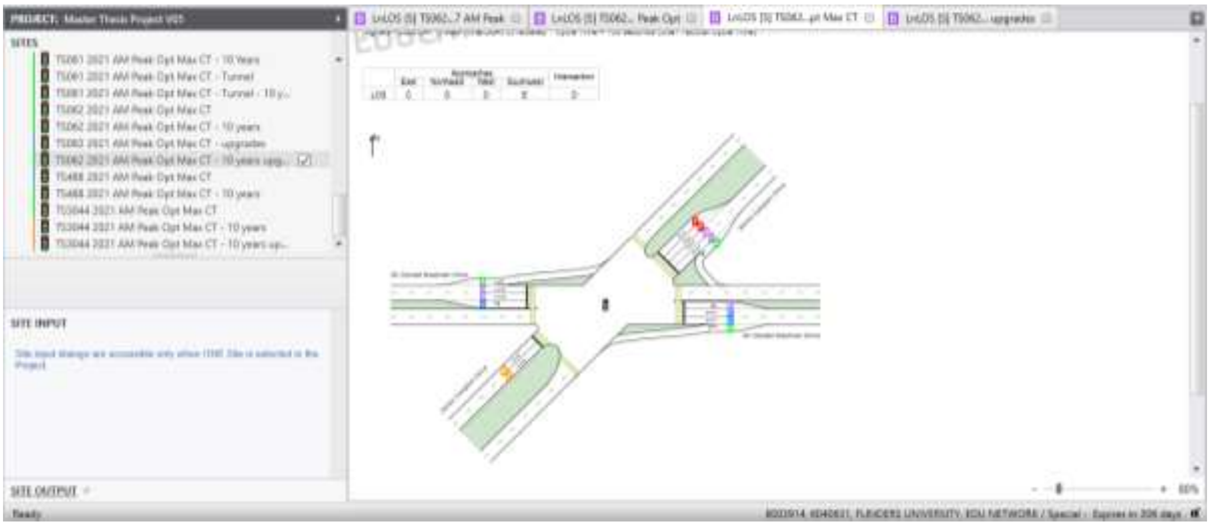

Figure 86 LOS for 2021 for MAX cycle time

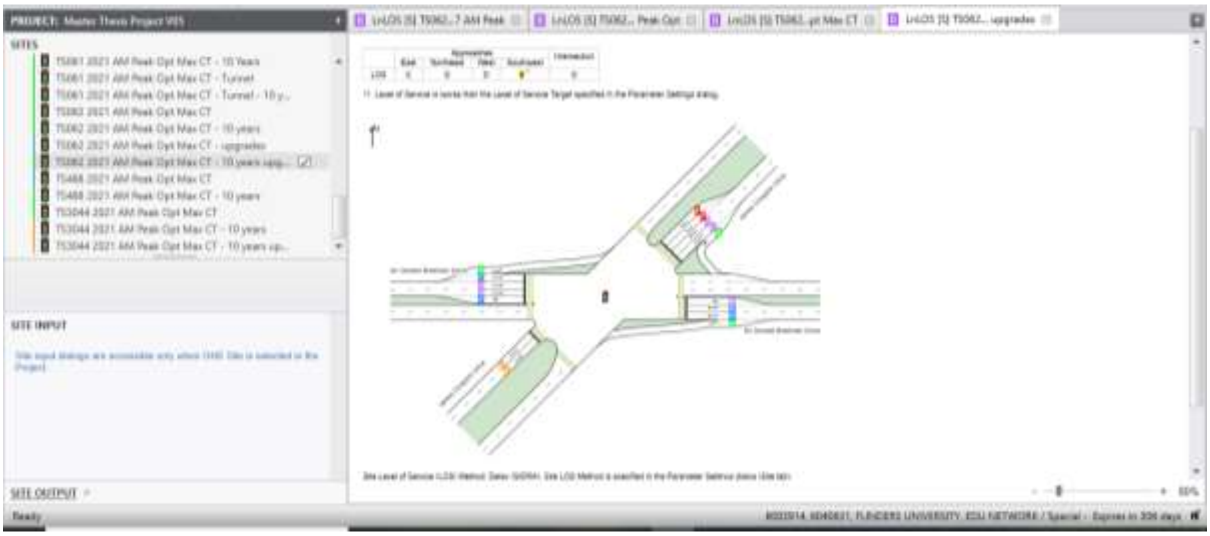

Figure 87 LOS for 10 years upgrade

TS3044

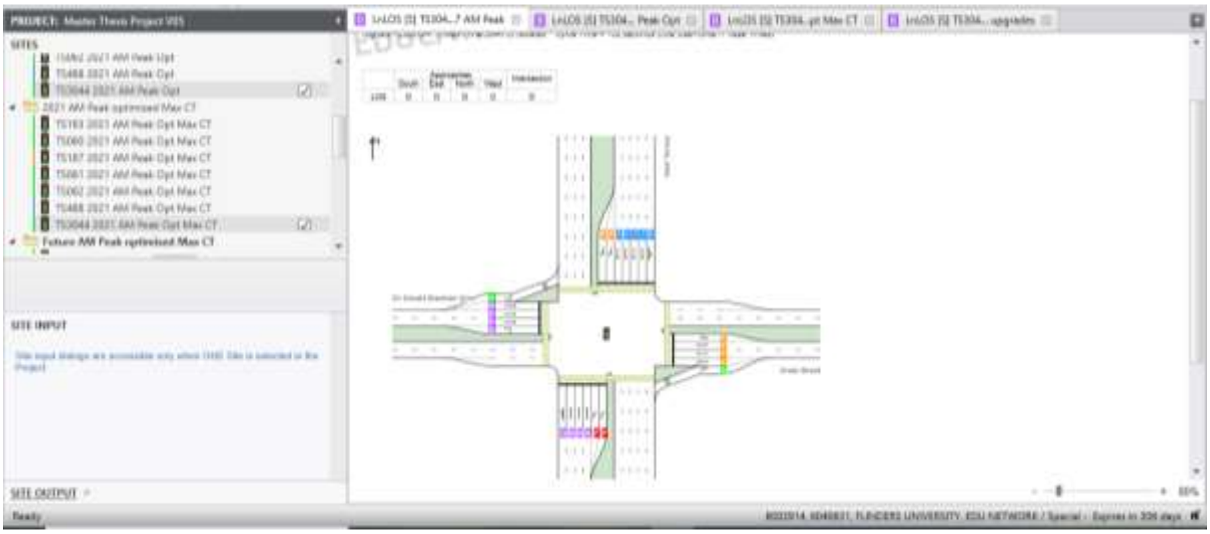

Figure 88 LOS for 2017

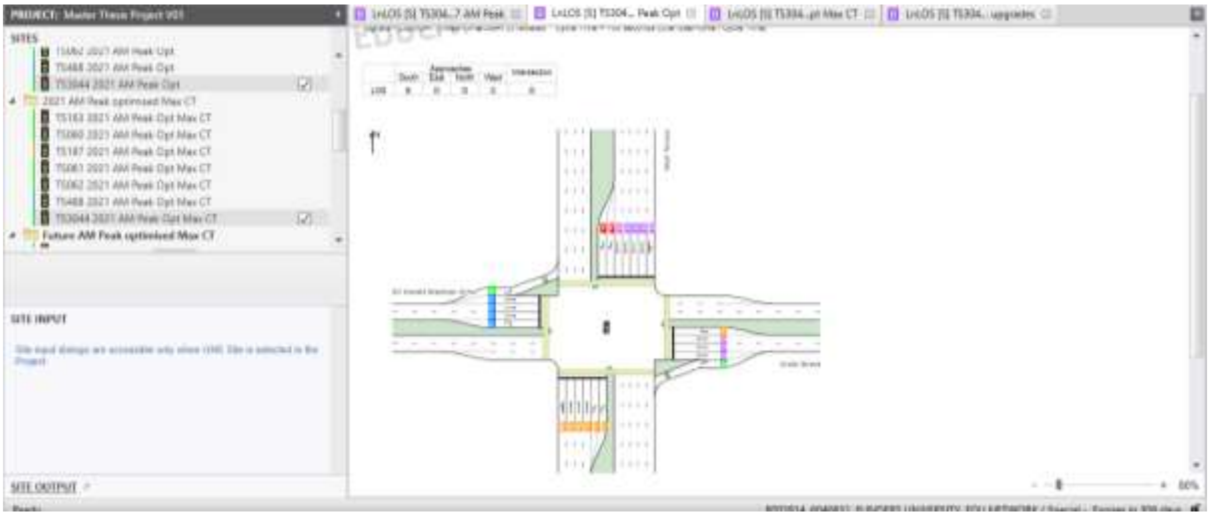

Figure 89 LOS for 2021 optimized cycle time

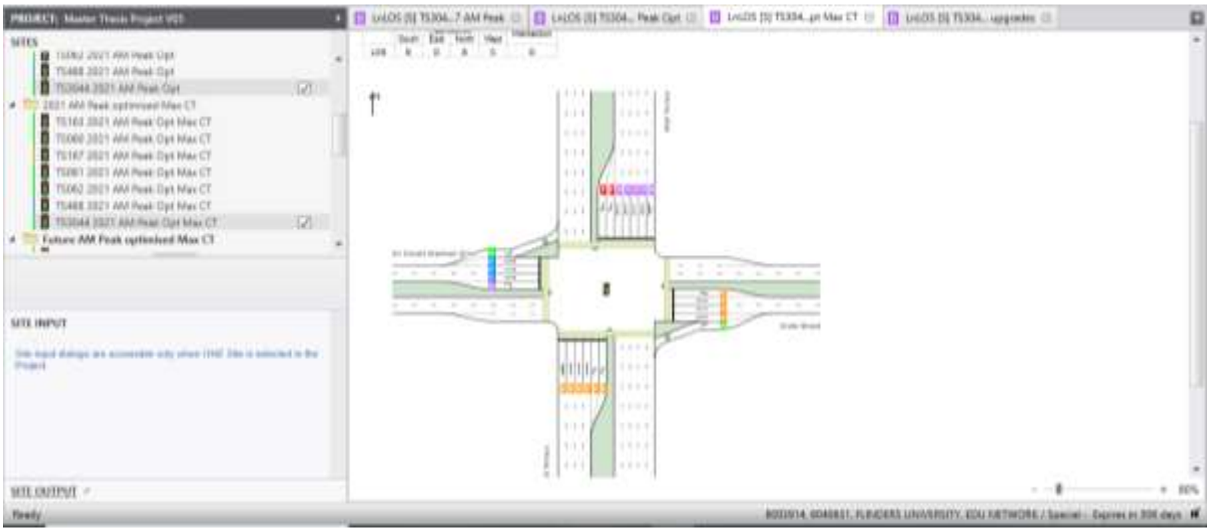

Figure 90 LOS for 2021 MAX cycle time

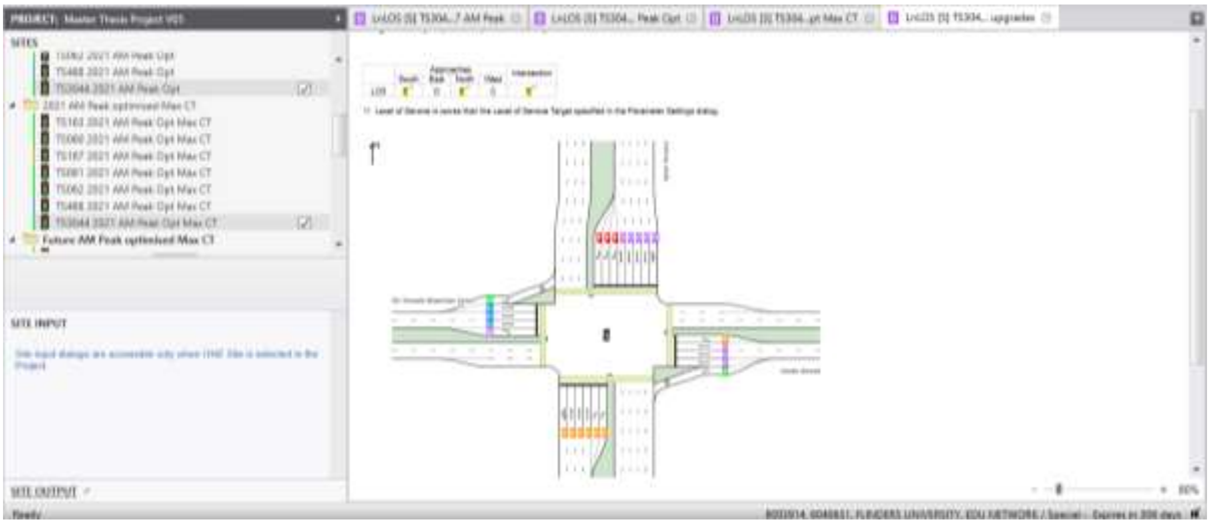

Figure 91 LOS for 10 years upgrade

Appendix D Network

Figure 92 Network for 2017

Figure 93 Network for 2021

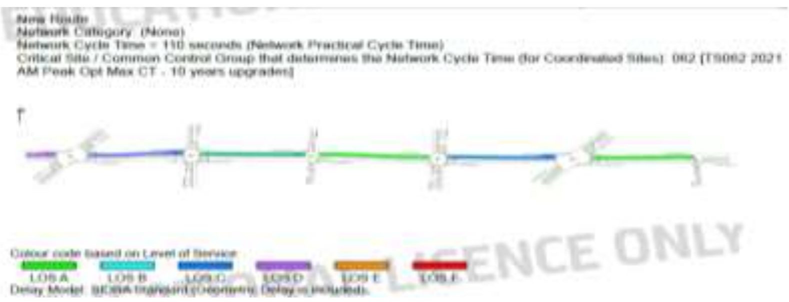

Figure 94 Network for Future upgrade