

1 **A GIS-BASED INTERACTIVE LANE CLOSURE AND TRAFFIC INFORMATION**
2 **TOOL**

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1 **ABSTRACT**

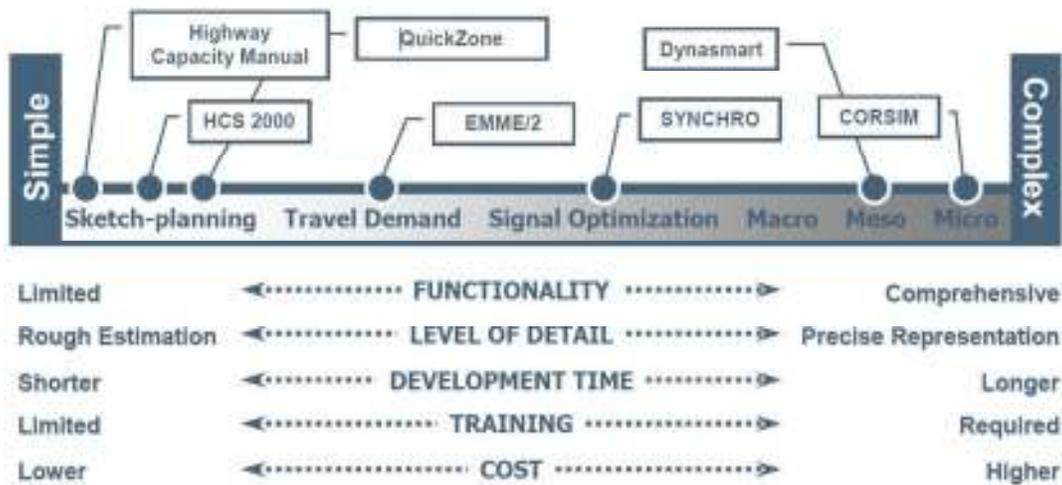
2 This paper describes the development of an interactive computer tool, namely RILCA, for
3 planning lane closures for work zones. This user-friendly tool is aimed at providing traffic
4 engineers with a computerized and easy to use lane closure application along with various other
5 useful features. RILCA was developed using ArcView GIS software package as the main
6 development environment. The interactive GIS map of New Jersey Turnpike (NJTPK), Garden
7 State Parkway (GSP), and other major freeways in NJ and its surrounding network is displayed
8 using ArcView. Various analysis and visualization options are provided for interactive planning
9 of lane closures, traffic volume information and accident queries. RILCA was successfully tested
10 and is currently being used by NJDOT and New Jersey Turnpike Authority (NJTA) engineers
11 with all its features presented in this paper. It has also received the annual implementation award
12 from the NJDOT in 2009 in recognition of its usefulness and potential future contributions to
13 improve efficiency of traffic operations as a practical decision support tool for lane closure
14 decisions.

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1 **BACKGROUND**

2 Traffic engineers at state Department of Transportation (DOT) and highway agencies are often
 3 confronted with traffic impact analysis of short term work zone projects that need to be
 4 conducted rather promptly. They are required to determine the suitable times for a specific work
 5 zone with one or more lanes closed to traffic that will cause minimal delays. However, when
 6 delays are unavoidable, the crucial task is determining the maximum queue length and the
 7 estimated time of clearance for motorist information.

8 There are various tools available to planners and engineers for analyzing the mobility
 9 impacts of work zones. These tools vary from simple to complex in terms of input data
 10 requirements, ease of use and accuracy of estimates. FHWA (1) presents the available tools in
 11 terms of their complexity, as shown in Figure 1.
 12



13 **Figure 1. Work zone modeling spectrum (1)**
 14

15 FHWA (1) lists five main factors that need to be considered when selecting a specific work
 16 zone analysis tool: functionality, level of detail, development time, training and cost. Some tools
 17 listed in Figure 1 were designed specifically for work zone applications. Other traffic analysis
 18 tools such as Corsim and Synchro, although not designed specifically for work zones, can be
 19 used to evaluate their impacts.

20 Each of these available tools has their strengths and weaknesses. For example, Schnell et al.
 21 (2) studied the accuracy of HCS, Synchro, CORSIM, NetSim and QueWZ92 at work zones for
 22 the Ohio DOT. They collected field data from four different work zones in Ohio. Queues lengths
 23 observed from the field data were compared with the outputs of each tool. They found that
 24 simulation tools, Synchro and CORSIM, have inaccuracies in prediction of queue lengths. It was
 25 reported that ODOT Spreadsheet produced the most realistic estimates of queue lengths as
 26 compared to the results from other tools.

27 A survey with nineteen state DOTs conducted by Edara and Cottrell (3) revealed that HCM-
 28 based tools and spreadsheets are the most popular among DOTs for the estimation of traffic
 29 impacts of work zone lane closures. The advantage of sketch-planning tools is their ease of use,
 30 low data requirement and ability to obtain results quickly.

1 The accuracy of the estimation of the impact of a work zone lane closure depends on various
2 factors, including three essential input data: (1) hourly traffic volume, (2) roadway capacity
3 under normal conditions, and (3) roadway capacity of during lane closure.

4 There has been much work done in the literature on the estimation of roadway capacity
5 during work zones (4-11). The results of these studies showed that capacity values observed at
6 work zones vary considerably across and within the states. The survey conducted by Edara and
7 Cottrell (3) also revealed that the most common tool for determining the capacity at work zone
8 bottlenecks appears to be the experience of the DOT staff.

9 However, it is often a challenge for traffic engineers to determine traffic volume levels,
10 because they vary considerably from one day to another, especially on weekdays and holidays.
11 Many traffic engineers at state DOTs still resort to estimating hourly traffic volumes using
12 outdated average annual daily traffic estimates, seasonal and hourly demand factors.

13 Today, many of the major highways in the US are monitored by loop detectors, GPS readers,
14 automatic vehicle identification readers and Bluetooth readers. Although traffic data are more
15 abundant than ever, they are not often organized and accessed efficiently. The demand for
16 efficient work zone planning can be met using advanced computing technology, high level
17 mapping and visualization tools and the ability of storing vast amount of data on personal
18 computers. In addition to traffic volumes, various data sources such as historical accident data,
19 weather data, and travel times can be integrated to aid traffic engineers in making critical
20 operational decisions.

21 INTRODUCTION

22 This paper describes the development of an interactive computer tool for planning lane closures
23 for work zones. This user-friendly tool is aimed at providing traffic engineers with a
24 computerized and easy to use lane closure application along with various other useful features, as
25 described in the following sections.

26 Rutgers Interactive Lane Closure Application (RILCA) was first developed for New Jersey
27 Turnpike Authority (NJTA). NJTA is responsible for operating and maintaining two major tolled
28 roads in New Jersey, namely New Jersey Turnpike (NJTPK) and Garden State Parkway (GSP).

29 RILCA was later adopted by the New Jersey DOT for planning its freeway lane closure for
30 work zones. 18 freeways in NJ were added to RILCA as requested by the NJDOT traffic
31 engineers.

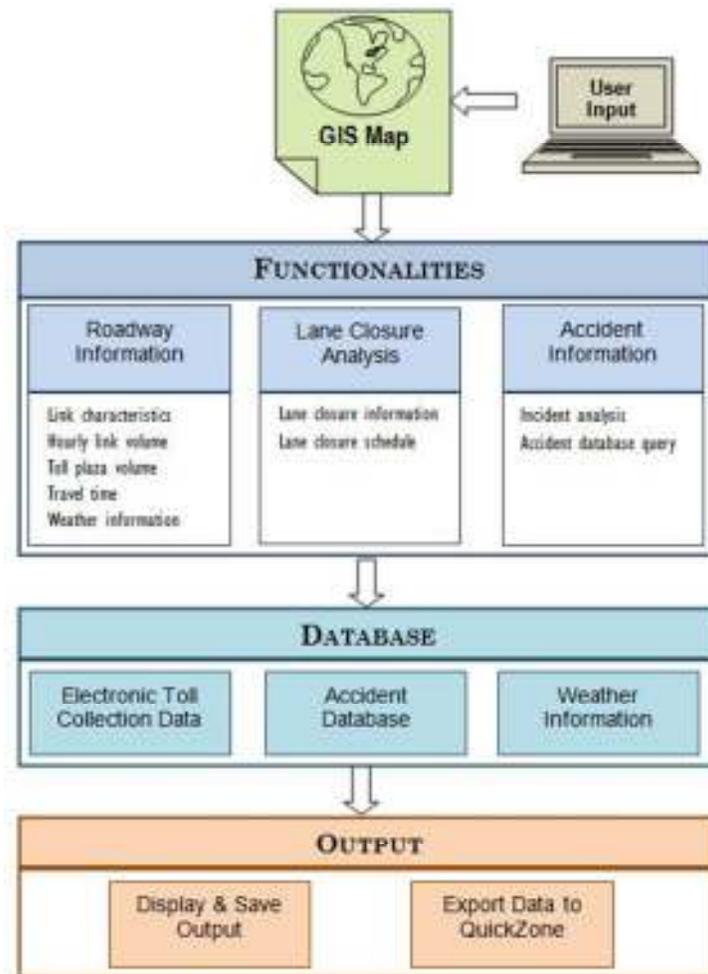
32 RILCA was developed using ArcView GIS software package as the main development
33 environment. The interactive GIS map of the NJTPK, GSP, and other major freeways in NJ and
34 its surrounding network is displayed using ArcView. Various analysis and visualization options
35 are provided for interactive planning of lane closures. The tool has the geometric details of
36 NJTPK, GSP and the surrounding highways and local streets. It provides users the following
37 applications:

- 38 ■ Hourly volume information on selected links at a given time period on any given date.
- 39 ■ Link characteristics (such as number of lanes, AADT, milepost, link length).
- 40 ■ A function that generates lane closure schedule for selected link based on the hourly
41 volume data.
- 42 ■ A simple visualization function that shows the extent of expected delays as a result of
43 lane closure and possibility of spill back onto the upstream links all in the form of link
44 colors.
- 45 ■ Allowable lane closure hours for a day, a week or a month.

- 1 ▪ Delay and queue length estimation for incidents.
- 2 ▪ Travel time information between interchanges at a given time period on any given date
- 3 (NJTPK only)
- 4 ▪ Historical accident information.
- 5 ▪ Historical weather information.

7 The flowchart of RILCA is shown in Figure 2.

9 A novel feature of RILCA is its ability to export hourly volume data and geometric
 10 characteristics of a selected highway link to QuickZone. One drawback of QuickZone is that
 11 users need to input very detailed traffic data for analyzing the impacts of long term lane closures
 12 (12). RILCA has the flexibility of presenting users to either (1) conduct short term lane closure
 13 analysis in RILCA, or (2) exporting the corresponding traffic volume from RILCA data to
 14 QuickZone, if a detailed long term lane closure analysis is required.



16 **Figure 2. RILCA Flowchart**

17
18

1 It should be noted that RILCA is a generic tool, where all the threshold values and use of historic
2 data can be customized for any State or freeway. As mentioned above a different version of RILCA
3 was developed for the NJDOT.

4 The intent of this paper is to demonstrate a GIS based platform and a methodology that is
5 easily modifiable for any roadway as long as data and expert information is available. The use of
6 a GIS based tool obviates the need for hardcoded look up tables. This GIS tool makes it easier to
7 store, process and extract related traffic and other data in a highly visual manner. Moreover,
8 since the traffic, link, weather and accident data are all spatially referenced, the system operator
9 can focus on the specific locations without having to worry about explicitly combining related
10 datasets.

11 **DATA SOURCES**

12 NJTPK is a 148-mile toll facility. There are 26 operational interchanges in NJTPK with average
13 daily traffic exceeding 500,000 vehicles. It is one of the principal north-south highway corridors
14 in New Jersey. It is a direct connection between Delaware Memorial Bridge in the south and the
15 George Washington Bridge, Lincoln Tunnel and Holland Tunnel to the New York City in the
16 north.

17 Vehicles enter the facility through an entry toll plaza. There are two payment options at
18 NJTPK, cash receipts and electronic toll collection (ETC), namely E-Z pass. Cash users get a
19 ticket at the entry toll plaza, and E-Z pass users drive through the dedicated toll booths without
20 having to stop. At the exit toll plazas, cash users have to make a full stop and pay the toll based
21 on their entry toll plaza; E-Z pass users drive through dedicated toll booths without having to
22 stop for payment. Entry and exit toll plazas on the NJTPK areas are not located en route but they
23 are located at separate areas at each intersection where the users enter or exit the freeway. This
24 type of toll plaza configuration does not impede the traffic flow on the freeway.

25 **GIS Map**

26 The GIS map of the NJTPK was extracted from the ESRI database of NJ highways shape file.
27 Number of lanes information for each link was manually input in the database. The GIS network
28 is to-scale representation of the NJTPK. It includes mainline links, ramp links and toll plaza
29 links. Each link has a link ID, link length, link's starting and ending milepost and the number of
30 lanes (See Figure 3).

31 **Electronic Toll Collection Database**

32 ETC database was provided by the NJTA and it includes the vehicle transaction data of NJTPK
33 between January 1, 2004 and August 31, 2010. An algorithm that was developed in C
34 programming language by the Rutgers Intelligent Transportation Systems (RITS) is used to
35 generate hourly link volumes, toll plaza volume and travel time information between
36 interchanges.

37 Each line in the ETC database represents a transaction of an individual vehicle and it appears
38 as follows:

39
40 009, 14X, 02/17/06, 06:36:54, 08, 01, 01, 011, 10E, 02/17/06, 06:28:01, 483138
41

1 The transaction information include (as it appears above):
2 Exit interchange, exit lane number, exit date and time, operation mode of toll lane, payment
3 method, fare class, entry interchange, entry lane number, entry date and time, message sequence
4 number.

5 The developed algorithm takes the network information from the NJTPK GIS network that
6 was developed to create RILCA tool.

7 The algorithm works as follows:

- 8 1. First, it parses the transaction data using a C programming code.
- 9 2. For each transaction, the algorithm first lists all links in the GIS map between the origin-
10 destination (O-D) pair.
- 11 3. Then, it calculates the distance from the origin to the center point of each link along the
12 path. Using a free flow speed the program assigns the vehicle to each link based on their
13 arrival time to the “center” of the link.

14 Note that the free flow speed is assumed as the average speed of a vehicle between the time it
15 enters the toll plaza and exits at an exit toll plaza. Because the algorithm uses “free flow speed”,
16 the link volumes show the “demand”, namely, what we should expected on each link, rather than
17 the “actual” volume. For instance, if there is an accident on link and the traffic flow is disturbed,
18 actual data would show lower volumes than what is reported in the link volume information of
19 RILCA.

20 For instance, if the vehicle leaves its origin (let us assume from interchange 1) at 8:52 am and
21 is destined to interchange 9, and its arrival time is at 9:33. The program computes the time the
22 vehicle arrives at the center of each link along its path. It will, for example, hit the link between
23 7-7A at 9:11 am, then we increase the volume of that link for 9 am-10 am by one vehicle. See
24 Figure 3 for the location of various interchanges on NJTPK.

25 In addition to total hourly link volumes, the algorithm can break down the volume based on
26 vehicle type, such as passenger cars, trucks and buses.

27
28 The algorithm also processes (1) travel times between each interchange within every hour
29 and (2) hourly toll plaza volumes by tollbooth using the available ETC database.

30 **Accident Database**

31 NJTPK accident database includes vehicle crash records between January 1, 1995 and May 31,
32 2009. These records are based on the reports filled out by police officers at the accident scene.
33 Each record involves accident specific information such as time, day and location of the
34 accident, the number of vehicles involved, type of vehicles involved, degree of severity, crash
35 type, etc.

36 **Weather Database**

37 Hourly weather information was obtained from 5 airports in NJ: Teterboro Airport, Newark
38 Liberty International Airport, McGuire AFB Airport, South Jersey Regional Airport and Atlantic
39 City International Airport. The database is available on National Climatic Data Center Website.
40 The weather database for each station gives historical hourly weather information (clear, rain,
41 snow, other).

1 **FUNCTIONALITIES OF RILCA**

2 Figure 3 shows the main window of RILCA. The Main Menu lists the functionalities of RILCA,
3 as shown in Figure 3. These functionalities can be consolidated in three main areas:

- 4 1. Roadway Information: Provides information about link characteristics, hourly link
5 volume, toll plaza volume, travel time, and historical weather conditions.
- 6 2. Lane Closure Analysis: Includes lane closure information for a specific link between
7 selected time periods, and lane closure schedule for a given day, week or month.
- 8 3. Accident Information: Includes incident analysis such as estimation of travel delays and
9 queue lengths for a specific incident on a selected link, and accident database.

10
11 The following sections describe these three main functionalities of RILCA in detail.
12



13
14
15 **Figure 3. RILCA main window**

1 **Roadway Information**

2 *Link Characteristics*

3 For all the options in the Main Menu a link has to be selected. A desired link in the network can
4 be selected by clicking on the link using the mouse. The selected link is highlighted when
5 selected. **Link Characteristics** button in the **Main Menu** window displays the starting
6 milepost, number of lanes and length of the selected link in a tabular form on the screen.

7 *Volume Information*

8 The volume information of a selected link can be obtained for a selected day, month, year and
9 time period using the **Volume Info** button in the **Main Menu** window. Hourly volumes within
10 the selected period by car, truck and bus are displayed on the screen. Also, historical volume
11 information for the previous year is also shown in a separate tab (See Figure 4)
12

Volume Info	Historical Volume Info	Mile Post	6-7 AM	Daily Vol.	# Lanes	Link Length
Total Volume		109	4249	70940	3	3.70
Car Volume		109	3526	59154	3	3.70
Truck Volume		109	717	11531	3	3.70
Bus Volume		109	6	155	3	3.70

13
14 **Figure 4. Volume information table**

15 *Toll Plaza Volume Information*

16 The toll plaza volume information can be obtained for a particular toll plaza from the list of toll
17 plazas for a selected day, month, year and time period using the **Toll Plaza Volume Info** button
18 in the **Main Menu** window. Total hourly volumes for the time period selected, including the
19 breakdown of cash, E-Z pass vehicles, car, truck, bus volumes are displayed in a tabular form on
20 the screen (See Figure 5)

21 *Travel Time Information*

22 Travel time between consecutive interchanges can be obtained selected for each hour for the
23 selected day, month, year using the **Travel time Info** button on the **Main Menu**. Average travel
24 time, free-flow travel time, maximum and minimum travel time are displayed in a tabular form
25 on the screen.
26



Volume Info	Historical Volume Info						
Interchange 13A Entry	6-7 PM	7-8 PM	8-9 PM	9-10 PM	10-11 PM	11-12 AM	Daily Vol.
Total Volume	2461	2035	1472	1332	933	712	34819
Cash Volume	824	535	389	407	284	211	10028
EZPass Volume	1837	1498	1083	925	649	501	24811
Car Volume	2213	1855	1314	1179	827	631	27104
Truck Volume	235	164	147	148	105	77	7358

Figure 5. Toll plaza volume information table

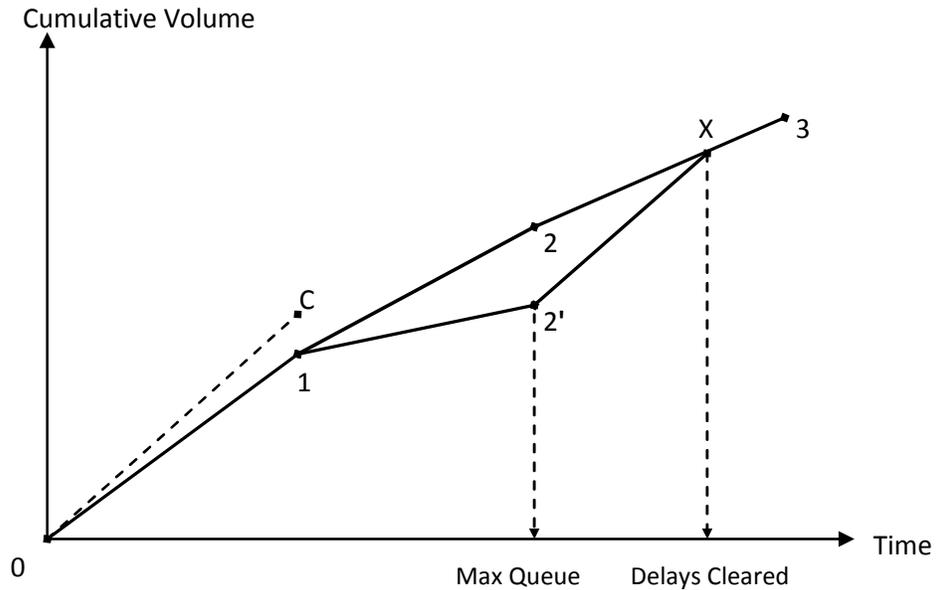
Lane Closure Analysis

Lane Closure Information

Lane Closure Info option can be used to generate the delays and queues resulting from a particular lane closure scenario. The estimation of delay and queue due to lane closure is based on a simple deterministic queuing theory.

Figure 6 depicts the change in the traffic flow due to a hypothetical lane closure between 1 pm- 2pm. This diagram is based on the deterministic queuing theory. The horizontal axis represents time and the vertical axis represents cumulative traffic volume arriving at the roadway link where the work zone takes place. The slopes of lines 0-1, 1-2 and 2-3 are the traffic flow rate between, say, 12 pm - 1pm, 1pm-2pm and 2pm -3 pm, respectively. Because of lane closure, the actual flow rate is reduced, to the level of 2', due to the reduction in the capacity of the roadway. The slope of line 1-2' represents the flow rate past the work zone. When the work zone is removed, the flow rate increases until it becomes equal to the maximum flow rate, the slope of 2-X. This is also equal to the slope of 0-C (See below explanation). When all the delayed traffic passes the work zone location after lane closure is removed, the traffic flow returns to its normal rate.

1 [In the absence of congestion all arriving cars are served because the line 0-C, which
 2 represents the cumulative capacity (maximum departure rate), has a steeper slope than the arrival
 3 rate of traffic. At 2', when all the lanes are cleared, traffic starts departing at capacity, thus the
 4 cumulative departure rate becomes equal to the maximum cumulative departure rate until the
 5 queue is cleared (point X).]
 6



7
 8 **Figure 6. Delay and queue formation during lane closure**

9 Once the link corresponding to the work zone location is selected on the map, **Lane Closure**
 10 **Info** button is activated through the **Main Menu**. The input window containing the information
 11 regarding the start and end hours, date, month and year of the lane closure and the number of
 12 lanes closed are selected from the dropdown list (See Figure 7a).

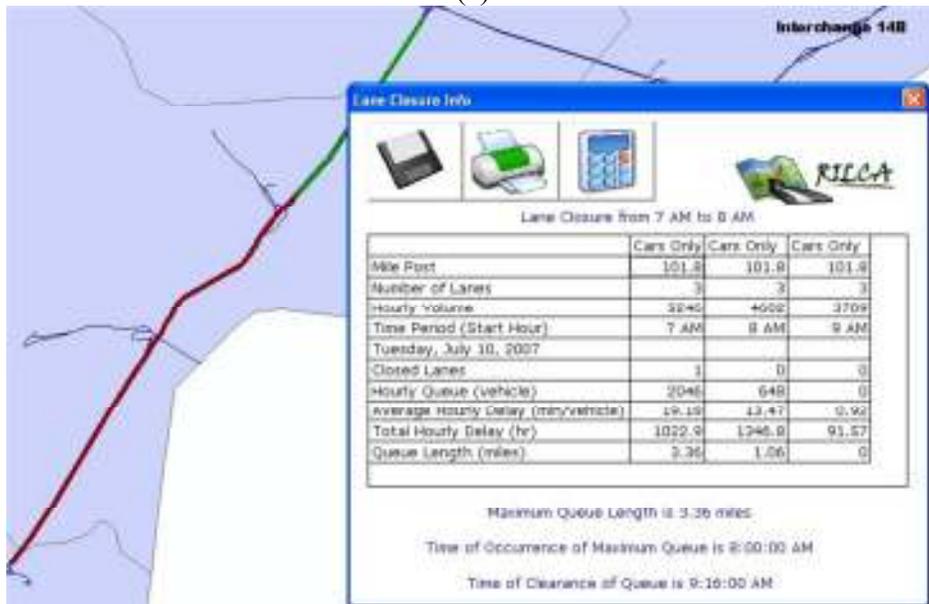
13 RILCA allows users to input parameters that traffic engineers would see as a best fit for the
 14 selected roadway, such as roadway capacity under normal and work zone conditions
 15 (vehicles/hour/lane), average vehicle length, and average gap between vehicles in queue. In
 16 addition, a percent change in traffic volume can be entered by users to reflect anticipated traffic
 17 diversion due to lane closure. This parameter simply modifies the hourly traffic volumes for the
 18 selected database accordingly. All of these parameters impact the queue and delay estimations.
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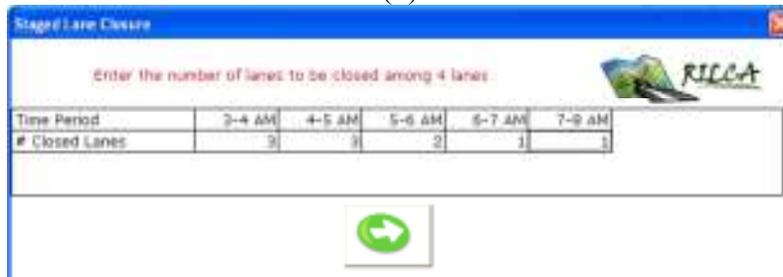
(a)

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(b)

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(c)

8 **Figure 7 (a) Input scenario for lane closure information (b) Lane closure information table**
9 **(c) Staged lane closure information**

10

1 The lane closure analysis results appear in a tabular form including information about the
2 maximum queue length and time of queue clearance. In addition the maximum queue length is
3 highlighted on the map as shown in Figure 7b.

4 RILCA also allows users to conduct staged lane closure analysis. When **Staged** button in
5 Figure 7a is selected, the information table shown in Figure 7c appears on the screen. In this
6 option, the number of lanes to be closed within each hour of the analysis period can be entered.

7 *Lane Closure Schedule*

8 A schedule for the minimum number of lanes to be open on a roadway section can be generated
9 using the **Lane Closure Schedule** button in the **Main Menu** window. Lane closure schedules
10 can be generated for a selected day, week, month or year starting with a selected day for each
11 month. A percentage increase (or decrease) in traffic can also be entered as an input to obtain the
12 schedules for the future traffic demand or for anticipated traffic diversion because of lane
13 closure.

14 Lane closure schedule is displayed in a tabular form as shown in Figure 8a. The table
15 includes the following information: date, day of the week, hour and the maximum number of
16 lanes that can be closed for each hour on each day without any causing queues.

17 RILCA allows users to generate schedule for lane closures where some queue formation is
18 unavoidable. Users can input the number of hours of lane closure, the number of lanes to be
19 closed and allowable queue length. Figure 8b shows the lane closure schedule for a single lane
20 closure for five hours with an allowable queue length of two miles. The "X" sign indicates that
21 this specific work zone cannot be started at that hour, while the sign "O" indicates otherwise. For
22 example, in Figure 8b, the results show that if this specific work zone were to start at 4pm on
23 Monday, it would generate queues longer than two-miles; whereas, if it were to start at 9am it
24 would not.

25 The schedule can be saved as a Microsoft Excel document using the "Save File" button on
26 the Lane Closure Schedule display form.

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Lane Closure Schedule

Schedule for a week starting with Monday, July 05, 2010

	July 5	July 6	July 7	July 8	July 9	July 10	July 11
	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Hour	Cars Only						
12-1 AM	1	2	2	2	2	2	2
1-2 AM	2	2	2	2	2	2	2
2-3 AM	2	2	2	2	2	2	2
3-4 AM	2	2	2	2	2	2	2
4-5 AM	2	2	2	2	2	2	2
5-6 AM	1	1	1	1	1	2	2
6-7 AM	0	0	0	0	0	1	2
7-8 AM	0	0	0	0	0	1	2
8-9 AM	0	0	0	0	0	1	2
9-10 AM	0	0	0	0	0	1	1
10-11 AM	0	1	1	0	1	0	1
11-12 PM	1	1	1	1	1	0	0
12-1 PM	1	1	1	1	1	0	0
1-2 PM	1	1	1	1	1	0	0
2-3 PM	1	1	1	1	0	0	0
3-4 PM	0	0	0	0	0	0	0
4-5 PM	0	0	0	0	0	0	0
5-6 PM	0	0	1	0	0	0	0
6-7 PM	0	1	0	0	0	0	0
7-8 PM	1	1	1	1	0	0	0
8-9 PM	1	1	1	1	1	0	0
9-10 PM	1	2	1	1	1	0	0
10-11 PM	2	2	2	1	1	0	1
11-12 PM	2	2	2	2	1	1	1

The values represent the maximum number of lanes that can be closed to traffic.

(a)

Lane Closure Schedule - Real Option

Feasibility Schedule of Lane Closure MP 101, E1721-Cars

Duration of Lane Closure	6						
Number of Lanes Closed	1						
Allowable Queue (miles)	2						
Date of Lane Closure	7/5/2010	7/6/2010	7/7/2010	7/8/2010	7/9/2010	7/10/2010	7/11/2010
Starting Time	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
12 AM-1 AM	O	O	O	O	O	O	O
1 AM-2 AM	O	O	O	O	O	O	O
2 AM-3 AM	X	X	X	X	X	O	O
3 AM-4 AM	X	X	X	X	X	O	O
4 AM-5 AM	X	X	X	X	X	O	O
5 AM-6 AM	X	X	X	X	X	O	O
6 AM-7 AM	X	X	X	X	X	O	O
7 AM-8 AM	X	X	X	X	X	O	O
8 AM-9 AM	X	X	X	X	X	O	O
9 AM-10 AM	O	O	O	O	O	X	X
10 AM-11 AM	O	O	O	O	O	X	X
11 AM-12 PM	O	O	O	O	O	X	X
12 PM-1 PM	O	O	O	O	X	X	X
1 PM-2 PM	O	O	O	X	X	X	X
2 PM-3 PM	X	O	O	X	X	X	X
3 PM-4 PM	X	O	O	X	X	X	X
4 PM-5 PM	X	O	O	X	X	X	X
5 PM-6 PM	O	O	O	O	X	X	X
6 PM-7 PM	O	O	O	O	O	X	X
7 PM-8 PM	O	O	O	O	O	O	X
8 PM-9 PM	O	O	O	O	O	O	X
9 PM-10 PM	O	O	O	O	O	O	O
10 PM-11 PM	O	O	O	O	O	O	O
11 PM-12 AM	O	O	O	O	O	O	O

NOTE: O - If the selected lane closure configuration can be undertaken
 X - If the selected lane closure configuration cannot be undertaken

(b)

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2

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4

5 **Figure 8 (a) Lane closure schedule for no queue allowed (b) Lane closure schedule 2-mile**
 6 **queue allowed**

1 **Accident Information**

2 *Incident Analysis*

3 **Incident Analysis** option can be used to estimate the delays and queues resulting from a
 4 particular incident. The estimation of delay and queue due to lane closure is based on the
 5 deterministic queuing approach depicted in Figure 6.

6 Users can select the link where the incident occurred and press **Incident Analysis** button on
 7 the **Main Menu** window. Time and date information, start hour and the expected duration of the
 8 incident can be entered in the Input scenario window, as shown in Figure 9a. Maximum queue
 9 length, time of maximum queue length and the clearance time are shown in the results table as
 10 shown in Figure 9b. In addition, the hourly queue, average and total hourly delay and queue
 11 length at the end of each hour are also displayed in the results table.

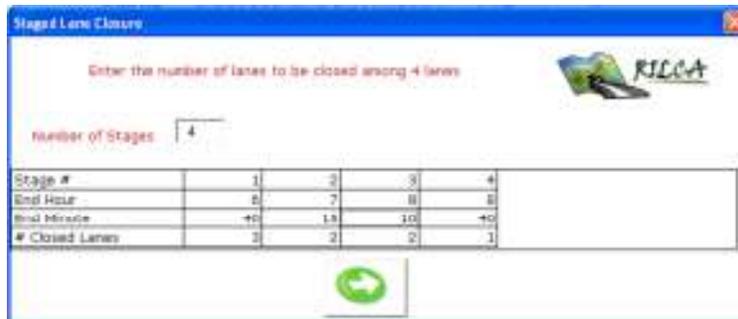
12 Similar to the lane closure information analysis, staged incident analysis can also be
 13 conducted with varying number of lanes closed throughout the incident duration, as shown in
 14 Figure 9c.



32 (a)



33 (b)



34 (c)

35 **Figure 9 (a) Input scenario information for incident analysis (b) Incident analysis results**
 36 **table (c) Staged lane closure information for incidents.**

1 *Accident Database*

2 RILCA allows users to query the extensive accident database of NJTPK, described in the
3 previous section, and obtain either customized or official NJTPK accident reports. A query
4 window, shown in Figure 10 appears when **Accident Database** button is selected in the **Main**
5 **Menu** of RILCA.

6 Users can specify the time period, milepost range, roadway section, direction and conduct
7 queries based on location, weather, pavement type, accident type, light conditions (day/night).
8 NJTPK has a generic internal accident report, that they distribute every month based on the
9 previous months' accident history. RILCA can automatically produce the identical report when
10 the Official Report option is selected, as shown in Figure 10.

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Figure 10. Accident database query window

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An example of the official NJTPK monthly accident query is shown in Figure 11. The presented accident statistics are generated for January 2006.

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ALL NETWORK	Count	Accidents	564
Total Mainline Accidents	388	Injury Accidents	108
Total Interchange Accidents	155	Injuries	157
Total Service Area Accidents	21	Fatal Accidents	1
Total Number of Accidents	564	Fatalities	1
Type of Accident			
Fatal Accident	1	Property Damage Accidents	454
Injury Accidents	108	Truck Accidents	176
Property Damage Only Accident	454	Bus Accidents	9
Total Number of Accidents	564	Accidents at Construction Areas	2
Number of Injuries by Severity		Accident involved Disabled Vehicle	2
Major	1	Principal Accidents Causes	
Minor	23	Driver drinking or under the influence	1
Slight	133	Improper starting or stopping on shoulder	0
Total	157	Following too close	64
Accident by Lighting Conditions		Improper passing	59
Daylight	400	Defective tires	2
Night-lights	91	Defective brakes	0
Night -no Lights	73	No Lights	0
Type of Vehicle Involved in Accidents		Other mechanical defects	7
Cars	766	Animal in roadway	7
Trucks	201	Object in roadway	23
Buses	9	Thrown, dropping or flying object	7
Motorcycles	0	Vehicle making U-Turn	3
Driver's seatbelts usage in accidents	927	Backing or stopping on roadway	15
Driver's Air bags deployment in accidents	64	Driver asleep or drowsy	0
Accident by Weather Condition		inattentive driver	274
Clear	389	Excessive speed	101
Rain	147	Pedestrian action	0
Snow	24	Driving too slow	0
Fog	1	Unknown cause	1
Total	564	Total accidents	564
Accident by Roadway Condition		Category	
Dry	361	Mainline Accidents MP 1 - MP 97	192
Wet	184	Mainline Accidents Penn. Ext.	5
Snow	1	Total Mainline Acc. with 65 MPH	197
Ice	17	Other Mainline Accidents	191
		Total Mainline Accidents	388
		Interchange Accidents	155
		Service Area Accidents	21

37 **Figure 11. An example result of accident query in RILCA**

38 **Users Feedback and Response for RILCA**

39 Prior to the development of RILCA there were a series of meetings with the NJTA staff to decide
 40 on data sources to be used in RILCA, and the functionalities that the operations engineers would
 41 like to use on a day-to-day basis. Also, during the course of development of RILCA there were a
 42 good amount of interaction with the staff to assess the various functionalities and the workflow
 43 of the tool.
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1 One year after they started testing RILCA, the authors conducted a user survey of NJTA
2 staff. The intent of the survey was to receive their feedback and improve the program based on
3 their recommendations.

4 Based on this survey, NJTA engineers seem to be in agreement that the accuracy of results
5 obtained from RILCA varies from good to excellent. During short-term work zone lane closures,
6 NJTA operations department monitor traffic backup either with their surveillance cameras or by
7 the field observations conducted by their maintenance crew. Any queue formation is reported in
8 the dispatchers' traffic log. NJTA engineers pointed out that the queue estimates obtained from
9 RILCA were in general in agreement with the actual queue lengths observed on the roadway.
10 However, they recommended that systematic field tests should be conducted at various work
11 zones to improve the validity of the queuing analysis in RILCA.

12 NJTA engineers also agreed that RILCA has improved their productivity because they do not
13 have to spend time obtaining correct hourly traffic volumes and conduct queuing analysis for
14 various lane closures scenarios. They consider RILCA as a useful tool for quick analysis of short
15 term lane closures, such as last minute maintenance requests. They suggested the use of satellite
16 imagery as overlays in RILCA to be able to find out the actual roadway geometry within the
17 program.

18 **CONCLUSIONS**

19 This paper describes the development of RILCA, an interactive GIS-based computer tool for
20 planning lane closures for work zones. This user-friendly tool is intended to increase the
21 productivity of traffic engineers by providing them with a computerized and easy-to-use lane
22 closure application along with various other useful features.

23 RILCA was developed using ArcView GIS software package as the main development
24 environment. The interactive GIS map of the NJTPK, GSP and other major highways in New
25 Jersey, and its surrounding network is displayed using ArcView. Various analysis and
26 visualization options are provided for interactive planning of lane closures. The tool has the
27 geometric details of NJTPK, GSP and the surrounding highways and local streets and other
28 major freeways in New Jersey. It provides users with the following functionalities:

- 29 ■ Volume information on selected links at a given time period on any given date.
- 30 ■ Link characteristics.
- 31 ■ Lane closure schedule.
- 32 ■ A visualization function that shows the extent of expected delays as a result of lane
33 closure and possibility of spill back onto the upstream links all in the form of link colors.
- 34 ■ Allowable lane closure hours for a day, a week or a month.
- 35 ■ Delay and queue length estimation for incidents.
- 36 ■ Travel time information between interchanges at a given time period on any given date
- 37 ■ Historical accident information.
- 38 ■ Historical weather information.

39
40 The novelty of RILCA is in its ability to process rich travel time and volume information
41 obtained from the ETC database, along with historical accident and weather database using
42 ArcGIS's visual display options.

43 RILCA can also export hourly volume data and geometric characteristics of a selected
44 highway link to QuickZone. QuickZone is used for estimation of traffic impacts of long term

1 lane closures, and requires detailed traffic volume information (12). RILCA helps users to
2 extract data required for QuickZone with little effort and save time for users.

3 RILCA is easily modifiable for any roadway as long as data and expert information is
4 available. It was successfully tested and is currently being used by NJDOT and NJTA engineers
5 with all its features presented in the previous sections. It has also received the annual
6 implementation award from the NJDOT in 2009 in recognition of its usefulness and potential
7 future contributions to improve efficiency of traffic operations as a practical decision support
8 tool for lane closure decisions.
9

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