PROJECT DEFINITION REVIEW

I. Introduction

McFarland-Johnson (MJ) has been hired to evaluate the current design and progress the project through the design and construction stages. This Project Definition Review includes an overall review of the Conceptual Plans. The main focuses of our review are the roundabout geometrics and design criteria, the geotechnical investigation, and the stormwater permitting requirements.

MJ has reviewed the conceptual design and propose the changes as described in the Recommendations section. Once a consensus is reached for the best design for this location, impacts to the adjacent properties can be determined and the design process can proceed rapidly.

II. Background

The project begins on US Route 5 approximately 400 feet south of the intersection with Sykes Mountain Avenue and continues north for about 800 feet. The project also extends from the intersection along Sykes Mountain Avenue approximately 800 feet. Roundabouts are to be constructed at the intersection of US Route 5/Sykes Mountain Avenue and the intersection of Sykes Mountain Avenue/Ralph Lehman Road. Also included in the project is approach work on Beswick Road and Ralph Lehman Road, accommodations for bicycle and pedestrians, drainage, and the construction of raised median islands.

To address concerns about the capacity of the existing US Route 5/Sykes Mountain Avenue intersection, a scoping study was initiated to evaluate alternatives for improving the capacity of the intersection. Following the completion of the scoping study, the Agency of Transportation was asked to reevaluate the project by adding roundabouts with a raised median island along Sykes Mountain Avenue. The roundabout alternative was approved, the design was progressed to Conceptual Plans (25%), and a public 502 hearing was held.

III. Roundabouts

The critical design elements for designing a roundabout are the required capacity, design speed, and design vehicle. The required capacity determines the number of circulating lanes needed for the roundabout. The safest roundabouts are those that minimize the number of circulating lanes. Multi-lane roundabouts typically have twice the number of crashes when compared to single lane roundabouts. Multi-lane approaches and exits also decrease the safety of pedestrians crossing at the roundabout.

Once the number of circulating lanes is known, the greatest factor for vehicle safety in roundabouts is the design speed. It is critical that roundabouts be designed so that the attainable speeds through the roundabout are consistent for each approach and compatible with the design speed. FHWA recommends an overall design speed between 20-25 mph, and a differential speed between movements of a maximum 10-12 mph. Speeds through the roundabout are controlled by the entrance, circulating and exit radii. By proper use of these radii, the designer can ensure that vehicles entering the roundabout are sufficiently deflected from a direct path to keep speeds near the recommended design speed. Also important to recognize is the impact of the design speed on pedestrian traffic. Figure 1 is a graphic from the FHWA design manual. The chance of a pedestrian fatality rises sharply as the vehicle speeds increase.

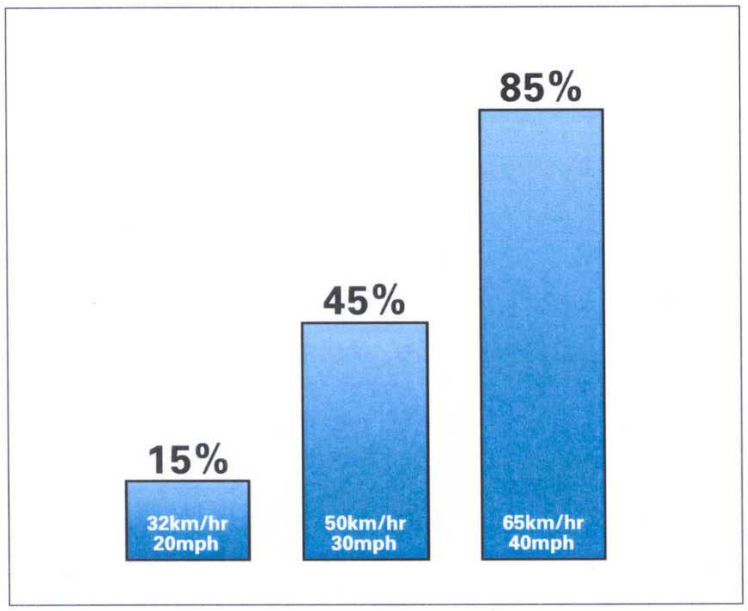

Figure 1-FHWA chart on Pedestrian Fatalities based on vehicle speed.

The other critical design factor is the design vehicle. The roundabout must take into account the largest vehicle likely to utilize the intersection on a regular basis. In general, larger diameters are needed to accommodate larger vehicles while maintaining appropriate operating speeds. Truck aprons must be used to accommodate the larger trucks while maintaining adequate deflection for smaller vehicles.

Based on the factors of capacity, design speed/safety, and design vehicle, McFarland-Johnson, and our subconsultant Michael Wallwork (Alternate Street Designs), have completed our review of the Conceptual Plans and offer the following comments:

A. US Route 5/Sykes Mountain Avenue Roundabout

Review of the current design for the US Route 5/Sykes Mountain Avenue roundabout, yields the following values:

FHWA Roundabout Classification	Urban Double-Lane Roundabout
Diameter of Inscribed Circle	130 Feet
Diameter of Truck Apron	70 Feet
Diameter of Central Island	45 Feet
Design Speed	25 MPH
Design Vehicle	WB-67
Width of Circulation Lane	30 Feet
Circulation Radius	35 Feet

Bicycle and pedestrian traffic is combined on an 8-foot wide multi-use path prior to entering the roundabout on all entrances. On the exits, bicyclists are returned to the roadway and pedestrians are directed to the existing 5-foot sidewalk.

Analysis of the required capacity confirms that a single-lane roundabout (single approaches and exits) would not have sufficient capacity to handle the design year traffic. Reviewing the design criteria used during the Phase A design work (also see Appendix A), 25 mph is compatible with the FHWA recommended design speed for an urban double-lane roundabout and a WB-67 truck is an appropriate design vehicle for this class of roadway.

The diameters of the inscribed circle and central island are significantly lower than the minimums recommended by FHWA. The FHWA recommends a minimum diameter for the inscribed circle of 150 feet for a two-lane roundabout. That value is based upon a WB-50 design vehicle. The FHWA criteria for the central island for a inscribed circle diameter of 150 feet is approximately 86 feet. The reasoning behind the FHWA minimum values is to control the speed of vehicles passing through the roundabout and the speed differential between a vehicle entering the roundabout and vehicles that are passing through. The circulating speed for a vehicle traveling around a roundabout with a circulation radius of 35 feet would have a speed of about 15 mph. To meet the FHWA recommendations for differential speed alone, the maximum speeds traveling through the roundabout should be between 25-27 mph.

The layout shown in the Conceptual Plans allows speeds significantly greater than the proposed design speed (See Figure 2). Higher speeds in roundabouts have been shown to have higher crash rates. As was shown in Figure 1, these higher speeds also have a significant impact on the safety of pedestrians at the intersection. The current geometry will also allow a significant speed differential between the circulating vehicles (vehicles going at least three-quarters of the way around the roundabout) and the vehicles passing through or taking a right turn. Roundabout locations with a

Northbound

Estimated enter speed 146m is approximately 60 km/h = 37 mph

Estimated R2 Speed 50m radius is 37 km/h = 23 mph

Estimated R3 exit speed 110m is approximately 48 km/h = 30 mph

Southbound

Estimated enter speed 77.45m is 42 km/h = 26mph

Estimated R2 Speed 59.73m radius is 39 km/h = 24mph

Estimated R3 exit speed 155.49m is approximately 65km/h = 40mph

FHWA Guidelines Recommends Maximum Entry Speed R1 of 40 kmp/h 25 mph

that R1 should be less than R2 and R1 should be smaller than R3.

R1, R2 and R3 should be similar if pedestrians are present.

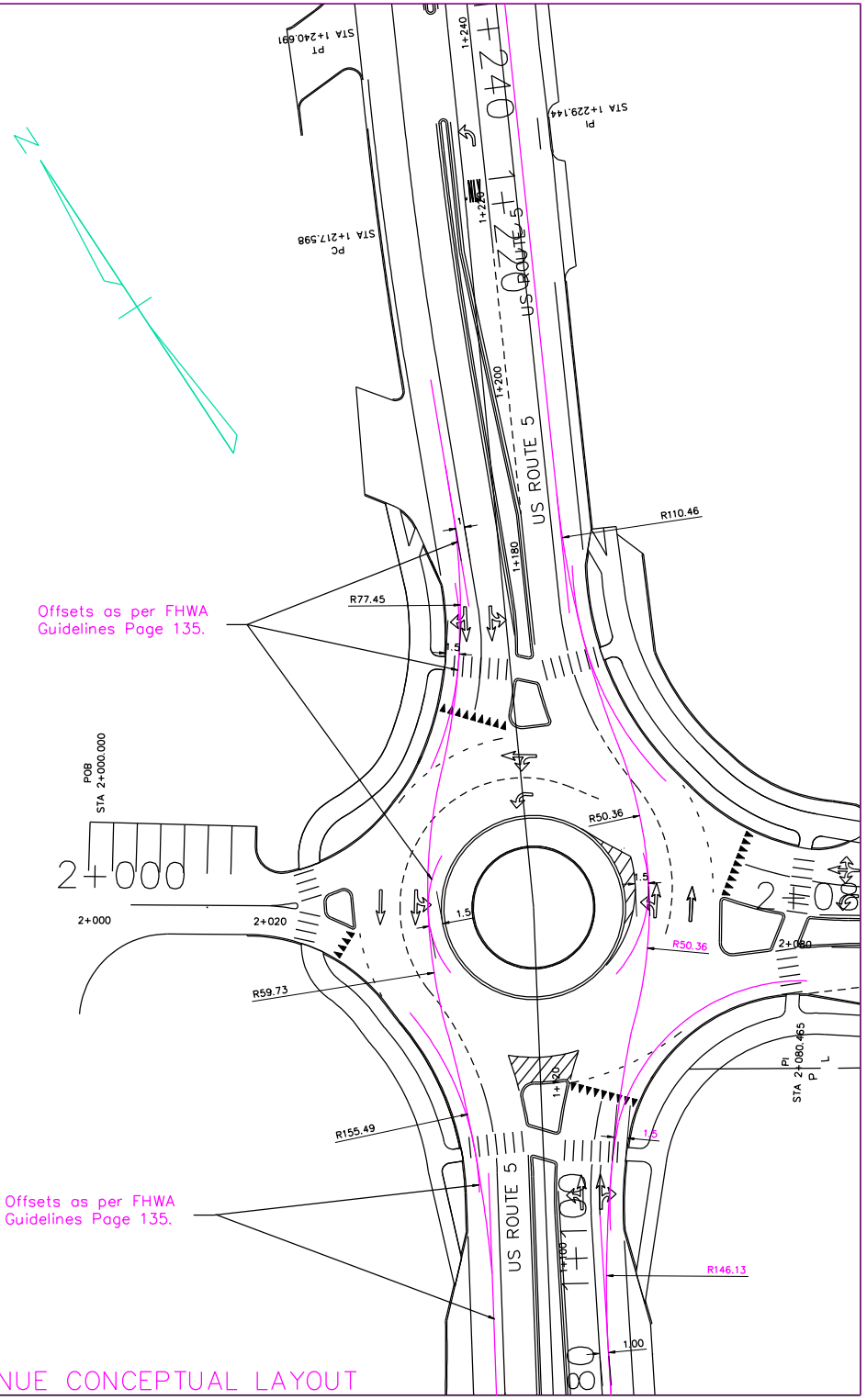

FIGURE 2–SPEED ANALYSIS US ROUTE 5/SYKES MOUNTAIN AVENUE CONCEPTUAL LAYOUT

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significant differential in speeds usually result in high numbers of crashes and injury crashes.

To modify the proposed two-lane roundabout to comply with the FHWA requirements for speed and deflection while still accommodating WB-67 trucks on all movements means that the roundabout would need to be much larger. Both the center island and the inscribed circle diameters would need to be increased. This would require an increase in the required right-of-way.

To mitigate some of the need for additional right-of-way, we recommend the use of a single-lane roundabout with turning lanes. The difference between this design and the two-lane roundabout is that there would only be a single lane exiting the roundabout for both northbound and southbound US Route 5. This design provides a roundabout that meets the projected traffic volumes while minimizing safety concerns (See Figure 3).

The advantages of this alternative design, which provides the required capacity through the design year, as opposed to the current layout are:

- Lower Projected Crash Rate
- Lower Construct Cost
- Safer for Pedestrians
- Less Property Impacts/Lower ROW costs

Typically, crash rates at multi-lane roundabouts are about twice that of a single lane roundabout. The higher crash rate at two lane roundabouts is higher than single lane roundabouts due to lane change crashes within the circulating roadway caused by drivers illegally changing lanes and cutting other vehicles off. Pedestrian incidents are also likely to be higher with the two-lane roundabout because of the longer pedestrian crossing distances across the higher speed exit area.

The treatment of the bicycles and pedestrians shown in the Conceptual Plans is a reasonable approach. Due to the combination of bikes and pedestrians, we would recommend that a ten-foot bike path be used instead of the 8-foot proposed to meet the VTrans Bicycle/Pedestrian requirements.

Once the type of roundabout has been decided, the design can be finalized. It is during this time that impacts to adjacent properties can be determined more definitively, including impacts to the gas station and Mazda dealership. This will also include detailed review of driveway access, landscaping, and bicycle and pedestrian facilities.

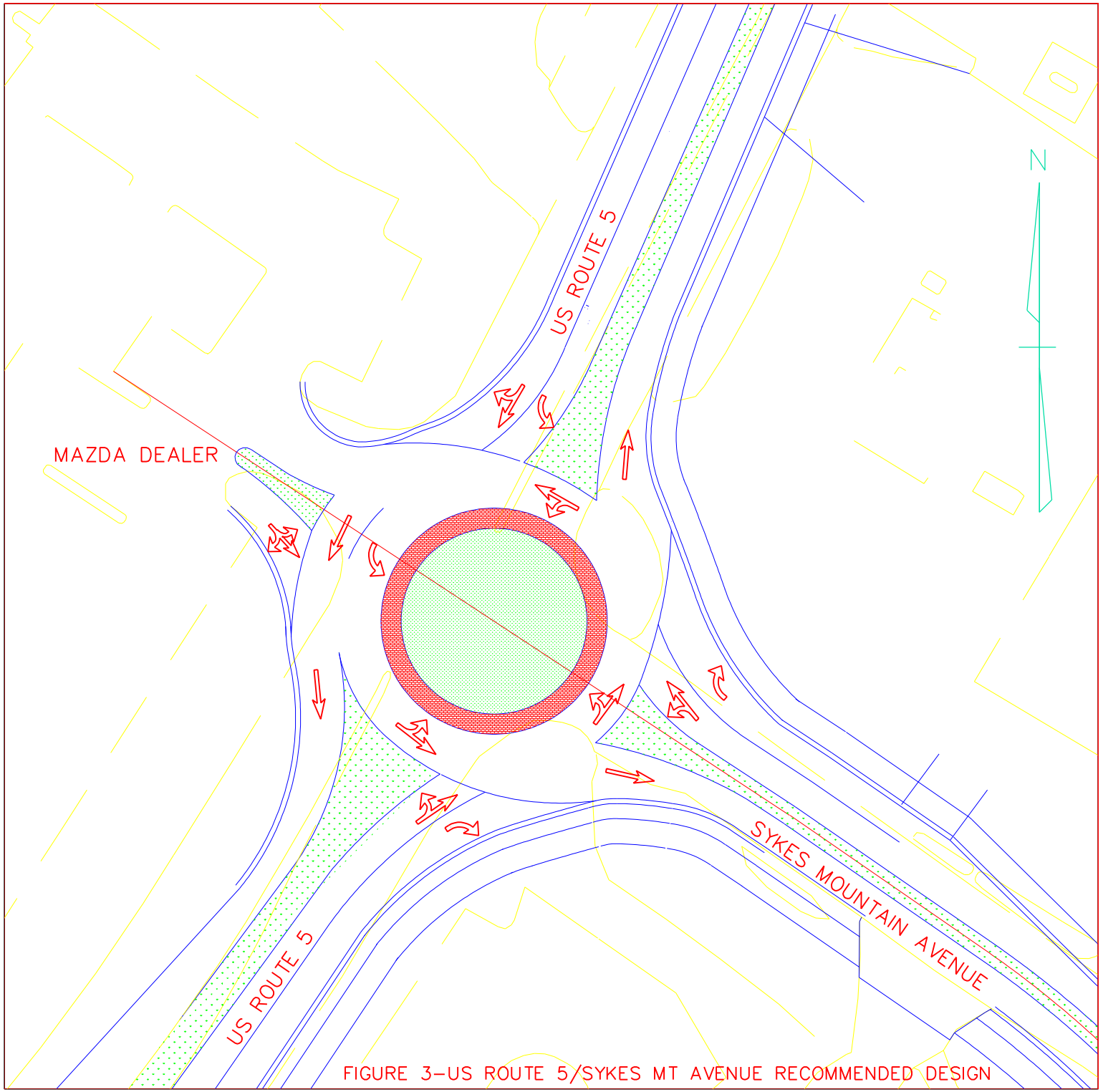

FIGURE 3–US ROUTE 5/SYKES MT AVENUE RECOMMENDED DESIGN

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B. Sykes Mountain Avenue/Ralph Lehman Road Roundabout

Review of the current design of the Sykes Mountain Avenue/Ralph Lehman Road roundabout, yields the following values:

FHWA Roundabout Classification	Mini-Roundabout
Diameter of Inscribed Circle	100 Feet
Diameter of Truck Apron	65 Feet
Diameter of Central Island	33 Feet *****
Design Speed	15 MPH
Design Vehicle	WB-67
Width of Circulation Lane	22 Feet
Circulation Radius	30 Feet

- **Fully traversable central Island**

Bicycle and pedestrian traffic is combined on an 8-foot wide multi-use path prior to entering the roundabout on all entrances. On the exits, bicyclists are returned to the roadway shoulders and the pedestrians are directed to the existing 5-foot sidewalk.

We feel that this site is not an appropriate location for a mini-roundabout given the traffic volumes, northern climate, and anticipated truck traffic. We also question the need for a WB-67 design vehicle making all moves through the roundabout. Our reasoning for these objections is described below:

A mini-roundabout is not a suitable treatment for an arterial road, especially one that has to accommodate very large trucks. These types of roundabout should only be used on low volume, low speed roads with minimal pedestrian traffic. To our knowledge, the only mini-roundabout that has been built on an arterial road in the United States was in Dimondale, Michigan. That intersection has three legs and is located in a retail and residential area with a gas station on one corner. The intersection has lower traffic volumes than Sykes Mountain Avenue. One of the advantages of a roundabout is the expectation of lowering the crash rate by at least 60%. The key statistic for the roundabout in Michigan was that after construction, there has been a slight <u>increase</u> in both total crashes and crash severity. Since the Ralph Lehman Road roundabout will be constructed at a location that currently has minimal crash potential, any increase in crashes at this location will quickly cast a negative light on the project.

The FHWA document, <u>Roundabouts: An Informational Guide</u>, recommends a design speed of only 15 mph for mini-roundabouts. It is simply not possible to design a mini-roundabout for a design speed of 15 mph that will accommodate WB-67 trucks (See Figure 4). When designing single lane roundabouts for WB-67 trucks, the central island must be enlarged to accommodate the enormous swept path of these trucks. To design a mini-roundabout at 15 mph would simply prohibit all larger vehicles except SU vehicles even making the through movement. To design a roundabout at 15 mph

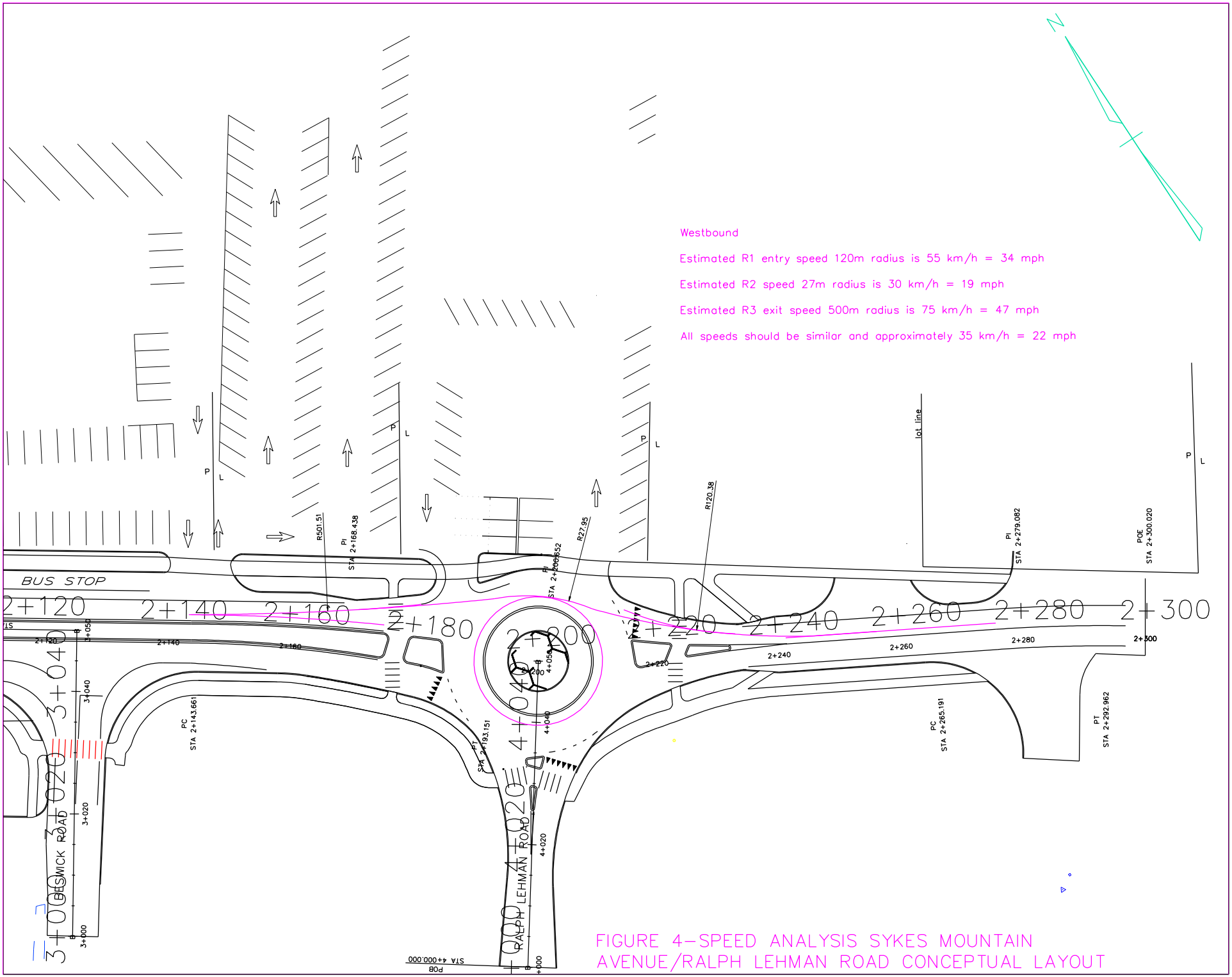

FIGURE 4–SPEED ANALYSIS SYKES MOUNTAIN AVENUE/RALPH LEHMAN ROAD CONCEPTUAL LAYOUT

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to comply with the FHWA Guidelines requires the use of very small radii and very narrow lanes that would not be compatible with a larger truck. The swept paths on the entry to a roundabout for a WB-67 truck are typically 22 to 30 feet depending on the diameter of the roundabout. This very wide swept path also substantially increases the speed through the roundabout and requires special design treatments even in a larger roundabout to achieve a design speed equal to 25 MPH per the FHWA recommendations.

Another serious problem with a mini-roundabout is the lack of visibility during inclement weather. Without a vertical element or signs in the central island, snow conditions can leave drivers with no visual clue of the roundabout configuration. Therefore, in inclement weather or under snow conditions a mini-roundabout will be much less visible to the driver. Drivers unfamiliar with the roundabout could be unaware of its existence except for the advance warning signs. Signs, trees, or other vertical elements cannot be used in the central island because of the large trucks turning over it. The splitter islands will have to be mountable or striped so that WB-67 trucks can turn over the islands and therefore limited protection to pedestrians will be provided. Pedestrians will be at high risk.

Because of the poor crash history on arterial roads, the need to design to 15 mph, and the inability to provide sufficient visibility in all weather conditions, the use of a mini-roundabout at this intersection is not recommended. Our recommendation is to design this intersection as a single lane roundabout with a raised central island and truck apron (See Figure 5). Per FHWA standards, the design speed for the single-lane roundabout should be approximately 20-25 mph.

We are also concerned about the requirement to provide full access for a WB-67 design vehicle. The Town of Hartford has expressed an interest in developing some vacant land with businesses that could potentially require deliveries from the larger long haul (WB-67) rigs, but that would only require that a WB-67 pass through the intersection.

The roundabout at Ralph Lehman Road should allow vehicles traveling eastbound on Sykes Mountain Avenue to reverse directions in order to access businesses on the north side of the road. The roundabout should also allow vehicles turning onto Sykes Mountain Avenue from Beswick Road or Ralph Lehman Road to reverse direction and access US Route 5. We have not been able to locate a single user within these areas that has deliveries from a vehicle larger than a WB-50 (See Appendix B). Traffic to the Comfort Inn could have vehicle traffic of varying sizes, but note that a WB-67 is a tractor that includes a sleeping compartment. To design the roundabout to completely circulate a vehicle of that size requires a choice between compromising the safety of all the other users versus significant right-of-way impacts. We recommend that the roundabout be designed for full access for a WB-50, while allowing a WB-67 to pass through the intersection along Sykes Mountain Avenue.

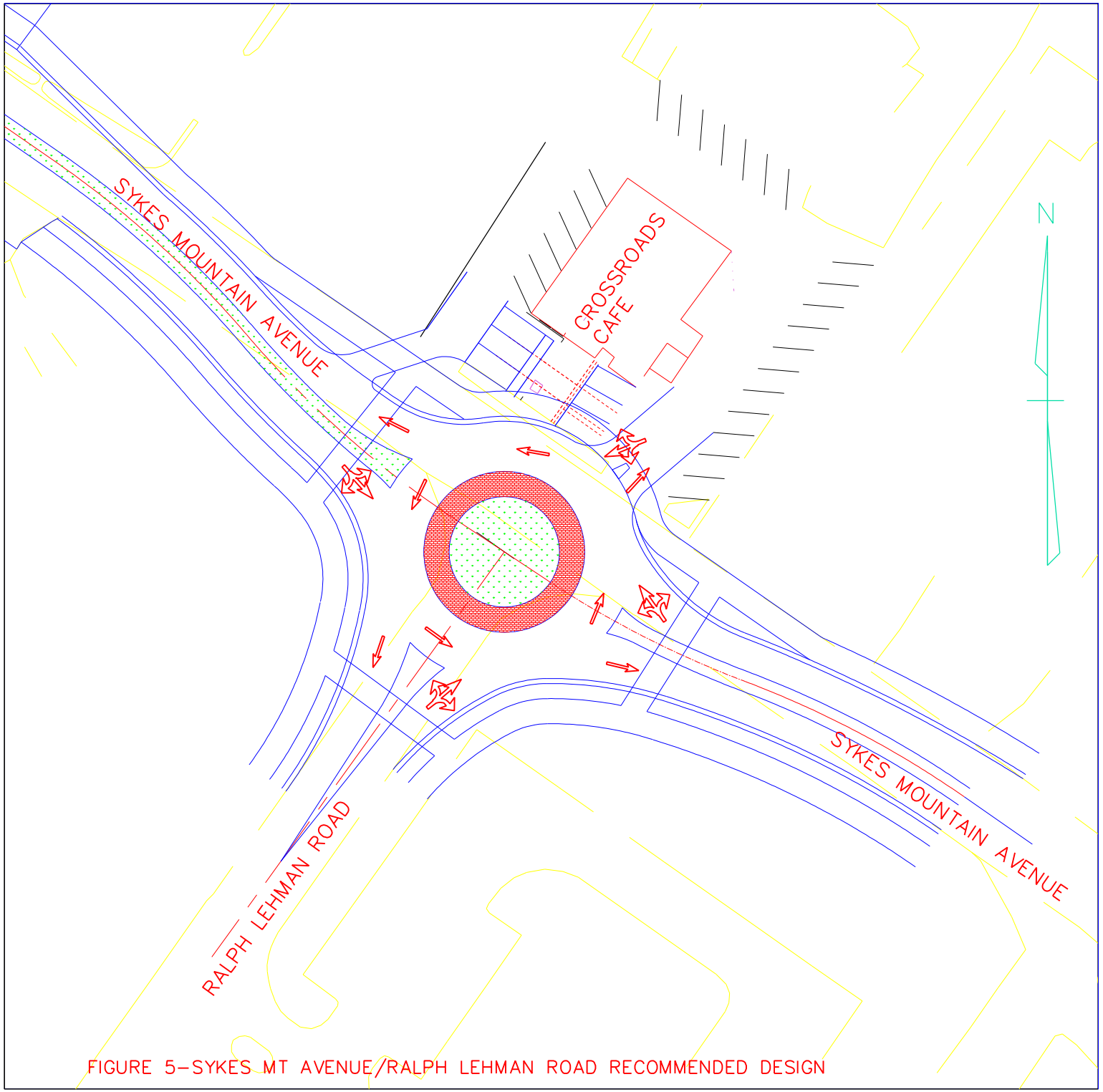

FIGURE 5–SYKES MT AVENUE/RALPH LEHMAN ROAD RECOMMENDED DESIGN

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In Figure 4 we have provided a proposed roundabout that meets the FHWA requirements for design speed, visibility, and pedestrian safety and is expected to provide the lowest crash rate for any form of traffic control for this intersection. This roundabout is designed for a WB-50 truck to make all movements. WB-67 trucks can proceed through the roundabout along Sykes Avenue with the addition of truck aprons at the entry lanes. Once the design vehicle and type of roundabout have been decided, final impacts to the adjacent properties, access points, landscaping, and bicycle and pedestrian facilities can be finalized.

IV. Geotechnical Investigations

As part of the preliminary investigations, four borings were taken within the roadways, two on Sykes Mountain Avenue and two on US Route 5. Investigations on US 5 were done in order to determine whether there was ledge within ten feet of the pavement surface. Borings along Sykes Mountain Avenue were done to determine the thickness of the pavement, thickness of the base material, and the gradation of the base and subbase material to determine the frost susceptibility. The pavement on Sykes Avenue is between 4 and 5 inches deep. The foundation material appears to be about 36 inches deep. Testing of the select materials within 2'-4' of the surface, found that only 9% of the material passed the number 200 sieve while having a natural moisture content of about 3%. Both are reasonable values for a roadbed.

More concerning was that when the material below the select materials was tested, the percent of material passing the No. 200 sieve. It is likely the original ground before the construction of Sykes Mountain Avenue or the drive-in. The material passing the No. 200 sieve ranged between 85 and 95 % with a natural moisture content of about 35%. Given these conditions, work outside the existing roadbed will require full depth construction in order to provide a sufficient roadbed.

This would also be true for any sideroads where significant truck traffic is expected. Figure 6 shows an existing structure on Ralph Lehman Road only a short distance from Sykes Mountain Avenue. Note the ponding of water on both sides of the structure. In the short time that this structure has been in place, it has been lifted above the surrounding road grade.

The result of the poor existing soil conditions will likely be an increased quantity of select materials at those locations where the proposed design is outside the footprint of the existing road.

Figure 6-Ralph Lehman Road Existing Drainage

IV. Stormwater Permitting

Given the magnitude of the project, it is likely that a stormwater discharge permit will be required. The total area of proposed impervious surfaces is approximately 3.5 acres. This includes about an acre of new impervious area and about 2.5 acres of existing impervious area that will remain. These areas are subject to change depending on the amount of green space incorporated into the project and the limits of the final design. Adjacent to the project are several large parking areas and paved islands. Conversion of some of these areas could lower the required volume of treatment.

Stormwater treatment requirements for projects exceeding two acres are very similar. The revised designs recommended within this report will have permitting requirements similar to what would have been required for the original design.

As part of the 60% plans, we will need to review the stormwater permits of the adjacent properties to ensure that our construction will not have any impact on their existing permits. Looking at the age of the respective developments, the properties that may have stormwater permits include the Mazda Dealership, Merchant's Bank, Comfort Inn, and the Car Wash. Of these properties, the project will only impact an existing stormwater treatment structure on the Merchant's Bank property.

VANR requires water quality treatment for 100% of all new pavement and 20% of existing pavement to remain. They also require groundwater recharge of 100% for the new pavement, but there is no requirement for recharge from existing pavement.

VANR requires 24-hour detention of a 1-year storm if the outlet of a structure does not discharge directly into a major body of water. Reviewing the developed area adjacent to US Route 5 and Sykes Mountain Avenue, the most promising area for any stormwater quality structures would be north of Marketplace Junction, on the west side of US Route 5. To avoid the need for detention storage, we recommend that stormwater from the US Route 5 system be discharged into a treatment basin at this location, then routed back into the US Route 5 stormwater system. In this manner, the detention of the water quality volume would increase the capacity of the US Route 5 system, then utilize the current outlet directly into the Connecticut River avoiding the need for the 1-year detention requirement.

This approach will need to be further refined as the design progresses and discussed with VANR prior to the formal permit application, but this appears to be a permitable solution to the stormwater drainage.

V. Summary

A successful project will be one that provides the safest, most efficient intersections at US Route 5/Sykes Mountain Avenue and Sykes Mountain Avenue/Ralph Lehman Road. Safety at roundabouts requires the control of speeds through the roundabouts. Acceptance of the roundabouts by the general public will require low crash rates, passage of the design vehicles, and the minimization of required right-of-way impacts.

The best way to meet these goals is to provide:

US Route 5/Sykes Mountain Avenue

Roundabout Type: Single-Lane with Turning Lanes (Raised Central Island)
Design Speed: 25 MPH
Design Vehicle: WB-67 (All Movements)

Sykes Mountain Avenue/Ralph Lehman Road

Roundabout Type: Standard Single-Lane Roundabout (Raised Central Island)
Design Speed: 25 MPH
Design Vehicle: WB-50 (All Movements), WB-67 (Through Movement along Sykes Mountain Avenue only)

APPENDIX A-CONCEPTUAL LAYOUT DESIGN CRITERIA (9/29/2003)

Design Criteria *9/29/03*
6310013.14
VTrans – Intersection of Rte 5 & Sykes Ave

Roundabout at…..	@ Route 5	@ R. Lehman Dr.	Ref.
Diameter of inscribed circle	40 m	30 m	RODEL
Diameter of truck apron	20 m	20 m	FHwA p150
Diameter of center island	14 m	10 m	AutoTurn
Circulating width	9.4 m	6 m	FHwA p150
Design Speed	40 kph	25 kph	FHwA p138
Design Vehicle (thru)	WB-20	WB-20	AASHTO & AT
(U-turns & lefts)	WB-20	WB-20	AASHTO & AT

	@ Route 5			@ Lehman	
Approaches…..	Rte 5 So.	Rte 5 No.	Sykes	Sykes	Lehman.
Design Speed	65 kph	65 kph	50 kph	50 kph	50 kph
Median width	4.8m	1 m	3 m	3.3 m	N/A
Lane width on approach	3.6 m (2)	3.6 m (2)	3.3 m	3.3 m	3.6 m
Median offset	0.3 m	0.3 m	0.3 m	0.3 m	N/A
Shoulder width	2.4 m	2.4 m	1.2 m	1.2 m	match
E (lane width @ entry)	8.2 m	8.2 m	7.5 m	5 m	4.5 m
PHI (entry angle)	33 º	45 º	45 º	40 º	45 º
L’ (1/2 length of flair)	10 m	10 m	15 m	9 m	8 m

Route 5 FC = Major Collector
ADT @ ramp C/D = 15,300 (sta Y029)
ADT N of Sykes = 10,400
2000 AVC shows 5% trucks (Y039) 4.2% (Y103) – both were about 1% heavy trucks

Sykes Ave FC = Local Road
’99 ADT 9100 vph (Y261)

Count Adjustments:
Latest Counts 7/24/02
Regression Group = C (rural primary secondary)
Seasonal Factor II (rural non-interstate)
daily > MADT = 0.99
MADT > AADT = 0.88

APPENDIX B-DESIGN VEHICLE DATA

From: "Charles Wise" <cwise@trorc.org>
To: "'Darren Benoit'" <dbenoit@mjinc.com>
Date: 1/24/2006 1:12:13 PM
Subject: truck numbers

Talked with Allyn Ricker to double-check the list. Then made the calls.
Didn't hear any evidence for those large interstate semi-trailers.

Chuck

McDonalds
Manager Nancy Hilliker
295-9816

"Every three days I get 2 trucks, they are regular-sized 18 wheelers."

Comfort Inn
Owner Dick Mackay
295-3051

Normal sized delivery trucks at least daily. Many come to sleep the night and we have parking to accommodate them

Allards Unfinished Furniture
No name
295-2333

Regular delivery tractor trucks 2-3 times a week

US Postal Service
Transportation coordinator Tom Weymouth
296-3246

Gets 12 tractor trucks a day, 53 foot trailers

District
District Tech Trevor Starr
295-8888

Dump trailers, rare to see a 53 footer come.

Other contributors not called. Are pretty standard.

Twin State Sand & Gravel = dump trucks
Auto dealers = standard car carriers
Temporary construction vehicles for residential construction down Sykes