PERFORMANCE ASSESSMENT OF TETTEH QUARSHIE INTERCHANGE USING COMPUTER SIMULATION

By

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A thesis submitted to the Department of Civil Engineering,

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

in partial fulfilment of the requirements for the degree of

MASTER OF SCIENCE

Department of Civil Engineering

College of Engineering

Novemberber, 2010

DECLARATION

I hereby declare that this submission is my own work towards the Master of Science and that, to the best of my knowledge, it contains no material previously published by another person nor material which has been accepted for the award of any other degree of the University, except where due acknowledgement has made in the text.

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DEDICATION

I dedicate this work to my family especially my parents, wife, and daughters.

ACKNOWLEDGEMENT

I wish to thank first and foremost the almighty GOD for bringing me to this far in the programme.

Secondary my appreciation goes to Mr Kwaku BOAMPONG, my director and resident engineer for his support during my pursuit of the programme.

I am indebted to my supervisors Rev. Charles Anum ADAMS and Dr. Yaw A. TUFFOUR for their immense support, guidance queries and corrections. I also acknowledge Prof. Mohammed SALIFU the programme manager for his understanding and patience even during the thigh timelines. I wish to thank Prof Samuel Innocent AMPADU head of department for his support and guidance during the selection of our thesis topics.

I acknowledge the support of my classmates for their encouragement and support.

Lastly I wish to thank my work colleagues at the Reconstruction of Sunyani Road in Kumasi project site for their infringed support.

ABSTRACT

Interchanges on urban arterials have in recent years become an essential intervention for most of the shortcomings associated with at-grade intersections. However the absence of the knowledge of their real operations can pose a serious set-back after the infrastructure has been built.

Interchanges are crucial structures in the operations and performance of an intersection in any traffic system. Analysis of the probable or potential performance of interchanges is essential to avoiding the construction of a structure that would not perform after being built or contribute to the problem it was intended to address.

In the advent of modern computers traffic simulation models have been widely used in both transportation operations and traffic analysis because simulation is safe, less expensive and faster than field implementation and testing. The need for micro-simulation has become more important in cities where rapid growth takes place such as Accra which has about fifteen interchanges/overpasses and still counting. Therefore, the need for calibrating simulation models to local situations is urgent to assess the performance of interchanges and also project the performance in the future.

The main objective of this research is to calibrate a micro-simulation models to assess the performance of Tetteh Quarshie Interchange.

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LIST OF ABBREVIATIONS

AMA	Accra Metropolitan Assemble
AWSC	All Way Sopped Controlled
CAD	Computer Aided Design
CBD	Central Business District
CORSIM	An Acronym of Traffic Software
FHWA	Federal Highway Administration
GHA	Ghana Highway Authority
HCM	Highway Capacity Manual
HCM(2000)	Highway Capacity Manual, 2000 Edition
HCS Plus	An Acronym of Traffic Software
HV	Heavy Vehicles
ICU	Intersection Capacity Utilization
KNUST	Kwame Nkrumah University of Science and Technology
LOS	Level of Service
MOE	Measure of Effectiveness
O-D	Origin - Destination
PCE	Passenger Car Equivalent
PHF	Peak Hour Factor
R/A	Round About Intersection
SIDRA	An Acronym of Traffic Software
SYNCHRO	An Acronym of Traffic Software
TENC	Traffic Engineering Council, US
TIA	Traffic Impact Assessment
TIS	Traffic Impact Statement

TQI	Tetteh Quarshie Interchange
TRB	Transport Research Board
TRRL	Transport Research Laboratory, England
TWSC	Two Way Stopped Controlled
v/c	Volume to Capacity
vphgpl	Vehicle per Hour of Green Time per Lane

CHAPTER 1: INTRODUCTION

1.1 Background

Interchanges on urban arterials have in recent years become an essential intervention to most of the shortcomings associated with at-grade intersections.

Of the many types of interchanges that may be adopted cloverleaves have been widely adopted because of the following advantages associated with them:

- no need of signs to prevent wrong way entrance
- left turn merging at acute angles and hence may not have to stop

However cloverleaves come with some disadvantages such as

- large area requirement
- long distances for left turn movements

In recent years Ghana has seen some of the major at-grade intersections in the country being replaced by an interchange. However some of these interchanges have had some problems after their construction.

Traffic flow and geometric data on the Tetteh Quarshie Interchange were collected on both ramps and mainlines, simulated and analysed to assess the performance of the interchange.

Simulation of traffic as a tool for investigating traffic systems has increased in popularity over the last decades. A large portion of this rise in popularity can be traced back to the rapid development in personal computer. Fast personal computers have made it possible to develop advanced traffic micro-simulation software packages. Traffic simulation is a powerful and

cost-effective tool for traffic planning and designing, testing different alternatives and evaluating traffic management schemes. The simulation model enables the engineer to predict the outcomes of a proposed change to the traffic system before it is implemented, and to evaluate the merits of competing designs. For the simulation model to correctly predict the system's response, however, it must first be shown to reproduce the existing traffic condition. The procedure by which the parameters of the model are adjusted so that the simulated response agrees with the measured field conditions is what is known as model calibration.

The Synchro/ SimTraffic simulation model has been calibrated and the capacity values under various turning traffic flows on the interchange analysed. The objective of this research is to provide basic data for performance assessment for a full cloverleaf interchange using computer simulation and modelling.

1.2 Problem Statement

The construction of the Tetteh Quarshie interchange has been completed and in operation. However, the general perception of the public is that the interchange is not performing as expected but rather compounding the existing traffic problem.

This research sought to investigate the overall level of service (LOS) of the interchange. The main reference is the Highway Capacity Manual 2000 (HCM, 2000).

1.3 Study Justification

The findings of this study are expected to offer an engineering insight into the performance of interchanges and also demonstrate the appropriateness of simulating the performance of a proposed interchange before its implementation.

1.4 Research Objectives

The main objectives of this study were as follows:

- to evaluate the over-all performance of the Tetteh Quarshie Interchange at present
- to evaluate the effect of the ongoing development on the interchange
- to develop calibration parameters for the future performance of the interchange.

1.5 Scope of Study

The scope of this study was limited to three scenarios, namely;

- assessment of the present performance of Tetteh Quarshie Interchange
- performance assessment of Tetteh Quarshie Interchange with improved legs (hypothetical)
- performance assessment of an improved interchange arrangement (hypothetical).

CHAPTER 2: LITERATURE REVIEW

2.1 History of Interchange Performance Appraisal

Until very recently, interchanges were not subjected to rigorous performance appraisal. On the advent of modern computer, performance appraisal of interchanges has become very important because investments in interchanges are capital intensive.

The Transportation Research Board's Highway Capacity Manual (HCM) presents methodologies recommended for use in planning and operational analysis of an individual transportation network element such as signalized intersection, interchanges or mainline section of a freeway. The HCM equations and worksheets are based on limited statistical models that can be considered to be macroscopic. In part because the HCM models do not consider the behaviour of individual vehicles, and due to the deterministic (i.e. uniform arrival/ flow pattern) nature of HCM models, there is a growing recognition that stochastic microscopic simulation models can be very useful in operational analysis on small to medium-sized transportation networks. An interchange is considered as a small network consisting of ramps, slipways and mainlines.

2.2 Interchange Inventory

Chapter 26 of the HCM (2000) deals with the inventory and analysis of interchange ramps. Even though a complete methodology is not yet available the chapter expanded on some pertinent factors that affect the performance of an interchange. Some of these factors are:

2.2.1 Influence of Interchange Type on Turning Movements

The type of interchange has a major influence on the turning movements of traffic. Movements that involve a right-side merge in one configuration may become left turns in

another. Movements approaching the interchange on the surface facility are also affected by the interchange type depending on whether the ramp movements involve left or right turns.

2.2.2 Queuing Characteristics

The most critical features of an interchange, therefore, are the interdependency of movements and the distance between intersections both of which influence queuing. The distance separating the intersections limits the amount of queuing that can occur downstream without blocking the upstream intersection. The extent of queuing at the downstream intersection depends on several factors such as the number and use of the lanes at both intersections and the flow rates in the movements that feed the downstream intersection.

2.2.3 Lane Change Movements

Because of the turning movements and the high volumes of traffic, the mainlines are subjected to abnormal high number of lane-changing manoeuvres. This occurs because of origin-destination patterns. The turbulence of the lane changing can decrease the normal link speed. In addition if there is queuing on the link, it reduces the effective weaving of lane-changing distance, increasing the turbulence and its potential effects on the traffic.

2.2.4 Lane Utilization

Because of the potential for heavy turning flows at interchanges, lane utilization may differ from those at other intersections. Because of short internal links, segregation may occur at the upstream intersection by driver selection or by designated signing and stripping.

2.2.4.1 Lane Groups and Configuration

The HCM describes a lane group as a single movement, a group of movements, or an entire approach that is defined by the geometry of the intersection and the distribution of movements over the various lanes. According to Garber and Hoel (1994), a lane group consists of one or

more lanes that have a common stopline, carry a set of traffic streams, and whose capacity is shared by all vehicles in the group.

2.3 The History and Concept of Cloverleaf Interchange

The cloverleaf is one of the oldest types of higher-capacity interchanges in the US. The basic idea is that each of the twelve possible movements (right, left, and straight from each of the incoming roads) can be made in the interchange without stopping for cross traffic. They can be found just about anywhere in the United States; almost every state has at least one, although some states (Texas and California, particularly) tend not to use them to any great extent. The first one was built in Avenel, New Jersey in 1929. At the time, it was the intersection of State Routes 4 and 25; it is now the junction of US 1 and 9 and NJ 35.

In the early days of freeway and interstate construction in the United States, cloverleaf interchanges were regarded as a great way to move traffic between two freeways or between a freeway and a busy crossroad. Traffic could keep moving without stopping through the entire interchange, regardless of its destination. Cloverleaf interchanges were comparatively cheap - the only other free-flow intersection with fewer bridges involved is a large traffic circle, which, (luckily) early engineers realized, would be a huge disaster if placed at the intersection of two high-speed freeways. A little bit of land was needed for the 270-degree loop ramps, but this was no problem; the loops could just be made smaller if needed. The interchange would not make a huge impact on the skyline (and the project budget) like a four-level stack might. As a result of all of these advantages, cloverleaf interchanges continued to be built all over the country at many freeway intersections and where a diamond interchange did not have enough traffic capacity.

However, there are a few problems with cloverleaves. First, the loop ramps must go around 270 degrees of rotation. To build the loop ramps, there must be a trade-off between size and utility. A ramp with a much larger radius can be taken at higher speeds and thus move more traffic, but it takes up a lot more real estate. A smaller loop takes up less space at the cost of slower speeds; taken to an extreme, small loop ramps can result in a danger of tipping for truck traffic.

The second (and, in my opinion, most major) problem with cloverleaf interchanges is the weaving that must occur between the left-turn movements. The basic problem is that two types of traffic is switching lanes in the middle of the interchange: traffic that has just entered from the right from the first loop ramp, and traffic that is about to exit to use the second ramp. Both of these streams of traffic must switch places between the right lane of the through highway and the auxiliary entrance/exit lane. In addition, the entering traffic is trying to accelerate to merge into the through traffic, while the exiting traffic must slow down to negotiate the tight turn on the loop ramp. These two factors are the cause of many traffic backups and an increased risk of collisions.

2.4 Micro-Simulation Model Softwares

This section outlines the proposed methods and softwares used for detailed traffic analysis and simulation for the various types of travel facilities included in the short-listed alternatives and identifies the supporting rationale for each method. The detailed traffic analysis will primarily be performed using the methods of the 2000 Highway Capacity Manual (HCM), published by the Transportation Research Board (TRB). This is the accepted practice in all 50 states.

There are several software options for capacity analysis and simulation of these facilities. Capacity analysis software packages include HCS Plus (HCS+), Synchro, aaSIDRA (SIDRA), RODEL, and ARCADY. Micro simulation software packages include CORSIM, SimTraffic, VISSIM, and Paramics. It should be noted that HCS+ data can be transferred to CORSIM for simulation. Similarly, Synchro data can be transferred to SimTraffic, CORSIM, or VISSIM for simulation or review of corridor measures of effectiveness (MOEs).

2.4.1 Capacity Analysis

For each type of facility, the applicable software packages are identified including consideration for the data input requirements, methodology, and the advantages and disadvantages for their application.

2.4.1.1 HCS Plus

HCS+ software was developed to translate the capacity analysis methodology of the HCM into a computer model. HCS+ can be used to analyse most types of traffic facilities. For a signalized intersection the MOE used to calculate LOS is average delay per vehicle in seconds. The basic premise is that a user/driver perceives how well a signalized intersection is working based on how long it takes him/her to pass through it. As congestion increases, delays and queue lengths increase, and a motorist may have to wait several cycles to clear the intersection. The inputs to determine average delay in HCS+ are: traffic volumes in vehicles per hour as well as signal data such as cycle length, green ratio, clearance times, etc. The HCS+ analysis yields average delay, LOS, and v/c ratios. The program now also offers a queuing module that can provide the average and 95th percentile queues for each lane group.

The advantage of HCS+ is that it follows the methodology outlined in the HCM verbatim. The disadvantage of HCS+ is that it does not handle interactions between intersections such

as queue spillback. The program analyses each intersection separately as an isolated location. In addition, HCS+ software cannot currently analyse two-lane roundabouts.

2.4.1.2 Synchro

Synchro was developed privately as an application of the HCM methodology. It can be used to analyse many different facilities, including arterials and intersections. Its primary function has been to analyse signalized intersections.

For an intersection, inputs include traffic volumes, geometrics, and control data including STOP/YIELD, or green time, cycle length, etc. The program explicitly outputs the Intersection Capacity Utilization (ICU) report and ICU LOS. These are based on the Percentile Delay Method, rather than the HCM methodology (Webster's Method). However, the program offers an HCM report for both signalized and unsignalized intersections that is based on the HCM methodology. The report details the delays, LOS, v/c ratio, and average and 95th percentile queues. The results on-screen do not exactly reflect the HCM methodology. However, the HCM report mirrors the MOEs and LOS as described in Chapters 16 and 17 of the HCM.

2.4.1.3 Sidra

SIDRA is a software package that was developed in Australia to analyse roundabouts. It has been commonly used in the U.S. to analyse roundabouts, particularly two-lane roundabouts. SIDRA is the roundabout analysis software accepted by VTrans. The inputs to SIDRA include the hourly volumes, as well as the intersection geometry. Although the intersection geometry is one of the inputs to SIDRA, it is not explicitly considered in the analysis. Because SIDRA can analyse other types of intersections, including both signalized and unsignalized intersections, particularly those with unusual geometry such as five-legged

intersections, the geometry is included in the inputs. However, in the case of roundabout analysis, the geometrics are not used in the analysis. The methodology included in the software is based on critical gaps, much like HCS+. A recent update of SIDRA introduced the use of an adjustment factor to account for the difference between U.S. driving conditions and those in the United Kingdom (U.K.) and Australia, where drivers are more familiar with roundabouts. Recent studies have concluded that SIDRA may overestimate the capacity of single-lane roundabouts and may underestimate capacity for two-lane roundabouts. The MOEs from SIDRA include average delay in seconds, LOS, v/c ratios, and queue lengths.

2.4.1.4 Rodel

RODEL is a software package that was developed in the U.K by Barry Crowne. RODEL has been used as the standard by some Departments of Transportation (DOTs) to analyse roundabouts, most notably in the Northeast by New York State DOT. The program inputs include the hourly volumes as well as the geometry of the roundabout. The program methodology is based solely on the geometrics of the roundabout. Gap theory does not factor into the results. RODEL can be run in design mode with performance targets specified or in evaluation mode with geometric parameters specified. This allows the user to determine the specific impacts on capacity of varying the intersection geometry. One disadvantage of this method for the Circ-Williston project is that it requires detailed knowledge of geometrics, possibly beyond what will be developed for the DEIS. The program is also not calibrated to U.S. conditions, and recent studies indicate that it may underestimate the capacity of single lane roundabouts and overestimate the capacity of two-lane roundabouts. The MOEs from RODEL include average delay, LOS, v/c ratios, and queue lengths.

2.4.1.5 Arcady

Assessment of Roundabout Capacity and DelaY (ARCADY) is a software package developed by TRL Software in the UK for use in analyzing roundabouts. The program is based upon empirical data in the UK. The MOEs that ARCADY predicts include capacity, delay, queue length, and accident risk. It can address all roundabout configurations, including mini-roundabouts. It also includes a crash prediction model and a pedestrian crossing model based on UK data and equations. Inputs to ARCADY include hourly volumes and geometry. One disadvantage of ARCADY is that there is only a 50 percent confidence interval in the results. It is also not calibrated to U.S. conditions, so may not accurately predict roundabout capacities in this country.

2.4.2 Simulation

There are several software packages available to perform micro-simulation for the various types of facilities. For each type of facility, the applicable software packages are identified including consideration for the data input requirements, methodology, and the advantages and disadvantages for their application.

2.4.2.1 Corsim

CORSIM is the corresponding micro-simulation program to HCS+ and was developed by the FHWA. The program works reasonably well for signalized and unsignalized intersections, and various freeway segments, including basic segments, ramps, and weaves. Since the data from HSC+ can be transferred directly into CORSIM, the use of CORSIM for the simulation of freeways and freeway segments is desirable. However, the simulation of an arterial corridor with signalized intersections requires additional inputs into CORSIM to complete the simulation, i.e., intersection offsets, must also be input for the simulation to accurately reflect corridor conditions. For an arterial corridor with roundabouts at intersections, CORSIM does

not provide roundabout specific features for input into the simulation model. In addition, there are known flaws with its modeling of roundabouts, particularly two-lane roundabouts. CORSIM can export reports on a variety of measures, including density, travel time, speed, and number of lane changes.

2.4.2.2 Sim Traffic

SimTraffic was privately developed and is the simulation partner to Synchro. Since SimTraffic and Synchro use the same interface, there is no need to input additional data when transferring from Synchro to SimTraffic. As with CORSIM, a high level of labour intensive calibration is required to have confidence in the simulation results. The primary advantage of the Synchro/SimTraffic package is that analysis and simulation can be done from the same interface. There is no need to input additional data, as the signal data, traffic volumes, link data, and other characteristics of the network are all contained in one file. The results will not exactly match the HCM methodology because Synchro is based upon the Percentile Delay Method rather than Webster's Method. However, for signalized intersections, the SimTraffic simulation gives a reasonable approximation of the expected conditions when properly calibrated. SimTraffic adequately simulates results for single-lane roundabouts; however, the results for two-lane roundabouts are flawed because the user cannot control lane use within the roundabout.

In response to a recent Traffic Engineering Council (TENC) listserv [(1)] question regarding a corridor analysis project involving roundabouts and the use of SimTraffic, Kittelson & Associates, Inc. (KAI) took a cursory look at SimTraffic's ability to model roundabouts.

[(1)]Listserv is an email based discussion group for TENC members. The discussions are technically oriented with the members seeking / sharing their guidance on various topics.

KAI tested single-lane roundabout capacity by loading a subject approach beyond capacity and then measured the outflow against a range of circulatory flows.

What KAI found was that SimTraffic appears to produce higher estimates of capacity at low circulating flows (<600 vph) than either the FHWA urban compact or FHWA single-lane model. At moderate to high circulating flows, the model appears to be in the same range as the two FHWA models. KAI did not check the SimTraffic results against U.S. field data of NCHRP 3-65.

KAI believes that the logic for lane selection should be the same for roundabouts as for any other intersection. For example, on a two-lane approach with two receiving lanes on the far side of the intersection, a driver would turn left from the left lane, right from the right lane, and proceed through from either lane, unless traffic control devices dictate otherwise. The MUTCD is being updated to better clarify lane use, including providing examples of circulatory roadway and exit striping to guide motorists.

SimTraffic assumes that a multilane roundabout operates as a series of T intersections with a section of circulatory roadway between the legs. Therefore, each downstream exit is considered independent of the upstream entry. However, at most roundabouts the paths of entering vehicles cross vehicles leaving the roundabout at the adjacent downstream exit rather than join and separate. As a result of this assumption, it appears that SimTraffic cannot accurately simulate the normal lane configuration for a standard two-lane roundabout with two lane entries and two-lane exits on all approaches. Due to these findings, KAI did not check the capacities that could be derived by SimTraffic for a two-lane roundabout.

2.4.2.3 Vissim

VISSIM is a simulation program developed overseas and distributed in the U.S. VISSIM can simulate arterials with both signalized and roundabout intersections. The FHWA's research shows that the results of roundabout simulation correlate closely with empirical data gathered at roundabouts within the U.S. VISSIM's graphical interface makes it more user friendly than some other simulation models. VISSIM can also simulate interaction with transit facilities, pedestrians, and other similar specialized cases. The outputs from VISSIM include travel time, queue length, and delay, just to name a few. A specific path or paths can be defined in VISSIM, for which the program will explicitly output travel times. For these defined paths, the program will also output delays. Queue counters at specific locations can also be specified in VISSIM to determine queue lengths at key locations. VISSIM can report average queue length, maximum queue length, and the number of stops within the queue. VISSIM allows the user to import a CAD file or aerial photograph as the background, thus making it easier for the public to relate to the location that is being simulated.

2.4.2.4 Paramics

Paramics is another microscopic simulation model, which was developed in Scotland. It has a good graphical interface, including 3-D animation. Although Paramics explicitly models roundabouts, experience by some Departments of Transportation (DOTs) indicates that it can be quite cumbersome to set up the network. In addition, Paramics is extremely costly. As a result, the use of Paramics in the U.S. has been extremely limited to date.

2.4.3 Conclusion

For the purposes of this research the Synchro and Sim Traffic 7 was adopted for capacity analysis and simulation respectively because they based on the full function of the HCM

methodology. As stated early on the HCM(2000) is adopted for this report as the main reference.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Description of Study Area

Accra is the capital and largest city of Ghana with population of about 4,400,000 (Four million and four hundred thousand ; Source 2010 Population and Housing Census by Statistical Service). Accra also doubles as the capital of the Greater Accra Region and the District Capital of the Accra Metropolitan Assembly.

Accra is located at 5°33'00" N 0°12'00" W with an average elevation of 9 m above sea level. The road network is radial with all kinds of intersections including roundabouts, signalized and unsignalized intersections as well as grade-separated intersections.

In recent years, Accra has seen a couple of its major at grade-intersections converted to grade-separated intersections and the trend seems to continue. Figure 3.2 is the map of Accra captured by Google Maps 2010.

Figure 3.1: Map of Accra, Source: Google Maps 2010

3.2 Description of Study Site

Tetteh Quarshie intersection is located at the intersection of two national roads namely N1 and N4. It is one of the busiest intersections in Accra. The intersection which was rotary until its conversion into a cloverleaf interchange in 1995 had a radius of about 215 m. Figure 3.2 is an aerial view of the interchange sourced from Google Maps 2010.

The immediate surroundings of the site have over the years seen increased mixed landuse, i.e. commercial, residential and industrial.

Figure 3.2: Map of Tetteh Quarshie Interchange, Source: Google Maps 2010

3.2.1 Spintex Road

The Spintex Road is one of the legs to the intersection. It is a major link to one of the fast growing industrial areas in Accra. The area served by the road has also seen increased residential land use lately.

3.2.2 Kwame Nkrumah Motorway

The Kwame Nkrumah Motorway is a very important link so far as Ghana's road network is concerned. It links the two major twin cities of Accra and Tema. Tema is the country's biggest industrial city and contributes a lot of the traffic on the motorway.

3.2.3 Tetteh Quarshie-Madina Road

This corridor forms part of the N4 and has over the years seen much traffic growth. The Madina and its environs are growing rapidly in residential settlements and that could be one of the reasons of the high volume traffic on that corridor.

3.2.4 Motorway Extension

This corridor which forms part of N1 had seen tremendous increase in traffic volumes over the years. Traffic flow has also worsened because of encroachment. The corridor is not uniform in its carriageway layout i.e. single and dual carriageways intermittently arranged.

3.2.5 Liberation Road

This is a very important corridor since it begins the route to the CBD of Accra. This corridor serves all traffic from the northern, western and eastern parts of Accra to the CBD. Even though it has a well-defined and uniform carriageway layout the corridor has seen increase in traffic over the years. The construction of the Arko Adjei interchange has been a great intervention since it has eased the bottle-neck that used to be at that intersection.

Figure 3.3 shows the census stations of Greater Accra Region. The figure shows Tetteh Quarshie at the intersection of N1 and N4 national roads.

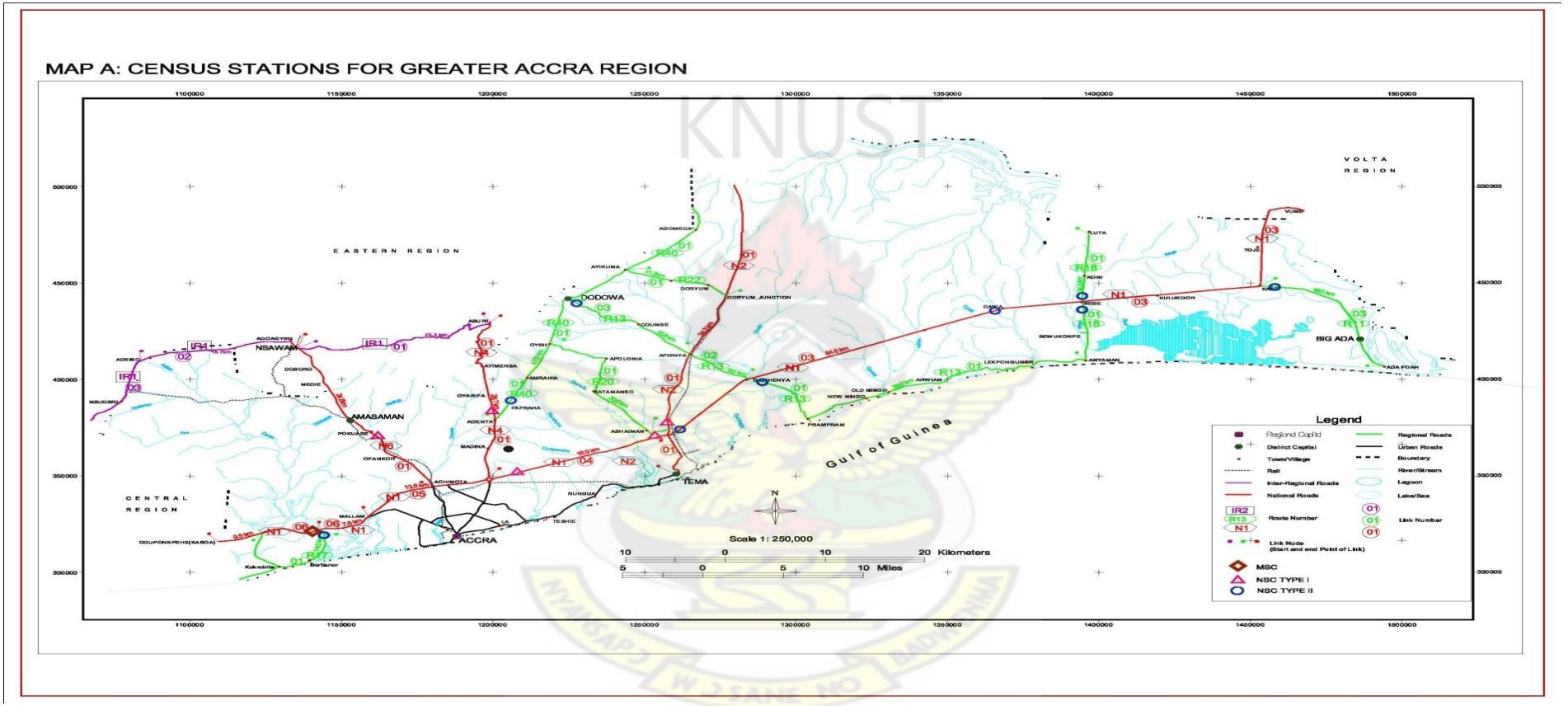

Figure 3.3 Census Stations for Greater Accra Region

3.3 Field Studies and Observations

3.3.1 Traffic Studies

3.3.1.1 Classified Manual Counts

Classified manual counts on all the ramps and links of the interchange were conducted. The counts were carried out for three (3) hours within the morning (7am-10am) and evening (3pm-6pm) peak periods for one typical week day. The counts were in 15 minutes segments.

3.3.1.2 Spot Speed Measurements

The speed data were collected as the tail of the vehicles crossed the enumerator who had positioned himself at the mid-way of the link or ramp. A radar gun was operated on randomly selected vehicles of all kinds (i.e. cars, pick-ups, buses, trucks and trailers).

3.3.1.3 Physical Measurements

As built measurements were taken with tapes and pedometer. Lane widths, lengths of ramps and links were measured and compared with the design. Elevations however were assumed to be the same as the design.

3.4 Calibration and Validation of Software Models

3.4.1 Inputs

Every model, no matter how carefully coded will require calibration and validation to ensure its outputs are meaningful. Calibration is the process by which model parameters are adjusted to reflect the unique driving conditions associated with the network being modelled and thereby generate a model that more closely reflect real-world conditions. Validation is the process whereby model outputs are compared to actual field data to determine how well the model replicate real-world conditions.

In this study the primary validation parameters were

- traffic volumes
- approach speeds
- geometry
- signing
- others such as %HV, PHF etc.

3.4.2 Outputs

Once the links and ramps were calibrated and validated each was run multiple times and results were analyzed with respect to key performance measures. The primary performance measures selected for comparison in this study were

- simulated volumes
- simulated link and ramp speeds and travel time.
- Simulated delays and queuing

3.4.3 Calibration Procedures

a) Settings

This setting procedure is peculiar to Synchro Studio 7 and Warrant 7. All references were taken from Synchro 7 Getting Started.

b) Map Setting

Map importation was from two sources namely Aerial Survey of Accra by Survey Department and Tetteh Quarshie Interchange design by Twum Boafo Ltd. (2005). The two maps were imported as DXF files at true national coordinates. Figure 3.4 is a screen shot of the imported maps

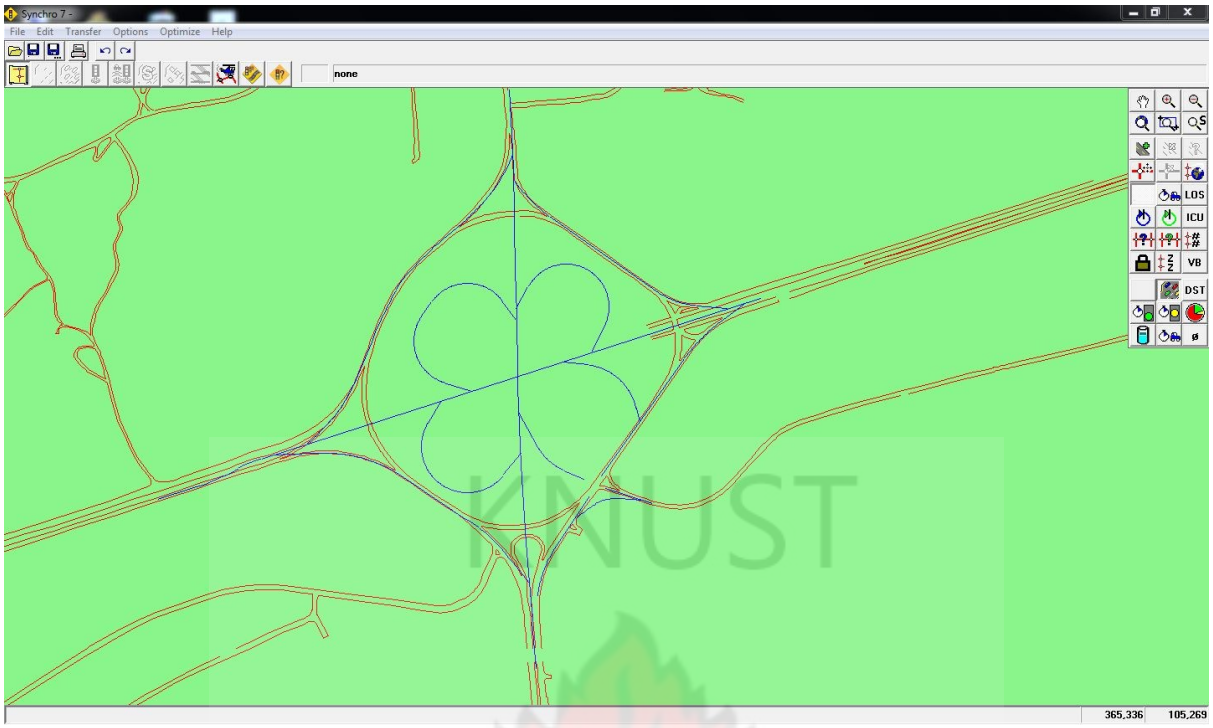

Figure 3.4: Screen Shot of Synchro 7 Map Setting

c) Lane Setting

This setting allows you to input lane and geometric information including lanes and sharing, street names, link distances, link speed etc. Figure 3.5 is a screen shot of lane setting window.

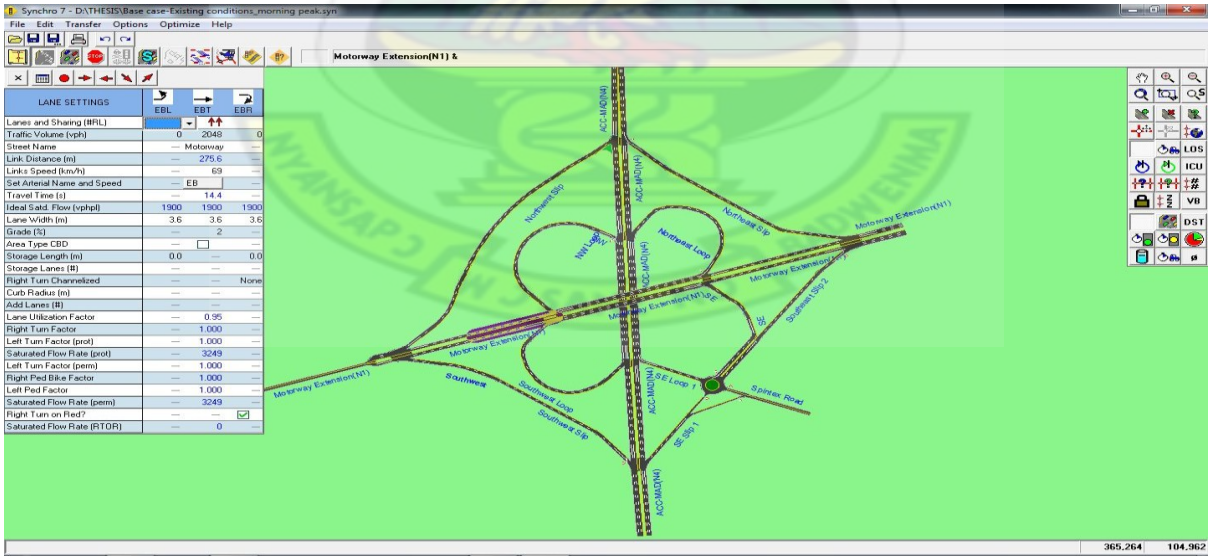

Figure 3.5: Screen shot of Synchro 7 Lane Setting

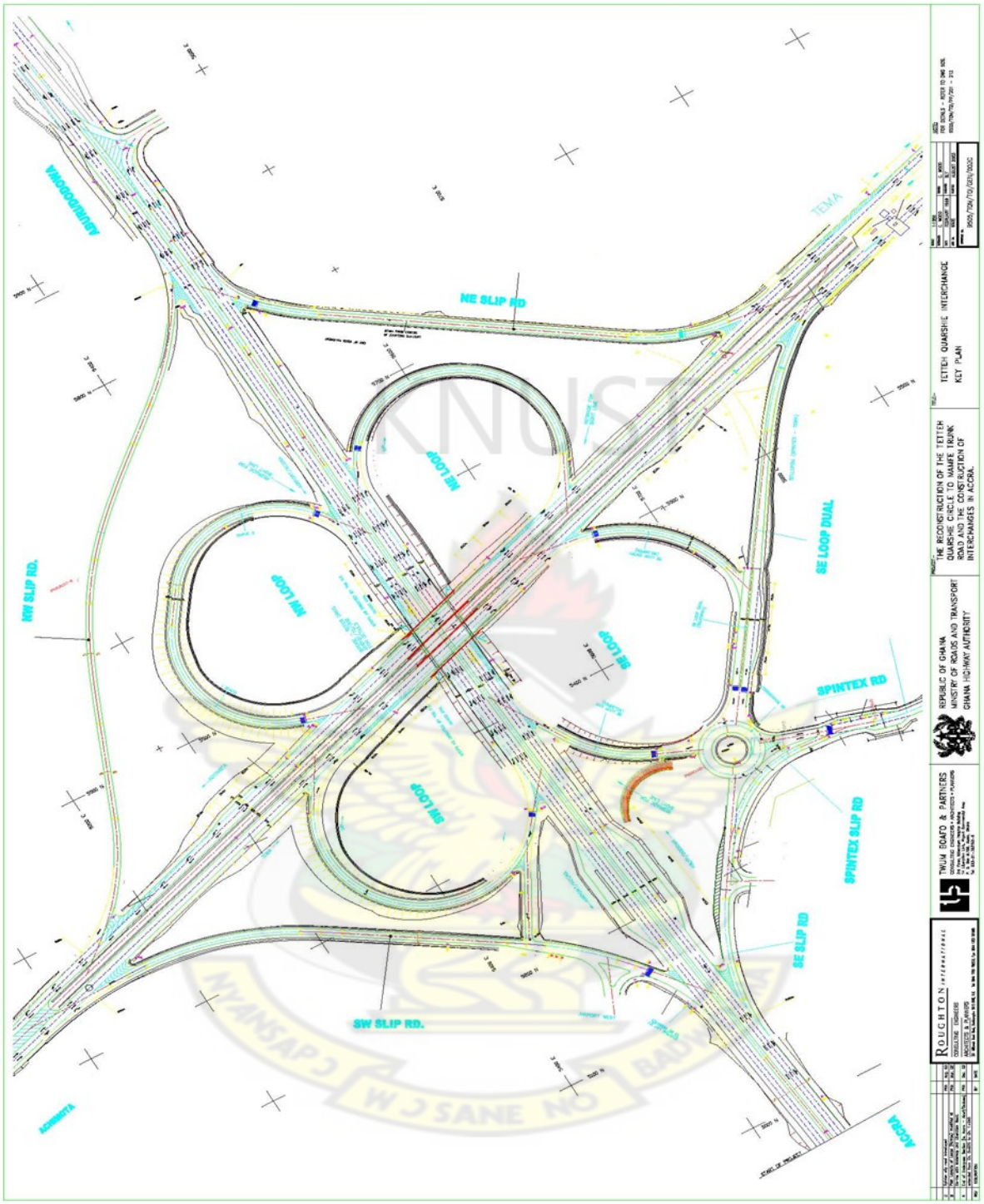

Figure 3.6: Designed Layout of TQI

d) Volume Setting

The Volume Setting allows you to enter volume information. This includes traffic volume, conflicting pedestrians, conflicting bicycles, peak hour factor, growth factor etc. Figure 3.7 is a screen shot of Volume Setting window.

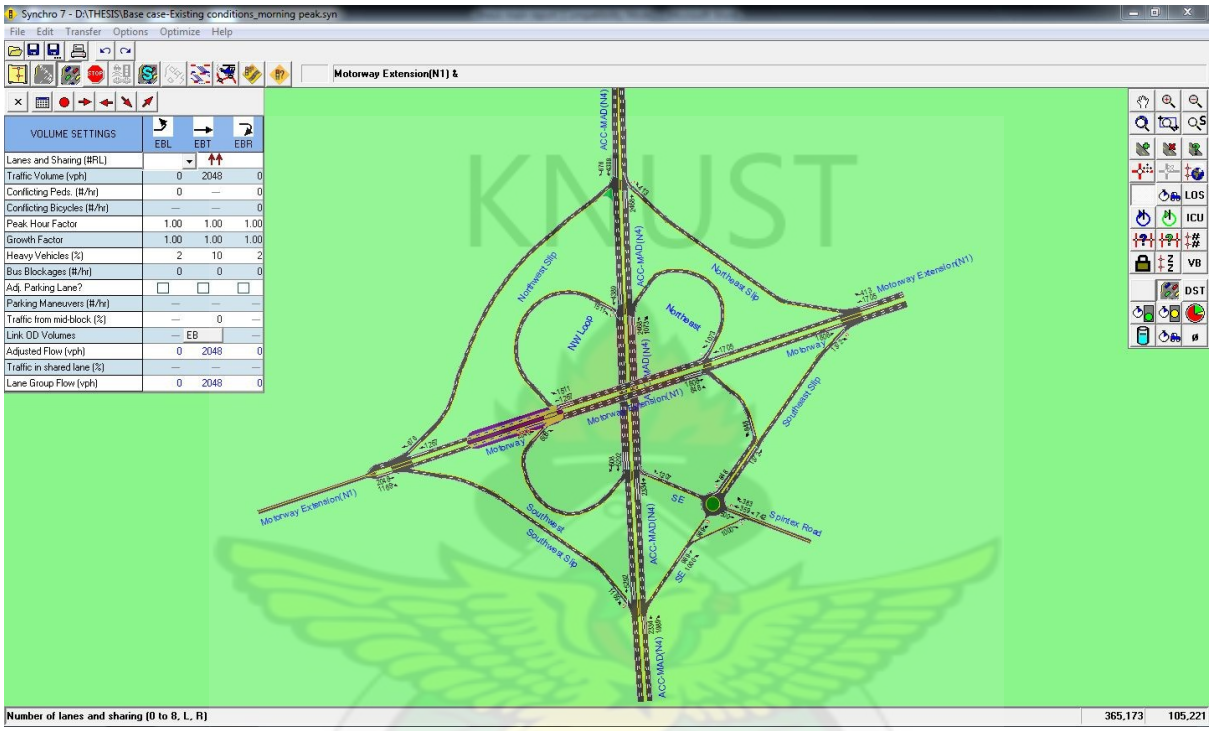

Figure 3.7: Screen shot of Synchro 7 Volume Setting window

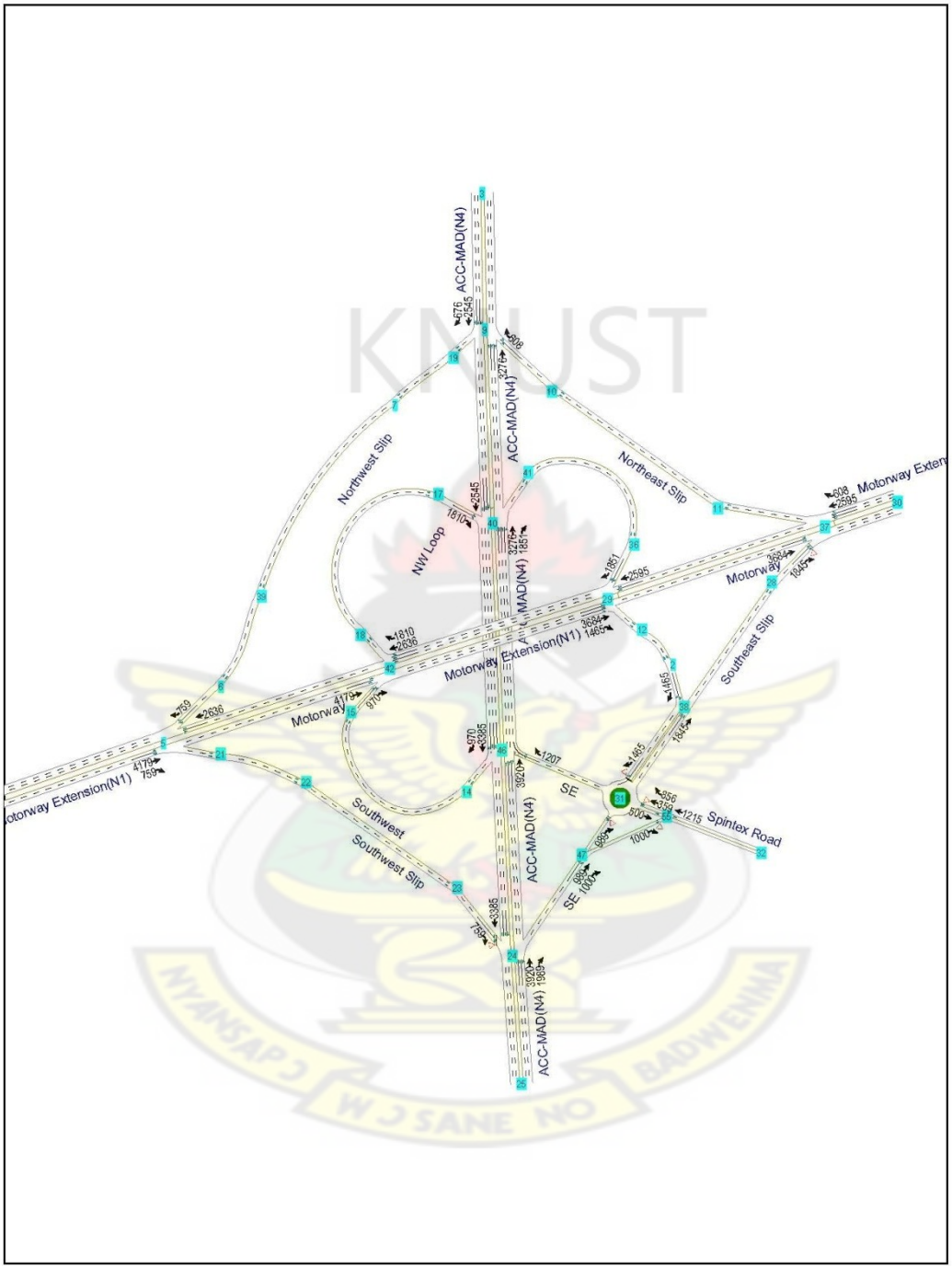

Figure 3.8: Screen shot of Synchro 7 showing Improved legs layout and volumes

e) Node Setting

The node setting allows for the following:

- Intersection ID or Node Number
- Zone
- Cycle Length, Control Type, Lock Timings and Optimize buttoms
- Coordinates (X, Y, Z)
- Description Note Box
- Signal Timing Data

Nodes are assigned unique number automatically. The X and Y coordinates were left as imported from the aerial survey map. The elevations (Z) were entered from the designed TQI. All the control types were set to Unsignalized. Figures 3.9 and 3.10 provide a screen shot of the Node Settings Window and layout of the Interchange showing node numbers respectively.

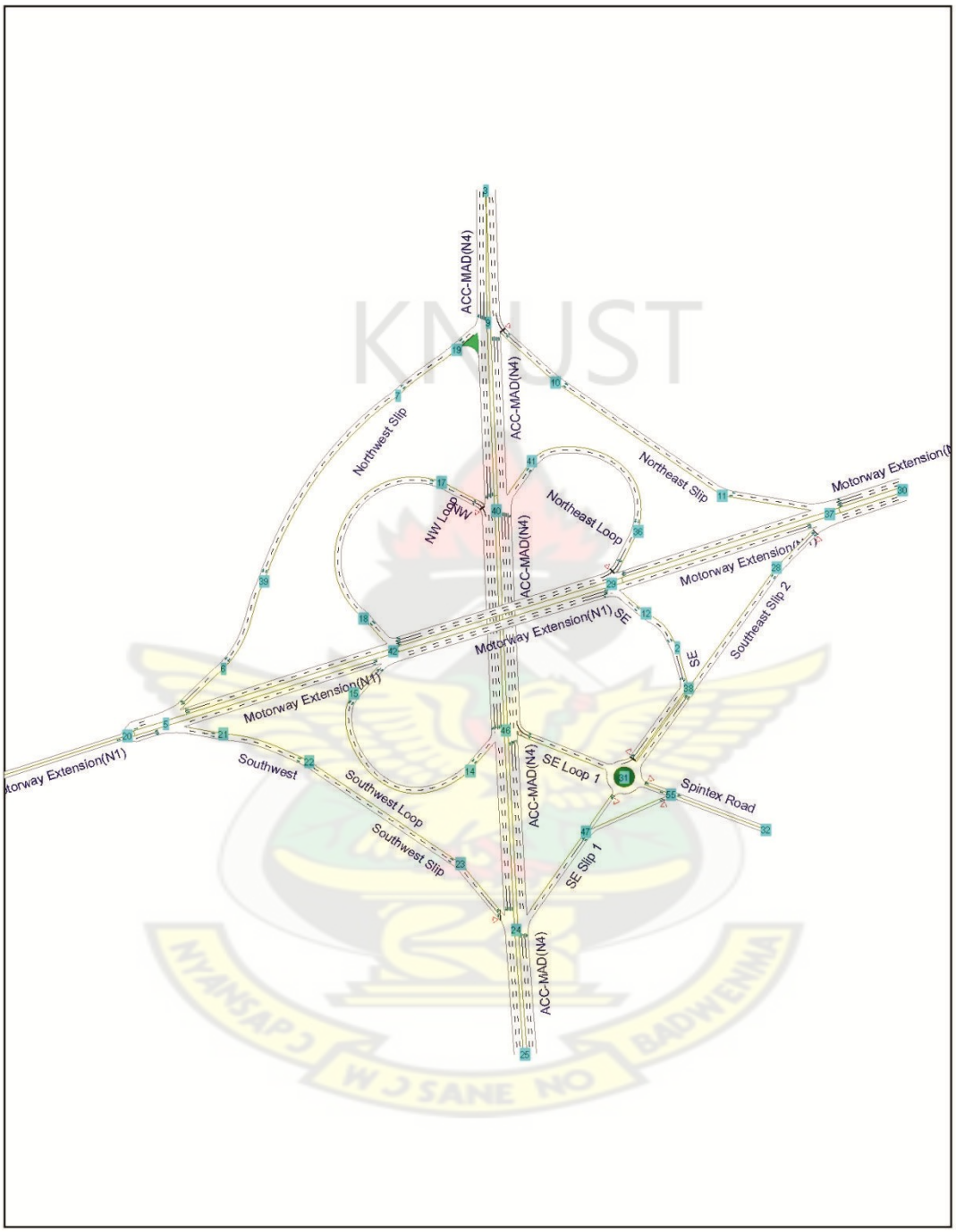

Figure 3.9: Screen shot of Synchro 7 Node Setting window and existing layout

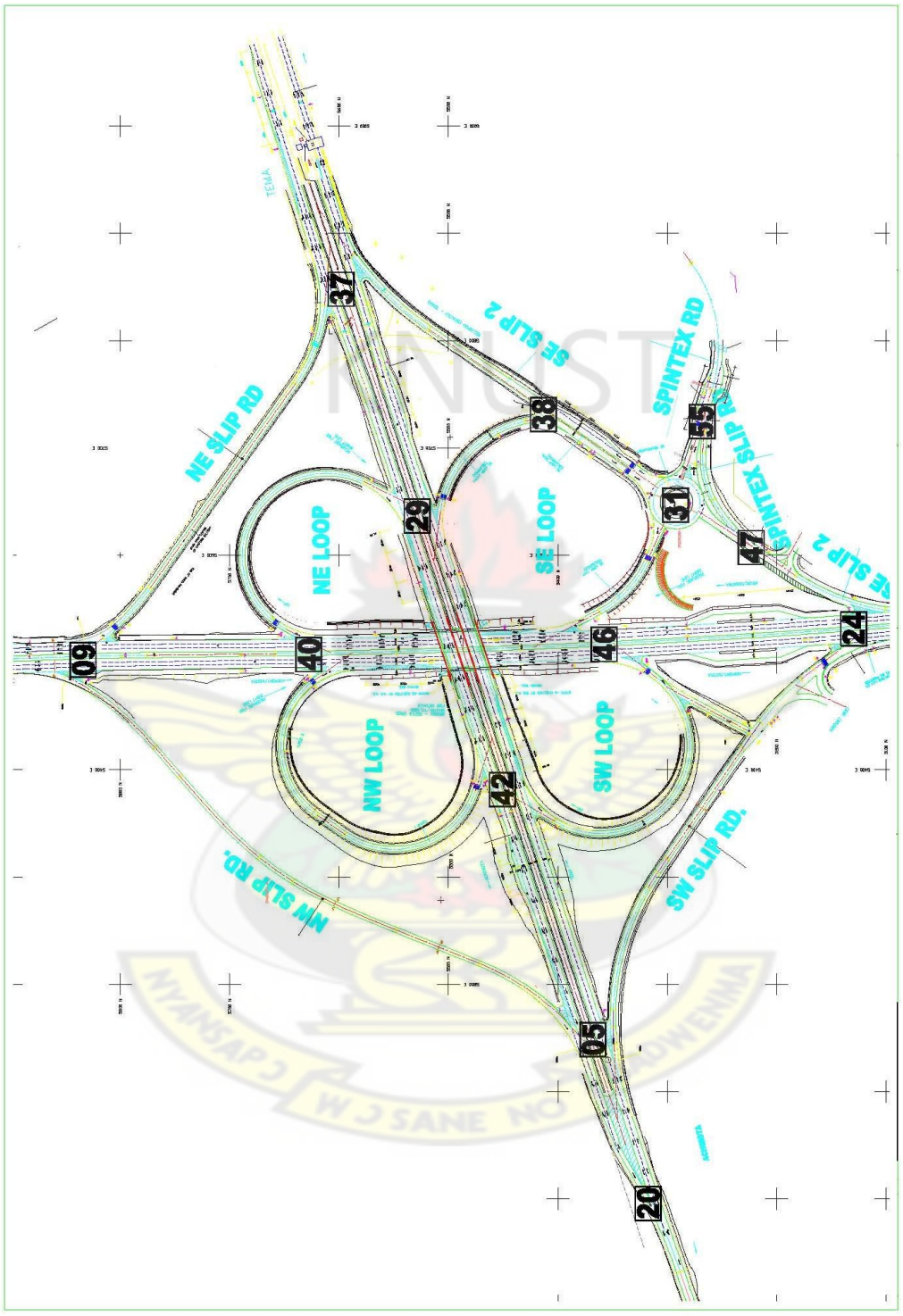

Figure 3.10: Tetteh Quarshie layout showing node numbers

f) Timing/ Signing Setting

The Timing Settings become the Signing Setting by selecting unsignalized or roundabout intersection.

There are three Sign Control Settings namely:

- Free: Traffic goes through the intersection without stopping
- Yield: Traffic has a yield sign and slows down, stopping only if necessary
- Stop: All traffic stops, and waits until all conflicting traffic is clear

Synchro models unsignalized intersections based on the methods of HCM Chapter 17. Figure 3.11 is a screen shot of Signing Setting window.

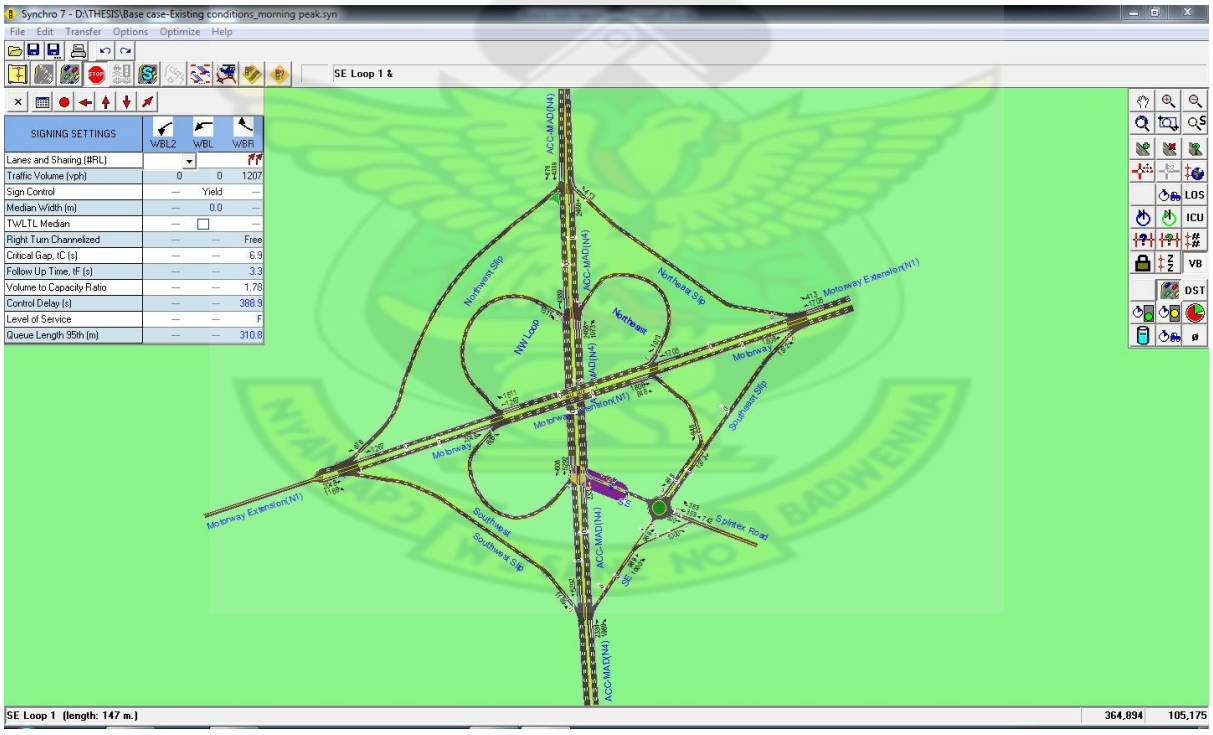

Figure 3.11: Screen shot of Synchro 7 Signing Setting window

3.5 Simulation and Performance Criteria

3.5.1 Intersection Level of Service

For an unsignalized Two-Way Stopped Controlled (TWSC) or All-Way Stopped Controlled (AWSC) intersection, the Level of Service (LOS) for the intersection is calculated by taking the Intersection Delay and converting into a letter using Table 3.1.

Table 3.1: TWSC & AWSC Level of Service Criteria (HCM 2000)

LOS	Control Delay Per Vehicle(s)
A	=< 10
B	> 10-15
C	> 15-25
D	> 25-35
E	> 35-50
F	> 50

3.5.2 Intersection Capacity Utilization

The ICU is shown for unsignalized intersections as well because it represents the potential capacity for the intersection if it were to be signalized.

3.5.2.1 ICU Level of Service

The ICU Level of Service (LOS) gives insight into how an intersection is functioning and how much extra capacity is available to handle traffic fluctuations and incidents. ICU is not a value that can be measured with a stopwatch, but it does give a good reading on the conditions that can be expected at the intersection.

Letters A to H are assigned to the intersection based on the Intersection Capacity Utilization using Table 3.2. Note that the ICU 2003 includes additional level past F to further differentiate congested operation.

Table 3.2: Level of Service Criteria (ICU 2003) for ICU Analysis

ICU (%)	Level of Service
0-55	A
> 55-64	B
> 64-73	C
> 73-82	D
> 82-91	E
> 91-100	F
> 100-109	G
> 109	H

A brief description of the conditions expected for each ICU LOS follows:

LOS A, (ICU<55 %): The intersection has no congestion. A cycle length of 80 sec or less will move traffic efficiently. All traffic should be served on the first cycle. Traffic fluctuations, accidents, and lane closure can be handled with minimal congestion. This intersection can accommodate up to 40% more traffic on all movements.

LOS B, (55 %< ICU<64 %): The intersection has very little congestion. Almost all traffic will be served on the first cycle. A cycle length of 90 sec or less will move traffic efficiently. Traffic fluctuations, accidents, and lane closure can be handled with minimal congestion. This intersection can accommodate up to 30% more traffic on all movements.

LOS C, (64 %< ICU<73 %): The intersection has no major congestion. The majority of traffic should be served on the first cycle. A cycle length of 100 sec or less will move traffic efficiently. Traffic fluctuations, accidents, and lane closure may cause some congestion. This intersection can accommodate up to 20% more traffic on all movements.

LOS D, (73 %< ICU<82%): The intersection normally has congestion. Most of the traffic should be served on the first cycle. A cycle length of 110 seconds or less will move traffic efficiently. Traffic fluctuations, accidents, and lane closures cause significant congestion. Sub optimal timings can cause congestion. This intersection can accommodate up to 10 % more traffic on all movements.

LOS E, (82 %< ICU< 91 %): The intersection is right on the verge of congested conditions. Many vehicles are not served on the first cycle. A cycle length of 120 seconds is required to move all traffic. Minor traffic fluctuations, accidents, and lane closures can cause significant congestion. Sub-optimal signal timings can cause significant congestion. This intersection has less than 10 % reserve capacity available.

LOS F, (91 %< ICU< 100 %): The intersection is over capacity and likely experiences congestion period of 15 to 60 consecutive minutes. Residual queues at the end of green are common. A cycle length over 120 seconds is required to move all traffic. Minor traffic fluctuations, accidents, and lane closures can cause increased congestion. Sub-optimal signal timing can cause increased congestion.

LOS G, (100 %< ICU< 109 %): The intersection is up to 9 % over capacity and likely experiences congestion periods of 60 to 120 consecutive minutes. Long queues are common.

A cycle length over 120 seconds is required to move all traffic. Motorist may be choosing alternative routes, if they exist or making fewer trips during peak hour.

LOS H, (109 %< ICU): The intersection is 9 % or greater over capacity and could experience congestion periods of over 120 minutes per day. Long queues are common. A cycle length over 120 seconds is required to move all traffic. Motorists may be choosing alternative routes, if they exist, or make fewer trips during the peak hour. Signal timings can be used to distribute capacity to the priority movements.

If intersections have LOS E or worse, queues between intersections can lead to blocking problems and spillbacks. Such problems could be addressed by in-depth analyses with microscopic simulation(Husch and Albeck, 2003)

CHAPTER 4.0: ANALYSIS OF RESULTS AND DISCUSSION

4.1 Existing/ Calibration Characteristics

4.1.1 Geometry and Lane Setting

The capacity analysis depends partly on the geometric and lane setting. Table 4.1 lists the various configurations for the lane groupings.

Table 4.1: Geometry and Lane Setting Parameters

Intersection	Street or Road Name	Lane Group	Lane Configuration	Direction to	No of Lanes	Lane Width (m)	Approach Grade (%)	Lane Alignment	Median Width (m)	Lane Utilization Factor
5	Motorway Extension (N1)	EBT		Tema	2	4.0	2	Left	6.0	0.95
		WBT		Madina	2	4.0	-2	Left	6.0	0.95
		SWR		Mallam	2	3.6	0	Right	0.0	0.88
9	ACC-MAD (N4)	NBT		Madina	3	3.7	1.0	Left	4.0	0.91
		SBT		Tema/ Spin	3	3.7	-1.0	Left	4.0	0.91
		NWR		Acc./ Mall.	2	3.0	-3.0	Right	0.0	0.88

Table 4.1 continued

Intersection	Street or Road Name	Lane Group	Lane Configuration	Direction to	No of Lanes	Lane Width (m)	Approach Grade (%)	Lane Alignment	Median Width (m)	Lane Utilization Factor
24	ACC-MAD (N4)	NBT		Accra	3	3.7	1.0	Left	4.0	0.91
		SER		Spin./ Tema	2	3.7	-1.0	Left	4.0	0.91
		SER		Madina	3	3.0	-1.0	Right	0.0	0.88
29	MOTORWAY EXT. (N1)	EBT		Tema	2	3.0	2	Left	6.0	0.95
		EBR		Madina/ Spin	1	3.0	2	Right	-	1.00
		WBT		Madina	2	3.0	-2	Left	6.0	0.95
		SBR		Mad./ Acc	2	3.0	1	Right	0.0	0.88
31	SOUTH EAST LOOP 1	WBT		Tema/ Mad.	1	3.5	2	Left	0.0	1.00
		NBR		Spintex	1	3.5	2	Right	0.0	1.00
		SWR		Madina	2	3.0	-2	Right	0.0	0.88

Table 4.1 continued

Intersection	Street or Road Name	Lane Group	Lane Configuration	Direction to	No of Lanes	Lane Width (m)	Approach Grade (%)	Lane Alignment	Median Width (m)	Lane Utilization Factor
37	MOTOR WAY EXT. (N1)	EBT		Tema	2	3.0	2	Left	6.0	0.95
		WBT		Acc/ Mad.	2	3.0	-2	Left	6.0	0.95
		WBR		Madina	1	3.0	-3	Right	6.0	1.00
		NER		Tema	2	3.0	-3	Right	0.0	0.88
38	SOUTH EAST LOOP 2	SBR		Mad./ Spin.	2	3.0	-2	Right	0.0	0.88
		NET		Tema	2	3.0	2	Left	2.0	0.95
40	NORTH WEST LOOP	EBR		Acc/ Tema	2	3.0	2	Right	0.0	0.88
		NBT		Madina	3	3.6	1	Left	4.0	0.91
		NBR		Mallam	1	3.0	1	Right	0.0	1.00
		SBT		Accra/Tema	3	3.6	-1	Left	4.0	0.91

Table 4.1 continued

Intersection	Street or Road Name	Lane Group	Lane Configuration	Direction to	No of Lanes	Lane Width (m)	Approach Grade (%)	Lane Alignment	Median Width (m)	Lane Utilization Factor
42	MOTORWAY EXT. (N1)	EBT		Tema/Mad	2	4.0	2	Left	6.0	0.95
		WBT		Mallam	2	4.0	-2	Left	6.0	0.95
		WBR		Accra	1	3.0	-2	Right	0.0	1.00
		NER		Tema/Mad	2	3.0	-1	Right	0.0	0.88
46	SOUTH EAST LOOP 1	WBR		Madina	2	3.0	-2	Right	0.0	0.88
		NBT		madina	3	3.7	1	Left	4.0	0.91
		SBT		Accra	3	3.7	-1	Left	4.0	0.91
		SBT		Tema	1	3.7	2	Left	0.0	1.00
47	SOUTH EAST SLIP 1	NBT		Tema	1	3.7	2	Left	0.0	1.0
		NBR		Tema	1	3.6	2	Right	0.0	1.0

Table 4.1 continued

Intersection	Street or Road Name	Lane Group	Lane Configuration	Direction to	No of Lanes	Lane Width (m)	Approach Grade (%)	Lane Alignment	Median Width (m)	Lane Utilization Factor
55	SPINTEX ROAD	EBT		Spintex	1	3.6	0	Left	0.0	1.0
		WBT		Madina	1	3.6	0	Left	0.0	1.0
		NER		Tema	1	3.6	0	Right	0.0	1.0

4.1.2 Volume and Speed Setting

Traffic volume and speed were the main variables measured at the site. The measurements were done on all the ramps and mainlines. Table 4.2 contains the details of the traffic and speed parameters captured on site.

Table 4.2: Traffic volume and speed parameters at the site

Intersection	Street or Road Name	Lane Group	Volume				Speed			
			Morning Peak		Evening Peak		Morning Peak		Evening Peak	
			Design Vol (vph)	% HV	Design Vol (vph)	% HV	Mean Spot Speed (km/h)	Standard Deviation (km/h)	Mean Spot Speed (km/h)	Standard Deviation (km/h)
5	Motorway Extension (N1)	EBT	2048	10	2048	12	69	9	69	9
		WBT	1267	6	1874	11	57	12	57	12
		SWR	676	2	759	8	54	8	54	8
9	ACC-MAD (N4)	NBT	2468	3	3276	2	47	13	35	10
		SBT	4389	2	2545	3	36	7	63	8
		NWR	413	9	608	12	40	6	40	6
24	ACC-MAD (N4)	NBT	2334	3	3920	2	47	13	35	10
		SER	5292	2	3385	3	36	7	63	8
		SER	1169	3	759	8	54	8	54	8

Table 4.2 continued

Intersection	Street or Road Name	Lane Group	Volume				Speed			
			Morning Peak		Evening Peak		Morning Peak		Evening Peak	
			Design Vol (vph)	% HV	Design Vol (vph)	% HV	Mean Spot Speed (km/h)	Standard Deviation (km/h)	Mean Spot Speed (km/h)	Standard Deviation (km/h)
29	MOTORWAY EXT. (N1)	EBT	1808	10	3684	12	69	9	69	9
		EBR	848	2	1465	7	44	7	44	7
		WBT	1705	6	2595	11	57	12	57	12
		SBR	1073	5	1851	9	40	6	40	6
31	SOUTH EAST LOOP 1	WBT	359	2	359	2	50	6	40	-
		NBR	989	2	989	4	50	-	50	-
		SWR	848	2	1465	7	50	-	50	-
37	MOTOR WAY EXT. (N1)	EBT	1808	10	3684	12	69	9	69	9
		WBT	1705	6	744	11	57	12	57	12
		WBR	413	9	608	12	46	8	46	8
		NER	1372	9	1845	7	34	7	34	7

Table 4.2 continued

Intersection	Street or Road Name	Lane Group	Volume				Speed			
			Morning Peak		Evening Peak		Morning Peak		Evening Peak	
			Design Vol (vph)	% HV	Design Vol (vph)	% HV	Mean Spot Speed (km/h)	Standard Deviation (km/h)	Mean Spot Speed (km/h)	Standard Deviation (km/h)
38	SOUTH EAST LOOP 2	SBR	848	6	1465	7	44	7	44	7
		NET	1372	9	1845	7	34	7	34	7
40	NORTH WEST LOOP	EBR	1511	5	1810	5	43	8	43	8
		NBT	2468	3	3276	2	47	13	35	10
		NBR	1073	2	1851	9	40	6	40	6
		SBT	4389	2	2545	3	36	7	63	8
42	MOTORWAY EXT. (N1)	EBT	2048	10	4179	12	69	9	69	9
		WBT	1267	6	785	11	57	12	57	12
		WBR	1511	5	1810	5	43	8	43	8
		NER	608	11	970	7	39	5	39	5

Table 4.2 continued.

Intersection	Street or Road Name	Lane Group	Volume				Speed			
			Morning Peak		Evening Peak		Morning Peak		Evening Peak	
			Design Vol (vph)	% HV	Design Vol (vph)	% HV	Mean Spot Speed (km/h)	Standard Deviation (km/h)	Mean Spot Speed (km/h)	Standard Deviation (km/h)
46	SOUTH EAST LOOP 1	WBR	1207	2	1207	2	44	7	44	7
		NBT	2334	3	3920	2	47	13	35	10
		SBT	5292	2	3385	3	36	7	63	8
		SBT	608	2	970	7	39	5	39	5
47	SOUTH EAST SLIP 1	NBT	989	4	989	4	34	7	34	7
		NBR	1000	4	1000	4	50	-	50	-
55	SPINTEX ROAD	EBT	500	2	500	2	50	-	50	-
		WBT	742	2	1215	2	50	-	50	-
		NER	100	4	1000	4	50	-	50	-

4.1.3 Control, Signage and Measure of Effectiveness

Table 4.3 shows the various signage and control type for the intersections. The table also shows the capacity utilisation for those intersections and their respective level of service.

Table 4.3: Control, Signage and Measure of Effectiveness

Intersection	Street or Road Name	Lane Group	Control Type	Sign Control	Delay /Veh (s)		Average Queue (m)		ICU LOS (%)	
					Morning Peak	Evening Peak	Morning Peak	Evening Peak	Morning Peak	Evening Peak
5	Motorway Extension (N1)	EBT	Un-signalized	Free	5.4	1.6	10.6	241.1	97.4	156.1
		WBT		Free	108.9	214.4	228.7	243.5	F	H
		SWR		Free	3.9	11.0	19.6	52.3		
9	ACC-MAD (N4)	NBT	Un-signalized	Free	1.8	1.4	14.8	7.2	144.3	119.2
		SBT		Free	126.9	3.7	114.2	44.9	H	H
		NWR		Free	6.0	4.0	15.6	7.8		
24	ACC-MAD (N4)	NBT	Un-signalized	Free	430.2	696.4	107.1	110.4	149.8	124.6
		SBT		Free	4.5	2.4	167.6	58.2	H	H
		SER		Yield	3648.7	1302.7	81.1	77.7		

Table 4.3 continued

Intersection	Street or Road Name	Lane Group	Control Type	Sign Control	Delay /Veh (s)		Average Queue (m)		ICU LOS (%)	
					Morning Peak	Evening Peak	Morning Peak	Evening Peak	Morning Peak	Evening Peak
29	MOTORWAY EXT. (N1)	EBT	Un-signalize	Free	1.6	1.8	11.1	233.4	104.6	173.0
		EBR		Free	4.2	4.2	50.7	66.3	G	H
		WBT		Free	9.7	292.9	74.4	222.3		
		SBR		Free	36.7	59.1	41.4	65.8		
31	SOUTH EAST LOOP 1	WBT	Un-signalized	Yield	34.3	145.8	29.0	27.5	110.2	139.4
		NBR		Yield	12.2	28.9	19.0	32.5	H	H
		SWR		Yield	4.7	3.0	11.6	2.5		
37	MOTOR WAY EXT. (N1)	EBT	Un-signalized	Yield	3.4	2.8	14.2	15.7	104.6	173.0
		WBT		Free	2.6	996.6	13.4	77.8	G	H
		WBR		Free	2.1	1246.1		1.2		
		NER		Yield	108.2	231.7	78.6	80.2		

Table 4.3 continued

Intersection	Street or Road Name	Lane Group	Control Type	Sign Control	Delay /Veh (s)		Average Queue (m)		ICU LOS (%)	
					Morning Peak	Evening Peak	Morning Peak	Evening Peak	Morning Peak	Evening Peak
38	SOUTH EAST LOOP 2	SBR	Un-signalize	Free	0.5	0.4	3.9		41.3	54.6
		NET		Free	70.2	184.0	61.6	87.3	A	A
40	NORTH WEST LOOP	EBR	Un-signalized	Free	14.6	24.2	57.8	50.2	144.3	119.2
		NBT		Free	2.1	2.0	68.9	27.2	H	H
		NBR		Free	4.7	8.6	26.8	0		
		SBT		Free	24.5	4.8	153.7	34.1		
42	MOTORWAY EXT. (N1)	EBT	Un-signalized	Free	7.0	6.6	15.6	34.1	97.4	156.1
		WBT		Free	55.1	293.9	138.8	32.6	F	H
		WBR		Free	16.3	64.4	14.7	253.4		
		NER		Free	3.1	6.9	20.6	247.7		

Table 4.3 continued.

Intersection	Street or Road Name	Lane Group	Control Type	Sign Control	Delay /Veh (s)		Average Queue (m)		ICU LOS (%)	
					Morning Peak	Evening Peak	Morning Peak	Evening Peak	Morning Peak	Evening Peak
46	SOUTH EAST LOOP 1	WBR	Un-signalize	Yield	2.9	0.3	9.4	15.5	149.0	124.6
		NBT		Free	1.9	2.8	7.1	4.8	H	H
		SBT		Free	6.8	1.7	45.6	38.2		
		SBR		Free	6.8	4.8	20.2	11.0		
47	SOUTH EAST SLIP 1	NBT	Un-signalize	Free	15.8	51.9	37.2	65.1	65.3	65.3
		NBR		Free	3.2	4.8	43.1	56.5	C	C
55	SPINTEX ROAD	EBT	Un-signalized	Free	4.0	4.3	17.5	18.0	94.9	94.9
		WBT		Free	388.5	2914.9	103.6	115.0	F	F
		NER		Yield	9.7	7.5	39.6	32.4		
TOTAL NETWORK					**358**	**745.6**	**6223 vehs (Queue Penalty)**	**13,754 vehs (Queue Penalty)**	**108** **G**	**125** **H**

4.2 Improved Legs Case

4.2.1 Sensitivity Analysis for the Interchange Network

Tables 4.4 and 4.5 tabulate changes in vehicular delays as the main link speeds were increased for morning and evening peaks respectively. The speed sensitivity analysis was informed by the fact that speeds on the main links would increase after the reconstruction works on them are completed. Speeds on the ramps and slipways were however maintained.

Table 4.4: Effect of increased link speed on the Network Delays-Morning Peak

Intersection	Street Name	Lane Group	Baseline Link Speed (km/h)	Baseline Delay (s)	Percentage Incremental Link Speeds- Morning Peak					
					10% increase		20% increase		30% increase	
					Adjusted Speed (km/h)	Delay/ Veh (s)	Adjusted Speed (km/h)	Delay/ Veh (s)	Adjusted Speed (km/h)	Delay/ Veh (s)
5		EBT	69	108.9	76	69.9	83	86.2	90	154.0
		WBT	57	5.4	63	1.3	68	2.0	74	2.2
9		NBT	47	1.8	52	2.6	56	2.4	61	3.3
		SBT	36	126.9	40	122.4	43	98.0	47	101.3

Table 4.4 continued

Intersection	Street Name	Lane Group	Baseline Link Speed (km/h)	Baseline Delay (s)	Percentage Incremental Link Speeds- Morning Peak					
					10% increase		20% increase		30% increase	
					Adjusted Speed (km/h)	Delay/ Veh (s)	Adjusted Speed (km/h)	Delay/ Veh (s)	Adjusted Speed (km/h)	Delay/ Veh (s)
24		NBT	47	430.2	52	285.0	56	334.7	61	323.2
		SBT	36	4.5	40	3.8	43	3.6	47	5.2
29		EBT	69	1.6	76	3.3	83	2.4	90	2.6
		WBT	57	9.7	63	8.1	68	8.5	74	10.1
37		EBT	69	3.4	76	3.8	83	4.1	90	4.3
		WBT	57	2.6	63	1.5	68	1.6	74	1.1
40		NBT	47	2.1	52	2.5	56	2.4	61	2.8
		SBT	36	24.5	40	25.3	43	18.2	47	15.3
42		EBT	69	7.0	76	11.3	83	6.6	90	8.5
		WBT	57	55.1	63	1.7	68	1.9	74	1.4

Table 4.4 continued.

Intersection	Street Name	Lane Group	Baseline Link Speed (km/h)	Baseline Delay (s)	Percentage Incremental Link Speeds- Morning Peak					
					10% increase		20% increase		30% increase	
					Adjusted Speed (km/h)	Delay/ Veh (s)	Adjusted Speed (km/h)	Delay/ Veh (s)	Adjusted Speed (km/h)	Delay/ Veh (s)
46		NBT	47	1.9	52	3.4	56	3.4	61	4.2
		SBT	36	6.8	40	5.4	43	5.0	47	6.6
TOTAL NETWORK				**358.0**		**196.4**		**185.8**		**207.6**

Table 4.5: Effect of increased link speed on the Network Delays- Evening Peak

Intersection	Street Name	Lane Group	Baseline Link Speed (k/h)	Baseline Delay (s)	Percentage Incremental Link Speed- Evening Peak					
					10% increase		20% increase		30% increase	
					Adjusted Speed (km/h)	Delay/ Veh (s)	Adjusted Speed (km/h)	Delay/ Veh (s)	Adjusted Speed (km/h)	Delay/ Veh (s)
5		EBT	69	214.4	76	387.9	83	223.3	90	283.5
		WBT	57	1.6	63	5.0	68	9.4	74	7.1
9		NBT	35	1.4	39	3.1	42	2.7	46	4.3
		SBT	63	3.7	69	13.4	76	5.1	82	14.0
24		NBT	35	696.4	39	429.6	42	396.3	46	340.2
		SBT	63	2.4	69	3.7	76	3.9	82	4.6
29		EBT	69	1.8	76	4.4	83	3.1	90	5.5
		WBT	57	292.9	63	12.9	68	17.7	74	25.2

Table 4.5 continued.

Intersection	Street Name	Lane Group	Baseline Link Speed (k/h)	Baseline Delay (s)	Percentage Incremental Link Speed- Evening Peak					
					10% increase		20% increase		30% increase	
					Adjusted Speed (km/h)	Delay/ Veh (s)	Adjusted Speed (km/h)	Delay/ Veh (s)	Adjusted Speed (km/h)	Delay/ Veh (s)
37		EBT	69	2.8	76	5.3	83	5.1	90	6.7
		WBT	57	996.6	63	15.1	68	16.3	74	24.0
40		NBT	35	2.0	39	4.3	42	4.3	46	5.7
		SBT	63	4.8	69	21.7	76	13.0	82	16.4
42		EBT	69	6.6	76	33.2	83	9.9	90	20.9
		WBT	57	293.9	63	2.7	68	2.9	74	4.0
46		NBT	35	2.8	39	3.2	42	5.5	46	12.2
		SBT	63	1.7	69	2.6	76	8.5	82	2.3
TOTAL NETWORK				**745.6**		**278.3**		**256.9**		**267.8**

4.3 Discussions

4.3.1 Existing Scenario

From Table 4.3, the Tetteh Quarshie Interchange presently is over congested with the evening peak showing the worse. The simulation resulted in ICU of **108 %** and **125 %** for morning and evening peaks respectively representing LOS of G and H.

4.3.2 Improved Legs Scenario

A sensitivity analysis performed by varying the speeds on the main-links namely N1-Tetteh Quarshie- Mallam and N4-Tetteh Quarshie-Pantang affected the delays on those links of the Interchange and eventually on the over-all cumulative delay of the Interchange. Tables 4.4 and 4.5 show 10 %, 20 % and 30 % increase in speeds on the main-links (ie N1 and N4) and their corresponding delays. For instance 10 % increase in speed on the main links reduced the overall delay from 745.6 to 278.3 sec/veh in the case of the evening peak representing about 63 % reduction. The simulation results showed progressive reduction in delays when speeds were increased by 10 % and 20 %. However 30 % increase in speeds showed an increase in the over-all delay of the Interchange. This could be attributed to the fact the gap-seeking from the ramps becomes difficult at very high speeds on the mainlines.

4.4 Limitation of Study

Some of the traffic volumes were replicated between the morning and evening peaks. Also where link speed count could not be performed the default setting was adopted. Traffic data collection did not include pedestrian counts and other forms of transport such as cycles. Thus the simulation results did not feature the influence of pedestrians and cyclists on the performance of the Tetteh Quarshie in this study.

5.0: CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The performance of the Tetteh Quarshie Interchange has been studied. The objectives of the study were to assess the over-all performance of the present Interchange configuration; establish the impact of the on-going legs improvements namely Tetteh Quarshie- Mallam and Tetteh Quarshie-Panteng would have on the performance of the interchange; establish a calibrated model for future studies on the Tetteh Quarshie Interchange.

The outcome of the study is a useful guide to transportation professionals to assess the performance of any grade-separated interchange before its implementation.

The key research findings are highlighted as follows:

- The present configuration of the Tetteh Quarshie Interchange is congested for the traffic volumes currently being handled.
- Any ancillary structures that tend to reduce such as speed humps, pelican lights etc would further worsen the performance of the Interchange.
- The on-going legs improvement would improve on the performance of the Interchange by reducing the over-all delay of the Interchange through link speed increase.

5.2 Recommendations

Based on the above findings the following recommendations are proposed:

- Other alternative routes should be constructed and improved upon to reduce the volume of traffic using the Tetteh Quarshie Interchange.

- Any ancillary structures that would reduce speeds especially on the main links (i.e. N1 and N4) should be discouraged. The present two pelican lights on the N4 even though were not considered in the study in my opinion if replaced with pedestrian overhead bridge would improve on the over-all performance of the Interchange.
- Further research should be carried out to assess the impact of the pelican lights on the N4 and how it affects the over-all performance of the Interchange.

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APPENDICES

APPENDIX A- MANUAL TRAFFIC COUNT RESULTS

TRAFFIC SURVEY IN .....

MANUAL CLASSIFIED COUNT FORM

SHEET NUMBER LOCATION

DATE: STATION NUMBER

DAY: ENUMERATOR:

WEATHER:

CLASSIFICATION	DIRECTION TO: HOUR FROM ..... To	SUM	DIRECTION TO: HOUR FROM ..... To	SUM
PEDESTRIAN				
CYCLES				
MOTOR BIKES				
TAXIS				
CARS				
PICK UP/VAN/4WD VEH				
SMALL BUS				
MED. BUS/MAMMY WAGON				
LARGE BUS				
LIGHT TRUCK				
MEDIUM TRUCK				
HEAVY TRUCK				
TRUCK TRAILER				
EXTRA LARGE TRUCK & OTHERS				

Figure A1: Sample Sheet of Manual Classified Count Form

Table A1: Morning and Evening Peak Traffic- NORTH BOUND (N4)

MANUAL TRAFIC COUNT

DATE(MOR) LOCATION TETTEH QUARSHIE INTERCHANGE
DATE(EVE) STATION NO NORTH BOUND

		CLASSIFICATION								
DURATION	CARS	PICK-UP	SMALL BUS	MEDIUM BUS	LARGE BUS	LIGHT TRUCK	MEDIUM TRUCK	HEAVY TRUCK	TRUCK TRAILER	TOTAL(PCE)
7:00-7:15	425	51	56	33	2	8	2	1	1	617
7:15-7:30	315	60	38	33	1	6	1	1	1	485
7:30-7:45	250	103	56	77	3	11	0	1	0	548
7:45-8:00	155	80	85	57	0	10	0	0	0	431
8:00-8:15	210	90	85	73	0	6	0	2	3	519
8:15-8:30	175	75	50	49	6	8	2	0	2	409
8:30-8:45	170	80	50	49	2	7	1	0	6	409
8:45-9:00	200	80	55	50	1	5	2	0	2	431
9:00-9:15	192	98	62	70	0	7	1	0	7	488
9:15-9:30	215	101	50	51	4	10	2	3	3	490
9:30-9:45	200	86	65	58	1	10	0	3	3	477
9:45-10:00	176	78	58	50	1	4	2	2	3	414
3:00-3:15	425	51	56	33	2	8	2	1	1	617
3:15-3:30	315	60	38	33	1	6	1	1	1	485
3:30:3:45	515	67	100	66	0	8	0	0	0	802
3:45-4:00	417	195	42	35	0	12	0	5	2	754
4:00-4:15	494	75	75	36	2	8	0	3	0	734
4:15-4:30	478	61	51	34	3	8	0	0	1	669
4:30-4:45	521	78	25	43	0	8	1	1	0	707
4:45-5:00	510	64	47	29	3	7	2	3	1	704
5:00-5:15	337	84	44	48	2	22	2	4	0	607
5:15-5:30	372	136	55	58	19	5	5	2	2	709
5:30-5:45	551	94	52	59	3	7	6	1	0	819
5:45-6:00	567	66	35	28	0	7	0	2	2	737
PCE VALUES	1	1	1.2	1.2	1.5	2.6	2.6	2.6	2.7	

MORNING PEAK

7:00-7:15	425	51	56	33	2	8	2	1	1	617
7:15-7:30	315	60	38	33	1	6	1	1	1	485
7:30-7:45	250	103	56	77	3	11	0	1	0	548
7:45-8:00	155	80	85	57	0	10	0	0	0	431

EVENING PEAK

5:00-5:15	337	84	44	48	2	22	2	4	0	607
5:15-5:30	372	136	55	58	19	5	5	2	2	709
5:30-5:45	551	94	52	59	3	7	6	1	0	819
5:45-6:00	567	66	35	28	0	7	0	2	2	737

PEAK HOUR FACTOR= VOLUME DURING PEAK HOUR / 4*VOL. DURING PEAK 15 MIN. WITHIN PEAK HOUR

DESIGN HOURLY VOL.= PEAK HOUR VOLUME / PEAK HOUR FACTOR

MORNING
PEAK HOUR FACTOR= 0.843

DESIGN HOURLY VOL.= **2468**
% HV= **3**

EVENING
PEAK HOUR FACTOR= 0.877

DESIGN HOURLY VOL.= **3276**
% HV= **2**

Table A3: Morning and Evening Peak Traffic-SOUTH BOUND (N4)

MANUAL TRAFIC COUNT

DATE(MOR) 4 August 2010 LOCATION TETTEH QUARSHIE INTERCHANGE
DATE(EVE) 4 August 2010 STATION NO SOUTH BOUND

		CLASSIFICATION								
DURATION	CARS	PICK-UP	SMALL BUS	MEDIUM BUS	LARGE BUS	LIGHT TRUCK	MEDIUM TRUCK	HEAVY TRUCK	TRUCK TRAILER	TOTAL(PCE)
7:00-7:15										0
7:15-7:30										0
7:30-7:45	240	31	24	20	3	2	1	1	1	341
7:45-8:00	772	22	64	70	2	5	0	3	3	987
8:00-8:15	657	50	40	64	4	10	1	15	1	908
8:15-8:30	865	53	66	71	3	1	3	0	0	1097
8:30-8:45	665	38	62	74	2	7	1	1	0	893
8:45-9:00	545	26	20	47	2	5	0	0	2	673
9:00-9:15	425	36	33	31	3	9	7	4	0	594
9:15-9:30	500	35	33	21	2	13	4	3	2	660
9:30-9:45	315	30	47	30	3	10	7	3	3	502
9:45-10:00	462	48	43	27	5	7	0	1	1	625
3:00-3:15	310	45	35	40	1	7	7	0	3	491
3:15-3:30	320	105	65	60	1	10	2	5	1	623
3:30:3:45	335	80	45	65	2	6	3	2	2	584
3:45-4:00	320	95	45	30	5	11	2	6	4	573
4:00-4:15	270	100	40	30	3	11	2	6	2	513
4:15-4:30	330	105	45	30	0	6	1	0	2	549
4:30-4:45	310	85	40	60	1	12	2	4	3	571
4:45-5:00	403	90	60	45	1	4	0	0	2	636
5:00-5:15	286	90	30	45	2	6	1	5	5	514
5:15-5:30	310	130	30	45	0	12	2	2	2	577
5:30-5:45	330	120	35	35	0	17	2	2	1	591
5:45-6:00	285	110	37	47	0	6	2	0	2	522
PCE VALUES	1	1	1.2	1.2	1.5	2.6	2.6	2.6	2.7	
MORNING PEAK										
8:00-8:15	657	50	40	64	4	10	1	15	1	908
8:15-8:30	865	53	66	71	3	1	3	0	0	1097
8:30-8:45	665	38	62	74	2	7	1	1	0	893
8:45-9:00	545	26	20	47	2	5	0	0	2	673
EVENING PEAK										
4:00-4:15	270	100	40	30	3	11	2	6	2	513
4:15-4:30	330	105	45	30	0	6	1	0	2	549
4:30-4:45	310	85	40	60	1	12	2	4	3	571
4:45-5:00	403	90	60	45	1	4	0	0	2	636

PEAK HOUR FACTOR= VOLUME DURING PEAK HOUR / 4*VOL. DURING PEAK 15 MIN. WITHIN PEAK HOUR

DESIGN HOURLY VOL.= PEAK HOUR VOLUME / PEAK HOUR FACTOR

MORNING
PEAK HOUR FACTOR= 0.814

DESIGN HOURLY VOL.= **4389**
% HV= **2**

EVENING
PEAK HOUR FACTOR= 0.892

DESIGN HOURLY VOL.= **2545**
% HV= **3**

Table A4: Morning and Evening Peak Traffic-SOUTH WEST SLIP

MANUAL TRAFIC COUNT

DATE(MOR) Thursday, 05 August 2010 LOCATION TETTEH QUARSHIE INTERCHANGE
DATE(EVE) Friday, 06 August 2010 STATION NO SOUTH WEST SLIP

		CLASSIFICATION								
DURATION	CARS	PICK-UP	SMALL BUS	MEDIUM BUS	LARGE BUS	LIGHT TRUCK	MEDIUM TRUCK	HEAVY TRUCK	TRUCK TRAILER	TOTAL(PCE)
7:00-7:15	223	95	36	4	0	5	3	1	0	389
7:15-7:30	178	66	40	3	0	1	2	0	0	303
7:30-7:45	191	60	20	21	0	5	1	1	0	318
7:45-8:00	190	94	13	24	1	4	0	1	0	343
8:00-8:15	165	85	25	25	2	4	1	0	0	326
8:15-8:30	163	96	20	24	0	11	2	0	0	346
8:30-8:45	210	100	20	23	0	7	0	0	0	380
8:45-9:00	107	53	9	6	0	10	0	0	0	204
9:00-9:15	90	50	15	1	0	2	3	1	0	175
9:15-9:30	76	47	13	0	0	2	4	1	0	157
9:30-9:45	114	58	18	1	1	6	5	2	0	230
9:45-10:00	99	43	15	0	1	5	0	0	0	175
3:00-3:15										
3:15-3:30										
3:30:3:45	58	25	3	0	0	5	3	1	0	110
3:45-4:00	81	38	10	2	0	3	6	0	0	157
4:00-4:15	73	42	7	0	0	4	4	2	0	149
4:15-4:30	92	39	10	1	2	3	4	1	0	168
4:30-4:45	86	42	10	2	9	6	5	2	0	190
4:45-5:00	81	33	8	3	0	2	6	2	0	153
5:00-5:15	83	30	4	0	3	3	6	0	0	146
5:15-5:30	90	42	13	2	0	1	1	0	0	155
5:30-5:45	106	32	15	0	0	5	2	3	0	182
5:45-6:00	76	28	3	1	0	5	6	0	0	119
PCE VALUES	1	1	1.2	1.2	1.5	2.6	2.6	2.6	2.7	

MORNING PEAK

7:00-7:15	223	95	36	4	0	5	3	1	0	389
7:15-7:30	178	66	40	3	0	1	2	0	0	303
7:30-7:45	191	60	20	21	0	5	1	1	0	318
7:45-8:00	190	94	13	24	1	4	0	1	0	343

EVENING PEAK

4:00-4:15	73	42	7	0	0	4	4	2	0	149
4:15-4:30	92	39	10	1	2	3	4	1	0	168
4:30-4:45	86	42	10	2	9	6	5	2	0	190
4:45-5:00	81	33	8	3	0	2	6	2	0	153

PEAK HOUR FACTOR= VOLUME DURING PEAK HOUR / 4*VOL. DURING PEAK 15 MIN. WITHIN PEAK HOUR

DESIGN HOURLY VOL.= PEAK HOUR VOLUME / PEAK HOUR FACTOR

MORNING
PEAK HOUR FACTOR= 0.869

DESIGN HOURLY VOL.= **1558**
% HV= **3**

EVENING
PEAK HOUR FACTOR= 0.870

DESIGN HOURLY VOL.= **759**
% HV= **8**

Table A5: Morning and Evening Peak Traffic-SOUTH WEST LOOP.

MANUAL TRAFIC COUNT

DATE(MOR): Friday, 06 August 2010 LOCATION: TETTEH QUARSHIE INTERCHANGE
DATE(EVE): STATION NO: SOUTH WEST LOOP

		CLASSIFICATION								
DURATION	CARS	PICK-UP	SMALL BUS	MEDIUM BUS	LARGE BUS	LIGHT TRUCK	MEDIUM TRUCK	HEAVY TRUCK	TRUCK TRAILER	TOTAL(PCE)
7:00-7:15										0
7:15-7:30	31	11	2	1	0	1	0	2	1	56
7:30-7:45	37	18	1	2	0	0	1	2	0	66
7:45-8:00	35	19	1	0	0	3	0	2	1	71
8:00-8:15	45	13	3	1	0	7	1	1	2	92
8:15-8:30	32	22	0	1	0	1	0	1	1	63
8:30-8:45	48	19	3	1	0	3	2	3	1	95
8:45-9:00	44	18	1	4	0	5	2	3	1	97
9:00-9:15	50	30	3	2	0	4	1	6	4	125
9:15-9:30	55	34	2	4	0	4	2	5	3	133
9:30-9:45	57	41	3	2	0	7	2	1	0	130
9:45-10:00	72	34	8	2	0	3	4	3	3	152
3:00-3:15										0
3:15-3:30										0
3:30:3:45	65	25	7	1	3	3	1	2	2	125
3:45-4:00	89	30	4	2	1	3	4	6	3	170
4:00-4:15	92	38	3	2	1	7	3	3	1	174
4:15-4:30	86	43	1	2	0	5	0	1	2	154
4:30-4:45	97	46	4	4	0	5	3	2	0	179
4:45-5:00	101	30	1	1	1	5	2	0	4	164
5:00-5:15	101	30	6	7	1	4	2	1	2	172
5:15-5:30	125	40	3	15	0	4	3	0	3	213
5:30-5:45	143	47	8	12	0	7	1	3	0	243
5:45-6:00	126	60	3	4	0	8	0	3	3	231
PCE VALUES	1	1	1.2	1.2	1.5	2.6	2.6	2.6	2.7	
MORNING PEAK										
9:00-9:15	50	30	3	2	0	4	1	6	4	125
9:15-9:30	55	34	2	4	0	4	2	5	3	133
9:30-9:45	57	41	3	2	0	7	2	1	0	130
9:45-10:00	72	34	8	2	0	3	4	3	3	152
EVENING PEAK										
5:00-5:15	101	30	6	7	1	4	2	1	2	172
5:15-5:30	125	40	3	15	0	4	3	0	3	213
5:30-5:45	143	47	8	12	0	7	1	3	0	243
5:45-6:00	126	60	3	4	0	8	0	3	3	231

PEAK HOUR FACTOR= VOLUME DURING PEAK HOUR / 4*VOL. DURING PEAK 15 MIN. WITHIN PEAK HOUR

DESIGN HOURLY VOL.= PEAK HOUR VOLUME / PEAK HOUR FACTOR

MORNING
PEAK HOUR FACTOR= 0.888

DESIGN HOURLY VOL.= **608**
% HV= **11**

EVENING
PEAK HOUR FACTOR= 0.884

DESIGN HOURLY VOL.= **970**
% HV= **7**

Table A6: Morning and Evening Peak Traffic-SOUTH EAST SLIP 1.

MANUAL TRAFIC COUNT

DATE(MOR):
DATE(EVE): Friday, 06 August 2010

LOCATION: TETTEH QUARSHIE INTERCHANGE
STATION NO: SOUTH EAST SLIP 1

		CLASSIFICATION								
DURATION	CARS	PICK-UP	SMALL BUS	MEDIUM BUS	LARGE BUS	LIGHT TRUCK	MEDIUM TRUCK	HEAVY TRUCK	TRUCK TRAILER	TOTAL(PCE)
7:00-7:15										0
7:15-7:30										0
7:30-7:45										0
7:45-8:00										0
8:00-8:15										0
8:15-8:30										0
8:30-8:45										0
8:45-9:00										0
9:00-9:15										0
9:15-9:30										0
9:30-9:45										0
9:45-10:00										0
3:00-3:15	188	75	16	1	2	11	4	5	1	341
3:15-3:30	196	96	42	5	2	8	4	6	0	398
3:30:3:45	204	88	22	2	1	7	6	1	0	359
3:45-4:00	220	99	51	1	5	3	8	4	0	428
4:00-4:15	270	110	48	4	5	4	5	4	0	484
4:15-4:30	258	116	35	5	2	8	1	0	1	451
4:30-4:45	277	107	54	2	3	3	10	3	0	497
4:45-5:00	208	110	54	1	3	5	3	4	0	420
5:00-5:15	180	69	42	2	5	4	5	4	0	343
5:15-5:30	234	98	47	1	1	6	5	2	1	428
5:30-5:45	235	110	37	7	4	2	7	3	0	435
5:45-6:00	206	113	34	1	4	2	2	3	0	385
PCE VALUES	1	1	1.2	1.2	1.5	2.6	2.6	2.6	2.7	

EVENING PEAK

4:00-4:15	270	110	48	4	5	4	5	4	0	484
4:15-4:30	258	116	35	5	2	8	1	0	1	451
4:30-4:45	277	107	54	2	3	3	10	3	0	497
4:45-5:00	208	110	54	1	3	5	3	4	0	420

PEAK HOUR FACTOR= VOLUME DURING PEAK HOUR / 4*VOL. DURING PEAK 15 MIN. WITHIN PEAK HOUR

DESIGN HOURLY VOL.= PEAK HOUR VOLUME / PEAK HOUR FACTOR

MORNING
PEAK HOUR FACTOR= #DIV/0!

DESIGN HOURLY VOL.= **#DIV/0!**
% HV= #DIV/0!

EVENING
PEAK HOUR FACTOR= 0.931

DESIGN HOURLY VOL.= **1989**
% HV= **4**

Table A7: Morning and Evening Peak Traffic- SOUTH EAST SLIP 2

MANUAL TRAFIC COUNT

DATE(MOR) LOCATION TETTEH QUARSHIE INTERCHANGE
DATE(EVE) STATION NO SOUTH EAST SLIP 2

		CLASSIFICATION								
DURATION	CARS	PICK-UP	SMALL BUS	MEDIUM BUS	LARGE BUS	LIGHT TRUCK	MEDIUM TRUCK	HEAVY TRUCK	TRUCK TRAILER	TOTAL(PCE)
7:00-7:15	179	21	25	30	7	6	3	4	0	310
7:15-7:30	161	7	37	23	1	8	1	1	1	270
7:30-7:45	133	25	23	12	5	6	3	0	2	236
7:45-8:00	103	13	13	17	3	7	1	1	3	188
8:00-8:15	136	8	14	16	1	10	1	3	0	218
8:15-8:30	145	25	13	25	7	10	6	1	1	273
8:30-8:45	80	20	19	20	1	2	3	5	1	177
8:45-9:00	131	37	17	11	2	6	4	4	3	249
9:00-9:15	91	44	16	12	3	3	2	3	2	199
9:15-9:30	146	53	25	20	8	11	13	5	1	343
9:30-9:45	154	53	17	12	3	14	7	2	2	312
9:45-10:00	145	51	30	15	4	8	3	8	1	308
3:00-3:15										0
3:15-3:30	225	76	25	22	2	6	8	4	3	415
3:30:3:45	220	80	25	6	2	7	1	0	0	361
3:45-4:00	207	52	22	20	5	8	5	1	4	364
4:00-4:15	217	75	42	17	4	8	5	1	1	408
4:15-4:30	245	66	12	16	4	8	4	1	1	387
4:30-4:45	255	39	37	16	3	12	1	2	0	401
4:45-5:00	190	67	13	31	2	6	3	4	2	352
5:00-5:15	237	70	28	15	3	12	3	0	0	402
5:15-5:30	220	72	18	1	1	19	17	3	1	420
5:30-5:45	223	73	16	10	5	6	5	1	0	366
5:45-6:00	193	73	35	18	8	13	30	2	1	461

PCE VALUES	1	1	1.2	1.2	1.5	2.6	2.6	2.6	2.7	

MORNING PEAK

9:00-9:15	91	44	16	12	3	3	2	3	2	199
9:15-9:30	146	53	25	20	8	11	13	5	1	343
9:30-9:45	154	53	17	12	3	14	7	2	2	312
9:45-10:00	145	51	30	15	4	8	3	8	1	308

EVENING PEAK

5:00-5:15	237	70	28	15	3	12	3	0	0	402
5:15-5:30	220	72	18	1	1	19	17	3	1	420
5:30-5:45	223	73	16	10	5	6	5	1	0	366
5:45-6:00	193	73	35	18	8	13	30	2	1	461

PEAK HOUR FACTOR= VOLUME DURING PEAK HOUR / 4*VOL. DURING PEAK 15 MIN. WITHIN PEAK HOUR

DESIGN HOURLY VOL.= PEAK HOUR VOLUME / PEAK HOUR FACTOR

MORNING
PEAK HOUR FACTOR= 0.847

DESIGN HOURLY VOL.= **1372**
% HV= **9**

EVENING
PEAK HOUR FACTOR= 0.894

DESIGN HOURLY VOL.= **1845**
% HV= **7**

Table A8: Morning and Evening Peak Traffic- SOUTH EAST LOOP 1

MANUAL TRAFIC COUNT

DATE(MOR)
DATE(EVE) Friday, 06 August 2010

LOCATION TETTEH QUARSHIE INTERCHANGE
STATION NO SOUTH EAST LOOP 1

		CLASSIFICATION								
DURATION	CARS	PICK-UP	SMALL BUS	MEDIUM BUS	LARGE BUS	LIGHT TRUCK	MEDIUM TRUCK	HEAVY TRUCK	TRUCK TRAILER	TOTAL(PCE)
7:00-7:15										0
7:15-7:30										0
7:30-7:45										0
7:45-8:00										0
8:00-8:15										0
8:15-8:30										0
8:30-8:45										0
8:45-9:00										0
9:00-9:15										0
9:15-9:30										0
9:30-9:45										0
9:45-10:00										0
3:00-3:15										0
3:15-3:30	157	58	13	19	1	7	4	4	1	297
3:30:3:45	136	25	19	13	0	8	3	2	2	239
3:45-4:00	120	67	12	17	2	2	1	3	1	243
4:00-4:15	160	75	13	14	0	5	2	1	0	288
4:15-4:30	146	67	15	13	0	5	2	6	4	291
4:30-4:45	147	54	17	12	0	10	0	1	0	264
4:45-5:00	133	64	16	14	0	2	1	3	2	254
5:00-5:15	152	58	7	18	0	6	0	4	0	266
5:15-5:30	160	67	20	18	0	6	2	2	1	301
5:30-5:45	149	51	21	20	1	3	0	1	4	272
5:45-6:00	172	65	13	18	1	8	0	2	0	302
PCE VALUES	1	1	1.2	1.2	1.5	2.6	2.6	2.6	2.7	

EVENING PEAK

5:00-5:15	152	58	7	18	0	6	0	4	0	266
5:15-5:30	160	67	20	18	0	6	2	2	1	301
5:30-5:45	149	51	21	20	1	3	0	1	4	272
5:45-6:00	172	65	13	18	1	8	0	2	0	302

PEAK HOUR FACTOR= VOLUME DURING PEAK HOUR / 4*VOL. DURING PEAK 15 MIN. WITHIN PEAK HOUR

DESIGN HOURLY VOL.= PEAK HOUR VOLUME / PEAK HOUR FACTOR

MORNING
PEAK HOUR FACTOR= #DIV/0!

DESIGN HOURLY VOL.= **#DIV/0!**
% HV= #DIV/0!

EVENING
PEAK HOUR FACTOR= 0.945

DESIGN HOURLY VOL.= **1207**
% HV= 5

Table A9: Morning and Evening Peak Traffic- SOUTH EAST LOOP 2

MANUAL TRAFIC COUNT

DATE(MOR) Friday, 06 August 2010 LOCATION TETTEH QUARSHIE INTERCHANGE
DATE(EVE) Thursday, 05 August 2010 STATION NO SOUTH EAST LOOP 2

		CLASSIFICATION								
DURATION	CARS	PICK-UP	SMALL BUS	MEDIUM BUS	LARGE BUS	LIGHT TRUCK	MEDIUM TRUCK	HEAVY TRUCK	TRUCK TRAILER	TOTAL(PCE)
7:00-7:15	45	17	22	17	0	5	3	0	0	130
7:15-7:30	75	19	22	31	1	3	1	1	4	183
7:30-7:45	76	31	25	18	0	2	1	2	0	172
7:45-8:00	72	19	14	9	1	5	0	2	0	138
8:00-8:15	80	32	15	12	0	5	3	4	5	189
8:15-8:30	55	21	16	8	0	1	0	5	1	123
8:30-8:45	105	18	10	12	0	1	2	1	0	160
8:45-9:00	89	35	25	25	0	3	2	2	0	202
9:00-9:15	83	37	17	13	0	0	1	8	1	182
9:15-9:30	82	45	23	15	0	5	3	5	1	209
9:30-9:45	101	52	11	16	0	3	3	1	2	209
9:45-10:00	97	40	20	12	0	2	5	5	2	212
3:00-3:15	191	80	18	12	3	14	1	2	2	361
3:15-3:30	210	60	16	12	2	11	5	5	0	361
3:30:3:45	165	85	20	15	1	10	2	3	1	335
3:45-4:00	158	92	19	17	4	8	4	2	3	344
4:00-4:15	185	90	12	12	0	13	3	8	0	366
4:15-4:30	175	65	18	19	0	8	5	4	7	348
4:30-4:45	183	72	16	12	1	13	6	2	0	345
4:45-5:00	170	75	13	18	2	11	7	1	4	345
5:00-5:15	193	62	6	11	1	15	5	5	0	342
5:15-5:30	171	68	16	14	0	7	4	5	0	317
5:30-5:45	142	60	21	15	1	10	2	2	3	291
5:45-6:00	145	50	15	22	9	3	7	1	2	287
PCE VALUES	1	1	1.2	1.2	1.5	2.6	2.6	2.6	2.7	

MORNING PEAK

9:00-9:15	83	37	17	13	0	0	1	8	1	182
9:15-9:30	82	45	23	15	0	5	3	5	1	209
9:30-9:45	101	52	11	16	0	3	3	1	2	209
9:45-10:00	97	40	20	12	0	2	5	5	2	212

EVENING PEAK

4:00-4:15	185	90	12	12	0	13	3	8	0	366
4:15-4:30	175	65	18	19	0	8	5	4	7	348
4:30-4:45	183	72	16	12	1	13	6	2	0	345
4:45-5:00	170	75	13	18	2	11	7	1	4	345

PEAK HOUR FACTOR= VOLUME DURING PEAK HOUR / 4*VOL. DURING PEAK 15 MIN. WITHIN PEAK HOUR

DESIGN HOURLY VOL.= PEAK HOUR VOLUME / PEAK HOUR FACTOR

MORNING
PEAK HOUR FACTOR= 0.958
DESIGN HOURLY VOL.= **848**
% HV= **6**

EVENING
PEAK HOUR FACTOR= 0.958
DESIGN HOURLY VOL.= **1465**
% HV= **7**

Table A10: Morning and Evening Peak Traffic- EAST BOUND

MANUAL TRAFIC COUNT

DATE(MOR) Wednesday, 04 August 2010 LOCATION TETTEH QUARSHIE INTERCHANGE
DATE(EVE) Wednesday, 04 August 2010 STATION NO EAST BOUND

		CLASSIFICATION								
DURATION	CARS	PICK-UP	SMALL BUS	MEDIUM BUS	LARGE BUS	LIGHT TRUCK	MEDIUM TRUCK	HEAVY TRUCK	TRUCK TRAILER	TOTAL(PCE)
7:00-7:15										0
7:15-7:30										0
7:30-7:45										0
7:45-8:00										0
8:00-8:15										0
8:15-8:30	201	21	22	30	0	20	4	8	2	373
8:30-8:45	225	33	21	18	1	15	3	7	4	382
8:45-9:00	230	23	15	28	0	16	8	7	13	420
9:00-9:15	151	21	7	22	0	5	6	7	1	256
9:15-9:30	227	25	17	31	2	20	12	10	4	433
9:30-9:45	204	20	12	23	3	15	4	6	6	352
9:45-10:00	272	43	23	34	0	10	5	3	7	449
3:00-3:15	315	36	22	33	3	21	7	10	10	547
3:15-3:30	300	28	7	15	1	11	7	9	8	448
3:30:3:45	288	12	22	24	1	16	10	7	9	467
3:45-4:00	410	43	15	16	0	15	10	2	5	574
4:00-4:15	270	33	21	28	1	11	12	4	10	461
4:15-4:30	245	18	14	18	0	16	1	9	10	396
4:30-4:45	185	28	32	23	5	15	10	8	12	405
4:45-5:00	204	25	20	27	1	20	11	5	8	402
5:00-5:15	290	21	13	47	3	16	3	4	6	464
5:15-5:30	262	20	21	35	2	12	7	5	6	431
5:30-5:45	305	36	25	38	4	17	7	15	6	540
5:45-6:00	377	55	55	30	20	58	35	36	8	921
PCE VALUES	1	1	1.2	1.2	1.5	2.6	2.6	2.6	2.7	
MORNING PEAK										
9:00-9:15	151	21	7	22	0	5	6	7	1	256
9:15-9:30	227	25	17	31	2	20	12	10	4	433
9:30-9:45	204	20	12	23	3	15	4	6	6	352
9:45-10:00	272	43	23	34	0	10	5	3	7	449
EVENING PEAK										
5:00-5:15	290	21	13	47	3	16	3	4	6	464
5:15-5:30	262	20	21	35	2	12	7	5	6	431
5:30-5:45	305	36	25	38	4	17	7	15	6	540
5:45-6:00	377	55	55	30	20	58	35	36	8	921

PEAK HOUR FACTOR= VOLUME DURING PEAK HOUR / 4*VOL. DURING PEAK 15 MIN. WITHIN PEAK HOUR

DESIGN HOURLY VOL.= PEAK HOUR VOLUME / PEAK HOUR FACTOR

MORNING
PEAK HOUR FACTOR= 0.829

DESIGN HOURLY VOL.= **1796**
% HV= **10**

EVENING
PEAK HOUR FACTOR= 0.639

DESIGN HOURLY VOL.= **3684**
% HV= **12**

Table A11: Morning and Evening Peak Traffic-WEST BOUND (N1)

MANUAL TRAFIC COUNT

DATE(MOR): Wednesday, 04 August 2010 LOCATION TETTEH QUARSHIE INTERCHANGE
DATE(EVE): Wednesday, 04 August 2010 STATION NO WEST BOUND

		CLASSIFICATION								
DURATION	CARS	PICK-UP	SMALL BUS	MEDIUM BUS	LARGE BUS	LIGHT TRUCK	MEDIUM TRUCK	HEAVY TRUCK	TRUCK TRAILER	TOTAL(PCE)
7:00-7:15										0
7:15-7:30										0
7:30-7:45										0
7:45-8:00										0
8:00-8:15	220	160	38	35	7	22	9	13	19	644
8:15-8:30	305	200	68	38	3	11	2	2	1	678
8:30-8:45	345	165	50	45	7	12	3	6	2	695
8:45-9:00	310	161	51	31	6	17	5	5	1	651
9:00-9:15	300	165	29	31	6	11	5	19	11	667
9:15-9:30	240	130	41	36	4	10	3	6	6	534
9:30-9:45	275	163	40	42	3	12	8	4	2	609
9:45-10:00	330	175	51	38	3	12	7	4	6	692
3:00-3:15	215	150	50	25	5	21	5	1	10	560
3:15-3:30	255	140	43	20	0	25	6	4	15	602
3:30:3:45	230	150	46	40	3	15	6	8	23	625
3:45-4:00	225	110	33	20	4	18	5	5	13	513
4:00-4:15	220	160	38	35	7	22	9	13	19	644
4:15-4:30	185	80	37	18	6	14	5	6	15	446
4:30-4:45	280	115	40	37	29	22	8	7	8	649
4:45-5:00	205	80	33	26	11	14	6	3	12	465
5:00-5:15	230	66	47	30	9	19	6	5	8	502
5:15-5:30	185	91	34	32	2	11	6	9	11	456
5:30-5:45	230	104	32	25	1	5	5	4	8	462
5:45-6:00	225	130	50	41	7	17	9	8	8	585
PCE VALUES	1	1	1.2	1.2	1.5	2.6	2.6	2.6	2.7	

MORNING PEAK

8:00-8:15	220	160	38	35	7	22	9	13	19	644
8:15-8:30	305	200	68	38	3	11	2	2	1	678
8:30-8:45	345	165	50	45	7	12	3	6	2	695
8:45-9:00	310	161	51	31	6	17	5	5	1	651

EVENING PEAK

4:00-4:15	220	160	38	35	7	22	9	13	19	644
4:15-4:30	185	80	37	18	6	14	5	6	15	446
4:30-4:45	280	115	40	37	29	22	8	7	8	649
4:45-5:00	205	80	33	26	11	14	6	3	12	465

PEAK HOUR FACTOR= VOLUME DURING PEAK HOUR / 4*VOL. DURING PEAK 15 MIN. WITHIN PEAK HOUR

DESIGN HOURLY VOL.= PEAK HOUR VOLUME / PEAK HOUR FACTOR

MORNING
PEAK HOUR FACTOR= 0.960

DESIGN HOURLY VOL.= **2778**
% HV= **6**

EVENING
PEAK HOUR FACTOR= 0.849

DESIGN HOURLY VOL.= **2595**
% HV= **11**

Table A12: Morning and Evening Peak Traffic- NORTH WEST LOOP.

MANUAL TRAFIC COUNT

DATE(MOR) Wednesday, 04 August 2010 LOCATION TETTEH QUARSHIE INTERCHANGE
DATE(EVE) Tuesday, 03 August 2010 STATION NO NORHT WEST LOOP

		CLASSIFICATION								
DURATION	CARS	PICK-UP	SMALL BUS	MEDIUM BUS	LARGE BUS	LIGHT TRUCK	MEDIUM TRUCK	HEAVY TRUCK	TRUCK TRAILER	TOTAL(PCE)
7:00-7:15										0
7:15-7:30	217	71	20	4	4	4	0	3	1	344
7:30-7:45	196	70	19	5	2	6	1	2	0	321
7:45-8:00	152	66	11	0	5	1	2	2	1	254
8:00-8:15	173	64	20	7	6	4	4	2	0	304
8:15-8:30	158	86	14	1	7	5	1	3	0	296
8:30-8:45	124	58	18	2	2	5	2	0	0	227
8:45-9:00	161	78	28	5	5	12	0	2	0	323
9:00-9:15	180	70	41	5	4	13	0	2	0	350
9:15-9:30	172	87	43	11	4	11	0	5	1	374
9:30-9:45	213	81	36	8	5	5	0	4	0	378
9:45-10:00	173	83	38	10	2	14	0	3	0	361
3:00-3:15										0
3:15-3:30	175	103	42	3	3	7	3	1	7	384
3:30:3:45	162	64	43	4	3	7	1	1	2	316
3:45-4:00	253	95	70	11	6	8	6	0	1	493
4:00-4:15	215	80	35	7	2	20	9	0	4	435
4:15-4:30	222	110	59	7	2	1	2	2	4	438
4:30-4:45	110	49	30	2	0	4	3	0	0	216
4:45-5:00	188	102	70	4	0	11	1	2	0	415
5:00-5:15	96	61	43	3	4	14	1	2	0	262
5:15-5:30	223	90	55	13	2	13	3	2	3	453
5:30-5:45	180	75	43	10	7	5	7	4	3	379
5:45-6:00	162	155	42	10	1	7	2	2	2	415
PCE VALUES	1	1	1.2	1.2	1.5	2.6	2.6	2.6	2.7	

MORNING PEAK

9:00-9:15	180	70	41	5	4	13	0	2	0	350
9:15-9:30	172	87	43	11	4	11	0	5	1	374
9:30-9:45	213	81	36	8	5	5	0	4	0	378
9:45-10:00	173	83	38	10	2	14	0	3	0	361

5:00-5:15	96	61	43	3	4	14	1	2	0	262
5:15-5:30	223	90	55	13	2	13	3	2	3	453
5:30-5:45	180	75	43	10	7	5	7	4	3	379
5:45-6:00	162	155	42	10	1	7	2	2	2	415

PEAK HOUR FACTOR= VOLUME DURING PEAK HOUR / 4*VOL. DURING PEAK 15 MIN. WITHIN PEAK HOUR DESIGN HOURLY VOL.= PEAK HOUR VOLUME / PEAK HOUR FACTOR

MORNING
PEAK HOUR FACTOR= 0.968 DESIGN HOURLY VOL.= **1511**
% HV= **5**

EVENING
PEAK HOUR FACTOR= 0.833 DESIGN HOURLY VOL.= **1810**
% HV= **5**

Table A13: Morning and Evening Peak Traffic- NORTHWEST SLIP

MANUAL TRAFIC COUNT

DATE(MOR): Wednesday, 04 August 2010 LOCATION: TETTEH QUARSHIE INTERCHANGE
DATE(EVE): Wednesday, 04 August 2010 STATION NO: NORTHWEST SLIP

		CLASSIFICATION								
DURATION	CARS	PICK-UP	SMALL BUS	MEDIUM BUS	LARGE BUS	LIGHT TRUCK	MEDIUM TRUCK	HEAVY TRUCK	TRUCK TRAILER	TOTAL(PCE)
7:00-7:15	17	11	7	3	0	1	0	0	0	43
7:15-7:30	63	27	9	7	0	0	0	0	0	109
7:30-7:45	60	19	39	14	7	0	2	1	3	169
7:45-8:00	90	20	14	7	0	1	0	0	0	138
8:00-8:15	68	27	18	6	0	3	0	2	0	137
8:15-8:30	86	29	11	13	0	1	0	1	0	149
8:30-8:45	63	21	11	7	0	0	0	0	0	106
8:45-9:00	75	24	7	7	0	2	0	1	0	124
9:00-9:15	64	24	12	10	0	1	1	0	0	120
9:15-9:30	50	25	15	21	0	2	2	1	0	131
9:30-9:45	56	25	8	7	0	2	0	0	0	104
9:45-10:00	48	22	8	10	0	3	0	0	1	102
3:00-3:15	31	6	8	0	0	2	1	2	0	60
3:15-3:30	34	7	8	0	0	2	0	1	0	58
3:30:3:45	31	13	12	0	0	1	1	2	0	69
3:45-4:00	13	12	6	0	0	1	0	0	0	35
4:00-4:15	33	8	7	0	0	2	0	0	1	57
4:15-4:30	44	9	4	0	0	1	1	2	1	71
4:30-4:45	28	5	3	0	0	0	1	1	1	45
4:45-5:00	32	8	2	0	1	3	0	1	0	54
5:00-5:15	28	6	2	1	0	0	0	0	0	38
5:15-5:30	24	6	1	0	0	2	0	0	0	36
5:30-5:45	23	6	2	1	0	0	0	1	0	35
5:45-6:00	42	11	0	0	1	1	1	0	0	60
PCE VALUES	1	1	1.2	1.2	1.5	2.6	2.6	2.6	2.7	

MORNING PEAK

7:00-7:15	17	11	7	3	0	1	0	0	0	43
7:15-7:30	63	27	9	7	0	0	0	0	0	109
7:30-7:45	60	19	39	14	7	0	2	1	3	169
7:45-8:00	90	20	14	7	0	1	0	0	0	138

EVENING PEAK

4:00-4:15	33	8	7	0	0	2	0	0	1	57
4:15-4:30	44	9	4	0	0	1	1	2	1	71
4:30-4:45	28	5	3	0	0	0	1	1	1	45
4:45-5:00	32	8	2	0	1	3	0	1	0	54

PEAK HOUR FACTOR= VOLUME DURING PEAK HOUR / 4*VOL. DURING PEAK 15 MIN. WITHIN PEAK HOUR

DESIGN HOURLY VOL.= PEAK HOUR VOLUME / PEAK HOUR FACTOR

MORNING
PEAK HOUR FACTOR= 0.678

DESIGN HOURLY VOL.= **676**
% HV= **3**

EVENING
PEAK HOUR FACTOR= 0.800

DESIGN HOURLY VOL.= **284**
% HV= **6**

Table A14: Morning and Evening Peak Traffic- NORTH EAST LOOP.

MANUAL TRAFIC COUNT

DATE(MOR) Wednesday, 04 August 2010 LOCATION: TETTEH QUARSHIE INTERCHANGE
DATE(EVE) Tuesday, 03 August 2010 STATION NO: NORHT EAST LOOP

		CLASSIFICATION								
DURATION	CARS	PICK-UP	SMALL BUS	MEDIUM BUS	LARGE BUS	LIGHT TRUCK	MEDIUM TRUCK	HEAVY TRUCK	TRUCK TRAILER	TOTAL(PCE)
7:00-7:15	173	60	16	0	3	1	2	0	0	265
7:15-7:30	154	80	7	1	0	6	2	0	0	264
7:30-7:45	150	72	17	0	1	3	4	0	0	262
7:45-8:00	134	74	8	1	2	4	4	0	0	243
8:00-8:15	153	66	11	0	5	6	4	1	0	268
8:15-8:30	136	85	13	0	1	5	3	2	0	264
8:30-8:45	120	68	20	0	1	6	4	1	0	242
8:45-9:00	104	82	19	3	1	14	0	0	0	250
9:00-9:15	122	64	14	1	0	12	0	1	1	241
9:15-9:30	112	63	12	0	0	11	3	1	0	228
9:30-9:45	120	73	16	0	0	8	2	2	1	246
9:45-10:00	106	58	10	0	0	9	2	3	0	212
3:00-3:15										0
3:15-3:30	93	42	8	1	0	14	1	3	0	193
3:30:3:45	111	58	16	0	1	12	4	0	0	231
3:45-4:00	122	52	22	1	3	11	3	0	0	243
4:00-4:15	241	101	33	1	3	21	7	0	1	463
4:15-4:30	118	35	18	3	0	14	1	0	2	223
4:30-4:45	124	35	14	1	0	13	5	2	1	232
4:45-5:00	106	53	15	1	1	15	1	2	0	227
5:00-5:15	133	33	17	3	1	8	4	4	0	233
5:15-5:30	121	38	14	5	0	8	2	1	0	210
5:30-5:45	123	44	11	1	2	8	7	0	0	223
5:45-6:00	96	32	14	1	1	4	6	2	0	179
PCE VALUES	1	1	1.2	1.2	1.5	2.6	2.6	2.6	2.7	
MORNING PEAK										
8:00-8:15	153	66	11	0	5	6	4	1	0	268
8:15-8:30	136	85	13	0	1	5	3	2	0	264
8:30-8:45	120	68	20	0	1	6	4	1	0	242
8:45-9:00	104	82	19	3	1	14	0	0	0	250
EVENING PEAK										
4:00-4:15	241	101	33	1	3	21	7	0	1	463
4:15-4:30	118	35	18	3	0	14	1	0	2	223
4:30-4:45	124	35	14	1	0	13	5	2	1	232
4:45-5:00	106	53	15	1	1	15	1	2	0	227

PEAK HOUR FACTOR= VOLUME DURING PEAK HOUR / 4*VOL. DURING PEAK 15 MIN. WITHIN PEAK HOUR

DESIGN HOURLY VOL.= PEAK HOUR VOLUME / PEAK HOUR FACTOR

MORNING
PEAK HOUR FACTOR= 0.955
DESIGN HOURLY VOL.= **1073**
% HV= **5**

EVENING
PEAK HOUR FACTOR= 0.618
DESIGN HOURLY VOL.= **1851**
% HV= **9**

Table A15: Morning and Evening Peak Traffic- NORTH EAST SLIP.

MANUAL TRAFIC COUNT

DATE(MOR):
DATE(EVE):

LOCATION: TETTEH QUARSHIE INTERCHANGE
STATION NO: NORTH EAST SLIP

		CLASSIFICATION								
DURATION	CARS	PICK-UP	SMALL BUS	MEDIUM BUS	LARGE BUS	LIGHT TRUCK	MEDIUM TRUCK	HEAVY TRUCK	TRUCK TRAILER	TOTAL(PCE)
7:00-7:15										0
7:15-7:30	47	15	5	0	0	0	5	2	0	86
7:30-7:45	41	11	9	0	0	0	2	0	0	68
7:45-8:00	43	15	6	0	0	0	1	3	1	78
8:00-8:15	51	27	8	0	0	1	1	1	0	95
8:15-8:30	43	23	7	0	0	3	3	0	0	90
8:30-8:45	34	23	7	0	0	2	2	4	1	89
8:45-9:00	48	12	10	0	0	1	4	7	0	103
9:00-9:15	25	14	7	1	0	2	0	1	0	56
9:15-9:30	39	17	6	0	1	2	1	2	1	80
9:30-9:45	38	16	11	1	0	1	4	3	1	92
9:45-10:00	45	21	7	0	0	2	1	5	0	95
3:00-3:15	30	13	7	0	0	3	0	6	0	75
3:15-3:30	30	17	6	0	0	2	3	2	0	72
3:30:3:45	33	16	5	0	1	3	5	0	0	77
3:45-4:00	34	20	7	1	0	1	4	3	0	84
4:00-4:15	35	15	10	0	0	2	2	2	1	80
4:15-4:30	29	17	9	1	0	5	3	1	1	84
4:30-4:45	31	23	8	1	0	2	3	1	0	80
4:45-5:00	57	25	12	0	1	9	3	2	0	134
5:00-5:15	38	40	9	0	0	4	2	5	0	117
5:15-5:30	48	17	6	1	1	2	3	4	0	98
5:30-5:45	65	32	13	0	0	5	2	3	0	139
5:45-6:00	76	25	10	0	0	5	4	5	1	152
PCE VALUES	1	1	1.2	1.2	1.5	2.6	2.6	2.6	2.7	

MORNING PEAK

8:00-8:15	51	27	8	0	0	1	1	1	0	95
8:15-8:30	43	23	7	0	0	3	3	0	0	90
8:30-8:45	34	23	7	0	0	2	2	4	1	89
8:45-9:00	48	12	10	0	0	1	4	7	0	103

EVENING PEAK

5:00-5:15	38	40	9	0	0	4	2	5	0	117
5:15-5:30	48	17	6	1	1	2	3	4	0	98
5:30-5:45	65	32	13	0	0	5	2	3	0	139
5:45-6:00	76	25	10	0	0	5	4	5	1	152

PEAK HOUR FACTOR= VOLUME DURING PEAK HOUR / 4*VOL. DURING PEAK 15 MIN. WITHIN PEAK HOUR

DESIGN HOURLY VOL.= PEAK HOUR VOLUME / PEAK HOUR FACTOR

MORNING
PEAK HOUR FACTOR= 0.914

DESIGN HOURLY VOL.= **413**
% HV= **9**

EVENING
PEAK HOUR FACTOR= 0.832

DESIGN HOURLY VOL.= **608**
% HV= **12**

APPENDIX B- SPOT SPEED MEASUREMENT

Table B1: Spot Speed Measurement- NORTH BOUND (N4)

SPOT SPEED COUNT

DATE(MOR): Thursday, August 05, 2010 LOCATION:
DATE(EVE): STATION NO: NORTH BOUND
WEATHER: ENUMERATOR:

MORNING

42	54	45	56	52	45	39	39	47	33	32
79	69	54	64	71	49	52	57	45	44	34
35	39	55	65	73	23	42	45	32	35	27
41	37	25	24	22	46	22	70	34	46	39
42	35	29	59	56	32	28	37	57	67	65
48	54	68	66	45	32	41	49	41	51	55
34	31	32	33	45	52	72	59	45	50	71
72	49	64	54	30	34	36	46	54	59	48
44	46	44	56	60	57	59	45	62	45	

EVENING

30	25	24	38	41	28	39	39	47	33	32
21	29	54	28	31	49	40	34	45	44	34
33	45	20	35	35	22	29	29	29	31	25
41	45	50	56	58	49	21	25	28	35	26

MORNING

No of Observed Vehicles (n)=	**98**		Standard Deviation(s)=	**13**	km/h
Time-Mean Speed (μ)=	**47**	km/h	Stand. Deviation of Mean(su)=	**1.36**	km/h
Variance=	**180.01**		85th Percentile(85th %)=	**62.9**	km/h

EVENING

No of Observed Vehicles (n)=	**44**		Standard Deviation(s)=	**10**	km/h
Time-Mean Speed (μ)=	**35**	km/h	Stand. Deviation of Mean(su)=	**1.5**	km/h
Variance=	**99.13**		85th Percentile(85th %)=	**46.1**	km/h

Table B2: Spot Speed Measurement- SOUTH BOUND (N4)

SPOT SPEED COUNT

DATE(MOR): Thursday, August 05, 2010
DATE(EVE):
WEATHER:
LOCATION:
STATION NO: SOUTH BOUND
ENUMERATOR:

MORNING

35	40	29	38	50	45	45	48	32	28	30
30	30	39	38	45	42	47	25	36	42	45
40	29	39	51	49	48	35	38	29	38	37
29	45	38	29	28	31	32	35	29	21	25
40	34	35	27	28	35	40	31	31	29	22
42	45	41	31	28	34	30	38	31	41	46
45	40	32	28	32	41	31	40	46	48	50

EVENING

59	50	65	71	73	75	65	71	65	65	48
59	71	65	65	59	50	51	49	50	53	58
56	56	60	70	68	60	59	55	56	70	72
60	58	68	89	75	62	58	55	68	58	69
59	68	58	52	56	63	63	54	55	68	72
67	67	61	75	65	65	71	68	66	59	49
66	59	59	58	69	68	69	58	73	69	

MORNING

No of Observed Vehicles (n)=	**77**		Standard Deviation(s)=	**7**	km/h
Time-Mean Speed (μ)=	**36**	km/h	Stand. Deviation of Mean(su)=	**0.85**	km/h
Variance	**55.14**		85th Percentile(85th %)=	**45**	km/h

EVENING

No of Observed Vehicles (n)=	**76**		Standard Deviation(s)=	**8**	km/h
Time-Mean Speed (μ)=	**63**	km/h	Stand. Deviation of Mean(su)=	**0.89**	km/h
Variance	**60.17**		85th Percentile(85th %)=	**70.75**	km/h

Table B3: Spot Speed Measurement- SOUTHWEST SLIP

SPOT SPEED COUNT

DATE(MOR): Thursday, August 05, 2010 LOCATION:
DATE(EVE): STATION NO: SOUTHWEST SLIP
WEATHER: ENUMERATOR:

MORNING

66	37	35	37	43	50	41	53	38	69	64
54	50	45	45	61	62	45	52	64	55	50
55	60	40	45	60	50	63	62	52	41	45
40	65	60	58	60	61	68	59	58	62	51
55	58	54	65	54	45	59	54	50	63	52
50	58	55	51	49	50	54	54	59	61	60
60	59	45	56	55	59	60	65	60	58	

EVENING

MORNING

No of Observed Vehicles (n)=	**76**		Standard Deviation(s)=	**8.1**	km/h
Time-Mean Speed (μ)=	**54**	km/h	Stand. Deviation of Mean(su)=	**0.93**	km/h
Variance	**65.46**		85th Percentile(85th %)=	**61**	km/h

EVENING

No of Observed Vehicles (n)=	**0**		Standard Deviation(s)=	**#DIV/0!**	km/h
Time-Mean Speed (μ)=	**#DIV/0!**	km/h	Stand. Deviation of Mean(su)=	**#DIV/0!**	km/h
Variance	**#DIV/0!**		85th Percentile(85th %)=	**#NUM!**	km/h

Table B4: Spot Speed Measurement- SOUTH WEST LOOP.

SPOT SPEED COUNT

DATE(MOR): Thursday, August 05, 2010 LOCATION:
DATE(EVE): STATION NO: SOUTHWEST LOOP
WEATHER: ENUMERATOR:

MORNING

45	37	42	34	35	35	40	34	47	34	40
36	43	30	42	40	39	39	40	39	31	43
35	45	38	39	40	26	39	35	44	30	49
33	34	36	34	45	42	48	40	44	38	33
34	40	35	37	45	38	41	38	35	48	37
45	37	44	44	33	39	34	38	38	35	40
50	37	37	40	39	38	49	41	34	38	44
35	39	42	33	37	49	34	38			

EVENING

MORNING

No of Observed Vehicles (n)=	85		Standard Deviation(s)=	4.9	km/h
Time-Mean Speed (μ)=	39	km/h	Stand. Deviation of Mean(su)=	0.53	km/h
Variance(v) =	23.59		85th Percentile(85th %)=	44	km/h

EVENING

No of Observed Vehicles (n)=	0		Standard Deviation(s)=	#DIV/0!	km/h
Time-Mean Speed (μ)=	#DIV/0!	km/h	Stand. Deviation of Mean(su)=	#DIV/0!	km/h
Variance(v) =	#DIV/0!		85th Percentile(85th %)=	#NUM!	km/h

Table B5: Spot Speed Measurement- SOUTH EAST SLIP

SPOT SPEED COUNT

DATE(MOR): Friday, August 06, 2010 LOCATION:
DATE(EVE): STATION NO: SOUHT EAST SLIP
WEATHER: ENUMERATOR:

MORNING

35	26	37	32	41	44	41	39	39	48	43
44	45	40	20	23	20	34	30	32	40	43
35	32	25	34	25	21	46	34	26	31	35
32	28	37	27	27	28	28	36	25	25	29
30	34	35	38	34	40	31	34	41	42	37
36	35	36	32	27	32	35	32	35	31	

EVENING

MORNING

No of Observed Vehicles (n)=	65		Standard Deviation(s)=	6.6	km/h
Time-Mean Speed (μ)=	34	km/h	Stand. Deviation of Mean(su)=	0.8	km/h
Variance=	42.94		85th Percentile(85th %)=	41	km/h

EVENING

No of Observed Vehicles (n)=	0		Standard Deviation(s)=	#DIV/0!	km/h
Time-Mean Speed (μ)=	#DIV/0!	km/h	Stand. Deviation of Mean(su)=	#DIV/0!	km/h
Variance=	#DIV/0!		85th Percentile(85th %)=	#NUM!	km/h

Table B6: Spot Speed Measurement- SOUTH EAST LOOP.

SPOT SPEED COUNT

DATE(MOR): Thursday, August 05, 2010 LOCATION:
DATE(EVE): STATION NO: SOUHT EAST LOOP
WEATHER: ENUMERATOR:

MORNING

30	39	35	43	46	35	43	25	32	35	40
35	42	46	40	44	42	50	45	40	40	39
55	40	41	35	60	45	45	50	48	42	40
56	44	49	51	44	44	41	41	40	42	54
45	60	46	41	49	56	39	42	54	54	50
40	58	47								

EVENING

MORNING

No of Observed Vehicles (n)=	**58**		Standard Deviation(s)=	**7.3**	km/h
Time-Mean Speed (μ)=	**44**	km/h	Stand. Deviation of Mean(su)=	**1.0**	km/h
Variance=	**53.19**		85th Percentile(85th %)=	**52.35**	km/h

EVENING

No of Observed Vehicles (n)=	**0**		Standard Deviation(s)=	**#DIV/0!**	km/h
Time-Mean Speed (μ)=	**#DIV/0!**	km/h	Stand. Deviation of Mean(su)=	**#DIV/0!**	km/h
Variance=	**#DIV/0!**		85th Percentile(85th %)=	**#NUM!**	km/h

Table B7: Spot Speed Measurement- EAST BOUND (N1)

SPOT SPEED COUNT

DATE(MOR): Thursday, August 05, 2010 LOCATION:
DATE(EVE): STATION NO: EAST BOUND
WEATHER: ENUMERATOR:

MORNING

56	70	59	59	58	75	56	57	80	61	68
75	74	73	80	83	60	60	67	78	69	60
69	72	63	62	53	64	65	66	86	76	80
70	79	74	58	59	78	65	81	79	79	62
59	61	68	83	77	79	80	63	59	71	68

EVENING

MORNING

No of Observed Vehicles (n)=	55		Standard Deviation(s)=	8.9	km/h
Time-Mean Speed (μ)=	69	km/h	Stand. Deviation of Mean(su)=	1.2	km/h
Variance=	78.32		85th Percentile(85th %)=	79	km/h

EVENING

No of Observed Vehicles (n)=	0		Standard Deviation(s)=	#DIV/0!	km/h
Time-Mean Speed (μ)=	#DIV/0!	km/h	Stand. Deviation of Mean(su)=	#DIV/0!	km/h
Variance=	#DIV/0!		85th Percentile(85th %)=	#NUM!	km/h

Table B8: Spot Speed Measurement- WEST BOUND (N1)

SPOT SPEED COUNT

DATE(MOR): Thursday, August 05, 2010 LOCATION:
DATE(EVE): STATION NO: WEST BOUND
WEATHER: ENUMERATOR:

MORNING

56	57	58	47	61	63	35	35	51	46	44
51	43	42	40	46	52	71	50	52	62	56
50	57	58	47	45	52	56	35	53	49	55
63	65	63	41	75	53	68	74	59	54	62
49	57	56	57	80	65	53	65	54	75	70
54	46	44	50	52	52	34	50	66	74	69
66	43	42	62	45	62	54	52	66	57	67
62	61	61	59	45	38	42	52	49	62	78
84	84	58	72	69	83	78				

EVENING

MORNING

No of Observed Vehicles (n)=	**95**		Standard Deviation(s)=	**11.6**	km/h
Time-Mean Speed (μ)=	**57**	km/h	Stand. Deviation of Mean(su)=	**1.2**	km/h
Variance=	**134.26**		85th Percentile(85th %)=	**68.9**	km/h

EVENING

No of Observed Vehicles (n)=	**0**		Standard Deviation(s)=	**#DIV/0!**	km/h
Time-Mean Speed (μ)=	**#DIV/0!**	km/h	Stand. Deviation of Mean(su)=	**#DIV/0!**	km/h
Variance=	**#DIV/0!**		85th Percentile(85th %)=	**#NUM!**	km/h

Table B9: Spot Speed Measurement- NORTH WEST LOOP.

SPOT SPEED COUNT

DATE(MOR): Thursday, August 05, 2010 LOCATION:
DATE(EVE): STATION NO: NORTH WEST LOOP
WEATHER: ENUMERATOR:

MORNING

37	45	47	46	38	52	49	26	49	39	49
22	28	31	40	44	51	52	34	34	54	43
48	52	43	45	50	45	39	42	52	34	45
38	36	37	45	28	44	52	46	45	30	39
47	45	44	45	55	44	41	45	55	45	47
45	54	49	57	41						

EVENING

MORNING

No of Observed Vehicles (n)=	**60**		Standard Deviation(s)=	**8**	km/h
Time-Mean Speed (μ)=	**43**	km/h	Stand. Deviation of Mean(su)=	**1.0**	km/h
Variance=	**59.16**		85th Percentile(85th %)=	**52**	km/h

EVENING

No of Observed Vehicles (n)=	**0**		Standard Deviation(s)=	**#DIV/0!**	km/h
Time-Mean Speed (μ)=	**#DIV/0!**	km/h	Stand. Deviation of Mean(su)=	**#DIV/0!**	km/h
Variance=	**#DIV/0!**		85th Percentile(85th %)=	**#NUM!**	km/h

Table B10: Spot Speed Measurement- NORTH WEST SLIP.

SPOT SPEED COUNT

DATE(MOR): Thursday, August 05, 2010 LOCATION:
DATE(EVE): STATION NO: NORTH WEST SLIP
WEATHER: ENUMERATOR:

MORNING

35	61	49	68	45	54	65	62	82	53	52
73	52	50	48	54	52	45	54	60	62	52
61	63	57	62	59	60	53	52	60	66	71
53	50	53	76	72	68	61	56	59	68	57
54	59	61	66	60	65	65	64	45	63	63
66										

EVENING

MORNING

No of Observed Vehicles (n)=	**56**		Standard Deviation(s)=	**9**	km/h
Time-Mean Speed (μ)=	**59**	km/h	Stand. Deviation of Mean(su)=	**1.1**	km/h
Variance=	**72.67**		85th Percentile(85th %)=	**66**	km/h

EVENING

No of Observed Vehicles (n)=	**0**		Standard Deviation(s)=	**#DIV/0!**	km/h
Time-Mean Speed (μ)=	**#DIV/0!**	km/h	Stand. Deviation of Mean(su)=	**#DIV/0!**	km/h
Variance=	**#DIV/0!**		85th Percentile(85th %)=	**#NUM!**	km/h

Table B11: Spot Speed Measurement- NORTH EAST LOOP.

SPOT SPEED COUNT

DATE(MOR): Thursday, August 05, 2010 LOCATION:
DATE(EVE): STATION NO: NORTH EAST LOOP
WEATHER: ENUMERATOR:

MORNING

46	46	38	40	40	37	32	33	35	38	50
43	44	38	41	41	45	34	42	39	37	34
42	40	41	32	38	38	32	36	53	38	45
47	42	20	45	34	49	43	44	35	49	34
46	37	45	46	39	30	38	37	37	37	39
47	44	34	39	43	41	37	53	51	48	

EVENING

MORNING

No of Observed Vehicles (n)=	65		Standard Deviation(s)=	6	km/h
Time-Mean Speed (μ)=	40	km/h	Stand. Deviation of Mean(su)=	0.7	km/h
Variance=	35.86	km/h	85th Percentile(85th %)=	46	km/h

EVENING

No of Observed Vehicles (n)=	0		Standard Deviation(s)=	#DIV/0!	km/h
Time-Mean Speed (μ)=	#DIV/0!	km/h	Stand. Deviation of Mean(su)=	#DIV/0!	km/h
Variance=	#DIV/0!	km/h	85th Percentile(85th %)=	#NUM!	km/h

Table B12: Spot Speed Measurement- NORTH EAST SLIP

SPOT SPEED COUNT

DATE(MOR): Monday, September 20, 2010 LOCATION:
DATE(EVE): STATION NO: NORTH EAST SLIP
WEATHER: ENUMERATOR:

MORNING

EVENING

43	45	43	45	35	47	54	52	59	57	52
46	45	34	48	45	53	64	36	40	59	39
44	38	41	48	44	40	45	44	40	39	32
55	35	35	43	53	51	36	46	43	53	46
47	52	42	42	50	45	39	46	45	60	56
59	48	49	51	29	63	39	51	43	34	39
43	39	49	49	34	59	59	45	63	47	38
36	63	59	31	56						

MORNING

No of Observed Vehicles (n)=	**0**		Standard Deviation(s)=	**#DIV/0!**	km/h
Time-Mean Speed (μ)=	**#DIV/0!**	km/h	Stand. Deviation of Mean(su)=	**#DIV/0!**	km/h
Variance=	**#DIV/0!**		85th Percentile(85th %)=	**#NUM!**	km/h

EVENING

No of Observed Vehicles (n)=	**82**		Standard Deviation(s)=	**8**	km/h
Time-Mean Speed (μ)=	**46**	km/h	Stand. Deviation of Mean(su)=	**0.93**	km/h
Variance=	**70.58**		85th Percentile(85th %)=	**56**	km/h

APPENDIX C – SYNCHRO AND SIM TRAFFIC REPORTS_EXISTING CONDITIONS

APPENDIX C1 – SYNCHRO AND SIM TRAFFIC REPORTS_EXISTING CONDITIONS (Morning Peak)

Lanes, Volumes, Timings
5: Motorway Extension(N1) &

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NWL	NWR	SWL	SWR
Lane Configurations										
Volume (vph)	0	2048	1169	0	1267	0	0	0	0	676
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		2%			-2%		0%		0%	
Lane Util. Factor	1.00	0.95	0.95	1.00	0.95	1.00	1.00	1.00	1.00	0.88
Frt		0.945								0.850
Flt Protected										
Satd. Flow (prot)	0	3143	0	0	3440	0	0	0	0	2760
Flt Permitted										
Satd. Flow (perm)	0	3143	0	0	3440	0	0	0	0	2760
Link Speed (k/h)		69			57		54		54	
Link Distance (m)		46.5			275.6		67.2		93.2	
Travel Time (s)		2.4			17.4		4.5		6.2	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	2%	10%	3%	2%	6%	2%	2%	2%	2%	3%
Adj. Flow (vph)	0	2048	1169	0	1267	0	0	0	0	676
Shared Lane Traffic (%)										
Lane Group Flow (vph)	0	3217	0	0	1267	0	0	0	0	676
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Right	Left	Right
Median Width(m)		6.0			6.0		0.0		0.0	
Link Offset(m)		0.0			0.0		0.0		0.0	
Crosswalk Width(m)		4.8			4.8		4.8		4.8	
Two way Left Turn Lane										
Headway Factor	1.01	1.01	1.01	0.99	0.99	0.99	1.00	1.00	1.00	1.00
Turning Speed (k/h)	25		15	25		15	25	15	25	15
Sign Control		Free			Free		Stop		Free	

Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization	97.4%	ICU Level of Service	F
Analysis Period (min)	15		

base case-morning peak
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Figure C1-1: Lanes, Volume & Timing Report-INTERSECTION(S) 5_N1

Lanes, Volumes, Timings
9: ACC-MAD(N4) &

Lane Group	NBL	NBT	NBR	SBL	SBT	SBR	NWL	NWR	NEL	NER
Lane Configurations										
Volume (vph)	0	2468	0	0	4389	676	0	413	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		1%			-1%		-3%		0%	
Lane Util. Factor	1.00	0.91	1.00	1.00	0.91	0.91	1.00	0.88	1.00	1.00
Frt					0.980			0.850		
Flt Protected										
Satd. Flow (prot)	0	5011	0	0	5009	0	0	2647	0	0
Flt Permitted										
Satd. Flow (perm)	0	5011	0	0	5009	0	0	2647	0	0
Link Speed (k/h)		47			36		40		50	
Link Distance (m)		224.2			157.5		105.3		48.9	
Travel Time (s)		17.2			15.8		9.5		3.5	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	2%	3%	2%	2%	2%	2%	2%	9%	2%	2%
Adj. Flow (vph)	0	2468	0	0	4389	676	0	413	0	0
Shared Lane Traffic (%)										
Lane Group Flow (vph)	0	2468	0	0	5065	0	0	413	0	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Right	Left	Right
Median Width(m)		4.0			4.0		0.0		0.0	
Link Offset(m)		0.0			0.0		0.0		0.0	
Crosswalk Width(m)		4.8			4.8		4.8		4.8	
Two way Left Turn Lane										
Headway Factor	1.01	1.01	1.01	0.99	0.99	0.99	0.98	0.98	1.00	1.00
Turning Speed (k/h)	25		15	25		15	25	15	25	15
Sign Control		Free			Free		Free		Stop	

Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization 144.3%		ICU Level of Service H	
Analysis Period (min) 15			

Figure C1-2: Lanes, Volume & Timing Report-INTERSECTION(S) 9_N4

Lanes, Volumes, Timings
24: ACC-MAD(N4) & Southwest Slip

Lane Group	NBL	NBT	NBR	SBL	SBT	SBR	SEL	SER	SWL	SWR
Lane Configurations										
Volume (vph)	0	2334	1989	0	5292	0	0	1169	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		1%			-1%		0%		0%	
Lane Util. Factor	1.00	0.91	0.91	1.00	0.91	1.00	1.00	0.88	1.00	1.00
Frt		0.931						0.850		
Flt Protected										
Satd. Flow (prot)	0	4686	0	0	5111	0	0	2760	0	0
Flt Permitted										
Satd. Flow (perm)	0	4686	0	0	5111	0	0	2760	0	0
Link Speed (k/h)		47			36		54		50	
Link Distance (m)		148.4			238.3		101.8		141.7	
Travel Time (s)		11.4			23.8		6.8		10.2	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	2%	3%	2%	2%	2%	2%	2%	3%	2%	2%
Adj. Flow (vph)	0	2334	1989	0	5292	0	0	1169	0	0
Shared Lane Traffic (%)										
Lane Group Flow (vph)	0	4323	0	0	5292	0	0	1169	0	0
Enter Blocked Intersection	No	No	No	No	No	No	No	2 veh	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Right	Left	Right
Median Width(m)		4.0			4.0		0.0		0.0	
Link Offset(m)		0.0			0.0		0.0		0.0	
Crosswalk Width(m)		4.8			4.8		4.8		4.8	
Two way Left Turn Lane										
Headway Factor	1.01	1.01	1.01	0.99	0.99	0.99	1.00	1.00	1.00	1.00
Turning Speed (k/h)	25		15	25		15	25	15	25	15
Sign Control		Free			Free		Yield		Stop	

Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization 149.8%		ICU Level of Service H	
Analysis Period (min) 15			

base case-morning peak
Synchro 7 - Report

Figure C1-3: Lanes, Volume & Timing Report-INTERSECTION(S) 24_N4&SW S

Lanes, Volumes, Timings
29: Motorway Extension(N1) &

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	SBL	SBR	NWL	NWR
Lane Configurations		↑↑	↱		↑↑			↱↱		
Volume (vph)	0	1808	848	0	1705	0	0	1073	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		2%			-2%		1%		-2%	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.88	1.00	1.00
Frt			0.850					0.850		
Flt Protected										
Satd. Flow (prot)	0	3249	1567	0	3440	0	0	2694	0	0
Flt Permitted										
Satd. Flow (perm)	0	3249	1567	0	3440	0	0	2694	0	0
Link Speed (k/h)		69			57		40		50	
Link Distance (m)		264.0			264.8		69.9		53.1	
Travel Time (s)		13.8			16.7		6.3		3.8	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	2%	10%	2%	2%	6%	2%	2%	5%	2%	2%
Adj. Flow (vph)	0	1808	848	0	1705	0	0	1073	0	0
Shared Lane Traffic (%)										
Lane Group Flow (vph)	0	1808	848	0	1705	0	0	1073	0	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Right	Left	Right
Median Width(m)		6.0			6.0		0.0		0.0	
Link Offset(m)		0.0			0.0		0.0		0.0	
Crosswalk Width(m)		4.8			4.8		4.8		4.8	
Two way Left Turn Lane										
Headway Factor	1.01	1.01	1.01	0.99	0.99	0.99	1.01	1.01	0.99	0.99
Turning Speed (k/h)	25		15	25		15	25	15	25	15
Sign Control		Free			Free		Free		Stop	

Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization 104.6%		ICU Level of Service G	
Analysis Period (min) 15			

Figure C1-4: Lanes, Volume & Timing Report-INTERSECTION(S) 29_N1

Lanes, Volumes, Timings
31: SE Loop 1 &

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBR	SWL	SWR
Lane Configurations										
Volume (vph)	0	0	0	0	359	383	0	989	0	848
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		-2%			0%		2%		-2%	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.88
Frt					0.930			0.865		0.850
Flt Protected										
Satd. Flow (prot)	0	0	0	0	1732	0	0	1595	0	2815
Flt Permitted										
Satd. Flow (perm)	0	0	0	0	1732	0	0	1595	0	2815
Link Speed (k/h)		50			50		50		50	
Link Distance (m)		147.3			57.9		78.5		129.7	
Travel Time (s)		10.6			4.2		5.7		9.3	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	0	0	0	0	359	383	0	989	0	848
Shared Lane Traffic (%)										
Lane Group Flow (vph)	0	0	0	0	742	0	0	989	0	848
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Right	Left	Right
Median Width(m)		0.0			0.0		0.0		2.0	
Link Offset(m)		0.0			0.0		0.0		0.0	
Crosswalk Width(m)		4.8			4.8		4.8		4.8	
Two way Left Turn Lane										
Headway Factor	0.99	0.99	0.99	1.00	1.00	1.00	1.01	1.01	0.99	0.99
Turning Speed (k/h)	25		15	25		15	25	15	25	15
Sign Control		Yield			Yield		Yield		Yield	

Intersection Summary			
Area Type:	Other		
Control Type: Roundabout			
Intersection Capacity Utilization	110.2%	ICU Level of Service	H
Analysis Period (min)	15		

base case-morning peak Synchro 7 - Report

Figure C1-1: Lanes, Volume & Timing Report-INTERSECTION(S) 31_SE LP1

Lanes, Volumes, Timings
37: Motorway Extension(N1) &

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SER	NEL	NER
Lane Configurations		↑↑			↑↑	↱				↱↱
Volume (vph)	0	1808	0	0	1705	413	0	0	0	1372
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		2%			-2%		-3%		2%	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	1.00	1.00	0.88
Frt						0.850				0.850
Flt Protected										
Satd. Flow (prot)	0	3249	0	0	3440	1496	0	0	0	2582
Flt Permitted										
Satd. Flow (perm)	0	3249	0	0	3440	1496	0	0	0	2582
Link Speed (k/h)		69			57		50		34	
Link Distance (m)		264.8			88.5		125.6		88.4	
Travel Time (s)		13.8			5.6		9.0		9.4	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	2%	10%	2%	2%	6%	9%	2%	2%	2%	9%
Adj. Flow (vph)	0	1808	0	0	1705	413	0	0	0	1372
Shared Lane Traffic (%)										
Lane Group Flow (vph)	0	1808	0	0	1705	413	0	0	0	1372
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Right	Left	Right
Median Width(m)		6.0			6.0		0.0		0.0	
Link Offset(m)		0.0			0.0		0.0		0.0	
Crosswalk Width(m)		4.8			4.8		4.8		4.8	
Two way Left Turn Lane										
Headway Factor	1.01	1.01	1.01	0.99	0.99	0.99	0.98	0.98	1.01	1.01
Turning Speed (k/h)	25		15	25		15	25	15	25	15
Sign Control		Free			Free		Stop		Yield	

Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization 104.6%		ICU Level of Service G	
Analysis Period (min) 15			

base case-morning peak Synchro 7 - Report

Figure C1-2: Lanes, Volume & Timing Report-INTERSECTION(S) 37_N1

Lanes, Volumes, Timings
38: SE LP 2 & Southeast Slip 2

Lane Group	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations						
Volume (vph)	0	848	0	1372	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Grade (%)	-2%			2%	0%	
Lane Util. Factor	1.00	0.88	1.00	0.95	1.00	1.00
Frt		0.850				
Flt Protected						
Satd. Flow (prot)	0	2708	0	3279	0	0
Flt Permitted						
Satd. Flow (perm)	0	2708	0	3279	0	0
Link Speed (k/h)	44			34	50	
Link Distance (m)	50.0			129.7	176.1	
Travel Time (s)	4.1			13.7	12.7	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	2%	6%	2%	9%	2%	2%
Adj. Flow (vph)	0	848	0	1372	0	0
Shared Lane Traffic (%)						
Lane Group Flow (vph)	0	848	0	1372	0	0
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Left	Left	Right
Median Width(m)	0.0			2.0	0.0	
Link Offset(m)	0.0			0.0	0.0	
Crosswalk Width(m)	4.8			4.8	4.8	
Two way Left Turn Lane						
Headway Factor	0.99	0.99	1.01	1.01	1.00	1.00
Turning Speed (k/h)	25	15	25			15
Sign Control	Free			Free	Stop	

Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization 41.3%		ICU Level of Service A	
Analysis Period (min) 15			

base case-morning peak Synchro 7 - Report

Figure C1-3: Lanes, Volume & Timing Report-INTERSECTION(S) 38

Lanes, Volumes, Timings
40: NW Loop &

Lane Group	EBL	EBR	NBL	NBT	NBR	SBL	SBT	SBR	SWL	SWR
Lane Configurations										
Volume (vph)	0	1511	0	2468	1073	0	4389	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)	2%			1%			-1%		0%	
Lane Util. Factor	1.00	0.88	1.00	0.91	1.00	1.00	0.91	1.00	1.00	1.00
Frt		0.850			0.850					
Flt Protected										
Satd. Flow (prot)	0	2680	0	5011	1575	0	5111	0	0	0
Flt Permitted										
Satd. Flow (perm)	0	2680	0	5011	1575	0	5111	0	0	0
Link Speed (k/h)	43			47			36		46	
Link Distance (m)	71.4			262.2			224.2		71.8	
Travel Time (s)	6.0			20.1			22.4		5.6	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	2%	5%	2%	3%	2%	2%	2%	2%	2%	2%
Adj. Flow (vph)	0	1511	0	2468	1073	0	4389	0	0	0
Shared Lane Traffic (%)										
Lane Group Flow (vph)	0	1511	0	2468	1073	0	4389	0	0	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Left	Right	Left	Left	Right	Left	Right
Median Width(m)	0.0			4.0			4.0		0.0	
Link Offset(m)	0.0			0.0			0.0		0.0	
Crosswalk Width(m)	4.8			4.8			4.8		4.8	
Two way Left Turn Lane										
Headway Factor	1.01	1.01	1.01	1.01	1.01	0.99	0.99	0.99	1.00	1.00
Turning Speed (k/h)	25	15	25		15	25		15	25	15
Sign Control	Free			Free			Free		Stop	

Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization 144.3%		ICU Level of Service H	
Analysis Period (min) 15			

base case-morning peak
Synchro 7 - Report

Figure C1-4: Lanes, Volume & Timing Report-INTERSECTION(S) 40_NW LP

Lanes, Volumes, Timings
42: Motorway Extension(N1) &

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SER	NEL	NER
Lane Configurations		↑↑			↑↑	↱				↱↱
Volume (vph)	0	2048	0	0	1267	1511	0	0	0	608
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (m)	3.6	4.0	3.6	3.6	4.0	3.6	3.6	3.6	3.6	3.0
Grade (%)		2%			-2%		0%		0%	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	1.00	1.00	0.88
Frt						0.850				0.850
Flt Protected										
Satd. Flow (prot)	0	3393	0	0	3593	1553	0	0	0	2390
Flt Permitted										
Satd. Flow (perm)	0	3393	0	0	3593	1553	0	0	0	2390
Link Speed (k/h)		69			57		50		39	
Link Distance (m)		275.6			264.0		51.7		67.6	
Travel Time (s)		14.4			16.7		3.7		6.2	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	2%	10%	2%	2%	6%	5%	2%	2%	2%	11%
Adj. Flow (vph)	0	2048	0	0	1267	1511	0	0	0	608
Shared Lane Traffic (%)										
Lane Group Flow (vph)	0	2048	0	0	1267	1511	0	0	0	608
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Right	Left	Right
Median Width(m)		6.0			6.0		0.0		0.0	
Link Offset(m)		0.0			0.0		0.0		0.0	
Crosswalk Width(m)		4.8			4.8		4.8		4.8	
Two way Left Turn Lane										
Headway Factor	1.01	0.96	1.01	0.99	0.93	0.99	1.00	1.00	1.00	1.09
Turning Speed (k/h)	25		15	25		15	25	15	25	15
Sign Control		Free			Free		Stop		Free	

Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization	97.4%	ICU Level of Service	F
Analysis Period (min)	15		

base case-morning peak Synchro 7 - Report

Figure C1-5: Lanes, Volume & Timing Report-INTERSECTION(S) 42_N1

Lanes, Volumes, Timings
46: SE Loop 1 &

Lane Group	WBL	WBR	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NER
Lane Configurations										
Volume (vph)	0	1207	0	2334	0	0	5292	608	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (m)	3.6	3.0	3.6	3.7	3.6	3.6	3.7	3.7	3.6	3.6
Grade (%)	-2%			1%			-1%		2%	
Lane Util. Factor	1.00	0.88	1.00	0.91	1.00	1.00	0.91	1.00	1.00	1.00
Frt		0.850						0.850		
Flt Protected										
Satd. Flow (prot)	0	2627	0	5066	0	0	5168	1609	0	0
Flt Permitted										
Satd. Flow (perm)	0	2627	0	5066	0	0	5168	1609	0	0
Link Speed (k/h)	44			47			36		50	
Link Distance (m)	147.3			238.3			262.2		63.6	
Travel Time (s)	12.1			18.3			26.2		4.6	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	2%	2%	2%	3%	2%	2%	2%	2%	2%	2%
Adj. Flow (vph)	0	1207	0	2334	0	0	5292	608	0	0
Shared Lane Traffic (%)										
Lane Group Flow (vph)	0	1207	0	2334	0	0	5292	608	0	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Left	Right	Left	Left	Right	Left	Right
Median Width(m)	0.0			4.0			4.0		0.0	
Link Offset(m)	0.0			0.0			0.0		0.0	
Crosswalk Width(m)	4.8			4.8			4.8		4.8	
Two way Left Turn Lane										
Headway Factor	0.99	1.08	1.01	0.99	1.01	0.99	0.98	0.98	1.01	1.01
Turning Speed (k/h)	25	15	25		15	25		15	25	15
Sign Control	Yield			Free			Free		Stop	

Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization	149.8%	ICU Level of Service	H
Analysis Period (min)	15		

base case-morning peak
Synchro 7 - Report

Figure C1-6: Lanes, Volume & Timing Report-INTERSECTION(S) 46_SE LP 1

Lanes, Volumes, Timings
47: SE Slip 1 &

Lane Group	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations			↑	↱		
Volume (vph)	0	0	989	1000	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Grade (%)	0%		2%			0%
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt				0.850		
Flt Protected						
Satd. Flow (prot)	0	0	1809	1537	0	0
Flt Permitted						
Satd. Flow (perm)	0	0	1809	1537	0	0
Link Speed (k/h)	50		34			50
Link Distance (m)	108.0		141.7			78.5
Travel Time (s)	7.8		15.0			5.7
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	2%	2%	4%	4%	2%	2%
Adj. Flow (vph)	0	0	989	1000	0	0
Shared Lane Traffic (%)						
Lane Group Flow (vph)	0	0	989	1000	0	0
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Right	Left	Left
Median Width(m)	0.0		0.0			0.0
Link Offset(m)	0.0		0.0			0.0
Crosswalk Width(m)	4.8		4.8			4.8
Two way Left Turn Lane						
Headway Factor	1.00	1.00	1.01	1.01	1.00	1.00
Turning Speed (k/h)	25	15		15	25	
Sign Control	Stop		Free			Stop

Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization 65.3%		ICU Level of Service C	
Analysis Period (min) 15			

base case-morning peak
Synchro 7 - Report

Figure C1-7: Lanes, Volume & Timing Report-INTERSECTION(S) 47_SE SLP1

Lanes, Volumes, Timings
55: Spintex Road &

Lane Group	EBT	EBR	WBL	WBT	NEL	NER
Lane Configurations	↑			↑		↱
Volume (vph)	500	0	0	742	0	1000
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt						0.865
Flt Protected						
Satd. Flow (prot)	1863	0	0	1863	0	1611
Flt Permitted						
Satd. Flow (perm)	1863	0	0	1863	0	1611
Link Speed (k/h)	50			50	50	
Link Distance (m)	57.9			117.1	108.0	
Travel Time (s)	4.2			8.4	7.8	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	500	0	0	742	0	1000
Shared Lane Traffic (%)						
Lane Group Flow (vph)	500	0	0	742	0	1000
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Left	Left	Right
Median Width(m)	0.0			0.0	0.0	
Link Offset(m)	0.0			0.0	0.0	
Crosswalk Width(m)	4.8			4.8	4.8	
Two way Left Turn Lane						
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (k/h)		15	25		25	15
Sign Control	Free			Free	Yield	

Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization 94.9%		ICU Level of Service F	
Analysis Period (min) 15			

base case-morning peak Synchro 7 - Report

Figure C1-8: Lanes, Volume & Timing Report-INTERSECTION(S) 55_SPIN

SIMULATION REPORT-MORNING PEAK

SimTraffic Simulation Summary
Baseline-Existing

Summary of All Intervals

Start Time	6:57
End Time	7:15
Total Time (min)	18
Time Recorded (min)	15
# of Intervals	2
# of Recorded Intvls	1
Vehs Entered	2906
Vehs Exited	2553
Starting Vehs	382
Ending Vehs	735
Denied Entry Before	209
Denied Entry After	1438
Travel Distance (km)	2898
Travel Time (hr)	345.3
Total Delay (hr)	271.4
Total Stops	3575
Fuel Used (l)	4906.6

Interval #0 Information Seeding

Start Time	6:57
End Time	7:00
Total Time (min)	3
Volumes adjusted by Growth Factors.	
No data recorded this interval.	

base case-morning peak SimTraffic Report

Figure C1-13: Performance Report- SUMMARY

SimTraffic Performance Report
Baseline-Existing

5: Motorway Extension(N1) & Performance by movement

Movement	EBT	EBR	WBT	SWT	SWR	All
Total Delay (hr)	0.3	0.2	7.0	0.0	0.1	7.7
Delay / Veh (s)	5.4	7.4	108.9	0.0	3.9	40.5
Stop Delay (hr)	0.1	0.2	6.2	0.0	0.1	6.6
St Del/Veh (s)	2.7	6.1	95.9	0.0	2.0	34.8
Total Stops	4	4	399	0	48	455
Stop/Veh	0.02	0.03	1.72	0.00	0.36	0.67
Travel Dist (km)	8.8	5.5	58.8	0.0	9.7	83.0
Travel Time (hr)	0.4	0.4	8.1	0.0	0.5	9.4
Avg Speed (kph)	21	12	7	46	23	9
Fuel Used (l)	16.1	4.6	99.6	0.0	5.0	125.3
Fuel Eff. (kpl)	0.5	1.2	0.6	0.9	2.0	0.7
HC Emissions (g)	2	0	3	0	0	5
CO Emissions (g)	478	11	666	1	28	1184
NOx Emissions (g)	5	0	7	0	0	12
Vehicles Entered	196	122	245	1	135	699
Vehicles Exited	195	119	219	1	135	669
Hourly Exit Rate	780	476	876	4	540	2676
Input Volume	2048	1169	1267	6	676	5166
% of Volume	38	41	69	67	80	52
Denied Entry Before	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0
Density (m/veh)						20
Occupancy (veh)	2	2	32	0	2	37

base case-morning peak SimTraffic Report

Figure C1-14: Performance Report- INTERSECTION(S) 5_N1

SimTraffic Performance Report
Baseline-Existing

9: ACC-MAD(N4) & Performance by movement

Movement	NBT	SBT	SBR	NWR	All
Total Delay (hr)	0.2	32.0	4.6	0.2	36.9
Delay / Veh (s)	1.8	126.9	131.1	6.0	89.2
Stop Delay (hr)	0.0	30.2	4.2	0.1	34.6
St Del/Veh (s)	0.3	119.8	120.1	5.5	83.6
Total Stops	26	156	20	53	255
Stop/Veh	0.07	0.17	0.16	0.55	0.17
Travel Dist (km)	76.0	139.2	19.1	9.0	243.2
Travel Time (hr)	1.8	36.2	5.2	0.4	43.7
Avg Speed (kph)	42	21	17	20	25
Fuel Used (l)	50.8	408.7	56.3	5.6	521.4
Fuel Eff. (kpl)	1.5	0.3	0.3	1.6	0.5
HC Emissions (g)	2	5	0	0	7
CO Emissions (g)	323	1296	123	76	1818
NOx Emissions (g)	5	15	1	1	22
Vehicles Entered	359	910	127	98	1494
Vehicles Exited	358	905	125	96	1484
Hourly Exit Rate	1432	3620	500	384	5936
Input Volume	2468	4389	676	413	7946
% of Volume	58	82	74	93	75
Denied Entry Before	0	41	6	0	47
Denied Entry After	0	211	26	0	237
Density (m/veh)					32
Occupancy (veh)	7	26	4	2	39

base case-morning peak SimTraffic Report

Figure C1–15: Performance Report- INTERSECTION(S) 9_N4

SimTraffic Performance Report
Baseline-Existing

24: ACC-MAD(N4) & Southwest Slip Performance by movement

Movement	NBT	NBR	SBT	SER	All
Total Delay (hr)	40.3	35.1	1.3	6.1	82.8
Delay / Veh (s)	430.2	409.2	4.5	3648.7	176.5
Stop Delay (hr)	40.0	33.6	0.0	6.1	79.7
St Del/Veh (s)	427.8	391.4	0.0	3645.2	170.0
Total Stops	11	101	0	13	125
Stop/Veh	0.03	0.33	0.00	2.17	0.07
Travel Dist (km)	48.6	44.4	224.5	0.3	317.7
Travel Time (hr)	41.5	36.5	7.6	6.1	91.6
Avg Speed (kph)	32	13	30	0	17
Fuel Used (l)	412.0	341.6	186.9	50.8	991.3
Fuel Eff. (kpl)	0.1	0.1	1.2	0.0	0.3
HC Emissions (g)	6	3	3	2	14
CO Emissions (g)	1790	831	802	276	3700
NOx Emissions (g)	13	4	12	1	31
Vehicles Entered	340	307	1041	13	1701
Vehicles Exited	335	310	1030	0	1675
Hourly Exit Rate	1340	1240	4120	0	6700
Input Volume	2334	1989	5292	1169	10784
% of Volume	57	62	78	0	62
Denied Entry Before	39	41	0	0	80
Denied Entry After	310	233	0	0	543
Density (m/veh)					17
Occupancy (veh)	6	13	30	24	74

base case-morning peak SimTraffic Report

Figure C1–16: Performance Report- INTERSECTION(S) 24_N4

SimTraffic Performance Report
Baseline-Existing

29: Motorway Extension(N1) & Performance by movement

Movement	EBT	EBR	WBT	SBT	SBR	All
Total Delay (hr)	0.1	0.1	1.2	0.0	1.4	2.8
Delay / Veh (s)	1.6	4.2	9.7	1.2	36.7	10.7
Stop Delay (hr)	0.0	0.0	0.3	0.0	1.3	1.6
St Del/Veh (s)	0.2	0.5	2.7	0.0	34.3	6.2
Total Stops	0	0	96	0	106	202
Stop/Veh	0.00	0.00	0.21	0.00	0.80	0.21
Travel Dist (km)	62.8	32.2	119.8	0.1	7.7	222.5
Travel Time (hr)	1.3	0.9	3.4	0.0	1.6	7.1
Avg Speed (kph)	50	37	36	29	5	31
Fuel Used (l)	70.5	28.9	102.3	0.1	16.8	218.5
Fuel Eff. (kpl)	0.9	1.1	1.2	2.4	0.5	1.0
HC Emissions (g)	12	1	6	0	0	20
CO Emissions (g)	2745	562	1494	0	77	4878
NOx Emissions (g)	33	4	19	0	1	58
Vehicles Entered	231	120	458	4	135	948
Vehicles Exited	235	120	453	4	131	943
Hourly Exit Rate	940	480	1812	16	524	3772
Input Volume	1882	848	1705	33	1073	5541
% of Volume	50	57	106	48	49	68
Denied Entry Before	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0
Density (m/veh)						53
Occupancy (veh)	5	3	13	0	6	28

base case-morning peak SimTraffic Report

Figure C1–17: Performance Report- INTERSECTION(S) 29_N1

SimTraffic Performance Report
Baseline-Existing

31: SE Loop 1 & Performance by movement

Movement	WBT	WBR	NBT	NBR	SWT	SWR	All
Total Delay (hr)	0.4	0.4	0.0	0.5	0.0	0.2	1.5
Delay / Veh (s)	34.3	33.8	1.3	12.2	0.2	4.7	13.9
Stop Delay (hr)	0.4	0.3	0.0	0.4	0.0	0.1	1.2
St Del/Veh (s)	32.5	32.3	0.2	10.0	0.2	1.7	11.6
Total Stops	45	35	0	58	1	40	179
Stop/Veh	1.00	0.92	0.00	0.37	0.07	0.32	0.46
Travel Dist (km)	1.8	1.5	0.2	9.0	0.9	13.1	26.5
Travel Time (hr)	0.5	0.4	0.0	0.8	0.0	0.6	2.3
Avg Speed (kph)	4	4	25	12	23	23	12
Fuel Used (l)	5.2	4.5	0.2	12.6	1.9	17.4	41.9
Fuel Eff. (kpl)	0.3	0.3	1.1	0.7	0.4	0.8	0.6
HC Emissions (g)	0	0	0	0	2	0	3
CO Emissions (g)	12	25	25	73	263	168	565
NOx Emissions (g)	0	0	0	1	4	2	8
Vehicles Entered	45	39	6	158	14	125	387
Vehicles Exited	45	38	7	154	14	126	384
Hourly Exit Rate	180	152	28	616	56	504	1536
Input Volume	359	383	20	989	34	848	2633
% of Volume	50	40	140	62	165	59	58
Denied Entry Before	0	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0	0
Density (m/veh)							37
Occupancy (veh)	2	2	0	3	0	2	9

base case-morning peak SimTraffic Report

Figure C1-18: Performance Report- INTERSECTION(S) 31_SE LP 1

SimTraffic Performance Report
Baseline-Existing

37: Motorway Extension(N1) & Performance by movement

Movement	EBT	WBT	WBR	NER	All
Total Delay (hr)	0.2	0.3	0.1	4.2	4.8
Delay / Veh (s)	3.4	2.6	2.1	108.2	18.6
Stop Delay (hr)	0.0	0.2	0.0	4.1	4.3
St Del/Veh (s)	0.6	1.4	1.1	106.2	16.9
Total Stops	15	5	0	125	145
Stop/Veh	0.07	0.01	0.00	0.90	0.16
Travel Dist (km)	55.1	35.7	7.9	9.4	108.1
Travel Time (hr)	1.0	1.3	0.4	4.5	7.2
Avg Speed (kph)	54	30	24	2	15
Fuel Used (l)	27.7	72.1	10.0	44.1	153.9
Fuel Eff. (kpl)	2.0	0.5	0.8	0.2	0.7
HC Emissions (g)	4	4	1	2	11
CO Emissions (g)	785	1354	251	302	2692
NOx Emissions (g)	12	14	4	3	32
Vehicles Entered	225	459	102	142	928
Vehicles Exited	227	458	103	136	924
Hourly Exit Rate	908	1832	412	544	3696
Input Volume	1808	1705	413	1372	5298
% of Volume	50	107	100	40	70
Denied Entry Before	0	0	0	0	0
Denied Entry After	0	2	0	0	2
Density (m/veh)					31
Occupancy (veh)	4	5	1	18	28

base case-morning peak SimTraffic Report

Figure C1–19: Performance Report- INTERSECTION(S) 37_N1

SimTraffic Performance Report
Baseline-Existing

38: SE LP 2 & Southeast Slip 2 Performance by movement

Movement	SBT	SBR	NET	All
Total Delay (hr)	0.0	0.0	3.9	3.9
Delay / Veh (s)	0.9	0.5	70.2	42.2
Stop Delay (hr)	0.0	0.0	3.7	3.7
St Del/Veh (s)	0.0	0.1	66.4	39.8
Total Stops	0	0	199	199
Stop/Veh	0.00	0.00	1.01	0.60
Travel Dist (km)	0.2	5.7	28.1	34.0
Travel Time (hr)	0.0	0.2	4.7	5.0
Avg Speed (kph)	33	25	7	8
Fuel Used (l)	0.2	2.8	57.8	60.7
Fuel Eff. (kpl)	1.2	2.1	0.5	0.6
HC Emissions (g)	0	0	4	5
CO Emissions (g)	2	58	690	750
NOx Emissions (g)	0	1	7	8
Vehicles Entered	6	127	203	336
Vehicles Exited	6	128	193	327
Hourly Exit Rate	24	512	772	1308
Input Volume	34	848	1467	2349
% of Volume	71	60	53	56
Denied Entry Before	0	0	0	0
Denied Entry After	0	0	7	7
Density (m/veh)				23
Occupancy (veh)	0	1	16	17

base case-morning peak SimTraffic Report

Figure C1–20: Performance Report- INTERSECTION(S) 38_SE LP 2

SimTraffic Performance Report
Baseline-Existing

40: NW Loop & Performance by movement

Movement	EBR	NBT	NBR	SBT	All
Total Delay (hr)	1.2	0.2	0.2	6.0	7.7
Delay / Veh (s)	14.6	2.1	4.7	24.5	16.3
Stop Delay (hr)	1.0	0.0	0.0	3.8	4.8
St Del/Veh (s)	11.5	0.3	0.2	15.2	10.1
Total Stops	101	33	12	457	603
Stop/Veh	0.33	0.09	0.09	0.51	0.36
Travel Dist (km)	18.0	98.3	37.2	190.3	343.8
Travel Time (hr)	1.9	2.4	1.1	11.4	16.8
Avg Speed (kph)	10	40	34	17	20
Fuel Used (l)	22.2	83.4	31.2	205.3	342.0
Fuel Eff. (kpl)	0.8	1.2	1.2	0.9	1.0
HC Emissions (g)	1	3	1	4	9
CO Emissions (g)	115	696	317	1002	2130
NOx Emissions (g)	1	9	3	15	29
Vehicles Entered	304	366	137	905	1712
Vehicles Exited	310	359	137	872	1678
Hourly Exit Rate	1240	1436	548	3488	6712
Input Volume	1511	2469	1073	4389	9442
% of Volume	82	58	51	79	71
Denied Entry Before	0	0	0	0	0
Denied Entry After	0	0	0	0	0
Density (m/veh)					27
Occupancy (veh)	7	10	4	46	67

base case-morning peak SimTraffic Report

Figure C1–21: Performance Report- INTERSECTION(S) 40_NW LOOP

SimTraffic Performance Report
Baseline-Existing

42: Motorway Extension(N1) & Performance by movement

Movement	EBT	WBT	WBR	NET	NER	All
Total Delay (hr)	0.4	4.0	1.4	0.0	0.1	5.9
Delay / Veh (s)	7.0	55.1	16.3	0.4	3.1	23.4
Stop Delay (hr)	0.1	3.3	0.1	0.0	0.1	3.6
St Del/Veh (s)	2.2	45.1	0.7	0.0	2.5	14.1
Total Stops	20	212	44	0	33	309
Stop/Veh	0.10	0.81	0.14	0.00	0.24	0.34
Travel Dist (km)	51.4	72.0	82.3	0.3	6.1	212.2
Travel Time (hr)	1.1	5.4	3.2	0.0	0.3	10.1
Avg Speed (kph)	45	13	26	33	18	21
Fuel Used (l)	58.6	95.8	66.9	0.2	4.3	225.9
Fuel Eff. (kpl)	0.9	0.8	1.2	1.8	1.4	0.9
HC Emissions (g)	8	6	3	0	0	17
CO Emissions (g)	2158	1432	816	0	68	4474
NOx Emissions (g)	21	15	9	0	1	46
Vehicles Entered	195	280	305	11	136	927
Vehicles Exited	196	246	305	11	136	894
Hourly Exit Rate	784	984	1220	44	544	3576
Input Volume	2048	1271	1511	55	608	5493
% of Volume	38	77	81	80	89	65
Denied Entry Before	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0
Density (m/veh)						35
Occupancy (veh)	5	22	13	0	1	40

base case-morning peak SimTraffic Report

Figure C1–22: Performance Report- INTERSECTION(S) 42_ NI

SimTraffic Performance Report
Baseline-Existing

46: SE Loop 1 & Performance by movement

Movement	WBR	NBT	SBT	SBR	All
Total Delay (hr)	0.1	0.2	2.0	0.2	2.5
Delay / Veh (s)	2.9	1.9	6.8	6.8	5.4
Stop Delay (hr)	0.0	0.0	0.1	0.0	0.1
St Del/Veh (s)	0.5	0.2	0.3	0.5	0.3
Total Stops	17	24	79	16	136
Stop/Veh	0.10	0.07	0.07	0.12	0.08
Travel Dist (km)	23.3	76.7	288.0	35.8	423.8
Travel Time (hr)	0.8	1.8	10.3	1.3	14.2
Avg Speed (kph)	29	42	28	27	30
Fuel Used (l)	22.5	53.1	267.1	33.7	376.4
Fuel Eff. (kpl)	1.0	1.4	1.1	1.1	1.1
HC Emissions (g)	0	2	7	0	10
CO Emissions (g)	204	434	1527	148	2313
NOx Emissions (g)	2	6	24	2	35
Vehicles Entered	171	335	1060	132	1698
Vehicles Exited	171	332	1052	127	1682
Hourly Exit Rate	684	1328	4208	508	6728
Input Volume	1207	2334	5338	608	9487
% of Volume	57	57	79	84	71
Denied Entry Before	0	0	0	0	0
Denied Entry After	0	0	0	0	0
Density (m/veh)					37
Occupancy (veh)	3	7	41	5	57

base case-morning peak SimTraffic Report

Figure C1–23: Performance Report- INTERSECTION(S) 46_SE LP 1

SimTraffic Performance Report
Baseline-Existing

47: SE Slip 1 & Performance by movement

Movement	NBT	NBR	All
Total Delay (hr)	0.7	0.1	0.9
Delay / Veh (s)	15.8	3.2	9.8
Stop Delay (hr)	0.6	0.1	0.7
St Del/Veh (s)	13.4	1.5	7.7
Total Stops	88	11	99
Stop/Veh	0.53	0.07	0.31
Travel Dist (km)	21.9	20.2	42.1
Travel Time (hr)	1.5	0.9	2.5
Avg Speed (kph)	15	22	18
Fuel Used (l)	29.3	20.3	49.6
Fuel Eff. (kpl)	0.7	1.0	0.8
HC Emissions (g)	1	1	2
CO Emissions (g)	217	182	399
NOx Emissions (g)	3	2	5
Vehicles Entered	169	153	322
Vehicles Exited	165	153	318
Hourly Exit Rate	660	612	1272
Input Volume	1029	1000	2029
% of Volume	64	61	63
Denied Entry Before	0	0	0
Denied Entry After	0	0	0
Density (m/veh)			29
Occupancy (veh)	6	4	9

base case-morning peak SimTraffic Report

Figure C1–24: Performance Report- INTERSECTION(S) 47_SE SLP 1

SimTraffic Performance Report
Baseline-Existing

55: Spintex Road & Performance by movement

Movement	EBT	WBT	NET	NER	All
Total Delay (hr)	0.1	9.5	0.0	0.4	10.0
Delay / Veh (s)	4.0	388.5	0.6	9.7	98.8
Stop Delay (hr)	0.1	9.4	0.0	0.3	9.8
St Del/Veh (s)	4.2	385.0	0.0	7.0	96.9
Total Stops	31	86	0	104	221
Stop/Veh	0.25	0.98	0.00	0.68	0.60
Travel Dist (km)	1.6	9.6	0.2	15.0	26.4
Travel Time (hr)	0.2	9.7	0.0	1.0	11.0
Avg Speed (kph)	9	3	23	15	6
Fuel Used (l)	4.4	89.5	0.3	18.8	113.0
Fuel Eff. (kpl)	0.4	0.1	0.6	0.8	0.2
HC Emissions (g)	0	1	0	0	2
CO Emissions (g)	22	302	46	123	494
NOx Emissions (g)	0	2	1	2	5
Vehicles Entered	123	92	3	154	372
Vehicles Exited	122	84	3	152	361
Hourly Exit Rate	488	336	12	608	1444
Input Volume	500	742	20	1000	2262
% of Volume	98	45	60	61	64
Denied Entry Before	0	0	0	0	0
Denied Entry After	0	84	0	0	84
Density (m/veh)					17
Occupancy (veh)	1	13	0	4	18

base case-morning peak SimTraffic Report

Figure C1–25: Performance Report- INTERSECTION(S) 55_SPINTEX

SimTraffic Performance Report
Baseline-Existing

Total Network Performance

Total Delay (hr)	271.4
Delay / Veh (s)	358.0
Stop Delay (hr)	251.0
St Del/Veh (s)	331.2
Total Stops	3575
Stop/Veh	1.31
Travel Dist (km)	2898.1
Travel Time (hr)	345.3
Avg Speed (kph)	19
Fuel Used (l)	4906.6
Fuel Eff. (kpl)	0.6
HC Emissions (g)	162
CO Emissions (g)	39148
NOx Emissions (g)	430
Vehicles Entered	2906
Vehicles Exited	2553
Hourly Exit Rate	10212
Input Volume	106044
% of Volume	10
Denied Entry Before	209
Denied Entry After	1438
Density (m/veh)	28
Occupancy (veh)	624

base case-morning peak SimTraffic Report

Figure C1–26: Performance Report- INTERSECTION(S) NETWORK

Queuing and Blocking Report
Baseline-Existing

Intersection: 5: Motorway Extension(N1) &

Movement	EB	B20	WB	WB	SW
Directions Served	TR	T	T	T	R
Maximum Queue (m)	43.7	195.3	241.0	246.3	40.4
Average Queue (m)	10.6	27.9	228.7	216.1	19.6
95th Queue (m)	39.0	140.6	274.8	271.4	35.1
Link Distance (m)	26.6	190.7	225.2	225.2	57.0
Upstream Blk Time (%)	20	15	62	14	
Queuing Penalty (veh)	0	0	396	88	
Storage Bay Dist (m)					
Storage Blk Time (%)					
Queuing Penalty (veh)					

Intersection: 9: ACC-MAD(N4) &

Movement	NB	NB	SB	SB	SB	NW	NW
Directions Served	T	T	T	T	TR	R	R
Maximum Queue (m)	6.2	21.2	157.3	157.3	157.3	34.8	23.5
Average Queue (m)	1.8	14.8	112.1	114.2	94.3	15.6	10.7
95th Queue (m)	6.4	23.3	229.0	225.6	213.2	34.1	22.1
Link Distance (m)	184.4	184.4	152.7	152.7	152.7	71.9	71.9
Upstream Blk Time (%)			3	2	3		
Queuing Penalty (veh)			0	0	0		
Storage Bay Dist (m)							
Storage Blk Time (%)							
Queuing Penalty (veh)							

base case-morning peak SimTraffic Report

Figure C1–27: Queuing and Blockage Report- INTERSECTION(S) 5 & 9

Queuing and Blocking Report
Baseline-Existing

Intersection: 24: ACC-MAD(N4) & Southwest Slip

Movement	NB	NB	NB	SE	SE	B23	B23	B22	B22	B21	B21
Directions Served	T	T	TR	R	R	T	T	T	T	T	T
Maximum Queue (m)	153.0	145.4	148.2	83.0	83.6	216.1	214.7	110.0	110.2	31.1	64.3
Average Queue (m)	21.9	61.4	107.1	79.5	81.1	167.6	166.0	48.4	49.6	7.8	17.8
95th Queue (m)	110.2	178.4	214.3	81.9	82.8	278.5	277.0	128.4	130.1	28.5	64.2
Link Distance (m)	143.6	143.6	143.6	63.5	63.5	195.6	195.6	88.4	88.4	31.1	31.1
Upstream Blk Time (%)	1	0	10	94	95	56	57	36	37	1	25
Queuing Penalty (veh)	0	0	0	552	556	328	335	209	217	5	144
Storage Bay Dist (m)											
Storage Blk Time (%)											
Queuing Penalty (veh)											

Intersection: 29: Motorway Extension(N1) &

Movement	WB	WB	SB	SB	B36	B36
Directions Served	T	T	R	R	T	T
Maximum Queue (m)	77.4	122.8	63.3	62.4	14.7	25.6
Average Queue (m)	11.1	74.4	50.7	41.4	7.2	4.6
95th Queue (m)	55.7	127.3	76.6	65.1	17.8	19.3
Link Distance (m)	225.6	225.6	42.2	42.2	176.8	176.8
Upstream Blk Time (%)			22	13		
Queuing Penalty (veh)			117	72		
Storage Bay Dist (m)						
Storage Blk Time (%)						
Queuing Penalty (veh)						

base case-morning peak SimTraffic Report

Figure C1–28: Queuing and Blockage Report- INTERSECTION(S) 24 & 29

Queuing and Blocking Report
Baseline-Existing

Intersection: 31: SE Loop 1 &

Movement	WB	NB	SW
Directions Served	TR	LR>	<R
Maximum Queue (m)	29.6	46.6	29.6
Average Queue (m)	29.0	19.0	11.6
95th Queue (m)	29.9	55.1	27.4
Link Distance (m)	25.0	43.0	99.3
Upstream Blk Time (%)	65	14	
Queuing Penalty (veh)	481	137	
Storage Bay Dist (m)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 37: Motorway Extension(N1) &

Movement	EB	EB	WB	WB	NE	NE	B28	B28
Directions Served	T	T	T	T	R	R	T	T
Maximum Queue (m)	19.7	56.2	81.2	81.2	84.8	88.6	168.5	169.8
Average Queue (m)	2.8	14.2	12.7	13.4	78.6	76.1	144.2	149.5
95th Queue (m)	14.2	47.1	59.1	59.6	84.9	84.5	208.6	206.5
Link Distance (m)	225.6	225.6	76.6	76.6	53.3	53.3	162.9	162.9
Upstream Blk Time (%)			1	1	88	81	49	51
Queuing Penalty (veh)			0	0	602	556	335	352
Storage Bay Dist (m)								
Storage Blk Time (%)								
Queuing Penalty (veh)								

base case-morning peak SimTraffic Report

Figure C1–29: Queuing and Blockage Report- INTERSECTION(S) 31 & 37

Queuing and Blocking Report
Baseline-Existing

Intersection: 38: SE LP 2 & Southeast Slip 2

Movement	SB	NE	NE
Directions Served	R	T	T
Maximum Queue (m)	27.5	96.9	114.5
Average Queue (m)	3.9	52.2	61.6
95th Queue (m)	19.8	122.7	143.9
Link Distance (m)	31.2	99.3	99.3
Upstream Blk Time (%)	1	10	24
Queuing Penalty (veh)	2	68	167
Storage Bay Dist (m)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 40: NW Loop &

Movement	EB	EB	B17	B17	SB	SB	SB
Directions Served	R	R	T	T	T	T	T
Maximum Queue (m)	71.2	63.2	117.0	111.5	181.6	188.7	191.9
Average Queue (m)	57.8	26.8	68.9	43.9	81.6	153.7	151.7
95th Queue (m)	86.6	58.8	137.7	118.2	204.3	215.8	201.8
Link Distance (m)	42.9	42.9	240.5	240.5	184.4	184.4	184.4
Upstream Blk Time (%)	37	4			0	1	2
Queuing Penalty (veh)	278	34			2	17	28
Storage Bay Dist (m)							
Storage Blk Time (%)							
Queuing Penalty (veh)							

base case-morning peak SimTraffic Report

Figure C1–30: Queuing and Blockage Report- INTERSECTION(S) 38&40

Queuing and Blocking Report
Baseline-Existing

Intersection: 42: Motorway Extension(N1) &

Movement	EB	EB	WB	WB	WB	NE	NE
Directions Served	T	T	T	T	R	R	R
Maximum Queue (m)	7.1	27.5	254.2	250.2	103.2	35.2	33.5
Average Queue (m)	1.0	15.6	138.8	91.4	14.7	20.6	7.6
95th Queue (m)	5.1	29.9	286.7	232.8	74.3	42.4	26.3
Link Distance (m)	225.2	225.2	252.8	252.8	252.8	30.7	30.7
Upstream Blk Time (%)			4	0		3	1
Queuing Penalty (veh)			40	2		9	2
Storage Bay Dist (m)							
Storage Blk Time (%)							
Queuing Penalty (veh)							

Intersection: 46: SE Loop 1 &

Movement	WB	NB	SB	SB
Directions Served	R	T	T	R
Maximum Queue (m)	16.8	15.5	166.7	141.2
Average Queue (m)	9.4	7.1	45.6	20.2
95th Queue (m)	22.8	14.7	164.9	101.7
Link Distance (m)	107.7	197.3	256.2	256.2
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (m)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

base case-morning peak SimTraffic Report

Figure C1–31: Queuing and Blockage Report- INTERSECTION 42 & 46

Queuing and Blocking Report
Baseline-Existing

Intersection: 47: SE Slip 1 &

Movement	NB	NB
Directions Served	T	R
Maximum Queue (m)	111.7	134.6
Average Queue (m)	37.2	43.1
95th Queue (m)	115.9	139.3
Link Distance (m)	107.3	107.3
Upstream Blk Time (%)	5	3
Queuing Penalty (veh)	48	32
Storage Bay Dist (m)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 55: Spintex Road &

Movement	EB	WB	NE
Directions Served	T	T	R
Maximum Queue (m)	20.3	130.0	84.5
Average Queue (m)	17.5	103.6	39.6
95th Queue (m)	19.4	146.7	83.2
Link Distance (m)		110.8	83.2
Upstream Blk Time (%)	0	64	1
Queuing Penalty (veh)	0	0	13
Storage Bay Dist (m)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Network Summary

Network wide Queuing Penalty: 6223

base case-morning peak SimTraffic Report

Figure C1–32: Queuing and Blockage Report- INTERSECTION 47 & 55

APPENDIX C2 – SYNCHRO AND SIM TRAFFIC REPORTS_EXISTING CONDITIONS (Evening Peak)

Lanes, Volumes, Timings
5: Motorway Extension(N1) &

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NWL	NWR	SWL	SWR
Lane Configurations										
Volume (vph)	0	4179	759	0	2636	0	0	0	0	759
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		2%			-2%		0%		0%	
Lane Util. Factor	1.00	0.95	0.95	1.00	0.95	1.00	1.00	1.00	1.00	0.88
Frt		0.977								0.850
Flt Protected										
Satd. Flow (prot)	0	3157	0	0	3285	0	0	0	0	2632
Flt Permitted										
Satd. Flow (perm)	0	3157	0	0	3285	0	0	0	0	2632
Link Speed (k/h)		69			57		54		54	
Link Distance (m)		46.5			275.6		67.2		93.2	
Travel Time (s)		2.4			17.4		4.5		6.2	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	2%	12%	3%	2%	11%	2%	2%	2%	2%	8%
Adj. Flow (vph)	0	4179	759	0	2636	0	0	0	0	759
Shared Lane Traffic (%)										
Lane Group Flow (vph)	0	4938	0	0	2636	0	0	0	0	759
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Right	Left	Right
Median Width(m)		6.0			6.0		0.0		0.0	
Link Offset(m)		0.0			0.0		0.0		0.0	
Crosswalk Width(m)		4.8			4.8		4.8		4.8	
Two way Left Turn Lane										
Headway Factor	1.01	1.01	1.01	0.99	0.99	0.99	1.00	1.00	1.00	1.00
Turning Speed (k/h)	25		15	25		15	25	15	25	15
Sign Control		Free			Free		Stop		Free	

Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization 156.1%		ICU Level of Service H	
Analysis Period (min) 15			

base case-evening peak
Synchro 7 - Report

Figure C2-1: Lanes, Volumes & Timings Report- INTERSECTION(S) 1_N1

Lanes, Volumes, Timings
9: ACC-MAD(N4) &

Lane Group	NBL	NBT	NBR	SBL	SBT	SBR	NWL	NWR	NEL	NER
Lane Configurations										
Volume (vph)	0	3276	0	0	2545	676	0	608	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		1%			-1%		-3%		0%	
Lane Util. Factor	1.00	0.91	1.00	1.00	0.91	0.91	1.00	0.88	1.00	1.00
Frt					0.969			0.850		
Flt Protected										
Satd. Flow (prot)	0	5060	0	0	4914	0	0	2576	0	0
Flt Permitted										
Satd. Flow (perm)	0	5060	0	0	4914	0	0	2576	0	0
Link Speed (k/h)		35			63		40		50	
Link Distance (m)		224.2			157.5		105.3		48.9	
Travel Time (s)		23.1			9.0		9.5		3.5	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	2%	2%	2%	2%	3%	2%	2%	12%	2%	2%
Adj. Flow (vph)	0	3276	0	0	2545	676	0	608	0	0
Shared Lane Traffic (%)										
Lane Group Flow (vph)	0	3276	0	0	3221	0	0	608	0	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Right	Left	Right
Median Width(m)		4.0			4.0		0.0		0.0	
Link Offset(m)		0.0			0.0		0.0		0.0	
Crosswalk Width(m)		4.8			4.8		4.8		4.8	
Two way Left Turn Lane										
Headway Factor	1.01	1.01	1.01	0.99	0.99	0.99	0.98	0.98	1.00	1.00
Turning Speed (k/h)	25		15	25		15	25	15	25	15
Sign Control		Free			Free		Free		Stop	

Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization 119.2%		ICU Level of Service H	
Analysis Period (min) 15			

base case-evening peak Synchro 7 - Report

Figure C2-2: Lanes, Volumes & Timings Report- INTERSEC. (S) 9_MAD-ACC(N4)

Lanes, Volumes, Timings
24: ACC-MAD(N4) & Southwest Slip

Lane Group	NBL	NBT	NBR	SBL	SBT	SBR	SEL	SER	SWL	SWR
Lane Configurations										
Volume (vph)	0	3920	1989	0	3385	0	0	759	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		1%			-1%		0%		0%	
Lane Util. Factor	1.00	0.91	0.91	1.00	0.91	1.00	1.00	0.88	1.00	1.00
Frt		0.950						0.850		
Flt Protected										
Satd. Flow (prot)	0	4807	0	0	5061	0	0	2632	0	0
Flt Permitted										
Satd. Flow (perm)	0	4807	0	0	5061	0	0	2632	0	0
Link Speed (k/h)		35			63		54		50	
Link Distance (m)		148.4			238.3		101.8		141.7	
Travel Time (s)		15.3			13.6		6.8		10.2	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	2%	2%	2%	2%	3%	2%	2%	8%	2%	2%
Adj. Flow (vph)	0	3920	1989	0	3385	0	0	759	0	0
Shared Lane Traffic (%)										
Lane Group Flow (vph)	0	5909	0	0	3385	0	0	759	0	0
Enter Blocked Intersection	No	No	No	No	No	No	No	2 veh	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Right	Left	Right
Median Width(m)		4.0			4.0		0.0		0.0	
Link Offset(m)		0.0			0.0		0.0		0.0	
Crosswalk Width(m)		4.8			4.8		4.8		4.8	
Two way Left Turn Lane										
Headway Factor	1.01	1.01	1.01	0.99	0.99	0.99	1.00	1.00	1.00	1.00
Turning Speed (k/h)	25		15	25		15	25	15	25	15
Sign Control		Free			Free		Yield		Stop	

Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization 124.6%		ICU Level of Service H	
Analysis Period (min) 15			

base case-evening peak
Synchro 7 - Report

Figure C2-3: Lanes, Volumes & Timings Report- INT.(S) 24_ACC-MAD(N4) and SW SLP

Lanes, Volumes, Timings
29: Motorway Extension(N1) &

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	SBL	SBR	NWL	NWR
Lane Configurations		↑↑	↱		↑↑			↱↱		
Volume (vph)	0	3684	1465	0	2595	0	0	1851	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		2%			-2%		1%		-2%	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.88	1.00	1.00
Frt			0.850					0.850		
Flt Protected										
Satd. Flow (prot)	0	3191	1494	0	3285	0	0	2595	0	0
Flt Permitted										
Satd. Flow (perm)	0	3191	1494	0	3285	0	0	2595	0	0
Link Speed (k/h)		69			57		40		50	
Link Distance (m)		264.0			264.8		69.9		53.1	
Travel Time (s)		13.8			16.7		6.3		3.8	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	2%	12%	7%	2%	11%	2%	2%	9%	2%	2%
Adj. Flow (vph)	0	3684	1465	0	2595	0	0	1851	0	0
Shared Lane Traffic (%)										
Lane Group Flow (vph)	0	3684	1465	0	2595	0	0	1851	0	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Right	Left	Right
Median Width(m)		6.0			6.0		0.0		0.0	
Link Offset(m)		0.0			0.0		0.0		0.0	
Crosswalk Width(m)		4.8			4.8		4.8		4.8	
Two way Left Turn Lane										
Headway Factor	1.01	1.01	1.01	0.99	0.99	0.99	1.01	1.01	0.99	0.99
Turning Speed (k/h)	25		15	25		15	25	15	25	15
Sign Control		Free			Free		Free		Stop	

Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization 173.0%		ICU Level of Service H	
Analysis Period (min) 15			

Figure C2-4: Lanes, Volumes & Timings Report- INTERSECTION(S) 29(N1)

Lanes, Volumes, Timings
31: SE Loop 1 &

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBR	SWL	SWR
Lane Configurations										
Volume (vph)	0	0	0	0	359	856	0	989	0	1465
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		-2%			0%		2%		-2%	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.88
Frt					0.905			0.865		0.850
Flt Protected										
Satd. Flow (prot)	0	0	0	0	1686	0	0	1564	0	2683
Flt Permitted										
Satd. Flow (perm)	0	0	0	0	1686	0	0	1564	0	2683
Link Speed (k/h)		50			50		50		50	
Link Distance (m)		147.3			57.9		78.5		129.7	
Travel Time (s)		10.6			4.2		5.7		9.3	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	4%	2%	7%
Adj. Flow (vph)	0	0	0	0	359	856	0	989	0	1465
Shared Lane Traffic (%)										
Lane Group Flow (vph)	0	0	0	0	1215	0	0	989	0	1465
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Right	Left	Right
Median Width(m)		0.0			0.0		0.0		2.0	
Link Offset(m)		0.0			0.0		0.0		0.0	
Crosswalk Width(m)		4.8			4.8		4.8		4.8	
Two way Left Turn Lane										
Headway Factor	0.99	0.99	0.99	1.00	1.00	1.00	1.01	1.01	0.99	0.99
Turning Speed (k/h)	25		15	25		15	25	15	25	15
Sign Control		Yield			Yield		Yield		Yield	

Intersection Summary			
Area Type:	Other		
Control Type: Roundabout			
Intersection Capacity Utilization 139.4%		ICU Level of Service H	
Analysis Period (min) 15			

base case-evening peak Synchro 7 - Report

Figure C2-5: lanes, Volumes & Timings Report- INTERSECTION(S) 31_SE LP 1

Lanes, Volumes, Timings
37: Motorway Extension(N1) &

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SER	NEL	NER
Lane Configurations		↑↑			↑↑	↱				↱↱
Volume (vph)	0	3684	0	0	2595	608	0	0	0	1845
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		2%			-2%		-3%		2%	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	1.00	1.00	0.88
Frt						0.850				0.850
Flt Protected										
Satd. Flow (prot)	0	3191	0	0	3285	1456	0	0	0	2630
Flt Permitted										
Satd. Flow (perm)	0	3191	0	0	3285	1456	0	0	0	2630
Link Speed (k/h)		69			57		50		34	
Link Distance (m)		264.8			88.5		125.6		88.4	
Travel Time (s)		13.8			5.6		9.0		9.4	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	2%	12%	2%	2%	11%	12%	2%	2%	2%	7%
Adj. Flow (vph)	0	3684	0	0	2595	608	0	0	0	1845
Shared Lane Traffic (%)										
Lane Group Flow (vph)	0	3684	0	0	2595	608	0	0	0	1845
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Right	Left	Right
Median Width(m)		6.0			6.0		0.0		0.0	
Link Offset(m)		0.0			0.0		0.0		0.0	
Crosswalk Width(m)		4.8			4.8		4.8		4.8	
Two way Left Turn Lane										
Headway Factor	1.01	1.01	1.01	0.99	0.99	0.99	0.98	0.98	1.01	1.01
Turning Speed (k/h)	25		15	25		15	25	15	25	15
Sign Control		Free			Free		Stop		Yield	

Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization 173.0%		ICU Level of Service H	
Analysis Period (min) 15			

Figure C2-6: Lanes, Volumes & Timings Report- INTERSECTION(S) 37(N1)

Lanes, Volumes, Timings
38: SE LP 2 & Southeast Slip 2

Lane Group	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations						
Volume (vph)	0	1465	0	1845	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Grade (%)	-2%			2%	0%	
Lane Util. Factor	1.00	0.88	1.00	0.95	1.00	1.00
Frt		0.850				
Flt Protected						
Satd. Flow (prot)	0	2683	0	3340	0	0
Flt Permitted						
Satd. Flow (perm)	0	2683	0	3340	0	0
Link Speed (k/h)	44			34	50	
Link Distance (m)	50.0			129.7	176.1	
Travel Time (s)	4.1			13.7	12.7	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	2%	7%	2%	7%	2%	2%
Adj. Flow (vph)	0	1465	0	1845	0	0
Shared Lane Traffic (%)						
Lane Group Flow (vph)	0	1465	0	1845	0	0
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Left	Left	Right
Median Width(m)	0.0			2.0	0.0	
Link Offset(m)	0.0			0.0	0.0	
Crosswalk Width(m)	4.8			4.8	4.8	
Two way Left Turn Lane						
Headway Factor	0.99	0.99	1.01	1.01	1.00	1.00
Turning Speed (k/h)	25	15	25			15
Sign Control	Free			Free	Stop	

Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization	54.6%	ICU Level of Service	A
Analysis Period (min)	15		

base case-evening peak Synchro 7 - Report

Figure C2-7: Lanes, Volumes & Timings Report- INTERSECTION(S) 38_SE SLP 2

Lanes, Volumes, Timings
40: NW Loop &

Lane Group	EBL	EBR	NBL	NBT	NBR	SBL	SBT	SBR	SWL	SWR
Lane Configurations										
Volume (vph)	0	1810	0	3276	1851	0	2545	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)	2%			1%			-1%		0%	
Lane Util. Factor	1.00	0.88	1.00	0.91	1.00	1.00	0.91	1.00	1.00	1.00
Frt		0.850			0.850					
Flt Protected										
Satd. Flow (prot)	0	2680	0	5060	1474	0	5061	0	0	0
Flt Permitted										
Satd. Flow (perm)	0	2680	0	5060	1474	0	5061	0	0	0
Link Speed (k/h)	43			35			63		46	
Link Distance (m)	71.4			262.2			224.2		71.8	
Travel Time (s)	6.0			27.0			12.8		5.6	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	2%	5%	2%	2%	9%	2%	3%	2%	2%	2%
Adj. Flow (vph)	0	1810	0	3276	1851	0	2545	0	0	0
Shared Lane Traffic (%)										
Lane Group Flow (vph)	0	1810	0	3276	1851	0	2545	0	0	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Left	Right	Left	Left	Right	Left	Right
Median Width(m)	0.0			4.0			4.0		0.0	
Link Offset(m)	0.0			0.0			0.0		0.0	
Crosswalk Width(m)	4.8			4.8			4.8		4.8	
Two way Left Turn Lane										
Headway Factor	1.01	1.01	1.01	1.01	1.01	0.99	0.99	0.99	1.00	1.00
Turning Speed (k/h)	25	15	25		15	25		15	25	15
Sign Control	Free			Free			Free		Stop	

Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization 119.2%		ICU Level of Service H	
Analysis Period (min) 15			

base case-evening peak
Synchro 7 - Report

Figure C2-8: Lanes, Volumes & Timings Report- INTERSECTION(S) 40_NW LP 1

Lanes, Volumes, Timings
42: Motorway Extension(N1) &

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SER	NEL	NER
Lane Configurations		↑↑			↑↑	↱				↱↱
Volume (vph)	0	4179	0	0	2636	1810	0	0	0	970
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (m)	3.6	4.0	3.6	3.6	4.0	3.6	3.6	3.6	3.6	3.0
Grade (%)		2%			-2%		0%		0%	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	1.00	1.00	0.88
Frt						0.850				0.850
Flt Protected										
Satd. Flow (prot)	0	3333	0	0	3431	1553	0	0	0	2479
Flt Permitted										
Satd. Flow (perm)	0	3333	0	0	3431	1553	0	0	0	2479
Link Speed (k/h)		69			57		50		39	
Link Distance (m)		275.6			264.0		51.7		67.6	
Travel Time (s)		14.4			16.7		3.7		6.2	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	2%	12%	2%	2%	11%	5%	2%	2%	2%	7%
Adj. Flow (vph)	0	4179	0	0	2636	1810	0	0	0	970
Shared Lane Traffic (%)										
Lane Group Flow (vph)	0	4179	0	0	2636	1810	0	0	0	970
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Right	Left	Right
Median Width(m)		6.0			6.0		0.0		0.0	
Link Offset(m)		0.0			0.0		0.0		0.0	
Crosswalk Width(m)		4.8			4.8		4.8		4.8	
Two way Left Turn Lane										
Headway Factor	1.01	0.96	1.01	0.99	0.93	0.99	1.00	1.00	1.00	1.09
Turning Speed (k/h)	25		15	25		15	25	15	25	15
Sign Control		Free			Free		Stop		Free	

Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization 156.1%		ICU Level of Service H	
Analysis Period (min) 15			

base case-evening peak Synchro 7 - Report

Figure C2-9: Lanes, Volumes and Timings Report- INTERSECTION(S) 42_N 1

Lanes, Volumes, Timings
46: SE Loop 1 &

Lane Group	WBL	WBR	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NER
Lane Configurations										
Volume (vph)	0	1207	0	3920	0	0	3385	970	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (m)	3.6	3.0	3.6	3.7	3.6	3.6	3.7	3.7	3.6	3.6
Grade (%)	-2%			1%			-1%		2%	
Lane Util. Factor	1.00	0.88	1.00	0.91	1.00	1.00	0.91	1.00	1.00	1.00
Frt		0.850						0.850		
Flt Protected										
Satd. Flow (prot)	0	2627	0	5116	0	0	5117	1534	0	0
Flt Permitted										
Satd. Flow (perm)	0	2627	0	5116	0	0	5117	1534	0	0
Link Speed (k/h)	44			35			63		50	
Link Distance (m)	147.3			238.3			262.2		63.6	
Travel Time (s)	12.1			24.5			15.0		4.6	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	3%	7%	2%	2%
Adj. Flow (vph)	0	1207	0	3920	0	0	3385	970	0	0
Shared Lane Traffic (%)										
Lane Group Flow (vph)	0	1207	0	3920	0	0	3385	970	0	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Left	Right	Left	Left	Right	Left	Right
Median Width(m)	0.0			4.0			4.0		0.0	
Link Offset(m)	0.0			0.0			0.0		0.0	
Crosswalk Width(m)	4.8			4.8			4.8		4.8	
Two way Left Turn Lane										
Headway Factor	0.99	1.08	1.01	0.99	1.01	0.99	0.98	0.98	1.01	1.01
Turning Speed (k/h)	25	15	25		15	25		15	25	15
Sign Control	Yield			Free			Free		Stop	

Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization	124.6%	ICU Level of Service	H
Analysis Period (min)	15		

base case-evening peak
Synchro 7 - Report

Figure C2-10: Lanes, Volumes and Timings Report- INTERSEC. (S) 46_SE LP 1

Lanes, Volumes, Timings
47: SE Slip 1 &

Lane Group	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations			↑	↱		
Volume (vph)	0	0	989	1000	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Grade (%)	0%		2%			0%
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt				0.850		
Flt Protected						
Satd. Flow (prot)	0	0	1809	1537	0	0
Flt Permitted						
Satd. Flow (perm)	0	0	1809	1537	0	0
Link Speed (k/h)	50		34			50
Link Distance (m)	108.0		141.7			78.5
Travel Time (s)	7.8		15.0			5.7
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	2%	2%	4%	4%	2%	2%
Adj. Flow (vph)	0	0	989	1000	0	0
Shared Lane Traffic (%)						
Lane Group Flow (vph)	0	0	989	1000	0	0
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Right	Left	Left
Median Width(m)	0.0		0.0			0.0
Link Offset(m)	0.0		0.0			0.0
Crosswalk Width(m)	4.8		4.8			4.8
Two way Left Turn Lane						
Headway Factor	1.00	1.00	1.01	1.01	1.00	1.00
Turning Speed (k/h)	25	15		15	25	
Sign Control	Stop		Free			Stop

Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization 65.3%		ICU Level of Service C	
Analysis Period (min) 15			

base case-evening peak
Synchro 7 - Report

Figure C2-11: Lanes, Volumes & Timings Report- INTERSECTION(S) 47_SE SLP 1

Lanes, Volumes, Timings
55: Spintex Road &

Lane Group	EBT	EBR	WBL	WBT	NEL	NER
Lane Configurations	↑			↑		↱
Volume (vph)	500	0	0	1215	0	1000
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt						0.865
Flt Protected						
Satd. Flow (prot)	1863	0	0	1863	0	1580
Flt Permitted						
Satd. Flow (perm)	1863	0	0	1863	0	1580
Link Speed (k/h)	50			50	50	
Link Distance (m)	57.9			117.1	108.0	
Travel Time (s)	4.2			8.4	7.8	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	2%	2%	2%	2%	2%	4%
Adj. Flow (vph)	500	0	0	1215	0	1000
Shared Lane Traffic (%)						
Lane Group Flow (vph)	500	0	0	1215	0	1000
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Left	Left	Right
Median Width(m)	0.0			0.0	0.0	
Link Offset(m)	0.0			0.0	0.0	
Crosswalk Width(m)	4.8			4.8	4.8	
Two way Left Turn Lane						
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (k/h)		15	25		25	15
Sign Control	Free			Free	Yield	

Intersection Summary			
Area Type:	Other		
Control Type: Unsignalized			
Intersection Capacity Utilization	94.9%	ICU Level of Service	F
Analysis Period (min)	15		

base case-evening peak Synchro 7 - Report

Figure C2-12: Lanes, Volumes & Timings Report- INTERSEC. (S) 55_SPINTEX

APPENDIX D – SIM TRAFFIC REPORTS_IMPROVED LEGS CONDITIONS

APPENDIX D1 – SIM TRAFFIC REPORT (SUMMARY) _IMPROVED LEGS CONDITIONS (Morning Peak)

SimTraffic Performance Report
Alternative 1-Leg Improvement 11/17/2010

Total Network Performance

Total Delay (hr)	109.4
Delay / Veh (s)	196.4
Total Stops	1614
Travel Dist (km)	2114.7
Travel Time (hr)	160.1
Avg Speed (kph)	23
Fuel Used (l)	2822.9
HC Emissions (g)	109
CO Emissions (g)	28363
NOx Emissions (g)	319
Vehicles Entered	2075
Vehicles Exited	1936
Hourly Exit Rate	11616
Input Volume	100884
% of Volume	12
Denied Entry Before	135
Denied Entry After	837

10% speed increase-morning
SimTraffic Report
Page 8

Figure D1-1: Performance Report NETWORK 10 % speed increase-Morning Peak.

SimTraffic Performance Report
Alternative 1-Improved Legs 11/17/2010

Total Network Performance

Total Delay (hr)	101.2
Delay / Veh (s)	185.8
Total Stops	1309
Travel Dist (km)	2042.1
Travel Time (hr)	148.8
Avg Speed (kph)	24
Fuel Used (l)	2688.3
HC Emissions (g)	108
CO Emissions (g)	29221
NOx Emissions (g)	315
Vehicles Entered	2038
Vehicles Exited	1883
Hourly Exit Rate	11298
Input Volume	100884
% of Volume	11
Denied Entry Before	104
Denied Entry After	771

SimTraffic Report
20% speed increase-morning peak Page 8

Figure D1-2: Performance Report NETWORK 20 % speed increase-Morning Peak.

SimTraffic Performance Report
Alternative 1-Improved Legs 11/17/2010

Total Network Performance

Total Delay (hr)	114.4
Delay / Veh (s)	207.6
Total Stops	1383
Travel Dist (km)	2106.1
Travel Time (hr)	161.6
Avg Speed (kph)	24
Fuel Used (l)	2862.6
HC Emissions (g)	115
CO Emissions (g)	31576
NOx Emissions (g)	331
Vehicles Entered	2041
Vehicles Exited	1925
Hourly Exit Rate	11550
Input Volume	100884
% of Volume	11
Denied Entry Before	159
Denied Entry After	831

SimTraffic Report
30% speed increase-morning peak Page 8

Figure D1-3: Performance Report NETWORK 30 % speed increase-Morning Peak

APPENDIX D1 – SIM TRAFFIC REPORT (SUMMARY) _IMPROVED LEGS CONDITIONS (Evening Peak)

SimTraffic Performance Report
Alternative 1-Legs improvement 11/16/2010

Total Network Performance

Total Delay (hr)	164.9
Delay / Veh (s)	278.3
Total Stops	1969
Travel Dist (km)	2267.7
Travel Time (hr)	213.8
Avg Speed (kph)	23
Fuel Used (l)	3430.2
HC Emissions (g)	188
CO Emissions (g)	44592
NOx Emissions (g)	489
Vehicles Entered	2206
Vehicles Exited	2060
Hourly Exit Rate	12360
Input Volume	123742
% of Volume	10
Denied Entry Before	203
Denied Entry After	1256

10% speed increase-evening peak SimTraffic Report
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Figure D1-4: Performance Report NETWORK 10 % speed increase-Evening Peak

SimTraffic Performance Report
Baseline 11/16/2010

Total Network Performance

Total Delay (hr)	156.8
Delay / Veh (s)	256.9
Total Stops	2189
Travel Dist (km)	2334.7
Travel Time (hr)	205.0
Avg Speed (kph)	22
Fuel Used (l)	3419.3
HC Emissions (g)	192
CO Emissions (g)	47098
NOx Emissions (g)	505
Vehicles Entered	2359
Vehicles Exited	2035
Hourly Exit Rate	12210
Input Volume	123742
% of Volume	10
Denied Entry Before	213
Denied Entry After	1026

20% speed increase-evening peak SimTraffic Report
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Figure D1-5: Performance Report NETWORK 20 % speed increase-Evening Peak

SimTraffic Performance Report
Baseline 11/16/2010

Total Network Performance

Total Delay (hr)	161.6
Delay / Veh (s)	267.8
Total Stops	2302
Travel Dist (km)	2351.4
Travel Time (hr)	208.8
Avg Speed (kph)	22
Fuel Used (l)	3502.1
HC Emissions (g)	199
CO Emissions (g)	49216
NOx Emissions (g)	523
Vehicles Entered	2319
Vehicles Exited	2025
Hourly Exit Rate	12150
Input Volume	123742
% of Volume	10
Denied Entry Before	190
Denied Entry After	1133

30% speed increase-evening peak SimTraffic Report
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Figure D1-6: Performance Report NETWORK 30 % speed increase-Evening Peak