Sabra, Wang & Associates, Inc.

Engineers • Planners • Analysts

MEMORANDUM

To: Jon Arason, Director of the Department of Planning and Zoning, City of Annapolis

From: Josh Smith, P.E., PTOE, Project Manager
Paul Silberman, P.E., PTOE, Director of Transportation Planning
Sabra, Wang & Associates, Inc.

Subject: Annapolis City Dock Data Collection & Analysis

Date: February 7, 2013

Introduction

The City of Annapolis contracted with Sabra, Wang & Associates (SWA) to provide transportation planning, traffic engineering, and traffic data collection support services in coordination with the development of the Annapolis City Dock Master Plan. The plan includes many elements which may impact the operating characteristics of the transportation network in the vicinity of City Dock. Full details of the plan are presented in the Master Plan document. This memorandum will summarize efforts undertaken by SWA to estimate the general impacts of different alternatives considered, some but not all of which have been advanced into the Master Plan recommendations.

Previous Study

SWA previously completed the "*Bicycle, Automotive and Pedestrian Safety Evaluation*" study dated May 2011on behalf of the City of Annapolis. This document summarized traffic and parking characteristics for the historic downtown Annapolis area generally bounded by Spa Creek, Duke of Gloucester Street, Cathedral Street, Calvert Street, St. Johns Street, College Avenue, and King George Street. Major intersections within the study area were reviewed for safety and operational characteristics, with a special emphasis on pedestrian-automobile conflicts. The intersections near City Dock were found to have the highest potential for conflict between pedestrians and automobiles. Among the recommendations made were to consider either removing Memorial Circle and replacing it with a signalized T-intersection or modifying the geometry of the circle to create a modern roundabout with narrower lanes and geometry that would compel entering drivers to reduce their speeds.

After this study, the City engaged SWA's services to further develop and evaluate variations of these alternative concepts for transportation improvements in a smaller study area immediately adjacent to City Dock. Results of traffic analysis for automobiles were considered and compared in the context of multiple competing objectives, including public space, pedestrian accessibility, safety, aesthetics, historic preservation, and business access.

SWA presented concept plans and results of this study to City staff and members of the City Dock Advisory Committee in presentations entitled "*City Dock Concept Refinement & Traffic Analysis"* on October 19, 2011 and January 19, 2012. For further details about the options considered in these studies, please refer to the presentation slides posted on the City of Annapolis website. The alternative concept plans prepared are found in **Figures 1, 2a, and 2b** for the like-numbered options.

SIGNAL DIAGRAM: RANDALL ST. AT DOCK ST.

LEGEND

- EXISTING / PROPOSED
- PROPOSED PAVEMENT
- PAVEMENT TO BE REMOVED

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City Dock Intersection Improvements – Option 1

Figure 1

1" = 60'

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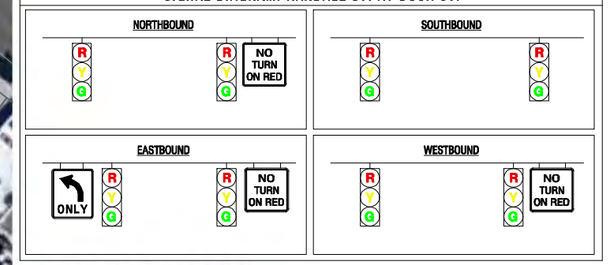
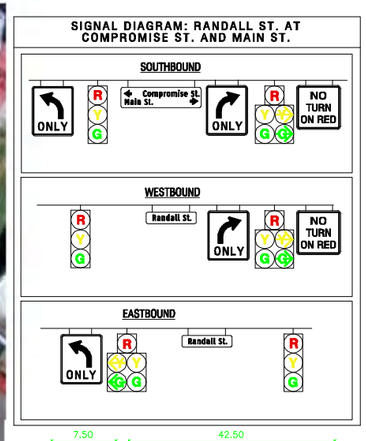
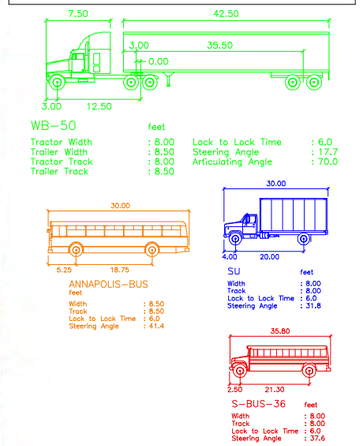
SIGNAL DIAGRAM: RANDALL ST. AT DOCK ST.



SIGNAL DIAGRAM: RANDALL ST. AT COMPROMISE ST. AND MAIN ST.





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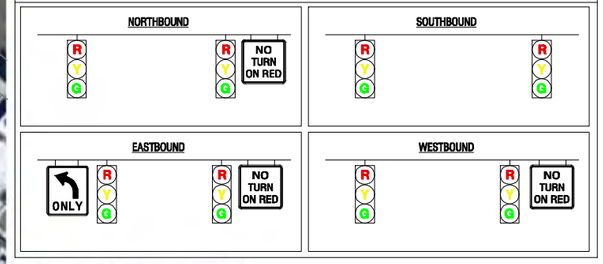
Annapolis, Maryland

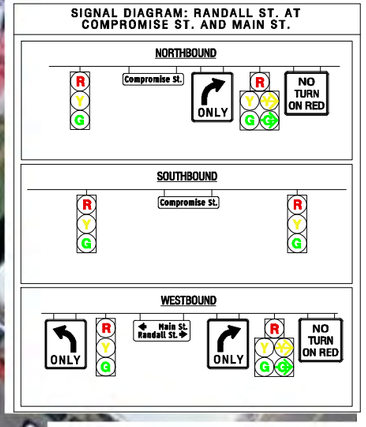
Concepts for discussion with City Advisory Committee 10/19/11 – Option 2a

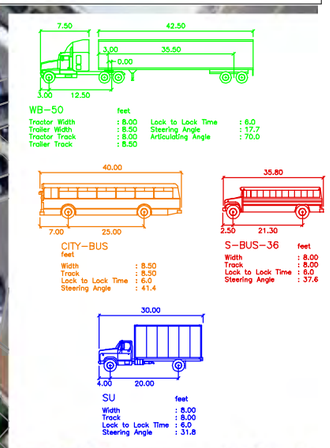
Figure 2a

SIGNAL DIAGRAM: RANDALL ST. AT DOCK ST.



SIGNAL DIAGRAM: RANDALL ST. AT COMPROMISE ST. AND MAIN ST.





LEGEND

- EXISTING
- PROPOSED
- PROPOSED PAVEMENT
- PAVEMENT TO BE REMOVED

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Concepts for discussion with City Advisory Committee 10/19/11 – Option 2b

Figure 2b

Alternative Concepts Considered

For the subject study, the Master Planning team asked SWA to explore variations of the previously considered options in terms of the intersection geometry at the existing Memorial Circle intersection of Main Street, Randall Street, and Duke of Gloucester Street. Option 2b was dismissed as being inferior to Option 2a since most of the new public space created in Option 2b would be in a large traffic island not adjacent to either the waterfront or the Market House.

For Option 2a, various alternative concepts were developed as part of this study. The different concepts considered would have additional benefits for public space, aesthetics, and business access with varying trade-offs in traffic operations and other objectives. The concepts considered may be described as follows and as shown in **Sketches 2a-1 through 2a-4r** as prepared by the Master Planning team:

- **Concept 2a-1:** T-intersection as previously designed, with multiple lanes for turning movements on each approach to the intersection. Seven angled parking spaces would be preserved in front of the businesses south of the intersection.
- **Concept 2a-2:** T-intersection with one lane for each approach and no turn lanes to provide for additional public space. As in Option 1, seven angled parking spaces would be preserved for the businesses south of the intersection.
- **Concept 2a-3:** T-intersection with multiple lanes for each approach, except with only one lane for the Main Street approach. A one-way eastbound service roadway and 13 parallel parking spaces would be created in front of the businesses south of the intersection.
- **Concept 2a-4:** T-intersection with multiple lanes for the Compromise Street approach only and a single lane for other approaches. A one-way eastbound service roadway and 14 parallel parking spaces would be created in front of the businesses south of the intersection.
- **Concept 2a-4r:** T-intersection with multiple lanes for the Compromise Street approach only and a single lane for other approaches. A one-way westbound service roadway and an undetermined number of angled or parallel parking spaces would be created in front of the businesses south of the intersection along with right-in/right out access to and from the business access at the signalized intersection.

Concept 3 ("Big Circle" or "Memorial Square" Concept): This concept was introduced by the Master Planning team as a means of consolidating more new public space in a single location. Market Space, Main Street, and Randall Street would all be changed to one-way streets in a counter-clockwise direction south and west of the Market House as shown in **Figure 3a**, also provided by the Master Planning Team, with the eastern portion of Market Space being one-way in the opposite, eastbound direction. An undetermined number of parallel parking spaces would be provided in front of the businesses south of the intersection and along Market Space. The figure shows only one lane provided in the circulating portion of the intersection, though SWA evaluated the option with both one circulating lane (Concept 3a) and two circulating lanes (Concept 3b).

Traffic modeling for Option 1 and Concept 2a-1 had been completed during previous studies using recent (2010) traffic and pedestrian volumes for typical weekday and Saturday peak periods. During the previous studies, the intersection footprint for Concept 2a-1 was minimized in order maximize the creation of new public space while still avoiding excessive traffic congestion at the intersection.

T-INTERSECTION W/ PARALLEL PARKING

Figure 2a-1

OLIN
PUBLIC LEDGER BUILDING,SUITE 1123
150 SOUTH INDEPENDENCE MALL WEST
PHILADELPHIA, PA 19106
TEL 215.440.0030 / FAX 215.440.0041
OLIN PARTNERSHIP, LTD.

Annapolis City Dock- 1209.00 - Traffic Studies

Drawing No. : SK-3
Date: 24 July 2012
Scale: 1"=50'

0 25 50 100

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Figure 2a-2

T-INTERSECTION
(LIMITED TURNING LANES)

OLIN
PUBLIC LEDGER BUILDING,SUITE 1123
150 SOUTH INDEPENDENCE MALL WEST
PHILADELPHIA, PA 19106
TEL 215.440.0030 / FAX 215.440.0041
OLIN PARTNERSHIP, LTD.

Annapolis City Dock- 1209.00 - Traffic Studies

Drawing No. : SK-2
Date: 24 July 2012
Scale: 1"=50'

N

0 25 50 100

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T-INTERSECTION W/ PARALLEL PARKING

Figure 2a-3

OLIN
PUBLIC LEDGER BUILDING,SUITE 1123
150 SOUTH INDEPENDENCE MALL WEST
PHILADELPHIA, PA 19106
TEL 215.440.0030 / FAX 215.440.0041
OLIN PARTNERSHIP, LTD.

Annapolis City Dock- 1209.00 - Traffic Studies

N

Drawing No. : SK-3
Date: 24 July 2012
Scale: 1"=50'

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Figure 2a-4

T-INTERSECTION W/ PARALLEL PARKING
(LIMITED TURNING LANES)

OLIN
PUBLIC LEDGER BUILDING,SUITE 1123
150 SOUTH INDEPENDENCE MALL WEST
PHILADELPHIA, PA 19106
TEL 215.440.0030 / FAX 215.440.0041
OLIN PARTNERSHIP, LTD.

Annapolis City Dock- 1209.00 - Traffic Studies

Drawing No. : SK-4
Date: 24 July 2012
Scale: 1"=50'

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T-INTERSECTION W/ PARALLEL PARKING
(LIMITED TURNING LANES)

OLIN
PUBLIC LEDGER BUILDING,SUITE 1123
150 SOUTH INDEPENDENCE MALL WEST
PHILADELPHIA, PA 19106
TEL 215.440.0030 / FAX 215.440.0041
OLIN PARTNERSHIP, LTD.

Annapolis City Dock- 1209.00 - Traffic Studies

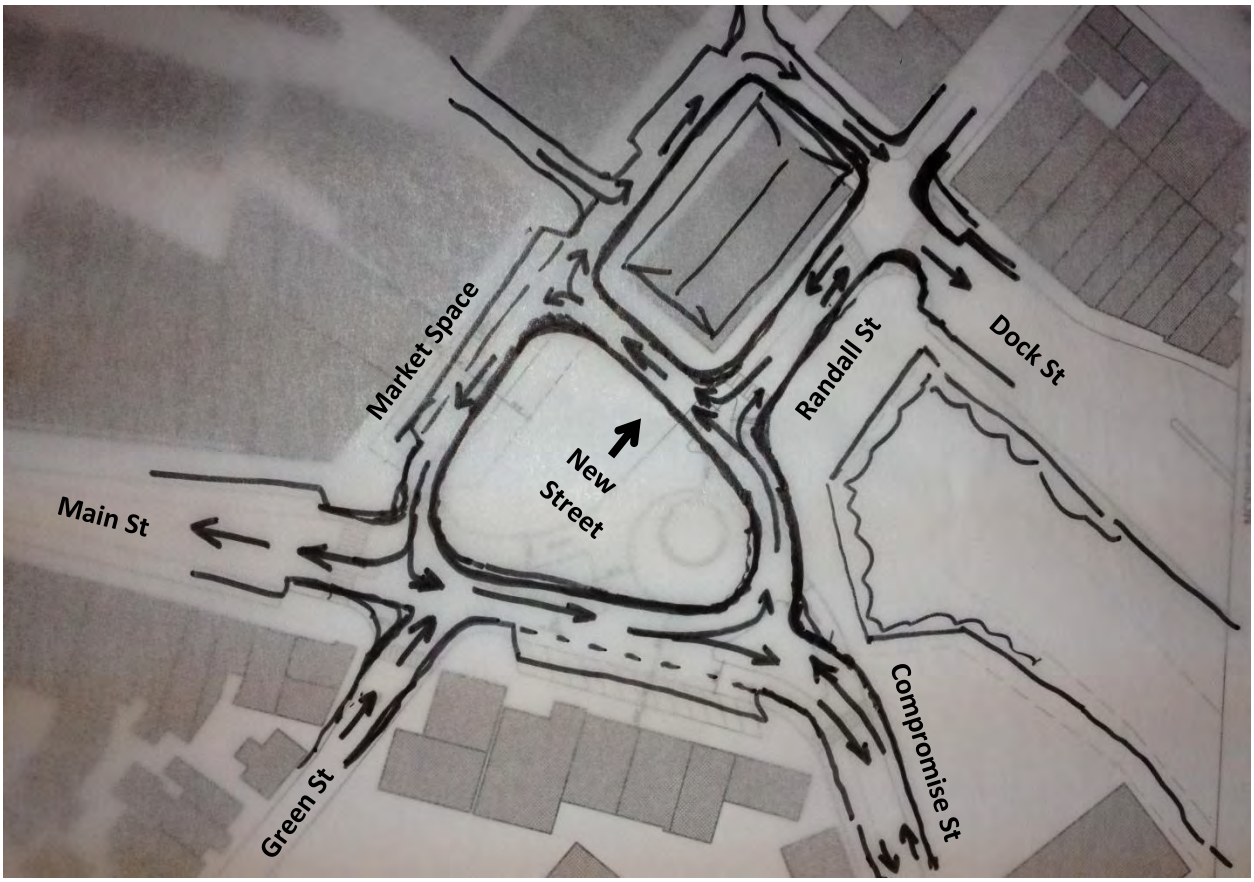
Drawing No.: SK-4
Date: 24 July 2012
Scale: 1"=50'

0 25 50 100

\\olinptr.com\files\Projects 2012\1209-Annapolis City Dock\CAD\200 Plot\Studies\TRAFFIC STUDIES\1209-00 Circulation

Figure 2a-4r

Figure 3a: Concept 3a ("Big Circle" or "Memorial Square"), one lane



While further reduction of the lane capacity as proposed in Concepts 2a-2 through 2a-4r would provide certain benefits to the public, either excessive congestion would need to be tolerated with these concepts or changes in travel demand patterns would need to encouraged and facilitated in order to route traffic to alternative routes avoiding the intersection.

Two potential means were identified for reducing traffic volumes through the Memorial Circle intersection in the future for any of the intersection conversion options shown in Concepts 2a-2 through 2a-4r:

1. Convert Duke of Gloucester Street to a two-way operation in order to reduce the volume of traffic from Eastport that must use the intersection to bypass Main Street or King George Street to access areas west of the historic district.
2. Provide improved parking wayfinding information to drivers to reduce the amount of recirculation that exists as drivers pass through the intersection multiple times while looking for parking spaces.

Note that in #1 above, multiple potential obstacles may exist to feasibly convert Duke of Gloucester Street to two-way traffic, including parking constraints, loading and unloading logistics adjacent to the St. Mary's Church and School, the need for new intersections such as Duke Street and

Figure 3b: Concept 3b ("Big Circle" or "Memorial Square"), two lanes

Compromise Street and Duke and Green Street to be signalized, or operational changes at Duke Street and Church Circle. The purpose of this study is not to evaluate these potential constraints specifically but rather to determine if two-way traffic on Duke of Gloucester Street would create a benefit significant enough at the Memorial Circle intersection to warrant further consideration of the idea.

Data Collection

In conjunction with the two volume-reduction scenarios presented above, three separate data collection efforts were undertaken to support the analysis of each concept:

1. **Eastport Origin-Destination Study** – to understand the percentage of drivers who might be willing to use Duke of Gloucester Street in the westbound direction were it converted to two-way traffic, thus bypassing Memorial Circle, the existing percentage of drivers from Eastport crossing the Spa Creek bridge and soon thereafter passing various key locations west of City Dock must be determined.
2. **Traffic Recirculation Study** – in order to assess the maximum potential percentage reduction in trips through the Memorial Circle intersection due to improved parking wayfinding measures, the existing percentage of vehicles that pass through the intersection more than once in an hour was determined.

Details of each study and its results are presented in the sections that follow.

Eastport Origin-Destination Study

An origin-destination study was conducted to assist the City in understanding the current travel patterns of Eastport motorists who are crossing the Spa Creek bridge and traveling through City Dock.

Observers were positioned at locations where vehicles were accelerating from turns or from traffic signals such that they were traveling slow enough to have license plate numbers captured either through a combination of video cameras and manual observations. Video cameras were set to record traffic at the four locations shown in **Figure 4** simultaneously for a one-hour period on Saturday, September 8, 2012 during peak hour traffic. Technicians recorded the license plate numbers for all vehicles passing each point into a spreadsheet. The spreadsheet data was then analyzed to identify matching license plate numbers, indicating the travel path of the vehicles.

The results of the study indicated, as shown in **Figure 5**, that over 90% of the Saturday traffic coming over the Spa Creek bridge was destined to locations in and around Memorial Circle, leaving only about 9% of existing traffic that would benefit from a two-way conversion on Duke of Gloucester Street in order to avoid potential congestion at a reconfigured Memorial Circle intersection.

Weekday video data was also collected, but because of the relatively low percentage of trips with potential to use westbound Duke of Gloucester Street during the Saturday peak hour that is critical to evaluation of the Memorial Circle concept, the potential benefits of the two-way conversion were determined to be low relative to the afore-mentioned potential constraints. Therefore, the weekday video data was not reduced into origin-destination percentages.

Figure 4: Origin-Destination Video Locations

CITY OF ANNAPOLIS

VEHICULAR MOVEMENT FROM SPA CREEK BRIDGE

Figure 5

Weekend Analysis

PERCENT OF VEHICLES LEAVING SPA CREEK BRIDGE

West St. 0.3 %

King George St. 2.7 %

Rowe Blvd. (Bladen St.) 6.1 %

Downtown Annapolis 90.9 %

City of Annapolis Gateway

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Traffic Recirculation Study

The purpose of the recirculation study is to identify what percentage of traffic is circling the City Dock repeatedly within a short period of time, presumably in search of surface or on-street parking at City Dock. Video cameras were set to record traffic at pre-determined location simultaneously for a one-hour period on Saturday, September 1, 2012. Technicians reduced the videos and transposed the license plate numbers into a spreadsheet. Each spreadsheet was then analyzed using customized formulas for matches at each location to identify any vehicles that returned to the same intersection within the one-hour study period.

The study was conducted at five locations as illustrated in **Figure 6**: (a) Compromise St south of Memorial Circle, (b) Randall St south of Dock St, (c) Main St east of Conduit St, (d) Duke of Gloucester St west of Green St, and (e) Green St between Duke of Gloucester St and Main St.

Figure 6: Recirculation Study Locations

The recirculation study found that between 3-6% of traffic surveyed passed the same location more than once:

- Compromise Street – 6.3%

- Randall Street – 3.2%
- Main St – 3.4%
- Duke of Gloucester – 3.3%
- Green Street – 4.0%

Parking Duration Study

In addition to the two studies described above, which served to estimate the potential volume reductions that might be realized at the Memorial Circle intersection by implementing various improvements, another study was conducted to provide input to the Master Planning team regarding parking behavior in the City Dock area. In this study, the average dwell times for each parking lot near City Dock were measured, providing a level of detail that will allow City planners to improve parking wayfinding as well as understand the demand of these lots.

The study area included five parking areas as illustrated in the **Figure 7**: Dock Street (P1), Market Space (P2), Main St immediately north of Market Space (P3), business parking south of Memorial Circle (P4), and the Donner Lot (P5).

Figure 7: Parking Duration Study Area

Technicians circulated through each lot on Saturday, August 11, 2012 from 10:00 am-9:00 pm. The license plate number of each car parked was recorded every 15 minutes for each zone where parking is restricted to a 30-minute time limit. For all other parking areas, technicians circulated in 30 minute intervals to record license plate numbers. The lists of license plate numbers were transposed into spreadsheet software and analyzed based on the number of intervals the same license plate is recorded, to extract approximate dwell times.

The results of the study are shown in **Table 1**. Note that while utilization was between 80-90% for most spaces, 30-minute parking zones on Market Space and immediately south of Memorial Circle were somewhat less utilized. The average turnover of 8 cars per space for the 289 total spaces surveyed represents over 2,300 vehicles parked during the 11-hour period of the survey. **Figures 8 and 9** show the distribution of parking dwell times for the 30-minute and 2-hour parking zones, illustrating a significant rate of violations where visitors park longer than the regulated duration.

Table 1: Parking Duration Study Results

City of Annapolis Parking Duration Study
Saturday, August 11th, 2012
10:00am - 9:00pm

LOT	TOTAL NO. OF SPACES	METER REGULATION		AVG TOTAL LENGTH OF STAY (MINS)	AVG TURNOVER IN LOT (NO. OF CARS IN EA. SPACE)	HIGHEST TURNOVER RECORDED	TOTAL DAILY VEHICLES PARKED	% Utilization
		TIME LIMIT	NO. OF SPACES					
Donner	26	2 HOUR	26	117	5	8	142	87%
Lower Main St	19	2 HOUR	19	112	6	9	116	97%
Mills Liquor	15	30 MIN	15	58	11	15	158	77%
Dock St	188	2 HOUR	182	132	5	10	976	91%
		30 MIN	6	43	11	15	67	80%
Market Space	41	2 HOUR	32	101	6	9	206	93%
		30 MIN	9	52	8	10	74	66%
Grand Total	**289**	--	**289**	**88**	**8**	**11**	**1739**	88%

Figure 8: Dwell Time Distribution for 30-Minute Parking

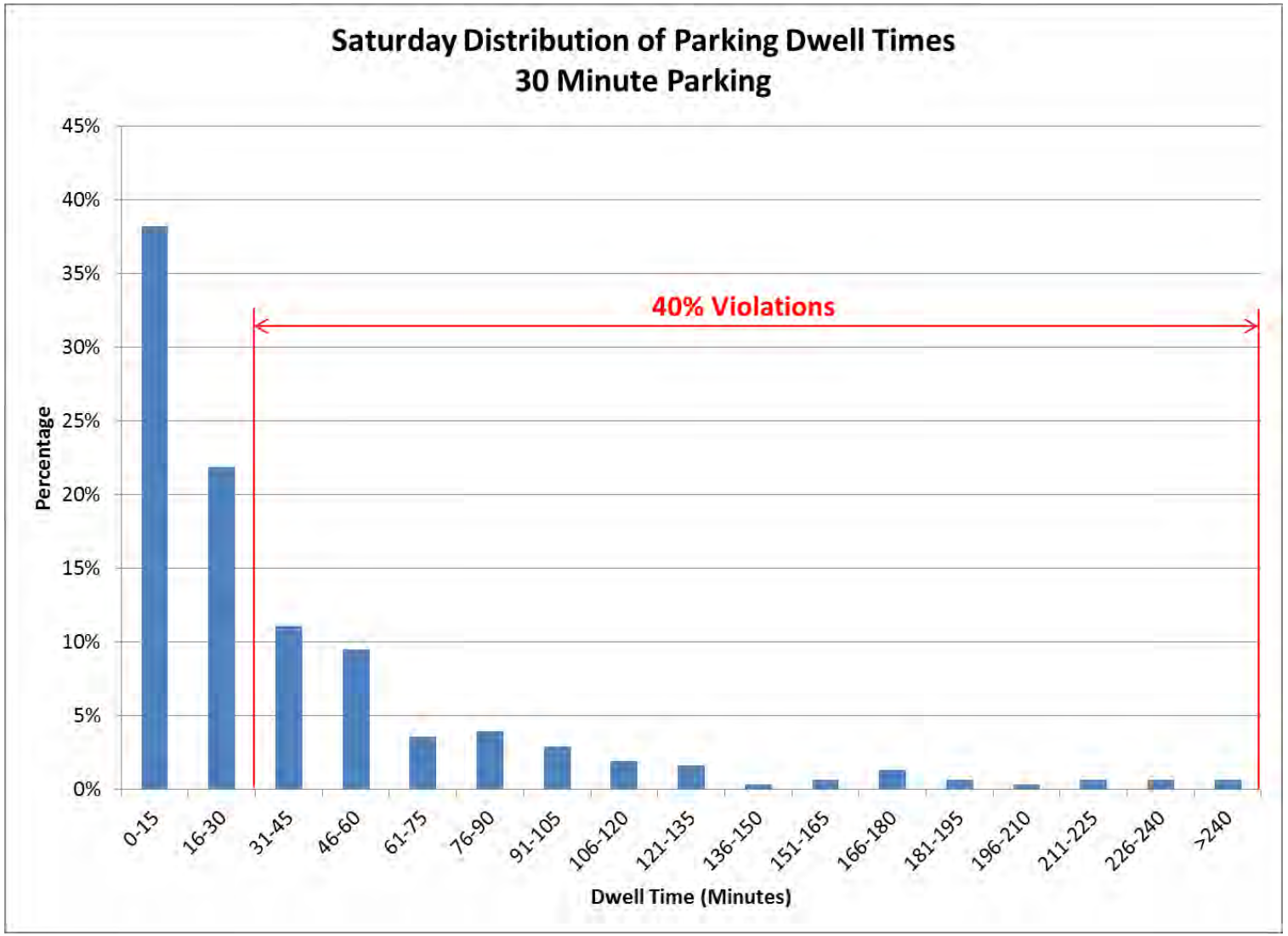
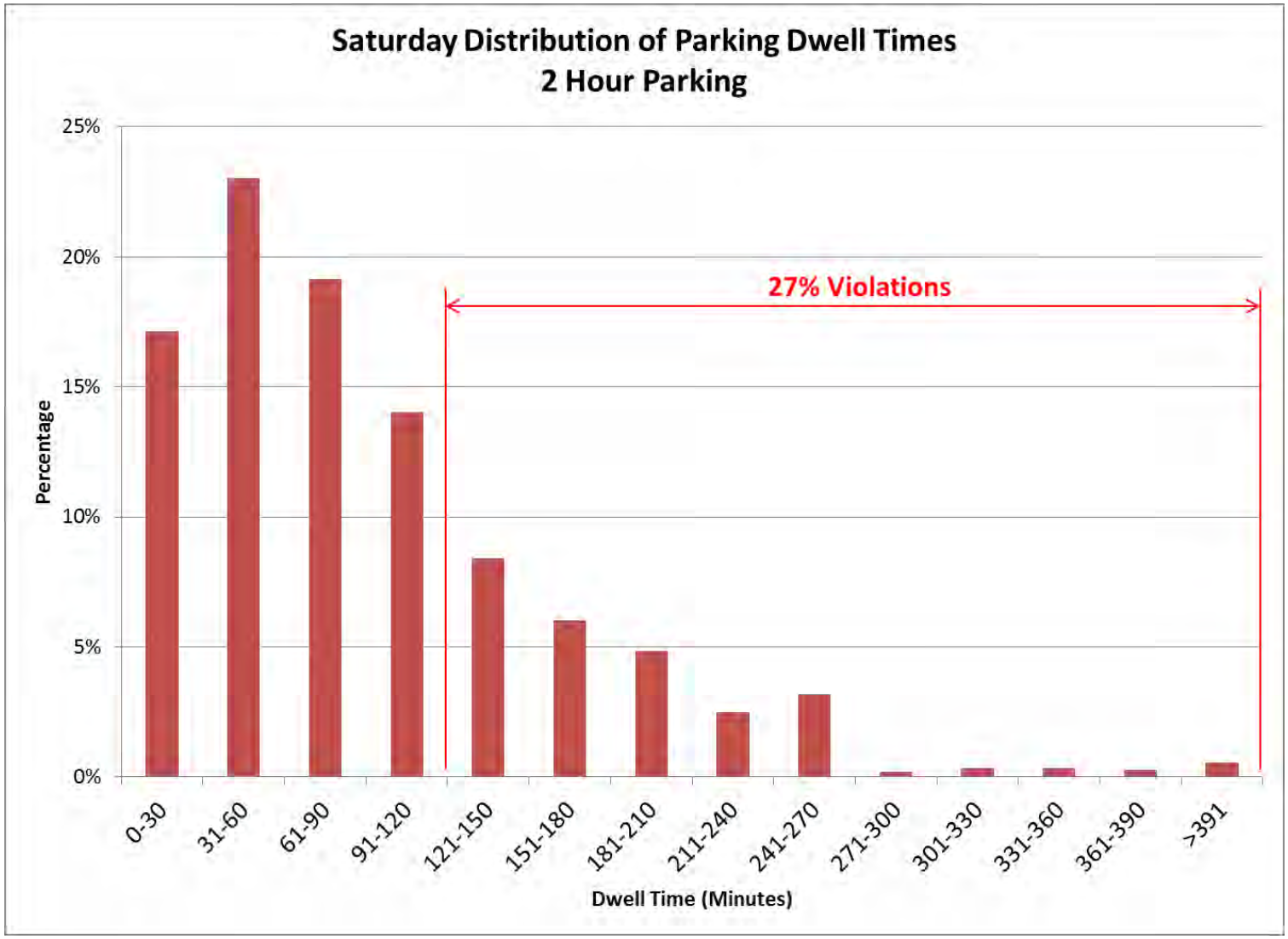


Figure 9: Dwell Time Distribution for 2-Hour Parking



Concepts Retained for more Detailed Analysis

Saturday peak hour traffic volumes for the study area were developed for a two-way Duke of Gloucester Street and for volume reductions based on the elimination of the existing recirculating volumes. Based on even the most generous conclusions about the amount of traffic that could be diverted away from the intersection that could be derived from the data collected, preliminary traffic analysis revealed that certain concepts mentioned earlier would not perform acceptably. Therefore, Concepts 2a-2 and 2a-3 were eliminated without further detailed analysis. Concept 2a-4r was also eliminated based on driver and pedestrian expectancy problems associated with having an unsignalized right-in, right-out approach from the businesses on the south side of the intersection to the otherwise signalized intersection.

Detailed Concept Refinement

Concept 2a-4 was refined further to develop acceptable access and parking for the businesses on the south side of the intersection. Refer to **Figures 10**. In this case, 13 angled parking spaces would be provided adjacent to a one-way westbound access lane in front of the businesses immediately south of the intersection. Ingress to the access lane would be via left turn or right turn from Compromise Street, preserving access for drivers approaching from Compromise Street, Green Street, or Randall Street. Egress would be via right turn only to lower Main Street, which would preserve egress via either Randall Street or Compromise Street but not egress via Main Street. Preserving left turn egress via Main Street would require signalizing the business driveway egress in conjunction with the proposed signal at the Main Street/Green Street intersection.

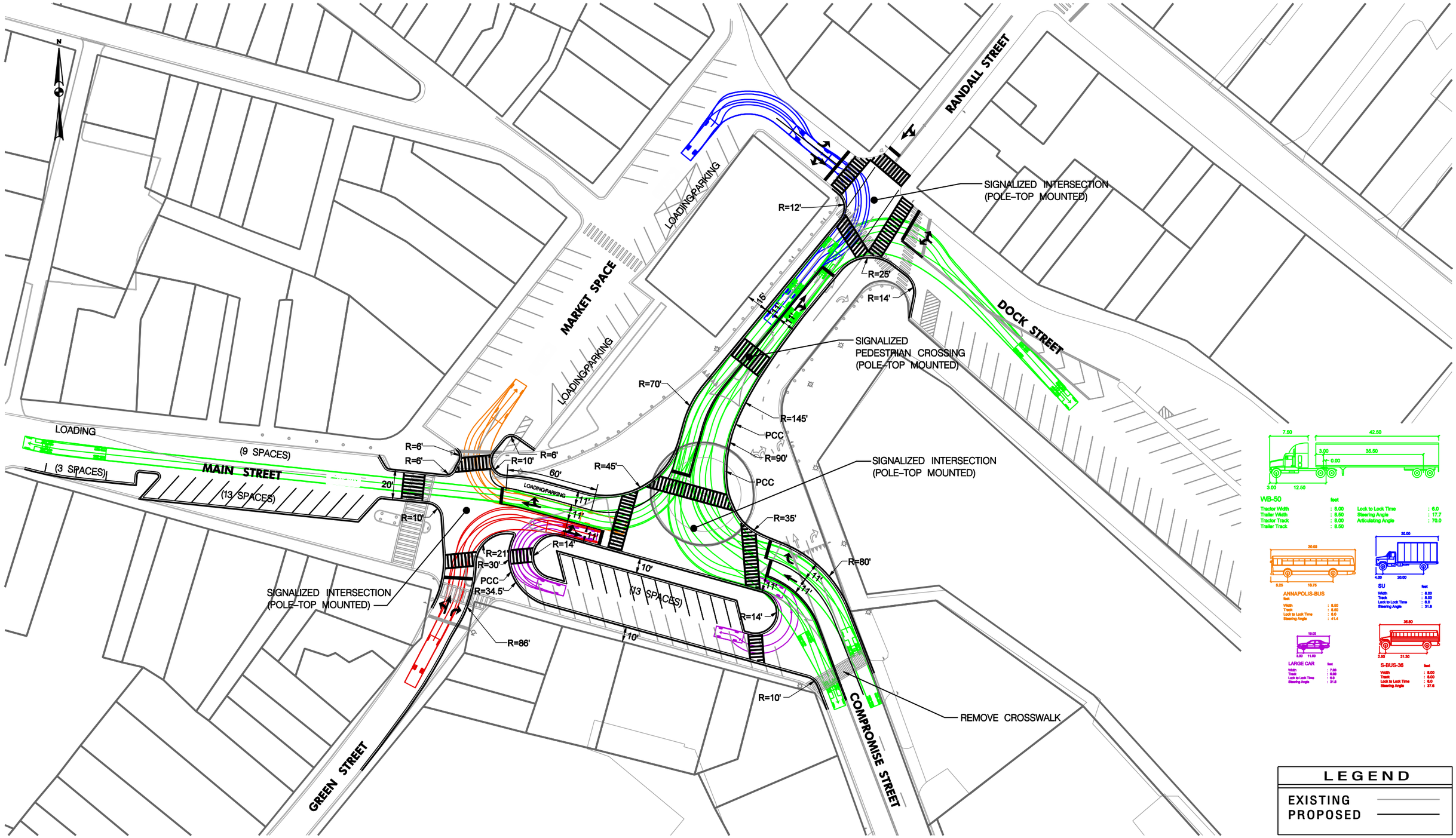
This concept also widens the sidewalk in front of the businesses south of the intersection from 5 feet to 10 feet. A loading zone is provided on the northwest corner of the intersection, and Randall Street is realigned slightly versus previous concepts to provide wider sidewalk in front of the Market House.

A similar variation of this concept, Concept 2a-5, as shown in **Figure 11**, was developed to add a left turn lane on Main Street for traffic capacity.

Capacity Analysis Results

Previous studies had analyzed alternatives both using Synchro and VISSIM software. Synchro software had been used to model each of the retained concepts at a macroscopic level to obtain level of service (LOS) results on a scale of A to F for each individual intersection. However, Synchro does not sufficiently model driver/pedestrian interactions when large numbers of pedestrians are present, nor is it well regarded for modeling the operation of roundabouts and other traffic circles. Therefore, VISSIM software had been used to evaluate Options 1 and 2a in the studies previously conducted due to its greater functionality for such circumstances.

Because VISSIM models are labor-intensive to code and run, a more efficient method of comparing the newly identified concepts in the subject study was sought. SWA elected to model the new concepts in Synchro but then use Synchro's companion microsimulation software, SimTraffic, to model Concepts 2a-1, 2a-4, 2a-5, 3a, and 3b. SimTraffic, while not particularly well-suited to modeling the existing Memorial Circle or the proposed roundabout in Option 1, provides quick and reliable modeling of



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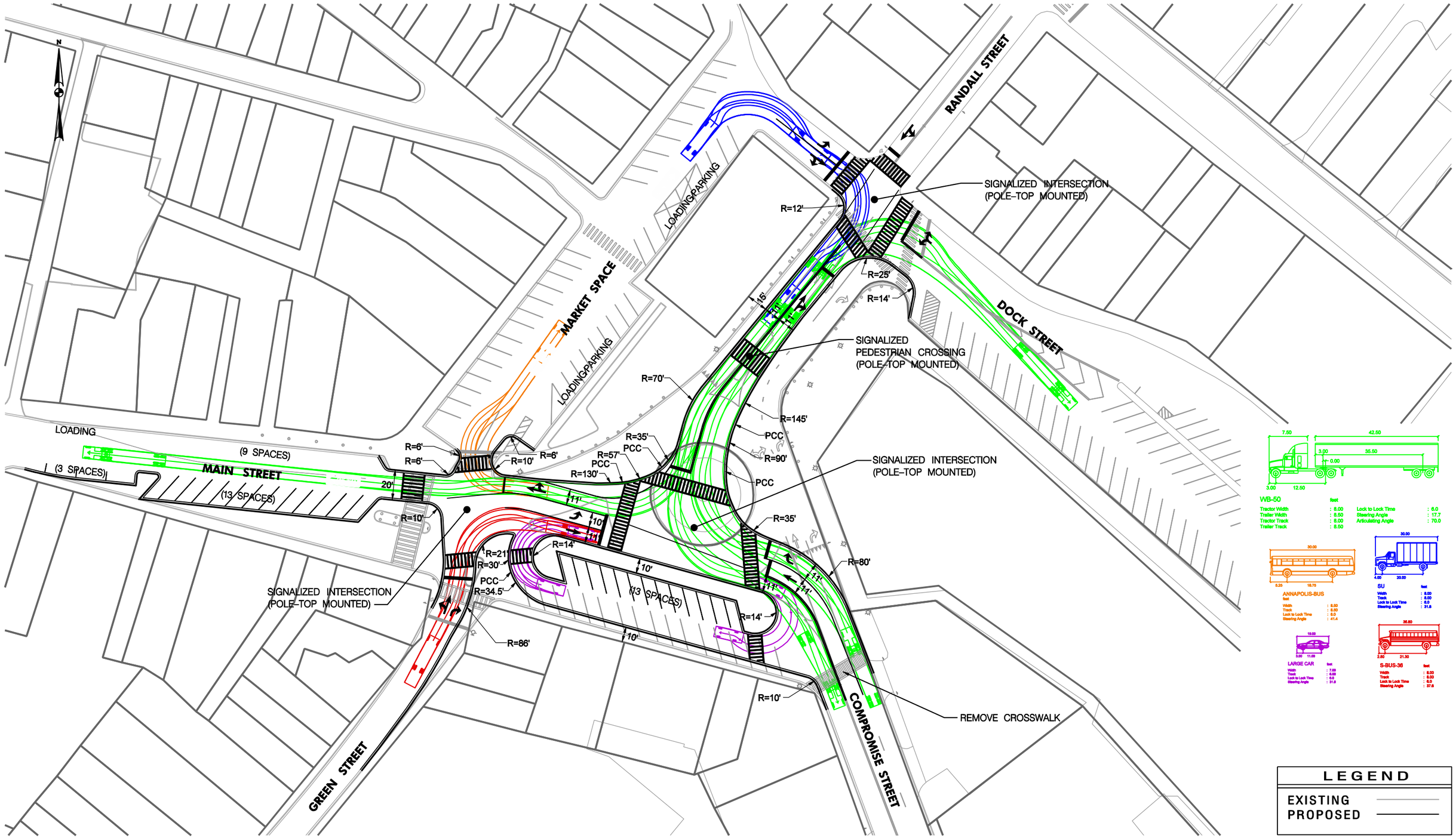
Annapolis, Maryland

Concepts for discussion with City Advisory Committee – Option 2a–4 Detail

Figure 10



interaction between closely-spaced intersections and can model well fully signalized intersections where heavy volumes of pedestrians have exclusive pedestrian movements, as remains the case for each of the signalized concepts.

For each concept, the total peak hour Saturday average travel time per vehicle passing through the study network was identified as a metric that would provide a straightforward comparison between concepts that could be extracted from each of the traffic models across the various software platforms. Analysis was not conducted for weekday AM and PM peak hours at this time, but would need to be conducted later to validate acceptable operations for the selected alternative.

Table 2 shows the resulting travel times extracted from VISSIM and SimTraffic for areawide network travel time. The left-most column in the table shows average travel times assuming existing traffic volumes remain unchanged. Under these circumstances, Concept 3b performs best of all the concepts analyzed with only 1:29 of average travel time to traverse the study area. However, the CDAC committee indicated in a recent meeting that this concept was highly undesirable from an aesthetic and public space standpoint because all the new public space would be "locked into" an area where pedestrians must cross high-volume streets. Option 1 and Concept 2a-1 would offer modest improvements in travel time versus existing conditions.

The right three columns in Table 2 represent travel time results that might be achieved through volume reduction at the reconfigured intersection of Main Street, Compromise Street, and Randall Street through the various measures described previously and for which the volume-reduction potential was measured as part of the data collection described in earlier sections. The 12% column in Table 2 represents the maximum reduction in traffic volumes that SWA estimates could realistically be achieved by both making Duke of Gloucester St two-way and improving parking wayfinding signing.

The 25% column represents results in conjunction with a very aggressive program to get people to park outside the City Dock area, probably with dynamic electronic parking wayfinding signing as seen, for example, at the BWI airport parking garage. It may be debatable whether this would be an achievable reduction. Reductions of this magnitude might also be achieved by reducing the number of parking spaces on Dock Street or elsewhere near City Dock to an appropriate number, though SWA defers judgment on this issue to the parking consultant serving as part of the Master Planning team.

The 30% column represents a possible reduction in left turn traffic at the intersection of Main Street, Compromise Street, and Randall Street that might be achieved by aggressive encouragement and wayfinding signing to dissuade travelers from using Green Street and instead diverting most inbound trips to Compromise Street via St. Mary's Street.

Though most of these trips would still be traveling through the intersection, they would be making an easier right turn from Compromise Street to Randall Street that would be provided with its own lane, rather than the more difficult left turn from Main Street to Randall Street, which in some of the concepts considered is not provided with a dedicated left turn lane. These scenarios may require prohibition of left turns from Main Street to Randall Street and/or signalization of the intersection of Compromise Street and St. Mary's Street. Further study is recommended for these scenarios under both weekday and weekend peak traffic volumes before a

Table 2: Simulated Travel Time Comparison for Memorial Circle Intersection Options

Option	Description	Travel Time/Vehicle (min:sec)			
		For Existing Volumes	12% Reduction in Existing Volumes[1]	25% Reduction in Existing Volumes[2]	30% Redistribution from Green St
Existing	Existing	3:23	Not Available		
Option 1	Modified Circle	2:25			
Concept 2a-1	T-Intersection (VISSIM)	2:31	Not Available		
	T-Intersection (SimTraffic)	2:33	4:14	1:26	1:38[3]
Concept 2a-4	Modified T-Intersection without Main St LT lane	11:22	11:01	2:57	1:37[3,4]
Concept 2a-5	Modified T-Intersection with Main St LT lane	7:51	5:46	1:36	2:12[3]
Concept 3a	Memorial Square 1-Lane	7:56	2:25	1:23	N/A
Concept 3b	Memorial Square 2-Lane	1:29	1:29	1:20	N/A

Notes:
1 - 12% reduction in existing volumes assumed due to 3% recirculation reduction and 9% reduction due to Duke of Gloucester being converted to two-way
2 - 25% reduction assuming additional improvement of dynamic electronic parking wayfinding signing to discourage parking near City Dock
3 - Assumes 30% reduction of traffic on Green Street with that traffic being redistributed to St. Mary's St. Main St at Green St would be able to have an exclusive pedestrian phase.
4 - Eastbound left-turns would be prohibited at Randall St in this Option and would be assumed to use Market Space.

An efficient screening of the concepts prevented the use of VISSIM analysis at this time for the Existing, Option 1, and Concept 2a-1 reduced-volume scenarios, though Concept 2a-1 was able to be quickly analyzed using SimTraffic. As such, further VISSIM analysis in the future is recommended if Option 1 is

pursued in conjunction with measures designed to produce a reduction in traffic volume at the intersection.

It should be noted that Table 2 produces some unexpected results, most notably the prediction that Concept 2a-1 would perform worse by more than a minute and a half if volumes were reduced by 12% than if they remained as existing. Both SimTraffic and VISSIM software include random components to mimic the varying flow of traffic on a day-to-day, so even though the results of Table 2 represent an average of 5 runs of the model, more modeling may be warranted for this option.

Table 2 illustrates that with only the 12% reduction in traffic volumes that could be achieved with a two-way conversion of Duke of Gloucester Street and traditional parking wayfinding signing improvements, each of the Option 2a concepts would result in more Saturday delay than under existing conditions unless the full complement of turn lanes shown in Concept 2a-1 is provided.

With 25% or higher reductions in traffic volumes, all of the concepts studied perform markedly better for travel time than existing conditions. In particular, further study of measures that can be used to designate and encourage the use of a Duke of Gloucester Street to St. Mary's Street to Compromise Street route for entering the area should be explored further.