TIENKEN ROAD CORRIDOR STUDY

CITY OF ROCHESTER HILLS

Volume 1 of 4

MARCH 2000

Prepared by:

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Consulting Engineers
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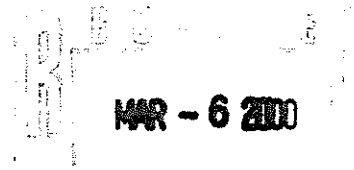
ORCHARD, HILTZ & MCCLIMENT, INC
34935 Schoolcraft Road
Livonia, MI 48150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March 1, 2000

City of Rochester Hills
1000 Rochester Hills Drive
Rochester Hills, Michigan 48309-3033

Attention: Mr. James A. Dietrick, P.E., City Engineer

Re: Tienken Road Corridor Study HRC Job No. 19970197.02

Dear Mr. Dietrick:

With this letter, Hubbell, Roth & Clark and Orchard, Hiltz & McCliment are pleased to transmit the final report on the Tienken Road Corridor Study. The HRC team has been working with the Corridor Steering Committee to develop a program of improvements for the corridor since June, 1999. The various portions of the corridor were examined in sequence to resolve capacity, safety and environmental issues affecting design. The alternative selected by the Steering Committee reflects a combination of the options developed for each portion of the corridor.

If you have any questions or require any additional information, please contact the undersigned.

Very truly yours,

HUBBELL, ROTH & CLARK, INC.
and ORCHARD HILTZ & MCCLIMENT, INC.

Richard F. Beaubien

Richard F. Beaubien, P.E., P.T.O.E.
Transportation Director

RFB/jjb

Attachment

pc: RCOC; D. Allyn
OHM; M. Loch
HRC; W. Alix, File

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Introduction

The City of Rochester Hills, in cooperation with the Road Commission for Oakland County (RCOC) and Rochester Community Schools, identified the Tienken Corridor as an area with a series of issues to be resolved before road improvements could be undertaken. The area between Livernois and Washington contains the site of a new high school, two intersections with capacity restrictions, a potential new access road south to the City of Rochester, and a historic district. There was a need to pave the portion of Sheldon Road adjacent to the new high school site and develop a design concept for the Sheldon/Tienken intersection serving that site.

The HRC team, composed of Hubbell, Roth & Clark, Inc. (HRC) and Orchard, Hiltz, & McCliment (OHM) was retained to develop responses to both vehicles and pedestrian circulation issues in the corridor. The HRC team would like to thank the Steering Committee for their review and guidance. The steering committee consisted of:

James Dietrick, P.E.	Rochester Hills
Stephen Dearing, P.E.	Rochester Hills
David Allyn, P.E.	Road Commission for Oakland County
Walter Schell, P.E.	Road Commission for Oakland County
Ken Johnson	Rochester
Robert Matouka	Rochester Community Schools
Deborah Walter	Rochester Community Schools

Working with the Steering Committee, the team developed a design concept to address the complex transportation issues in the corridor and a program of improvements to address the needs identified.

Chapter 1 – Data Collection

1.1 Existing Condition

The existing Tienken Road corridor, Livernois Road to Washington Road, consists mainly of a two-lane bituminous roadway with widenings at its intersections with Rochester Road and Livernois Road to accommodate left and right traffic turning movements. Additional deceleration/acceleration lanes and passing lanes have been added over the years as site developments have evolved.

The existing horizontal alignment for Tienken Road is straight with the exception of a tight S-curve at the Tienken Road and Sheldon Road intersection. The curve at this location does not meet warrants for 30 miles per hour.

The existing vertical alignment has prominent vertical relief throughout the project corridor. There is one location, between Livernois Road and Rochester Road that barely meets criteria for 35 miles per hour. Drainage along the corridor is conveyed through ditches and swales and at places along the shoulder point.

Sheldon Road is an existing straight gravel road, also with vertical relief. This road is very rural in nature with large trees within close proximity to the roadway. There is no real system to convey roadway drainage other than the road edge and periodic ditches.

1.2 1996 Master Thoroughfare Plan

HRC reviewed the 1996 Master Thoroughfare Plan Update, prepared by BRW, Inc. and adopted by the Rochester Hills Planning Commission on June 2, 1998. This document examined existing transportation trends and problems in order to identify future transportation facility needs and to recommend a transportation improvement program. The Tienken Road Corridor Study wanted to coordinate any proposed improvements with the goals and established criteria of the Plan.

The Master Thoroughfare Plan Update designates Tienken Road a minor arterial; its function is to provide mobility within and between neighborhoods and to accommodate trips of moderate length. The Plan indicates a need for a major arterial in the northern third of the city. Although, Tienken Road is a heavily used corridor, it did not meet the criteria for a major arterial classification because it is neither continuous through the city nor is it linked to the regional roadway system.

The Master Thoroughfare Plan Update does not recommend a future roadway geometric for Tienken Road. However, the Plan recommends establishing a Right-of-Way width of 120 feet for the whole length of the road. This ROW width will accommodate a typical minor arterial with a 3 lane cross section up to a typical major arterial designed as a 4 lane residential boulevard.

The Master Thoroughfare Plan Update does recommend that Sheldon Road between Tienken and Mead be classified as a Minor Arterial and improved to a 3 lane roadway in order to accommodate 2015 roadway conditions.

1.3 Traffic Studies

The traffic studies were conducted by Hubbell, Roth, & Clark (HRC) during June 1999. The complete results by location and study can be found in Appendix A.

1.3.1 Speed

The speed data based on weekday 24-hour counts is summarized in Table 1-1. Data was collected at seven locations in the study area.

The primary basis for establishing a proper, realistic speed limit is the nationally recognized method of using the 85th percentile speed. This is the speed at or below which 85% of the traffic moves. For example, if 85 of each 100 motor vehicles were recorded at 45 mph or under, then 45 mph is the 85th percentile speed.

Historically, before and after, traffic engineering studies have shown that changing the posted speed limit does not significantly affect the 85th percentile speed. The driving environment, which includes other traffic on the road and roadway conditions, is the primary factor, which influences the prevailing speed.

The driving environment is reflected by the 85th percentile speed. The majority of drivers, consciously or unconsciously, consider the factors in the driving environment and travel at a speed that is safe and comfortable regardless of the posted speed limit.

Table 1-1 shows that the 85th percentile and the average speeds are higher than the current posted speed limit of 40 mph on Tienken and 25 mph on Mead and Sheldon.

The speed study indicated that the 24-hour weekday traffic speeds were similar on specific segments of the corridor. On Tienken, from Brewster to Rochester Road, the 85th percentile ranges from 43 – 45 mph. On Tienken, from Rochester to the old Washington/Runyon intersection, the 85th percentile ranges from 49 – 54 mph. Speeds are potentially a problem along these segments of Tienken. In addition, speed data was collected on Sheldon and Mead, which had an 85th percentile of 38.75 mph and 34.67 mph, respectively.

Table 1-1
SPEED SUMMARY

Road Name	Start	End	1-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	> 60	Total	Avg. Speed (mph)	85% ile	Posted Speed	% in violation of Posted Speed	Top of Pace (mph)	% in Pace
Tienken	Brewster	Livernois	152	150	2231	9449	5225	721	71	33	511	18543	40.7	43.89	40	35.38	36-45	79.14
Tienken	Livernois	Kings Cove	361	380	2834	7577	5704	1014	103	34	444	18451	40.25	44.18	40	39.56	36-45	71.98
Tienken	King s Cove	Rochester	180	298	2148	7144	6689	1509	154	47	440	18609	41.3	44.62	40	47.50	36-45	74.34
Tienken	Rochester	Sheldon	52	118	564	1427	2128	2333	1399	574	384	8979	46.27	53.89	40	75.93	41-50	49.68
Tienken	Sheldon	Washington	13	64	373	727	408	455	489	205	55	2790	43.74	49.43	40	57.78	46-55	33.83
Sheldon	Tienken	Mead	681	581	580	354	148	50	18	2	39	2453	29.11	38.75	25	72.24	1-25	27.76
Mead	Rochester	Sheldon	163	157	143	52	14	1	1	0	0	531	26.2	34.67	25	69.30	1-25	30.70

* Note: Speeds are in mph

1.3.2 Traffic Volumes

HRC documented the growth in traffic along the main thoroughfare in the study area. Refer to Table 1-2.

The summary of the 1999 traffic counts, shown on Table 1-3, indicates that the 24-hour weekday traffic volumes vary significantly along the Tienken corridor, between 7,000 and 19,000 vehicles per day. In addition, traffic volume counts taken on Mead Road, from Rochester to Sheldon (531 vehicles per day), and Sheldon, from Tienken to Mead Road (2453 vehicles per day). The highest traffic volumes on Tienken were found west of Rochester Road and east of Livernois. The lowest traffic volumes on Tienken were found east of Rochester and west of the old Tienken/Runyon/Washington intersection. The summary also indicated that the westbound traffic volumes were consistently higher throughout the Tienken corridor. Additional reviews of the hourly traffic volumes also indicated the presence of a morning and afternoon peak in the total traffic volumes. Typically, the morning peak is observed between 7:00 AM to 9:00 AM and the evening peak is observed between 4:00 PM and 6:00 PM.

Table 1-2
COMPARISON OF ADT COUNTS
HISTORIC AND CURRENT

Street	End Points		1999	1997	1993	1991	1989	1986
Tienken	Brewster	Livernois	18543	20815	18115	16246	18232	13353
	Livernois	Rochester	18530**	19745	18168	16700	17761	17136
	Rochester	Sheldon	8979	9186	5702	5412	2570	2087
	Sheldon	Washington	7398	4762*	2965	N/A	N/A	2333
Sheldon	Tienken	Mead	2453	1451*	963	1096	425	224
Mead	Rochester	Sheldon	531	704	721	679	607	747
Rochester	Tienken	Mead	N/A	18523*	18520	18803	21777	14835

* 1996 Count

Source: HRC, City of Rochester Hills and RCOC

** Average of ADT Counts taken between Livernois and Kings Cove and between Kings Cove and Rochester.

Table 1-3
1999 DIRECTION VOLUME COUNTS

Road Name	Start	End	Eastbound	Westbound	Total
Tienken	Brewster	Livernois	8866	9677	18543
Tienken	Livernois	Kings Cove	9015	9436	18451
Tienken	Kings Cove	Rochester	9080	9529	18609
Tienken	Rochester	Sheldon	4285	4694	8979
Tienken	Sheldon	Washington	2245	5153	7398
Mead	Rochester	Sheldon	263	268	531
Sheldon	Tienken	Mead	1257	1196	2453

1.3.3 Gaps

HRC conducted a gap study at seven locations in the study area.

Gap studies refer to the determination of the number of available gaps in traffic passing a point that are of adequate length to permit pedestrians to cross or for vehicles to enter the roadway. In this context a gap is defined as the time that elapses from when the rear of a vehicle passes a point on a roadway until the front of the next arriving vehicle (from either direction) passes the same point. Gaps are expressed in units of seconds.

The summary of the gap data, shown on Table 1-4, indicated that the 24-hour weekday gap data varies significantly along the Tienken corridor. Along Tienken, from Brewster to Rochester, approximately 30% of the gaps are less than two seconds making it very difficult for pedestrians to cross or for vehicles to enter the main roadway from minor streets. Conversely, Tienken Road east of Rochester has larger gaps in traffic with only 13% of the gaps less than two seconds. On Sheldon and Mead, no problems are observed for the length of gaps on these roads.

Table 1-4

GAP SUMMARY

Road Name	Start	End	0-1	1.0-2.0	>2	Total
Tienken	Brewster	Livernois	3194	1403	13946	18543
Tienken	Livernois	Kings Cove	2696	1341	14414	18451
Tienken	Kings Cove	Rochester	2614	1310	14685	18609
Tienken	Rochester	Sheldon	729	483	7767	8979
Tienken	Sheldon	Washington	653	306	6439	7398
Sheldon	Tienken	Mead	89	51	2313	2453
Mead	Rochester	Sheldon	2	1	528	531

* Note: Gaps are in seconds

1.3.4 Vehicle Classification

There are two summary Tables for the vehicle classification study. Table 1-5 shows the actual number of vehicles by classification and Table 1-6 shows the percentage of vehicles by classification. The summary of the data indicates that the 24-hour weekday vehicle classification varies significantly along the Tienken corridor. On Tienken, from Brewster to Rochester, and on Mead, approximately 80% of the vehicles travelling along these segments are cars. From Rochester to Sheldon, 50% of the vehicles travelling along this segment are classified as two-axle/four-tire vehicles other than cars, such as pick-ups and vans.

From Sheldon to Washington, 18% of vehicles were classified as busses. All vehicles classified under this heading are passenger carrying vehicles with two axles and six tires or three or more axles. This classification includes traditional busses such as transit, school and Intra/Interstate buses.

On Sheldon, almost 60% of the vehicles travelling along this segment are pick-ups, vans, and other two axle four tire vehicles.

Table 1-5
VEHICLE CLASSIFICATION SUMMARY (FREQUENCY)

Road Name	Start	End	Cycle	Cars	2A-4T	Buses	2A-SU	3A-SU	4A-SU	4A-ST	5A-6T	6A-ST	5A-MT	6A-MT	7A-MT	None	Other	Total
Tienken	Brewster	Livernois	43	15181	429	147	277	30	179	299	5	2	1	0	53	0	1897	18543
Tienken	Livernois	Kings Cove	38	14442	549	121	132	316	205	285	26	9	3	0	43	0	2282	18451
Tienken	Kings Cove	Rochester	44	14978	895	134	197	41	149	348	5	1	3	0	29	0	1785	18609
Tienken	Rochester	Sheldon	9	1447	4465	173	2166	39	28	136	24	10	1	0	7	0	474	8979
Tienken	Sheldon	Washington	204	742	304	1366	1118	101	50	134	5	3	4	0	10	0	3357	7398
Sheldon	Tienken	Mead	12	127	1453	80	310	106	4	33	0	2	0	0	7	0	319	2453
Mead	Rochester	Sheldon	2	404	84	14	8	1	0	5	0	2	0	0	0	0	11	531

Table 1-6

VEHICLE CLASSIFICATION SUMMARY (PERCENTAGE)

Road Name	Start	End	Cycle	Cars	2A-4T	Buses	2A-SU	3A-SU	4A-SU	4A-ST	5A-6T	6A-ST	5A-MT	6A-MT	7A-MT	None	Other	Total
Tienken	Brewster	Livernois	0.23%	81.87%	2.31%	0.79%	1.49%	0.16%	0.97%	1.61%	0.03%	0.01%	0.01%	0.00%	0.29%	0.00%	10.23%	100.00%
Tienken	Livernois	Kings Cove	0.21%	78.27%	2.98%	0.66%	0.72%	1.71%	1.11%	1.54%	0.14%	0.05%	0.02%	0.00%	0.23%	0.00%	12.37%	100.00%
Tienken	Kings Cove	Rochester	0.24%	80.49%	4.81%	0.72%	1.06%	0.22%	0.80%	1.87%	0.03%	0.01%	0.02%	0.00%	0.16%	0.00%	9.59%	100.00%
Tienken	Rochester	Sheldon	0.10%	16.12%	49.73%	1.93%	24.12%	0.43%	0.31%	1.51%	0.27%	0.11%	0.01%	0.00%	0.08%	0.00%	5.28%	100.00%
Tienken	Sheldon	Washington	2.76%	10.03%	4.11%	18.46%	15.11%	1.37%	0.68%	1.81%	0.07%	0.04%	0.05%	0.00%	0.14%	0.00%	45.38%	100.00%
Sheldon	Tienken	Mead	0.49%	5.18%	59.23%	3.26%	12.64%	4.32%	0.16%	1.35%	0.00%	0.08%	0.00%	0.00%	0.29%	0.00%	13.00%	100.00%
Mead	Rochester	Sheldon	0.38%	76.08%	15.82%	2.64%	1.51%	0.19%	0.00%	0.94%	0.00%	0.38%	0.00%	0.00%	0.00%	0.00%	2.07%	100.00%

1.4 Intersection Turning Movement Counts

HRC conducted turning movement counts during the AM Peak (7:00 – 9:00AM) and PM Peak (4:00 – 6:00 PM) at 10 intersections in the study area.

Tienken and Livernois	Tienken and Sheldon
Tienken and Kings Cove	Tienken and Van Hoosen
Tienken and Pine	Tienken and Washington
Tienken and Rochester	Rochester and Mead
Tienken and Lakeview	Sheldon and Mead

Figures 1 and 2 display the turning movement counts by intersection and by peak hour.

The most noteworthy movement occurs in the PM peak at the intersection of Rochester and Tienken. On the eastbound approach, approximately 50% of turning movements are left turns. HRC also noted in Table 1-7 other significant turn movements.

Table 1-7
SIGNIFICANT TURN MOVEMENTS

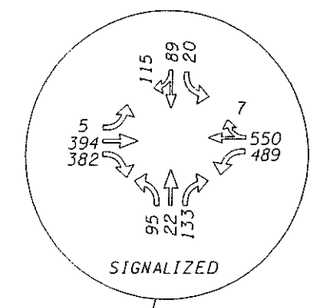
INTERSECTION	APPROACH	AM PEAK		PM PEAK	
		RT	LT	RT	LT
Tienken/Rochester	Eastbound	X			X
	Northbound				X
Tienken/Livernois	Eastbound	X			
	Westbound		X		
	Northbound			X	X

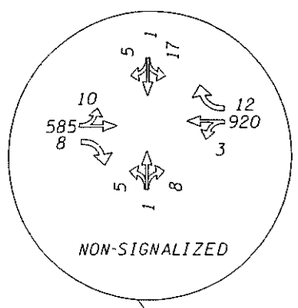
The complete summary of turning movement counts can be found in Appendix B.

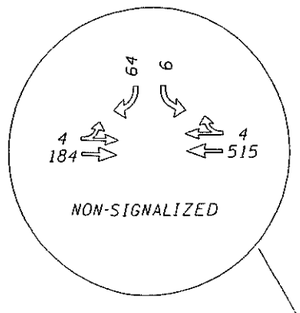
1.5 Right-of-Way Data

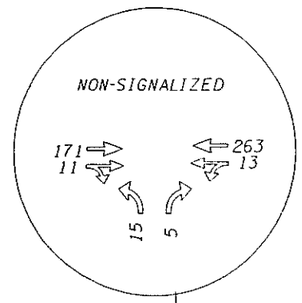
Existing Right-of-Way (ROW) data was collected from the City of Rochester Hills by Orchard, Hiltz, & McCliment (OHM) and placed onto a digital base map of the Tienken Corridor. The ROW data is incorporated into the recommended corridor alternative plans and can be found in Volume 3 to this report.

EXISTING AM PEAK TURNING MOVEMENT COUNTS









Livernois N.

Tienken W.

Oakbrook Ridge

Oakbrook W.

Kings Cove

Oakbrook E.

Cliffview

Winry

Bedford Square

Pine

Tienken Ct.

Tienken W.

Rochester N.

Tienken E.

Courtland

Lakeview

Sheldon

Tienken E.

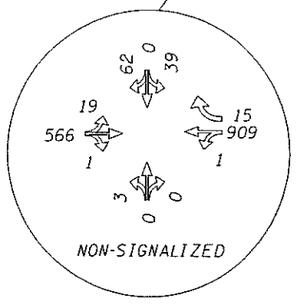
Letica (Proposed)

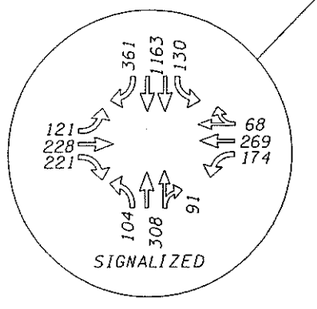
Clear Creek (Proposed)

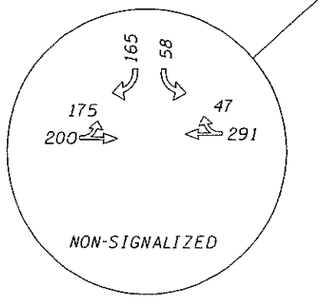
Van Hoosen

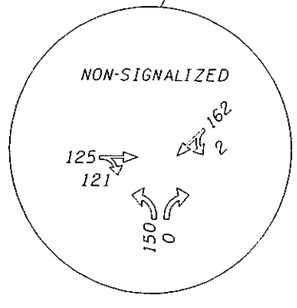
Washington

Washington









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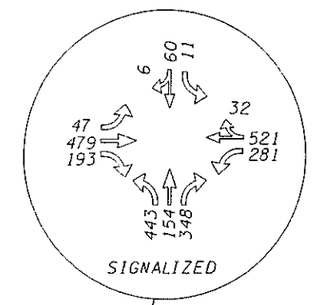
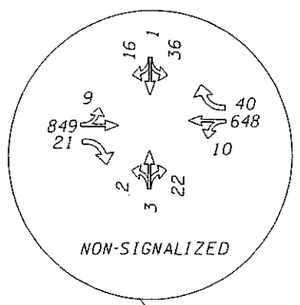
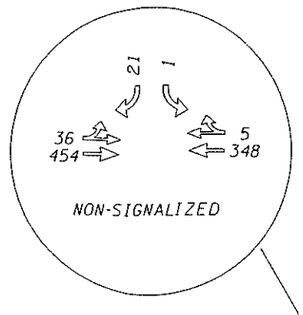
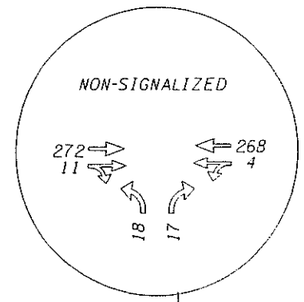
EXISTING PM PEAK TURNING MOVEMENT COUNTS

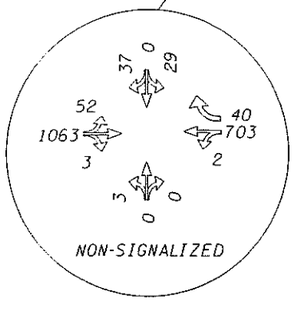


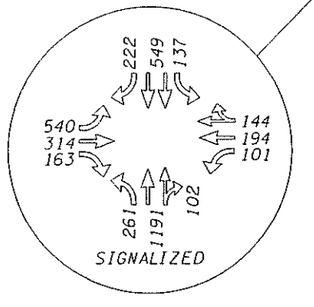


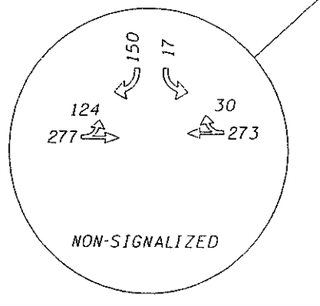


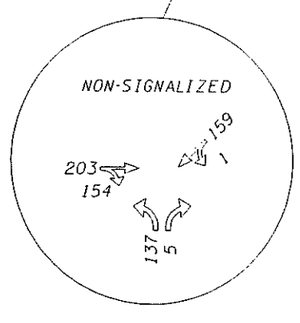


Livernois N.
Tienken W.
Kings Cove
Cliffview
Bedford Square
Tienken Ct.
Rochester N.
Tienken W.
Tienken E.
Lakeview
Sheldon
Tienken E.
Clear Creek (Proposed)
Washington
Letica (Proposed)
Van Hoosen
Washington
Oakbrook Ridge
Oakbrook W.
Oakbrook E.
Winry
Pine
Courtland









JOB NO. 19990197	HUBBELL, ROTH & CLARK, INC.	SHEET NO.
DATE 10/18/99	CONSULTING ENGINEERS 555 HULET DRIVE, BLOOMFIELD HILLS, MICH. P.O. BOX 824, 48303-0824	2

USER NAME • mradulski DESIGN FILE • F:\1999\199901\19990197\caddv7traffic\pmpeak.dgn PLOT NAME • N/A STROKE TIME • 15-DEC-1999 15:25

The Master Thoroughfare Plan for the City of Rochester Hills, updated in 1996, has established desired widths for ROW for every mile road in the City. For the study area, the ROW plans are shown below:

Tienken	120 feet
Livernois	120 feet
Rochester	150 feet
Sheldon	86 feet

The impact of ROW will be discussed further in the Chapter on Alternatives Analysis.

1.6 Topographical Data

Topographical data was collected by OHM from the City of Rochester Hills and merged with the proposed geometrics for the Tienken Corridor. OHM utilized the digital orthophotography and two-foot contours to create an existing base plan for the corridor. Other features provided by the City of Rochester Hills and utilized in the creation of the base plans include existing right of way lines, parcel lines, existing utilities and homeowner information.

Existing water main information was also obtained from the City of Rochester. Geometrics for the roundabout at Washington/Tienken were provided by Ziemet-Wozniak. The location for the future Letica Road was provided by Hubbell, Roth, and Clark. The driveways for the future high school was shown per plans provided by the firm of Spalding DeDecker Associates, Inc. Finally, the geometrics for the proposed roundabout at Tienken Road and Sheldon Road was provided by the City of Rochester Hills.

The two-foot contours were utilized in the creation of a Digital Terrain Model (DTM). From the DTM, proposed vertical geometry was developed and grading limits established. The impact of the topography will be discussed further in the Chapter on Alternative Analysis.

1.7 Sight Distance

Sight distance was expected to be an important design factor because of the varying topography of the study area. Sight distance is defined as the length of highway visible to the driver. It results from the

three-dimensional design of the highway, and is a primary design control for all highway types. At-grade intersections are inherent points of potential vehicle-vehicle conflict. A driver approaching an intersection should have an unobstructed view of sufficient length to permit control of the vehicle to avoid collision. The AASHTO guideline presents four cases for intersection control, each of which results in different intersection sight-distance requirements:

I. No control, with vehicles adjusting speeds to avoid collision.

II. Yield control, with vehicles on the minor roadway yielding to the major roadway.

III. Stop control on the minor roadway.

IV. Signal control.

Cases III and IV are the most common, with Case III representing the most critical conditions generally encountered. Within Case III are a range of possible operational assumptions regarding the stopped approach.

HRC used Case III criteria to determine sight distances at all the intersections and a number of key driveways. The sight distance data is summarized on Table 1-9.

Table 1-9

SIGHT DISTANCE

Intersection	Direction of Travel	Case IIIB-Turning Left into a Major Highway (ft)	Case IIIC-Turning Right into a Major Highway (ft)	Comments
Tienken/Livernois	SB	653	454	Trees/Bushes
Tienken/Livernois	NB	Greater than 1500	Greater than 1500	
Tienken/Livernois	WB	Greater than 1500	Greater than 1000	
Tienken/Livernois	EB	Greater than 1000	Greater than 1500	
Tienken/Paint Creek Trail	SB	812	1269	Trees/Bushes/Elevations
Tienken/Paint Creek Trail	NB	1238	1981	Trees/Bushes/Elevations
Tienken/Kings Cove	SB	184	1552	Trees/Bushes/Elevations
Tienken/Winry	NB	412	761	Elevations
Tienken/Pine	NB	489	Greater than 2000	Elevations
Tienken/Tienken Ct	SB	Greater than 3000	467	Elevations
Tienken/Rochester	SB	Greater than 2000	Greater than 2000	
Tienken/Rochester	NB	Greater than 2000	Greater than 2000	
Tienken/Rochester	WB	Greater than 2000	Greater than 2000	
Tienken/Rochester	EB	Greater than 2000	Greater than 2000	
Tienken/Courtland	NB	379	353	Trees/Signs
Tienken/Lakeview	SB	1195	608	Trees/Bushes
Tienken/Sheldon	SB	525	1508	Trees/Bushes

TABLE 1-9 (CON'T)

Intersection	Direction of Travel	Case IIIB-Turning Left into a Major Highway (ft)	Case IIIC-Turning Right into a Major Highway (ft)	Comments
Tienken/Clear Creek	SB	393	263	Trees/Bushes
Tienken/Van Hoosen	NB	378	200	Trees/Bushes
Tienken/Washington	NB	713	Greater than 3000	Trees/Bushes
Sheldon/School Drive South	EB	616	333	Elevations
Sheldon/School Drive Middle	EB	1598	Greater than 1500	Elevations
Sheldon/School Drive North	EB	458	809	Elevations
Sheldon/Clear Creek	WB	Road is not yet built	Road is not yet built	
Sheldon/Cross Creek	EB	374	442	Elevations
Sheldon/Mead	NB	137	167	Trees/Bushes
Rochester/Mead	WB	481	975	Trees/Bushes
Rochester/Orion	EB	Greater than 2000	Greater than 3000	
Rochester/Orion	SB	N/A	Greater than 2000	
Rochester/Orion	NB	Greater than 2000	N/A	

From the table above, the American Association of State Highway and Transportation Officials (AASHTO) defines Case IIIB as a vehicle entering a cross road from a stopped position by clearing vehicles approaching from the left and then by turning left and entering the traffic stream approaching from the right. AASHTO defines Case IIIC as a vehicle departing from a stopped position, turning right and merging with traffic from the left.

Intersections that failed to meet the minimum sight distance requirements by AASHTO are listed in Table 1-10. At a posted speed limit of 25 mph, AASHTO's minimum sight distance requirement is 295 feet. At a posted speed limit of 40 mph, AASHTO's minimum sight distance requirement is 574 feet. At a posted speed limit of 50 mph, AASHTO's minimum sight distance requirement is 803 feet. HRC noted reasons for the sight problems if the intersections failed to meet AASHTO's minimum sight distance requirements.

Table 1-10

INTERSECTIONS LESS THAN THE AASHTO MINIMUM SIGHT DISTANCE

Intersection	Direction of Travel	Case IIIB-Turning Left into a Major Highway (ft)	Case IIIC-Turning Right into a Major Highway (ft)	Comments
AASHTO Minimum sight distance = 295ft			**Posted Speed = 25mph**	
Sheldon/Mead	NB	137	167	Trees/Bushes
AASHTO Minimum sight distance = 574ft			**Posted Speed = 40mph**	
Tienken/Livernois	SB	653	454	Trees/Bushes
Tienken/Kings Cove	SB	184	1552	Trees/Bushes/Elevations
Tienken/Winry	NB	412	761	Elevations
Tienken/Pine	NB	489	Greater than 2000	Elevations
Tienken/Tienken Ct	SB	Greater than 3000	467	Elevations
Tienken/Courtland	NB	379	353	Trees/Signs
Tienken/Sheldon	SB	525	1508	Trees/Bushes
Tienken/Clear Creek	SB	393	263	Trees/Bushes
Tienken/Van Hoosen	NB	378	200	Trees/Bushes
AASHTO Minimum sight distance = 803ft			**Posted Speed = 50mph**	
Rochester/Mead	WB	481	975	Trees/Bushes

1.8 Pedestrian Traffic

1.8.1 Paint Creek Trailway

The Paint Creek Trailway is an unpaved recreation trail that starts in the City of Rochester and ends in the Village of Lake Orion. It is a heavily used trail that crosses Tienken Road about 2,000 feet east of Livernois. Studies by the Trailway Commission have shown that the trail is used by walkers and runners in the cold weather and by bicyclists in the warm weather. The path of the trail generally follows the path of the Paint Creek, which adds to the natural beauty and attractiveness of the trail. Usage of the trail varies considerably by day and weather. Table 1-11 summarizes historical surveys done by the Trailway Commission.

Table 1-11
PAINT CREEK TRAIL
HISTORICAL USAGE COMPARISONS
ON TRAIL NEAR TIENKEN ON A SUNDAY

Time Period	Sample Size	Actual UPH*	Average UPH*	Highest UPH*
6/6/99		125		
10/17/93		22		
4/92-6/92	6		81	144
1/92 - 3/92	9		30	92
7/91 - 11/91	14		109	204

*Users per Hour

HRC updated the user surveys with two counts in June 1999. On June 3, 1999, from 4:30 – 5:30 p.m., HRC conducted a pedestrian study that showed that only 22 pedestrians per hour were crossing at the Tienken and Paint Creek Trail intersection. HRC also conducted a second pedestrian study and gap study on June 6, 1999, which showed 125 pedestrians crossing at this point. Types of users by direction are shown in Table 1-12.

Table 1-12
PAINT CREEK TRAIL USER SURVEY
Counts from Sunday, 6/6/99, 11:30 a.m. - 12:30 p.m.

User Type	Southbound	Northbound	Total by User	% of Total
Bikers	48	41	89	71.2
Joggers	16	2	18	14.4
Walkers	10	8	18	14.4
Total by Direction	74	51	125	100

Based on the road width, HRC calculated that a minimum of 20 seconds between passing cars was needed to cross Tienken Road. The gap study counted all gaps for an hour period that exceeded that minimum. Table 1-13 has the results of the gap study.

Table 1-13
PAINT CREEK TRAIL GAP STUDY
GAPS > 20 SECONDS
Counts from Sunday, 6/6/99, 11:30 a.m. - 12:30 p.m.

Gap Size (sec.)	# of Observances
21	-
22	1
23	-
24	1

The gap study revealed, that even on a Sunday, traffic was so heavy that 98.72% of the time when a pedestrian wanted to cross, he/she did not have an acceptable gap of 20 seconds to cross safely.

In the past, Tienken Road was a popular starting point for trail users because they could park their motorized vehicles in the empty lot in the northwest corner of the trail and Tienken Road. This area is being developed into a residential subdivision. Parking for trail users during construction is prohibited. After the subdivision is completed, .20 acres in the very southeast corner will be dedicated for use as a parking lot by the Paint Creek Trailway Commission. This lot will provide space for approximately ten vehicles.

1.8.2 Pedestrians at Tienken and Rochester

RCOC provided information on the number of pedestrian calls made at the intersection of Rochester and Tienken. The data was collected on Wednesday, June 3, 1999. Results are shown in Table 1-14. Fifty percent of the calls were to cross the south leg of the intersection.

Table 1-14
PEDESTRIAN CALLS BY APPROACH
ROCHESTER AND TIENKEN

Approach Being Crossed	No. of Calls	% of Total
West	17	22.4
North	13	17.1
South	38	50.0
East	8	10.5
Total	76	100

Table 1-15 shows the distribution of the calls by time of day. Results from the Table show that the peak demand for pedestrians to cross is from 2-3 PM. Studies have shown that this time range falls within the peak period for people to do their shopping.

Table 1-15
PEDESTRIAN CALLS BY TIME OF DAY
ROCHESTER AND TIENKEN

Time of Day	12-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15
# of Calls	0	3	1	1	5	5	3	3	8	17
% of Total	0	3.9	1.3	1.3	6.6	6.6	3.9	3.9	10.5	22.4

Time of Day	15-16	16-17	17-18	18-19	19-20	20-21	21-22	22-23	23-24	Total
# of Calls	6	6	8	4	2	3	1	0	0	76
% of Total	7.9	7.9	10.5	5.3	2.6	3.9	1.3	0	0	100

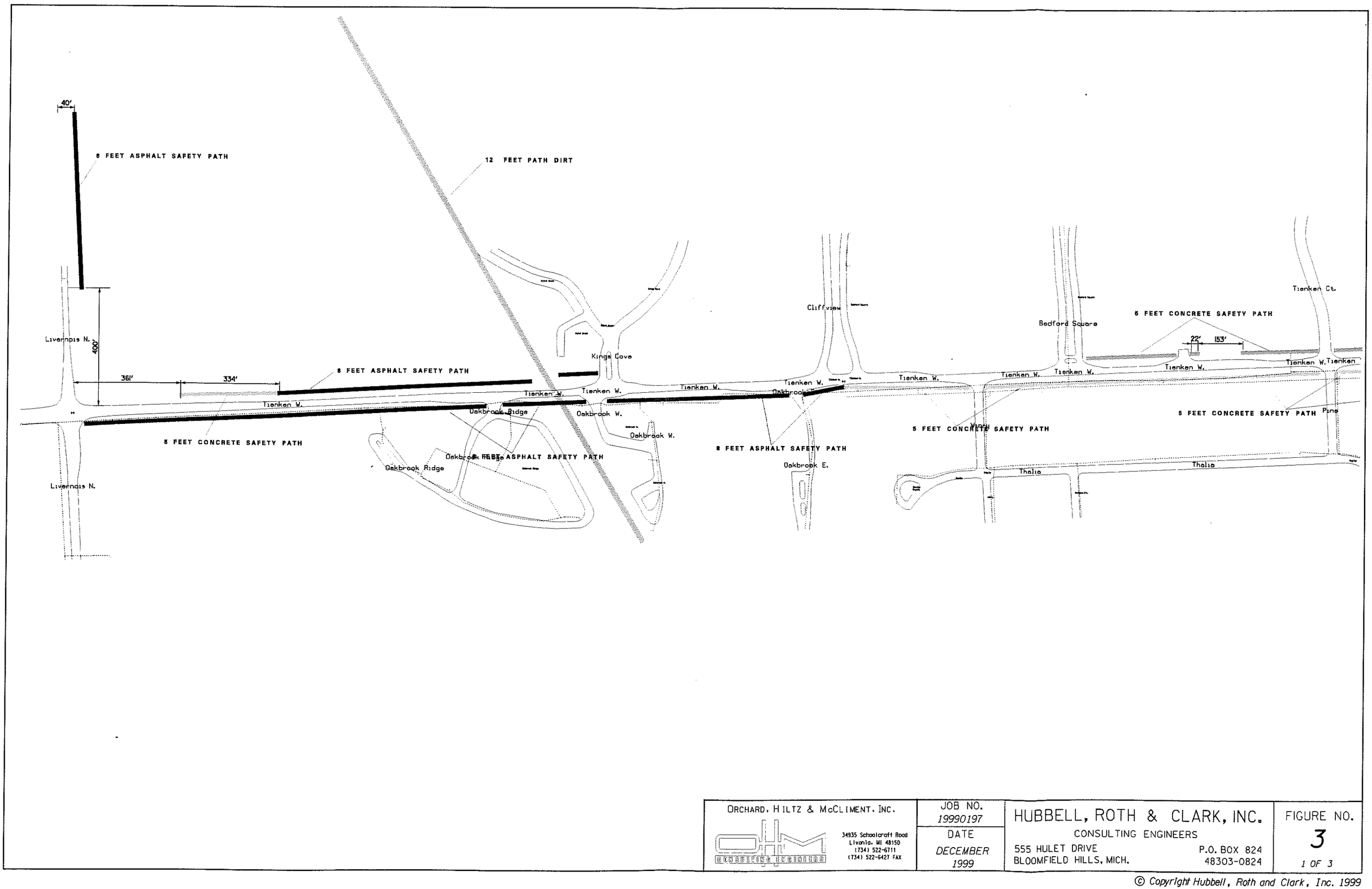
1.8.3 Pedestrian Path Network

One of the key objectives of the Rochester Hills Master Thoroughfare Plan Update is to encourage the development and use of non-motorized facilities. The City is committed to installing safety paths on both sides of the road, whenever a road is improved.

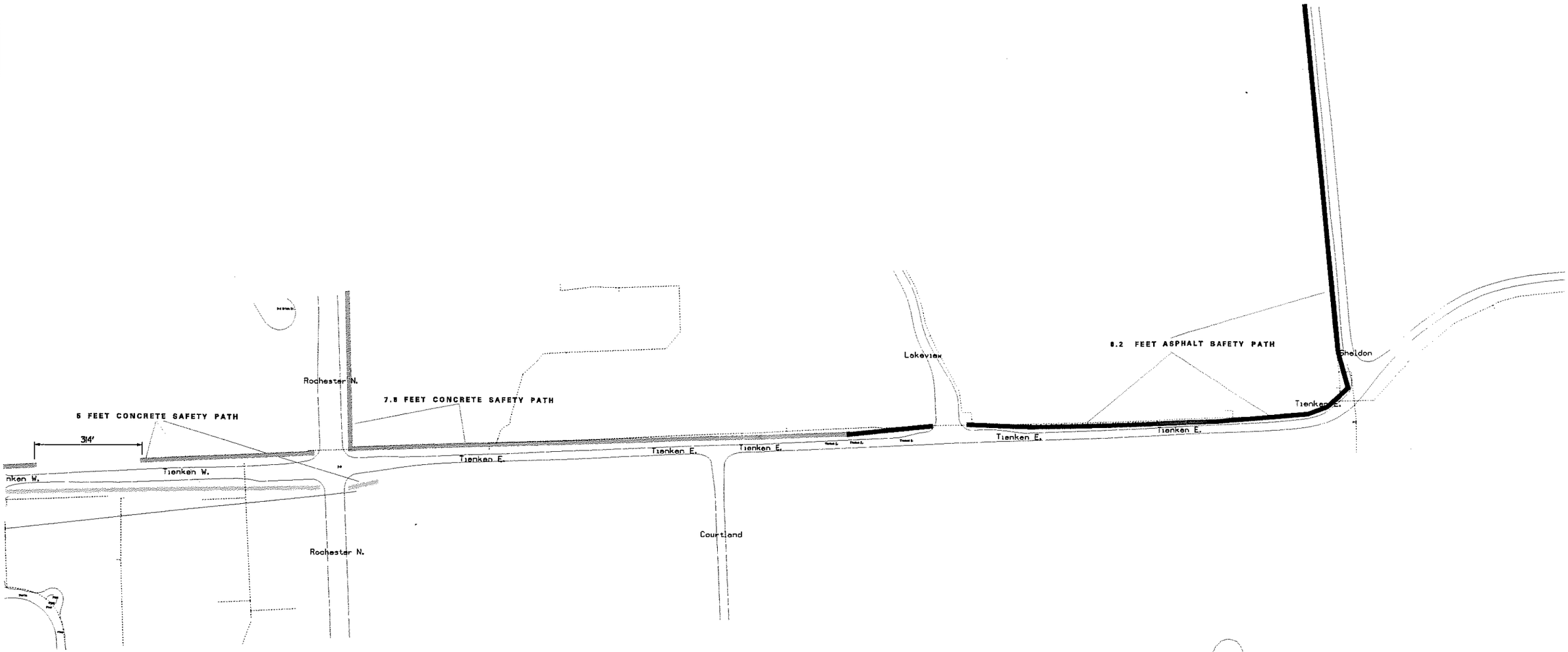
HRC did field surveys to determine where the safety path network is in place, and what is the width and pavement material. Currently, the network is a combination of 5 foot concrete sidewalks and 8 foot bituminous pathways. The field data is shown in Figures 3, 4, and 5. Various gaps were observed in the safety path network along the corridor. Table 1-16 shows the locations and length of gaps within the corridor. A total of 15,282 linear feet of paths are needed to complete the network along Tienken and along the future paved section of Sheldon. All gaps are proposed to be closed with 8 foot bituminous pathways, except in the Historic District. Here, due to width constraints, a 5 foot sidewalk is recommended.

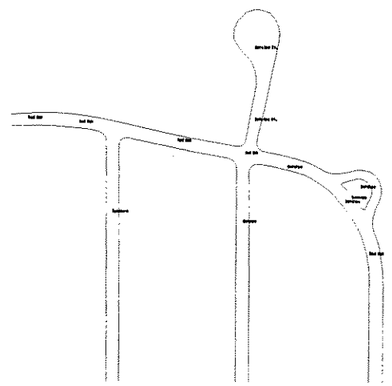
Table 1-16
SAFETY PATH GAPS

ROAD	STATION	SIDE OF ROAD	QUANTITY
Tienken	447+43 - 451+05	North	362 lft.
	454+66 - 463+92	North	926 lft.
	465+89 - 472+59	North	663 lft.
	473+11 - 473+85	North	74 lft.
	474+21 - 480+88	North	668 lft.
	500+51 - 510+85	South	1,041 lft.
	511+42 - 538+26	South	2,686 lft.
	538+68 - 544+85	South	614 lft.
	545+14 - 547+97	South	286 lft.
	548+64 - 552+91	South	429 lft.
	548+66 - 560+52	North	1,187 lft.
	553+44 - 560+52	South	706 lft.
	Subtotal		9,642 lft.
Sheldon	27+65 - 55+85	West	2,820 lft.
	11	East	2,820 lft.
	Subtotal		5,640 lft.

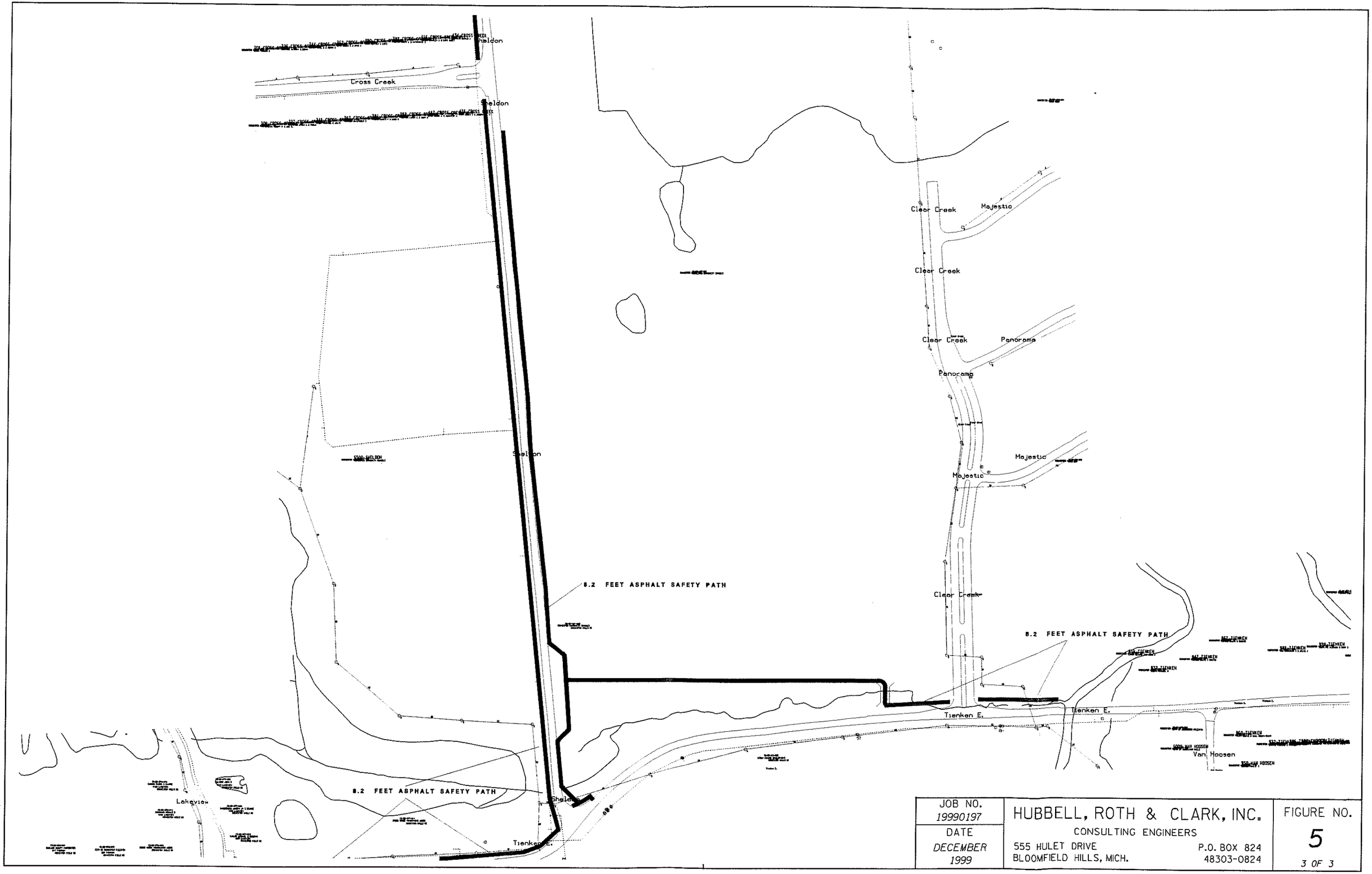


ORCHARD, HILTZ & McCLIMENT, INC. CONSULTING ENGINEERS 34935 Schoolcraft Road Livonia, MI 48150 (734) 522-6711 (734) 522-6427 FAX	JOB NO. *19990197* DATE *DECEMBER 1999*	HUBBELL, ROTH & CLARK, INC. CONSULTING ENGINEERS 555 HULET DRIVE P.O. BOX 824 BLOOMFIELD HILLS, MICH. 48303-0824	FIGURE NO. *3* *1 OF 3*





ORCHARD, HILTZ & McCLIMENT, INC. CONSULTING ENGINEERS 34935 Schoolcraft Road Livonia, MI 48150 (734) 522-6711 (734) 522-6427 FAX	JOB NO. 19990197 DATE DECEMBER 1999	HUBBELL, ROTH & CLARK, INC. CONSULTING ENGINEERS 555 HULET DRIVE P.O. BOX 824 BLOOMFIELD HILLS, MICH. 48303-0824	FIGURE NO. 4 2 OF 3



JOB NO. 19990197	HUBBELL, ROTH & CLARK, INC.	FIGURE NO. 5
DATE DECEMBER 1999	CONSULTING ENGINEERS 555 HULET DRIVE P.O. BOX 824 BLOOMFIELD HILLS, MICH. 48303-0824	3 OF 3

1.9 Underground Utilities

Information about public underground utilities was provided by the City of Rochester Hills to OHM. This data was placed on the digital base map. The location of private underground utilities and data for the City of Rochester were not requested at this time.

1.10 Proposed Developments

Table 1-17 below shows the status of proposed developments in Rochester Hills and Rochester, which are expected to add traffic to the Tienken corridor study area. This information formed a basis for forecasting future trips in the corridor.

Table 1-17
STATUS OF PROPOSED DEVELOPEMENTS

Rochester Hills

Clear Creek Subdivision North of Tienken between Sheldon & Washington Phase I under construction Access to Sheldon & Tienken	246 dwelling units
Clear Creek Subdivision North of Tienken between Sheldon & Washington 40 acres available for future growth	62 dwelling units
Hillside Creek Subdivision NE corner of Tienken & Livernois Under construction Access to Tienken & Livernois	33 dwelling units
Quail Crest Subdivision NW corner of Rochester & Orion Under construction Access to Orion via two driveways	45 dwelling units

Rochester

Stoney Creek Ridge North Subdivision NE corner of Runyon & Washington Under construction Access to Runyon via two driveways	186 dwelling units
Stoney Creek Ridge North No. 2 Subdivision NE corner of Runyon & Washington	24 dwelling units

Being proposed – Plat issues

Stoney Creek Ridge No. 5 Subdivision — 75 dwelling units
South of Runyon at Washington
Under construction
Access to Runyon and Sub to South

Stoney Creek Ridge No. 6 Subdivision — 15 dwelling units
SE corner of Runyon & Washington
Being proposed – Plat issues

Maple Ridge Creek Village Condominiums — 124 dwelling units
South of Washington between Tienken & Dequindre
Under construction
Access to Washington

Stoney Pointe North Subdivision — 60 dwelling units
South of Tienken, East of Sheldon
Being proposed
Access to Tienken and Romeo Plank

Village Green Apartments — 300 units
SW corner of Letica & Parkdale
Under construction
Access to Letica

1.11 Public Transportation Services

1.11.1 Public Transportation

The City of Rochester Hills is currently served by two public transport operators, one being the Older Persons Commission that operates Paratransit Services for the Elderly and Handicapped, and the other, the City of Rochester Hills School District that provides school bus service to students from elementary through high school. The City does not receive any regional public transportation services from SMART at this time.

1.11.2 Older Persons Commission (OPC) Paratransit Operation

The bus service operates door-to-door, as needed. However, the preference is curb-to-curb operations. The service operates on a one-day advance reservation notice for most trips, but a two-day notice is required for medical, therapy and hair appointments, etc.

To be eligible, a person must be 59 years or older and have a written statement from a doctor stating the individual is disabled or handicapped. The fare is a suggested donation of $2.00 per one-way trip.

The majority of trips have either origins or destinations from the following land use:

- Tienken Road Health Club
- Bedford Square Apartments
- Kings Cove
- Oakbrook Apartments
- Cliffview Senior Housing
- North Hills Shopping Center

The service operates every day during the hours shown below:

Sunday	8:00 am – 1:00 pm
Monday – Friday	*9:00 am – 5:00 pm
Saturday	*8:00 am – 5:00 pm

*Service operates earlier for job related trips.

1.11.3 School Bus Operations

The bus service that operates in the Tienken Road Corridor primarily serves the following schools:

- Rochester High
- Hart Middle School
- Hugger Elementary
- Holy Family K-8
- St. John's K-8

The bus activity stops and pick-ups are focused primarily along Mead Road, with only a small number on Tienken Road.

The school bus service operates split runs that are geared for morning and afternoon school bell times. The stop load and arrival times are shown in Tables 1-18 through 1-21. The number of students

boarding/deboarding is approximately 46. The number of times that the bus stops/dwells is estimated at 34.

Given the peaking characteristics, the bus movements are evenly distributed between morning and afternoon (morning – 17 and afternoon – 17). The school bus operation begins as early as 6:00 am and is generally concluded by 5:00 pm.

Table 1-18

SCHOOL BUS RUN AM #438

Intersection	Arrival Time	No. of Students
960 Tienken	7:03	2
Wimberly & Mead	7:21	2
Mead & Oakland	7:28	3
Total		**7**

SCHOOL BUS RUN PM #438

Intersection	Arrival Time	No. of Students
960 Tienken	2:30	2
Wimberly & Mead	2:42	2
Mead & Oakland	2:49	2
Total		**6**

Table 1-19

SCHOOL BUS RUN AM #75

Intersection	Arrival Time	No. of Students
Mead & Wimberly	8:30	1
Wimberly Drive	8:31	0
Wimberly Drive	8:32	6
Mead	8:34	0
Total		**7**

SCHOOL BUS RUN PM #75

Intersection	Arrival Time	No. of Students
Mead & Wimberly	4:13	1
Wimberly Drive	4:13	0
Wimberly Drive	4:15	4
Mead	4:16	0
Total		**5**

Table 1-20

HUGGER-SCHOOL BUS RUN AM #77

Intersection	Arrival Time	No. of Students
Sheldon (Slow School Sign)	8:38	3

School Bus Run PM #77

Intersection	Arrival Time	No. of Students
Sheldon (Slow School Sign)	4:04	3

Table 1-21

ROCHESTER HIGH SCHOOL

SCHOOL BUS RUN AM #601

Intersection	Arrival Time	No. of Students
Mead & Wimberly	6:43	2
Mead & Oakland Valley	7:13	4
Mead & Blue Beech	7:17	1
Total		**7**

SCHOOL BUS RUN PM #601

Intersection	Arrival Time	No. of Students
Mead & Wimberly	3:19	1
Mead & Oakland Valley	3:20	4
Mead & Blue Beech	3:20	2
Total		**7**

1.12 Photo Log

To assist in the analysis and design process, photos were taken along the Tienken Road segments every 1/2-mile on flat, straight portions and every ¼ mile on hilly terrain or curved portions of the road. Photos were also taken at the intersections listed below.

Tienken and Livernois
Tienken and Paint Creek Trail
Tienken and Rochester
Tienken and Sheldon
Tienken and Van Hoosen
Sheldon and Mead
Rochester and Orion

These photos plus the alley in the historic district are found in Appendix C.

Video photography was also taken by OHM along Tienken, from Livernois to Washington. The tapes have been provided to Rochester Hills and the Road Commission for Oakland County under separate cover.

1.13 Crash Data

Crash data was obtained from the Traffic Improvement Association for the years 1995-1997. The data was requested for 10 intersections and four segments. The crash data for Tienken was mapped to assist in analysis. The collision diagrams for the intersections and the segments can be found in Appendix D. The collision analysis and trends can be found in Chapter 2 for Tienken Road. Crash data for Sheldon Road was obtained for the period 1996-1998 and used in the Benefit-Cost Analysis.

Chapter 2 – Data Analysis

2.1 Traffic Crash Experience

The traffic engineer's most critical contribution to traffic safety is the analysis of high accident locations and the recommendation of improvements to correct the roadway deficiencies and to make the roads safer.

2.1.1 Crash Frequency and Rates for Tienken

The traffic engineer's analysis of the traffic safety problem must include two critical pieces of information – traffic crash data and traffic volume data. HRC gathered traffic volumes and crash data for 1995 through 1997 for the City of Rochester Hills and analyzed it to identify areas of concern. It is important to compute crash rates and crash frequencies because it provides a relationship between the crash experience and the exposure. For example, fifteen crashes at an intersection carrying 20,000 vehicles per day, may be a more serious problem than fifteen crashes at an intersection carrying 50,000 vehicles per day. The traffic volume information helps put the accident experience into perspective so that priorities can be set rationally for a transportation improvement program.

For five key intersections and for three segments along Tienken Road, the crashes were summarized and the crash types were listed and tabulated. A summary of the reported crashes is listed in Tables 2-1 and 2-2.

Table 2-1
TIENKEN CORRIDOR INTERSECTION CRASH SUMMARY
1995 - 1997

Intersection	1997 ADT	Crashes				Crash Rate[1]	Injuries				Injury Rate[1]	Fatalities				Fatality Rate[1]
		1995	1996	1997	Average		1995	1996	1997	Average		1995	1996	1997	Average	
Tienken & Livernois	29878	18	10	15	14.33	**1.3143**	3	2	5	3.33	**0.3057**				0.00	**0.0000**
Tienken & Kings Cove	20745	5	4	5	4.67	**0.6163**	1	2	2	1.67	**0.2201**	1			0.33	**0.0440**
Tienken & Rochester	44829	36	39	27	34.00	**2.0779**	6	12	6	8.00	**0.4889**				0.00	**0.0000**
Tienken & Sheldon	8115	0	1	1	0.67	**0.2251**				0.00	**0.0000**				0.00	**0.0000**
Tienken & Washington	7415	0	0	0	0.00	**0.0000**				0.00	**0.0000**				0.00	**0.0000**
TOTAL		59	54	48			10	16	13			1	0	0		

[1] Million Entering Vehicle Miles (MEV)

SOURCE: TIA and City of Rochester Hills

Table 2-2
TIENKEN CORRIDOR SEGMENT CRASH SUMMARY
1995 - 1997

No.	Segment of Tienken	1997 ADT	Crashes/Mile				Crash Rate[2]	Injuries				Injury Rate[2]	Fatalities				Fatality Rate[2]
			1995	1996	1997	Average		1995	1996	1997	Average		1995	1996	1997	Average	
1	Bet. Livernois & Rochester	19745	29	28	31	29.33	**4.0702**	10	7	8	8.33	**1.1563**				0.00	**0.0000**
2	Bet. Rochester & Sheldon	9186	1	1	7	3.00	**0.8948**	1		2	1.00	**0.2983**				0.00	**0.0000**
3	Bet. Sheldon & Washington	4762	5	2	7	4.67	**2.6849**	1	1		0.67	**0.3836**				0.00	**0.0000**
4	TOTAL		35	31	45			12	8	10			0	0	0		

[2] Million Vehicle Miles Traveled (VMT)

SOURCE: TIA and City of Rochester Hills

2.1.2 Comparison to Regional Intersection Statistics

SEMCOG publishes a Traffic Safety Manual, which provides tables of average and critical crash rates as well as average and critical crash frequency taken from regional samples of intersections. HRC compared the data from Tienken to the data in Table 3-4 in this manual. The results of the comparison are as follows:

Despite an average of 14.33 crashes per year, the intersection of Tienken and Livernois only has an average crash rate of 1.3143. This figure is just under the regional crash rate of 1.43 for a signalized intersection with an ADT of 20,001-30,000.

The intersection of Tienken and Rochester has an average crash frequency of 34 and crash rate of 2.0779. Both of these statistics exceed the critical levels for signalized intersection with an ADT between 40,001-50,000. The crash experience would classify this intersection as a high-crash location and measures should be taken to improve the safety of this intersection.

HRC also compared the crash statistics for the unsignalized intersection of Tienken and Kings Cove. The average crash frequency of 4.67 and crash rate of .6163 for this intersection falls between the average and critical levels for an unsignalized intersection with an ADT of 20,001 and 30,000.

HRC also examined the crash statistics for the one mile segment of Tienken between Livernois and Rochester. The average crash frequency was 29.33 and crash rate was 4.0702. Both these statistics exceed the critical levels for a segment with an ADT between 10,001 and 20,000. This segment can be classified as a high-crash segment.

2.1.3 Collision Types

HRC analyzed the crashes to determine if there was a pattern of collision types. Table 2-3 summarizes the collision types by intersection. From 1995 to 1997, rear-end crashes were the most common accidents at both the intersections and along Tienken Road, from Livernois to Washington. More than 50% of the intersection crashes were rear-end types. Diagrams of the types of accidents by intersection and segment can be found in Appendix D.

Table 2-3

COLLISION TYPES ON TIENKEN INTERSECTIONS

	Head-On Left Turn			Head-On Right Turn			Rear-End			Head-On			Side-Swipe Same			Side-Swipe Opposite			Out of Control			Backing Vehicle			Pedestrian			Angle			Animal		
	95	96	97	95	96	97	95	96	97	95	96	97	95	96	97	95	96	97	95	96	97	95	96	97	95	96	97	95	96	97	95	96	97
Livernois		2	1			2	11	5	7				1	1	2				2			1								1			
Kings Cove	1						4	3	4												1								1	1			
Winry	1	1						2	2		1									1													1
Tienken Ct/Pine		1	1				3	3	2																			2		1			
Rochester	2	3	1	2			14	7	13			4	1	4			1		3	3					1	1		8	11	3			
Courtland			1																														
Lakeview																																	
Sheldon									1																								
Van Hoosen																				1													
Washington																								1									
TOTAL	4	7	4	2		2	32	20	29		1	4	2	5	2		1		5	5	1	1		1	1	1		10	12	6			1

2.2 Traffic Forecasting Model

HRC forecasted future traffic volumes to the year 2015. HRC's methodology was to start with 1999 traffic counts and add trip generated by all the proposed developments along the corridor. HRC then generated the PM peak hour volumes and assigned the trips from the new developments to the appropriate intersections and segments.

2.3 Trip Generation for Proposed Developments

One of the most critical elements of site impact studies is estimating the amount of traffic to be generated by a proposed development. This is usually done by using trip generation rates or equations. Trip generation rates or equations provide an estimate of all trips generated by a site.

Rates are commonly expressed in trips per unit of development. For example, trips per dwelling unit are commonly used for residential developments, while trips per 1,000 square feet of gross floor area are used for offices and schools. Equations provide a direct estimate of trips based upon development units being multiplied in a mathematical relationship.

Trips are defined as a single or one directional movement with either the origin or destination of the trip inside the study site. Thus, a car entering and leaving a site would be recorded as generating two trips. Trip generation estimates are often the most critical factors in assessing impacts and needs of a proposed development.

There are several sources for trip generation rates and equations, which are based on data collected from locations in the United States and Canada. These are compilations of data that have been gathered over many years for various land uses. National data sources are starting points in estimating the amount of traffic that may be generated by a specific building or land use. Whenever possible, the National rates should be adjusted to reflect local or forecasted conditions. These National sources are not intended to be used without question, deviation or sound judgment. They often reflect what are supposed to be the average or typical conditions. Data collected from local sites may be more representative than National averages of other developments within the area.

The most widely used source of National Trip Generation data is the Trip Generation Manual, published by the Institute of Transportation Engineers. The information in this report is almost solely derived from suburban and urban sites. Data included in trip generation was obtained from actual driveway counts of vehicular traffic entering and exiting the site. The sixth edition contains more than 2,000 data sets from individual trip generation studies. The report also includes discussions on the application and use of trip generation rates and equations; descriptions of the characteristics of each land use; maximum/minimum average rates for weekdays, weekends and peak hours of the generator and adjacent street traffic; and additional statistical data regarding data variability.

As discussed in Chapter 1, there are many new home developments planned in the cities of Rochester Hills and Rochester, which would add traffic to roads in the Tienken Road Corridor. Table 2-4 below lists the development name, the number of dwelling units and the estimated trips. Also shown is the inbound and outbound traffic movements in the peak hours.

Table 2-4
WEEKDAY TRIP GENERATION FOR NEW RESIDENTIAL DWELLING UNITS

ITE Land Use Code	Development	AM Peak Hour Trips			PM Peak Hour Trips			Daily Trips
		In	Out	Total	In	Out	Total	
210	Clear Creek Sub 264 Units (Under construction)	49	149	198	171	96	267	2,526
210	Clear Creek Sub 62 Units (Potential Future)	12	35	47	40	23	63	593
210	Hillside Creek Sub 33 Units (Under construction)	6	19	25	21	12	33	316
210	Quail Crest Sub 45 Units (Under construction)	9	25	34	29	16	45	431
210	Stony Pointe North Sub 60 Units (Proposed)	11	34	45	39	22	61	574
210	Stony Creek Ridge North Sub 186 Units (Under construction)	35	105	140	120	68	188	1,780
210	Stony Creek Ridge North No. 2 Sub 24 Units (Proposed)	4	14	18	16	8	24	230
210	Stony Creek Ridge No. 5 Sub 75 Units (Under construction)	14	42	56	49	27	76	718
210	Stony Creek Ridge No. 6 Sub 15 Units (Proposed)	3	8	11	10	5	15	144
230	Maple Ridge Creek Village Condos 124 Units (Under construction)	10	45	55	45	22	67	727
	TOTAL	**153**	**476**	**629**	**540**	**299**	**839**	**8,039**

A new high school for Rochester Community Schools is being built on Sheldon Road, north of Tienken. The gross floor area of the new high school is expected to be 300,000 sq. ft. The school is expected to accommodate 1,500 students and generate 3,270 daily trips.

Table 2-5
WEEKDAY TRIP GENERATION FOR NEW HIGH SCHOOL

ITE Land Use Code	Development	AM Peak Hour Trips			PM Peak Hour Trips			Daily Trips
		In	Out	Total	In	Out	Total	
580	High School with 1,500 students	519	183	702	198	384	582	3270

The AM peak hour for the school coincides with the AM peak hour for the adjacent street. However, in the afternoon, the PM peak hour of traffic for the school falls outside the PM peak hour for the adjacent street.

2.4 Trip Distribution

2.4.1 High School

To determine how the site generated traffic from the high school will be distributed to the adjacent roadway network, HRC relied on a Traffic Input Study prepared for the Rochester Community Schools in November 1997. In that report, HRC estimated that trips generated by the new high school will be 30% from the north, 35% from the south, 27% from the east and 8% from the west.

2.4.2 Residential Development

Trip distribution for the residential developments adjacent to the corridor are based on location of development to the study area. Distribution also reflected the preponderance of shopping opportunities located primarily south of the corridor and accessed most directly via Rochester Road.

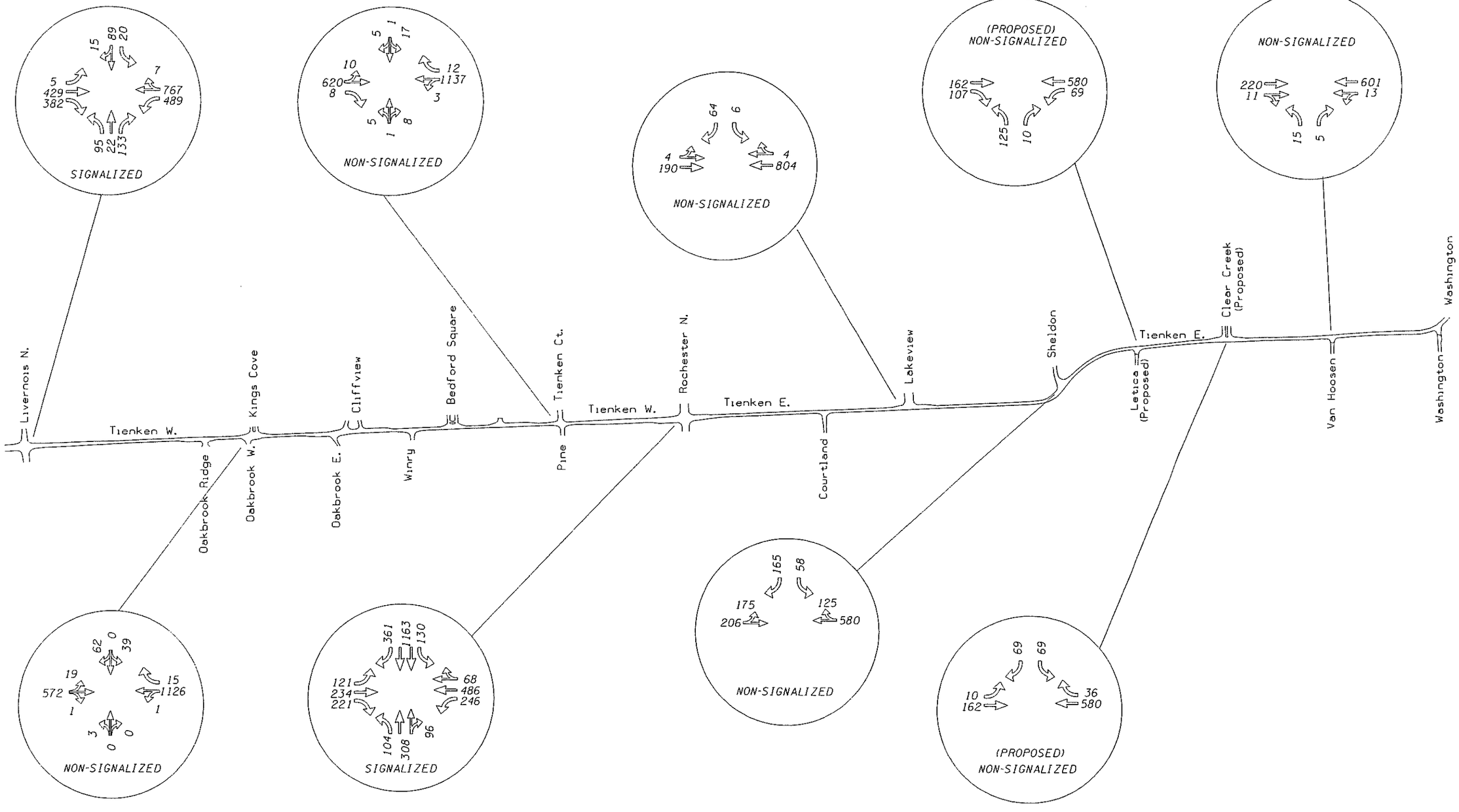
2.4.3 Assignment of Future Traffic

Figures 6 and 7 display the future trips assigned to intersections in the corridor during the AM peak and PM peak, respectively. The capacity analysis and CORSIM modeling are based on these volumes.

2.5 Capacity Analysis

A critical part of the corridor study is the capacity analysis of key signalized and unsignalized intersections. The level of service was calculated for current conditions at 10 intersections in both the AM and PM peak hours. The level of service with future traffic volumes was calculated at five intersections, which included three existing and two proposed intersections. One new intersection will be at Letica Road and Tienken Road and the other new intersection will be at the driveway to the Clear

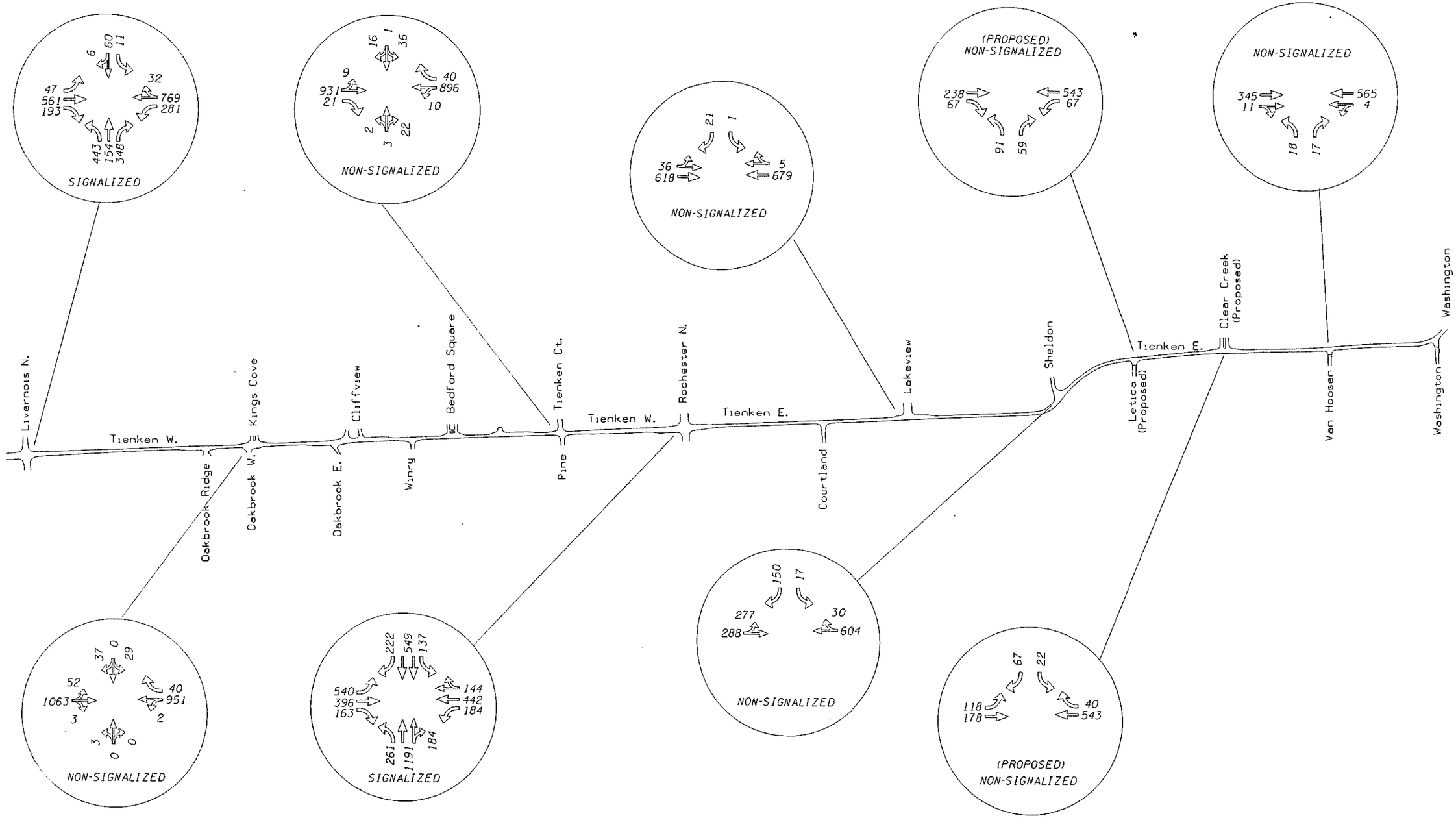
FUTURE AM PEAK TURNING MOVEMENT COUNTS FOR 2015



ORCHARD. HILTZ & McCLIMENT. INC. CONSULTING ENGINEERS 34935 Schoolcraft Road Livonia, MI 48150 (734) 522-6711 (734) 522-6427 FAX	JOB NO. ~~19990197~~ 19990197	HUBBELL, ROTH & CLARK, INC. CONSULTING ENGINEERS 555 HULET DRIVE BLOOMFIELD HILLS, MICH. P.O. BOX 824 48303-0824	SHEET NO. 6
	DATE 10/18/99		

USER NAME • ccozma DESIGN FILE • f:\1999\19990\19990197\caddd\traffic\ampeak1.dgn PLOT NAME • N/A STROKE TIME • 05-NOV-1999 14:38

FUTURE PM PEAK TURNING MOVEMENT COUNTS FOR 2015



ORCHARD, HILTZ & McCLIMENT, INC. CONSULTING ENGINEERS 34935 Schoolcraft Road Livonia, MI 48150 (734) 522-6711 (734) 522-6427 Fax	JOB NO. 19990197 DATE 10/18/99	HUBBELL, ROTH & CLARK, INC. CONSULTING ENGINEERS 555 HULET DRIVE P.O. BOX 824 BLOOMFIELD HILLS, MICH. 48303-0824	SHEET NO. 7

USER NAME • ccozma DESIGN FILE • f:\1999\19990\19990197\cadd\traffic\impeak1.dgn PLOT NAME • N/A STROKE TIME • 05-NOV-1999 14:37

Creek subdivision and Tienken Road. Table 2-6 below lists which intersections were analyzed for current and future conditions.

Table 2-6
LOCATIONS WHERE LOS ANALYSIS WAS CONDUCTED

INTERSECTION	CURRENT CONDITIONS	FUTURE CONDITIONS
Tienken/Livernois	X	X
Tienken/Kings Cove	X	
Tienken/Pine	X	
Tienken/Rochester	X	X
Tienken/Lakeview	X	
Tienken Sheldon	X	X
Tienken/Letica		X
Tienken/Clear Creek		X
Tienken/Van Hoosen	X	
Tienken/Washington	X	
Sheldon/Mead	X	
Rochester/Mead	X	

2.5.1 Level of Service Criteria for Signalized Intersections

The procedures for analysis were those outlined in Transportation Research Board Special Report 209, 1997 Highway Capacity Manual. This manual defines level of services for signalized intersections in terms of delay. The level of service calculation provides a measure of performance of the current roadway system and indicates the urgency for roadway improvements.

Delay is a measure of driver discomfort, frustration, fuel consumption, and lost travel time. Specifically, level of service criteria are stated in terms of the average stopped delay per vehicle for a 15-min. analysis period. The criteria are given in the Table below.

Table 2-7
LEVEL OF SERVICE CRITERIA FOR SIGNALIZED INTERSECTIONS

Level of Service	Stopped Delay per Vehicle (Seconds)
A	>10
B	>10 to ≤20
C	>20 to ≤35
D	>35 to ≤55
E	>55 to ≤80
F	>80

Delay may be measured in the field, or it may be estimated. Delay is a complex measure, and is dependent on a number of variables, including the quality of progression, the cycle length, the green ratio, and the volume to capacity ratio for the lane group or approach in question.

Level of Service A describes operations with very low control delay up to 10.0 sec per vehicle. This occurs when progression is extremely favorable, and most vehicles arrive during the green phase. Most vehicles do not stop at all. Short cycle lengths may also contribute to low delay.

Level of Service B describes operations with control delay in the range of 10.1 to 20.0 sec per vehicle. This generally occurs with good progression and/or short cycle lengths. More vehicles stop than for Level of Service A, causing higher levels of average delay.

Level of Service C describes operations with control delay in the range of 20.1 to 35.0 sec per vehicle. These higher delays may result from fair progression and/or longer cycle lengths. Individual cycle failures may begin to appear in this level. The number of vehicles stopping is significant at this level, although many still pass through the intersection without stopping.

Level of Service D describes operations with control delay in the range of 35.1 to 55.0 sec per vehicle. At level D, the influence of congestion becomes more noticeable. Longer delays may result from some combination of unfavorable progression, long cycle lengths, or high volume to capacity ratios. Many vehicles stop, and the proportion of vehicles not stopping declines. Individual cycle failures are noticeable.

Level of Service E describes operations with control delay in the range of 55.1 to 80.0 sec per vehicle. This is considered to be the limit of acceptable delay. These high delay values generally indicate poor progression, long cycle lengths, and high volume to capacity ratios. Individual cycle failures are frequent occurrences.

Level of Service F describes operations with control delay in excess of 80.1 sec per vehicle. This is considered to be unacceptable to most drivers. This condition often occurs with over saturation, i.e., when arrival flow rates exceed the capacity of the intersection. It may also occur at high volume to capacity ratios below 1.00 with many individual cycle failures. Poor progression and long cycle lengths may also be major contributing causes to such delay levels.

2.5.2 Level of Service Criteria for Unsignalized Intersections

The procedures for analysis were those outlined in Transportation Research Board Special Report 209, Highway Capacity Manual. The manual defines level of service in terms of delay.

Table 2-8
LEVEL OF SERVICE CRITERIA FOR UNSIGNALIZED INTERSECTIONS

Level of Service	Stopped Delay per Vehicle (Seconds)
A	<5.0
B	5.1 to 10.0
C	10.1 to 20.0
D	20.1 to 30.0
E	30.1 to 45.0
F	>45.0

Level-of-Service A describes operations with very low delay, i.e., less than 5.0 seconds per vehicle. This condition exists when there is no conflicting traffic for a minor street movement.

Level-of-Service B describes operations with delay in the range of 5.1 to 10.0 seconds per vehicle. There is more conflicting traffic for a minor street movement than occurs for the Level-of-Service A condition.

Level-of-Service C describes operations with delay in the range of 10.1 to 20.0 seconds per vehicle. The volume of conflicting traffic has increased but the minor street traffic is still able to maneuver through the intersection without much difficulty.

Level-of-Service D describes operations with delay in the range of 20.1 to 30.0 seconds per vehicle. At level D, the influence of congestion becomes more noticeable and the minor street traffic finds it difficult to maneuver through the intersection.

Level-of-Service E describes operations with delay in the range of 30.1 to 45.0 seconds per vehicle. This is considered to be the limit of acceptable delay.

Level-of-Service F describes operations with delay in excess of 45.0 seconds per vehicle. This is considered to be unacceptable to most drivers. This condition exists when there are insufficient gaps of suitable size to allow the side street demand to cross safely through a major street traffic stream.

Level-of-Service (LOS) criteria for unsignalized intersections are stated in very general terms and are related to general ranges. The Table below describes the expected delay associated with a level of service.

Table 2-9
LEVEL OF SERVICE CRITERIA FOR UNSIGNALIZED INTERSECTIONS

Level of Service	Expected Delay to Minor Street Traffic
A	Little or no delay
B	Short traffic delays
C	Average traffic delays
D	Long traffic delays
E	Very long traffic delays
F	Severe congestion*

*When demand volume exceeds capacity of a lane, extreme delays will be encountered with queuing which may cause severe congestion affecting other traffic movements in the intersection. This condition usually warrants improvements at the intersection.

2.5.3 LOS Results

2.5.3.1 Current Conditions

The results of the LOS analysis for current conditions are shown on the following page. The complete analysis for each intersections can be found in Appendix E.

The traffic signal timing plans for the two signalized intersections of Tienken and Livernois and Tienken and Rochester are based on the SCATS timing plans provided by the Road Commission for Oakland County. SCATS is a fully adaptive traffic control system which allows each cycle to change depending on traffic demand by approach. However, during peak times when all approaches are heavily congested, SCATS operates virtually in a fixed time plan.

Currently, only the two signalized intersections have an overall LOS D or higher. All of the non-signalized intersections have a LOS A. Please refer to Table 2-11. However, looking at the individual approaches, the analysis reveals that considerable delay is occurring not only at the heavily congested signalized intersections, but also at some of the minor unsignalized ones. The approaches with a LOS E or higher are show in the Tables 2-10 and 2-12 below.

Table 2-10
AM PEAK PROBLEMS BY APPROACH

INTERSECTION	APPROACH	MOVEMENT	LOS
Tienken/Livernois	Westbound	Left Turn	F
	Northbound	Left Turn	F
	Southbound	Left Turn	E
Tienken/Kings Cove/Oakbrook W	Northbound	Left Turn	E
	Southbound	Left Turn	E
Tienken/Pine/Tienken Ct.	Northbound	Left Turn	F
	Southbound	Left Turn	E
Rochester/Mead	Westbound	Left Turn	F
	Westbound	Right Turn	F

Table 2-11
LEVEL OF SERVICE – CURRENT CONDITIONS

AM Peak (7-8)	Eastbound			Westbound			Northbound			Southbound			Intersection LOS	Intersection Delay (secs.)
Intersection	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**		
Tienken & Livernois	D	B	B	F	C	C	F	D	D	E	D	D	F	> 60
Tienken & Kings Cove	B	A	A	A	A	A	E	N/A	N/A	E	N/A	B	A	1.9
Tienken & Pine	B	A	A	A	A	A	F	D	D	E	D	B	A	0.6
Tienken & Rochester	F	D	C	D	D	D	F	D	D	D	B	B	F	> 60
Tienken & Lakeview	A	A	N/A	N/A	A	A	N/A	N/A	N/A	B	N/A	B	A	0.5
Tienken & Sheldon	A	A	A	A	A	A	N/A	N/A	N/A	B	N/A	B	A	2.9
Tienken & Van Hoosen	A	N/A	A	A	A	N/A	B	N/A	B	N/A	N/A	N/A	A	0.3
Tienken & Washington	A	N/A	A	N/A	N/A	N/A	B	N/A	B	B	A	N/A	A	3.9
Sheldon & Mead	A	A	A	A	A	A	A	A	A	A	A	A	A	2.7
Rochester & Mead	N/A	N/A	N/A	F	N/A	F	N/A	A	A	A	A	N/A	A	1.2

PM Peak (5-6)	Eastbound			Westbound			Northbound			Southbound			Intersection LOS	Intersection Delay (secs.)
Intersection	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**		
Tienken & Livernois	D	D	C	F	D	D	F	C	C	E	C	C	F	> 60
Tienken & Kings Cove	B	A	A	B	A	A	F	N/A	N/A	F	N/A	B	A	2.2
Tienken & Pine	A	A	A	B	A	A	C	D	B	E	D	B	A	1.4
Tienken & Rochester	D	D	D	E	E	E	C	C	C	D	D	C	D	31
Tienken & Lakeview	A	A	N/A	N/A	A	A	N/A	N/A	N/A	A	N/A	A	A	0.3
Tienken & Sheldon	A	A	A	A	A	A	N/A	N/A	N/A	B	N/A	A	A	1.6
Tienken & Van Hoosen	N/A	A	A	A	A	N/A	B	N/A	B	N/A	N/A	N/A	A	0.4
Tienken & Washington	A	N/A	A	N/A	N/A	N/A	B	N/A	A	B	B	N/A	A	3.8
Sheldon & Mead	A	A	A	A	A	A	A	A	A	A	A	A	A	2.3
Rochester & Mead	N/A	N/A	N/A	F	N/A	F	N/A	A	A	B	A	N/A	A	2.1

Source: Highway Capacity Manual
Non-Sinalized Intersections: Highway Capacity Software (HCS) Version 2.1b
Signalized Intersections: Highway Capacity Software (HCS) Version 2.3

Table 2-12
PM PEAK PROBLEMS BY APPROACH

INTERSECTION	APPROACH	MOVEMENT	LOS
Tienken/Livernois	Westbound	Left Turn	F
	Northbound	Left Turn	F
	Southbound	Left Turn	E
Tienken/Kings Cove	Northbound	Left Turn	F
	Southbound	Left Turn	F
Tienken/Pine	Southbound	Left Turn	E
Tienken/Rochester	Westbound	Left Turn	E
		Through	E
		Right	E
Rochester/Mead	Westbound	Left Turn	F
		Right Turn	F

The analysis confirms that traffic turning left onto Tienken Road from a side street during either the AM or PM peak periods experiences considerable delay. Further, during both peak periods, traffic from Mead Road has long waits before it can turn either right or left onto Rochester Road.

2.5.3.2 Future Conditions

After assigning the trips to the network from the new high school and residential developments, HRC conducted a LOS analysis of five key intersections. The analysis for the intersections of Tienken and Livernois, and Tienken and Rochester and Tienken and Sheldon were integrated into the alternatives analysis for each of the intersections. The development of the alternatives and recommendations from the analysis will be discussed in the Chapter 3.

In the future, two new unsignalized intersections are expected to be part of the network. First is the proposed new street from the south to be called Letica Drive, which will intersect Tienken Road about 780 feet east of Sheldon Road. The second intersection will be driveway to the Clear Creek subdivision, which intersects Tienken Road from the north about 1,400 feet east of Sheldon Road.

HRC did a queuing analysis in conjunction with the LOS analysis. The results are shown in Table 2-13 below.

Table 2-13
FUTURE LEVEL OF SERVICE AND QUEUES

INTERSECTION	DIRECTION	AM			PM		
		Queue Length (ft)	LOS	Delay (sec)	Queue Length (ft)	LOS	Delay (sec)
Tienken/Clear Creek	Eastbound	55	A	0.2	115	A	1.5
	Westbound	0	A	0	0	A	0
	Southbound	89	C	23	36	B	14.9
	Overall	--	A	3.5	--	A	1.8
Tienken/Letica	Eastbound	0	A	0	0	A	0
	Westbound	186	A	0	178	A	0.1
	Northbound	170	D	36.9	137	D	29.6
	Overall	--	A	4.8	--	A	4.2

Source: Highway Capacity Software (HCS) Version 2.1b

2.6 Signal Warrant Analysis

A comprehensive investigation of traffic conditions and physical characteristics of the location is required to determine the necessity for a signal installation and to furnish necessary data for the proper design and operation of a signal that is found to be warranted. The satisfaction of a warrant or warrants is not in itself justification for a signal. Information should be obtained by means of engineering studies and compared with the requirements set forth in the warrants. The engineering study should indicate the installation of a traffic signal will improve the overall safety and/or operation of the intersection.

2.6.1 Traffic Signals

Based on the forecasted traffic volumes and LOS, HRC conducted a traffic signal warrant analysis at two locations. The first intersection was Tienken and Sheldon, which is existing but unsignalized. The second intersection was the proposed future intersection of Tienken and Letica. A summary of the studies are shown below. The complete description of the warrant analysis can be found in Appendix F.

Table 2-14
RESULTS OF TRAFFIC SIGNAL WARRANT STUDIES

TRAFFIC SIGNAL WARRANT	TIENKEN/SHELDON	TIENKEN/LETICA
Minimum Vehicular Volume	No	No
Interruptions of Continuous Traffic	No	No
Minimum Pedestrian Volume	Not Applicable	Not Applicable
School Crossings	No	No
Accident Experience	Not Applicable	Not Applicable
Four Hour Volumes	Yes	Yes
Peak Hour Volume	Yes	No

The fact that a location meets one of the signal warrants does not mean that the signal must be installed. Other factors are considered, such as, signal spacing and progressive traffic movement. A location that meets only a four hour or peak hour warrant should be considered for part time operation where warrant volumes are present. Based on the results of the Warrant Studies, HRC recommends that the intersection of Tienken and Sheldon be signalized.

2.6.2 Pedestrian Signal

As noted in the last chapter, the popular Paint Creek Trailway for walkers and bicyclists crosses Tienken Road about 2,000 feet east of Livernois. The high usage of the trail and concerns raised by local residents prompted the City of Rochester Hills to request that a pedestrian signal warrant analysis be conducted at this location.

The Minimum Pedestrian Volume Warrant is satisfied when, for each of the any eight hours of an average day, on a major street, six hundred or more vehicles per hour enter the intersection (total of both approaches) and during the same eight hours, there are 150 or more pedestrians per hour on the highest volume crosswalk, crossing the major street. In addition, the 85th percentile speed of the major street traffic must exceed 40 mph in either an urban or a rural area to meet this warrant.

On Thursday, June 24, 1999 and Friday, June 25, 1999, HRC conducted a volume study on Tienken between Livernois and Kings Cove. The following Table summarizes the results for an 8 hour block of an average day:

Table 2-15
8 HOUR TRAFFIC VOLUMES ON TIENKEN ROAD

Hour	Eastbound	Westbound	Total
8:00 a.m.	363	766	1129
9:00 a.m.	443	613	1056
10:00 a.m.	446	517	963
11:00 a.m.	494	521	1015
12:00 p.m.	557	524	1081
1:00 p.m.	535	567	1102
2:00 p.m.	538	522	1060
3:00 p.m.	566	539	1105

The results show that the totals are all greater than 600 vehicles per eight hours that enter the intersection, which satisfies the first part of Warrant 3.

On Thursday, June 3, 1999, from 4:30 – 5:30 p.m., HRC conducted a pedestrian study that showed that only 22 pedestrians per hour were crossing at the Tienken and Paint Creek Trail intersection. HRC conducted a second pedestrian study on Sunday, June 6, 1999, from 11:30 a.m. – 12:30 p.m., which showed 125 pedestrians crossing this intersection. Therefore, the results of the pedestrian studies are fewer than the 150 pedestrians per hour for an 8 hour period, as required by the warrant.

HRC also conducted a speed study on Tienken Road, from Livernois to Kings Cove. The 85th percentile was 44.18 mph, which was greater than the 40 mph minimum requirement by the warrant.

The studies show that only 2 of the 3 requirements for the warrant are met. Therefore, a pedestrian signal is not warranted for the Paint Creek Trail and Tienken Road intersection.

2.7 CORSIM Network Development and Traffic Simulation

2.7.1 Methodology

HRC used the CORSIM Simulation Program to analyze the Tienken Corridor. The model has two sub-components for detailed analysis of vehicle movements. NETSIM is used to simulate driver behavior traversing a street network, such as Tienken. FRESIM is used to simulate freeway travel. Using these tools, it is possible to predict the effect of traffic control and transportation system management strategies on the system's operational performance. Computer simulation is a practical alternative to field experimentation since it is less costly, results are obtained quickly, and descriptions to the traffic system due to field experimentation is avoided. The NETSIM model produces information that allows the engineer to identify the best alternative for the situation with a high probability of success in the field. By simulating the traffic system that will be influenced, it is possible to predict the effect of traffic engineering strategies on the network's operational performance. This performance is expressed in measures of effectiveness (MOE) which include delay time, queue time, fuel consumption, pollutant emissions and vehicle miles of travel. The results generated by the simulation model establish a basis for selecting the best improvements.

A HRC had analyzed four (4) scenarios to evaluate the impact of the proposed improvements. The four scenarios are explained below.

Scenario #1 – Existing AM peak traffic conditions on existing roadway network

Existing roadway network of the impact area has been simulated using existing AM peak traffic conditions.

Scenario #2 – Existing PM peak traffic conditions on existing roadway network

Existing roadway network of the impact area has been simulated using existing PM peak traffic conditions.

Scenario #3 – Year 2015 AM peak traffic conditions on improved roadway network

Roadway network of the impact area, with suggested improvements in place, has been simulated using year 2005 AM peak traffic conditions.

Scenario #4 – Year 2015 PM peak traffic conditions on improved roadway network

Roadway network of the impact area, with suggested improvements in place, has been simulated using year 2005 PM peak traffic conditions.

2.7.2 Results

The following table compares the results of all the scenarios:

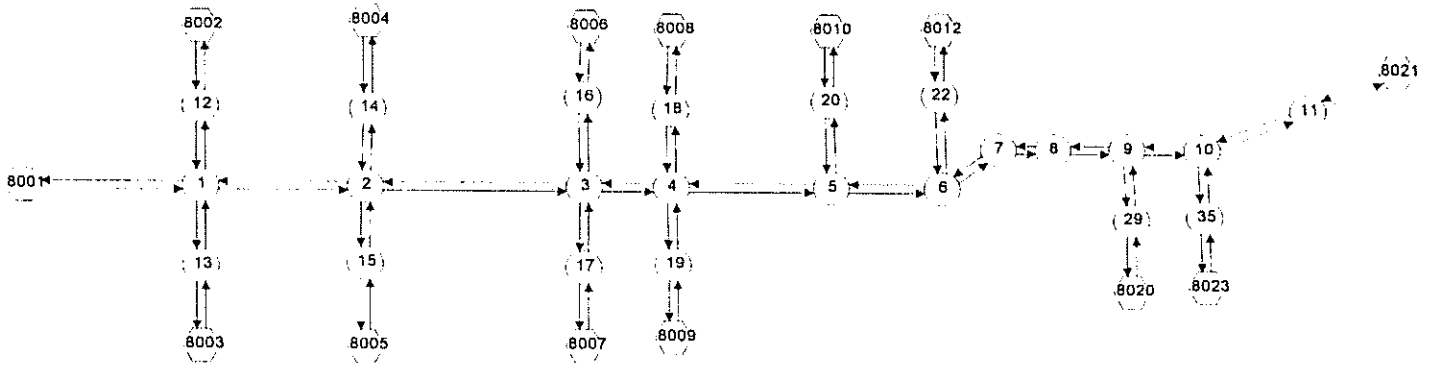
Table 2-16
CORSIM MOE Results

MOE	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Average Speed (MPH)	9.6	8.9	20.6	19.8
Delay (Minutes/Mile)	4.22	4.75	0.91	1.02
Delay time (vehicle-min.)	228.56	257.51	64.72	100.23
Queue time (Sec. /veh.)	3.22	3.52	0.49	0.66

Based on the information provided in the above table and the traffic conditions during the simulation runs, it can be concluded that the proposed improvements will help reduce traffic congestion within the impact area. The model also clearly demonstrated the need to signalize crossovers at the intersection of Tienken and Rochester. Signalization improved the operation of the crossover on the northbound, southbound and westbound approach.

A graphic depiction of the simulated network is shown in Figure 8.

Figure 8 – TIENKEN ROAD CORRIDOR NETWORK



KEY TO TIENKEN ROAD CORRIDOR NETWORK

Intersection Number	Name	Dist. From Previous Intersection
1	Tienken and Livernois	0.0
2	Tienken and Kings Cove	1835.0
3	Tienken and Pine	2460.0
4	Tienken and Rochester	985.0
5	Tienken and Lakeview	1800.0
6	Tienken and Sheldon	1260.0
9	Tienken and Van Hoosen	2240.0
10	Tienken and Washington	850.0

2.8 Environmental Assessment

The Tienken Corridor Study included a preliminary environmental assessment of both Tienken Road and Sheldon Road. The entire report can be found in Appendix G. Based on the report and other field work, any proposed reconstruction and/or widening of these two roads need to be sensitive to the following concerns:

- The far east end of Tienken Road runs through a designated Historic District. There are many historic buildings including homes, the Stoney Creek Schoolhouse, the Van Hoosen Farmhouse (now a historical museum). Some of the historic buildings are less than 20 feet from the road. Any proposed road widening will have a direct impact on the structures and would have a divisive effect on this unique neighborhood.
- The Tienken Road Corridor Study Area crosses over several waterbodies: the Paint Creek, the Stoney Creek, a wetlands area within the Cross Creek subdivision, and the Tienken Road branch connecting the wetlands to the Stoney Creek. Several segments lie within the 100 year flood plain. Wider bridges and culverts will be needed to cross these waterbodies and consideration for the impact on the wildlife and their habitat must be taken into account.
- Currently Tienken Road has gravel shoulders and no gutters and Sheldon Road is unpaved. Stormwater runoff either infiltrates into the soil or flows to one of the waterbodies noted above. It is common for sediment to be transmitted with the runoff. Any proposed road improvements that include curb and gutters will improve the runoff problem and flooding adjacent to the road. However, with the addition of impervious surfaces, the amount of runoff will increase and may need to be retained and released at an approved rate to the creeks to avoid flooding downstream.
- There are significant trees along Tienken especially between Rochester and Lakeview. The mature trees on the south side are very close to the road and may have to be removed if the road is widened. If the City desires to save these trees, further investigation will be needed to see if the road alignment can be moved to the north.
- Sheldon Road is projected to handle an increasing number of trips. Currently, it is a little used road lined with heavy vegetation. Widening the road and even just paving it will dramatically alter its current natural appearance. However, clearing the ROW will improve the safety of the segment, where a fatality occurred in 1996.

- There is a concern about soil erosion and sedimentation during reconstruction of the roads. However, the effects of soil erosion and sedimentation can be minimized by the use of multiple Best Management Practices (see full report for more details) which are now required on all Federally funded projects.
- The corridor study is investigating different locations where sight lines are inadequate and create a safety hazard. The topography is especially variable between Cliffview and Pine/Tienken Ct. In this same segment, there are a large number of homes and businesses with driveways that access Tienken. Any alternatives that cut down crests or fill a sag in this segment will be controversial and costly to implement because so many property owners will be affected.

The impact of the proposed road improvements on pedestrians was assessed separately and can be found in Section 3.

Chapter 3 – Corridor Improvement Alternatives

3.1 Approach

The process of developing an improvement program for the Tienken Road Corridor was driven by an analysis of separate areas along the corridor, requiring special attention. The first of these areas was the intersection of Letica Drive and Tienken Road. Letica is a proposed connection from the City of Rochester to form a T-intersection with Tienken Road in Rochester Hills. Challenging topography and sensitive land uses to the south side of Tienken Road limits the areas where this connection can be made. In consultation with the City of Rochester, the HRC team determined that the intersection of Letica Drive with Tienken Road could be made between the proposed high school driveway with Tienken Road and Clear Creek.

The next area of concern was the design for the Tienken/Sheldon intersection. We concluded that this intersection could operate as a conventional T-intersection or as a modern roundabout. A detailed analysis of the feasibility of a modern roundabout at this intersection was conducted separately.

A third area of concern was the paving of Sheldon Road, North of Tienken. The HRC team developed a cost estimate for constructing Sheldon Road as a three-lane cross section from Tienken to a point approximately 3,400 feet north of Tienken. The school district and the City of Rochester Hills apparently have reached an agreement that this is the appropriate cross section for this portion of Sheldon Road, and our analysis confirms that this cross section will provide adequate capacity for the expected traffic on this portion of Sheldon Road. The balance of Sheldon Road to Mead can be a two-lane cross section.

Our capacity analysis of the intersections in the corridor revealed serious capacity deficiencies at the Tienken/Rochester and Tienken/Livernois intersections. We explored several alternatives for providing additional capacity to the Tienken/Livernois intersection, and we are recommending additional turn lanes at this intersection to provide an acceptable Level of Service.

The analysis of the capacity deficiencies at the Tienken/Rochester intersection was more involved. The need to provide capacity for a left turn movement at this intersection during the PM peak hour leads to

geometric designs which provide significantly more lanes at the intersection than currently exist. Capacity analysis suggests that two through lanes in each direction are required on Rochester Road and two through lanes are required in each direction on Tienken Road at this intersection. In addition, significant left turn capacity is required, and this can be provided through double left turn lanes or through a boulevard cross section on both Rochester Road and Tienken Road. The boulevard design provides a more aesthetic treatment to the intersection and a safer operation for turning movements. This design also conforms with the recommendation from the Master Thoroughfare Plan Update for Rochester Road to be a boulevard. A boulevard has the added benefit of giving motorists two options for making a left turn.

Our analysis of the corridor outside of the major intersections indicated that a pattern of rear-end accidents could be addressed with a center lane for left turns. The center lane for left turns is proposed for those areas not involved in intersection improvement, except that the portion of Tienken Road near the Stoney Creek bridge at the east end of the corridor can be accommodated with a two-lane section. This two-lane section will allow the bridge in the historic district to remain at two-lanes in width. For the other portions of Tienken Road, currently two lanes in width, the HRC team recommends a three-lane cross section.

Thus, our evaluation of alternatives occurred in a segment by segment and intersection by intersection basis, rather than alternative alignments and/or cross sections for the entire corridor. The resulting recommended alternative is a mixture of cross sections customized to the location along the corridor. The critical capacity deficiencies are now which occurred at major intersections, are addressed for this alternative. The historic area at the east end of the corridor is not significantly changed, and traffic flow in and out of the new high school and Tienken/Sheldon is accommodated.

3.2 Alternatives for Vehicular Traffic

3.2.1 Letica Connection

The HRC team explored options for creating a connection from the City of Rochester north to Tienken Road. The option of extending Sheldon Road to the south has been precluded by conflicts with cemetery property in this area. The City of Rochester has new restricted developments under construction on the south side of Tienken, east of Sheldon. A location for a connector to the south adjacent to these

developments has been identified. It is approximately midway between the Tienken Road drive to the new high school and Clear Creek Road. Severe topography immediately south of Clear Creek prevents a connection directly to the south of Clear Creek. The analysis of anticipated turning movements indicates that the left turn movements at Tienken/Letica and Tienken/Clear Creek will not conflict.

3.2.2 Tienken/Sheldon

This intersection will serve as a gateway to the new high school being constructed on the northeast corner. Currently traffic volumes are low, there is no signal and there are few crashes at this location. Future traffic projections are expected to increase the AM Peak and PM Peak volumes by 46 percent and 63 percent respectively. The future traffic volumes warrant a signal as shown in Appendix F. To accommodate future traffic, the intersection can be designed as a conventional signalized intersection or as a modern roundabout.

The City has adopted a policy to pursue roundabouts where appropriate. The city had a feasibility study for a Sheldon/Tienken roundabout conducted concurrently with the Tienken Road Corridor Study. The report prepared by Parsons Brinckerhoff Michigan, Inc. is attached in Appendix H. The study found that a four-leg 150 foot diameter modern roundabout will have a peak hour LOS B and provide good service to road users. The preliminary design of the roundabout is shown in Volume 4, plan drawing 22A.

HRC conducted a capacity analysis at this intersection for existing and future conditions. Table 3-1 compares the LOS results. The proposed geometry accommodates the heavy future left turn traffic from eastbound Tienken and provides for a three phase signal timing plan. Figure 9 displays the recommended intersection design for a traditional signalized intersection.

The critical design period for the operation of this intersection will be the morning peak hour when arrivals for the start of school coincide with the AM peak hour traffic on the adjacent roads. According to HRC's and PBM's level of service analysis, either a traditional intersection with a properly designed traffic signal timing plan or a modern roundabout will be able to handle the peak 15 minute period in the morning.

Table 3-1
TIENKEN AND SHELDON
INTERSECTION LOS (LEVEL OF SERVICE)
EXISTING VS. FUTURE

	Eastbound			Westbound			Southbound			Intersection LOS	Intersection Delay (sec)
	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right		
AM Peak – Existing	B+	B+	A	A	A	A	B	B	B	B+	11.5
AM Peak – Proposed	A	A	A	A	B+	A	C+	A	B+	A	9.1
PM Peak – Existing	A	A	A	A	A	A	B	B	B	A	9.8
PM Peak – Proposed	B+	A	A	A	B+	A	B	A	C+	B+	11.6

Existing Assumptions:

- 2 phase signalized operation in AM and PM
- WB-one thru and right lane
- EB-one thru and left lane
- SB-one left and right lane
- Cycle length = 60 sec.

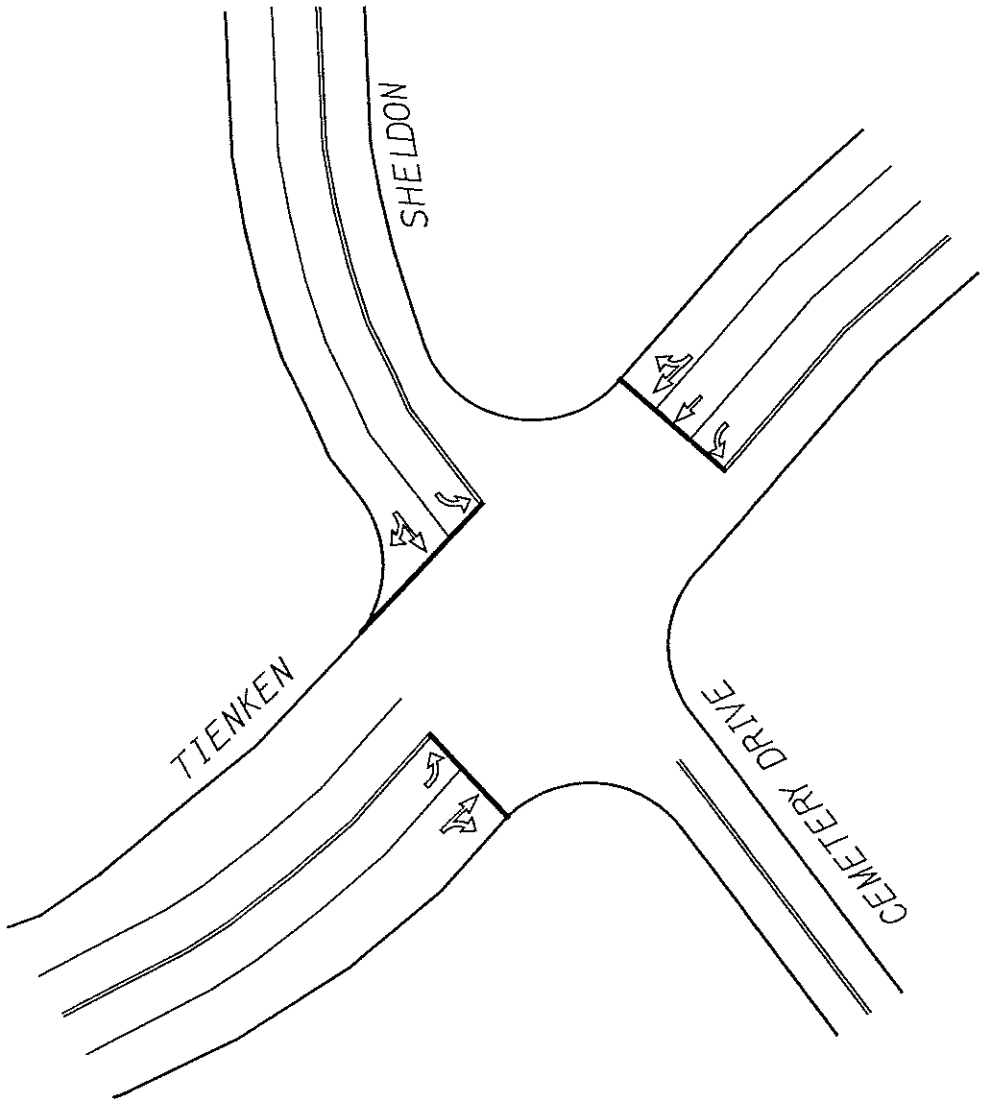
Proposed Assumptions:

- 3 phase signalized operation in AM
- 2 phase signalized operation in PM
- WB-one left, thru, and right lane
- EB-one left and thru lane
- SB-one left and thru-right lane
- Cycle length = 60 sec.
- Future (2015) volumes

INTERSECTION OF SHELDON & TIENKEN (FUTURE 4 LANE)

N

SCALE: 1" = 50'



JOB NO. 19990197	HUBBELL, ROTH & CLARK, INC.	FIGURE NO.
DATE September/1999	CONSULTING ENGINEERS 555 HULET DRIVE P.O. BOX 824 BLOOMFIELD HILLS, MICH. 48303-0824	9

3.2.3 Sheldon Road

Detailed cost estimates for the paving of Sheldon Road, Tienken to Mead have been prepared. The HRC team recommends that the 3,400 feet immediately north of Tienken be constructed as a three lane section to accommodate left turn movements for Hart Middle School, the new high school and the Cross Creek subdivision. This cross section will also provide a left turn stacking lane for the north leg of the Sheldon/Tienken intersection. The balance of Sheldon up to Mead should be a paved, two-lane road. Safety paths for the entire length of Sheldon are incorporated into the recommendation.

3.2.4 Tienken/Livernois

Figure 10 displays the current layout of the four legged, four phase SCATS controlled intersection.

The capacity analysis at this intersection indicates that additional approach lanes are needed to handle both existing peak hour traffic and future peak hour traffic. However, there are ROW constraints at this intersection. The recommended number of lanes on the intersection approaches are shown in Figure 11. This proposed geometry will improve the overall level of service for this intersection from a LOS F to a LOS C. Table 3-2 compares the existing and future conditions and LOS results. The Road Commission for Oakland County has expressed a need to have a dedicated right turn lane for eastbound traffic on Tienken who desire to go southbound on Livernois. When ROW is available in the future, this improvement can be implemented.

Table 3-2
TIENKEN AND LIVERNOIS
INTERSECTION LOS (LEVEL OF SERVICE)
EXISTING VS. FUTURE

	Eastbound			Westbound			Northbound			Southbound			Intersection	Intersection Delay (sec)
	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right		
AM Peak – Existing	D	B	B	F	C	C	F	D	D	E	D	D	F	>60
AM Peak – Proposed	C	C	C	C	B+	B+	C	C+	A	C+	C	C	C+	22.0
PM Peak – Existing	D	D	C	F	D	D	F	C	C	E	C	C	F	>60
PM Peak – Proposed	C	C	C	C	C+	C+	C	C	B	C	C	C	C	29.2

Existing Assumptions:

- AM & PM LOS F
- EB & NB-one thru, left, and right lane
- WB & SB-one left and thru-right lane
- Cycle length = 120 sec.

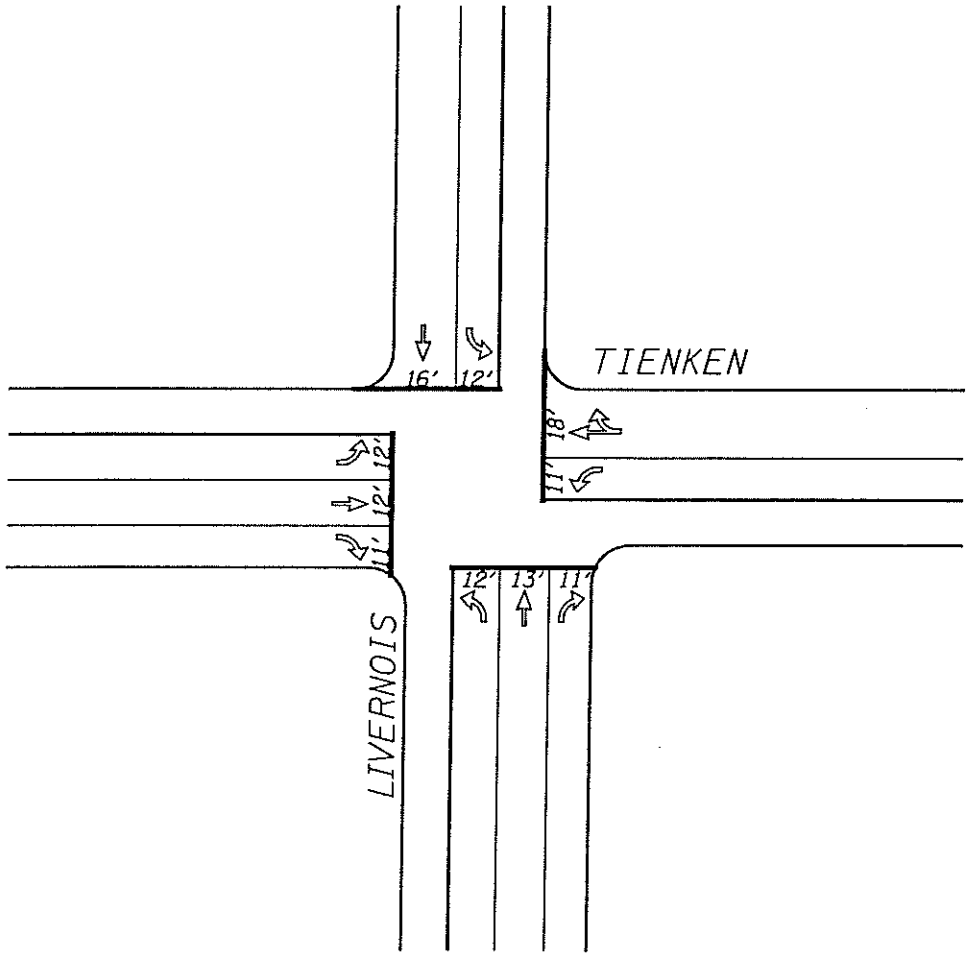
Proposed Assumptions:

- AM LOS C+
- PM LOS C
- EB & WB-one left, thru, and thru-right lane
- NB-one left, thru, and right lane
- SB-one left and thru-right lane
- Cycle length = 80 sec.
- Future (2015) volumes

INTERSECTION OF LIVERNOIS & TIENKEN (EXISTING)

N

SCALE: 1" = 50'

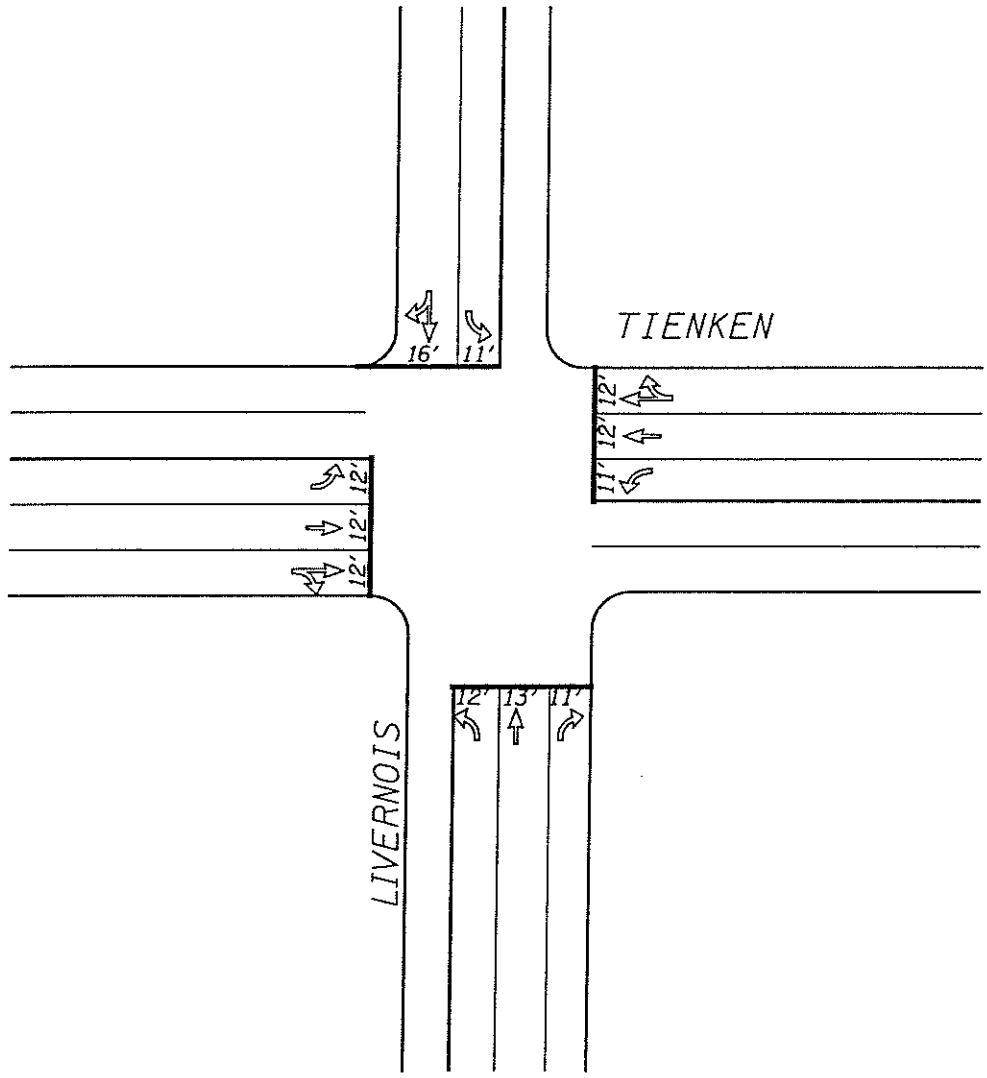


JOB NO. 19990197	HUBBELL, ROTH & CLARK, INC.	FIGURE NO.
DATE DECEMBER 1999	CONSULTING ENGINEERS 555 HULET DRIVE P.O. BOX 824 BLOOMFIELD HILLS, MICH. 48303-0824	10

INTERSECTION OF LIVERNOIS & TIENKEN (FUTURE PROPOSED)

N

SCALE: 1" = 50'



JOB NO. 19990197	HUBBELL, ROTH & CLARK, INC.	FIGURE NO.
DATE DECEMBER 1999	CONSULTING ENGINEERS 555 HULET DRIVE P.O. BOX 824 BLOOMFIELD HILLS, MICH. 48303-0824	11

USER NAME • ccozma DESIGN FILE • f:\1999\19990\19990197\cadd\trafficVnt3.dgn PLOT NAME • N/A STROKE TIME • 16-DEC-1999 12:51

3.2.5 Tienken/Rochester

Figure 12 displays the current layout, which is four legged, four phase SCATS controlled intersection.

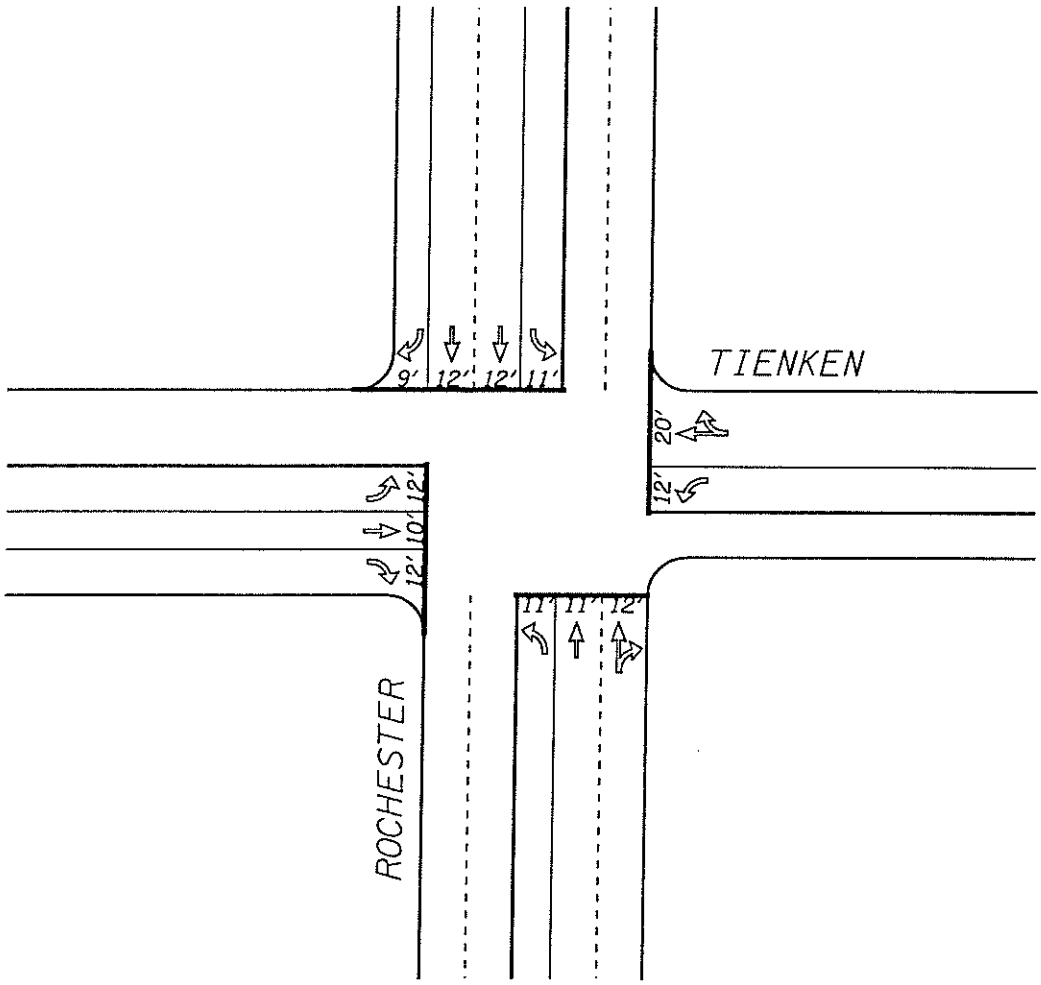
The intersection will require extensive improvements to handle projected future traffic volumes. Under existing conditions, the intersection of Tienken and Rochester operates at a LOS F for the AM peak hour and LOS D for the PM peak hour. Left turn demand, particularly eastbound to northbound in the PM peak, will require significant additional capacity. To achieve a LOS D or better during future peak periods, a conventional intersection design would require two left turn lanes and two right turn lanes for all approaches. A LOS C+ can also be achieved with a boulevard design on all four approaches. A boulevard design with signalized left turn crossovers on all approaches is the alternative recommended by the HRC team.

The HRC team analyzed a number of versions and assumptions regarding the boulevard design and how left turns were allowed (See Table 3-3). Sketches of each version can be found in Appendix I. HRC concluded that version 3b was the most acceptable. When the proposed geometry (See Figure 13) was simulated for the existing AM and PM peak hour traffic volumes, the level of service at the intersection increased to a LOS C+. Table 3-4 compares the level of service for Tienken and Rochester for three conditions: existing, future traditional intersection with left turns, and future boulevard. The selection of the boulevard option has significant benefits for Tienken. The curb-to-curb width of the road under a boulevard option would be 88 feet. If the traditional intersection was selected, the road width would be 120 feet. Figure 14 show a view of the whole proposed boulevard with the location of the crossovers and u-turns.

INTERSECTION OF TIENKEN & ROCHESTER (EXISTING)

N

SCALE: 1" = 50'



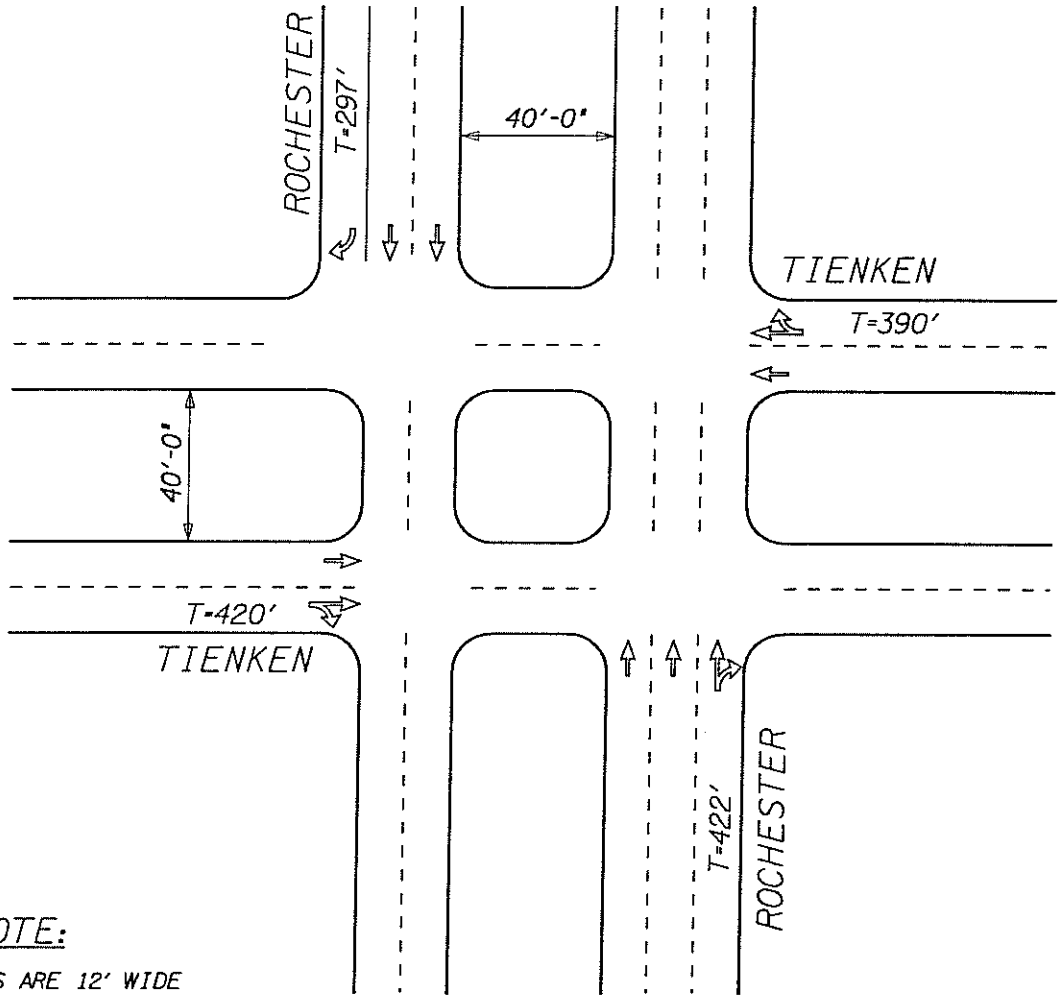
JOB NO. 19990197	HUBBELL, ROTH & CLARK, INC.	FIGURE NO.
DATE DECEMBER 1999	CONSULTING ENGINEERS 555 HULET DRIVE P.O. BOX 824 BLOOMFIELD HILLS, MICH. 48303-0824	12

INTERSECTION OF ROCHESTER & TIENKEN (PROPOSED BOULEVARD)

VERSION 3B

N

SCALE: 1" = 50'

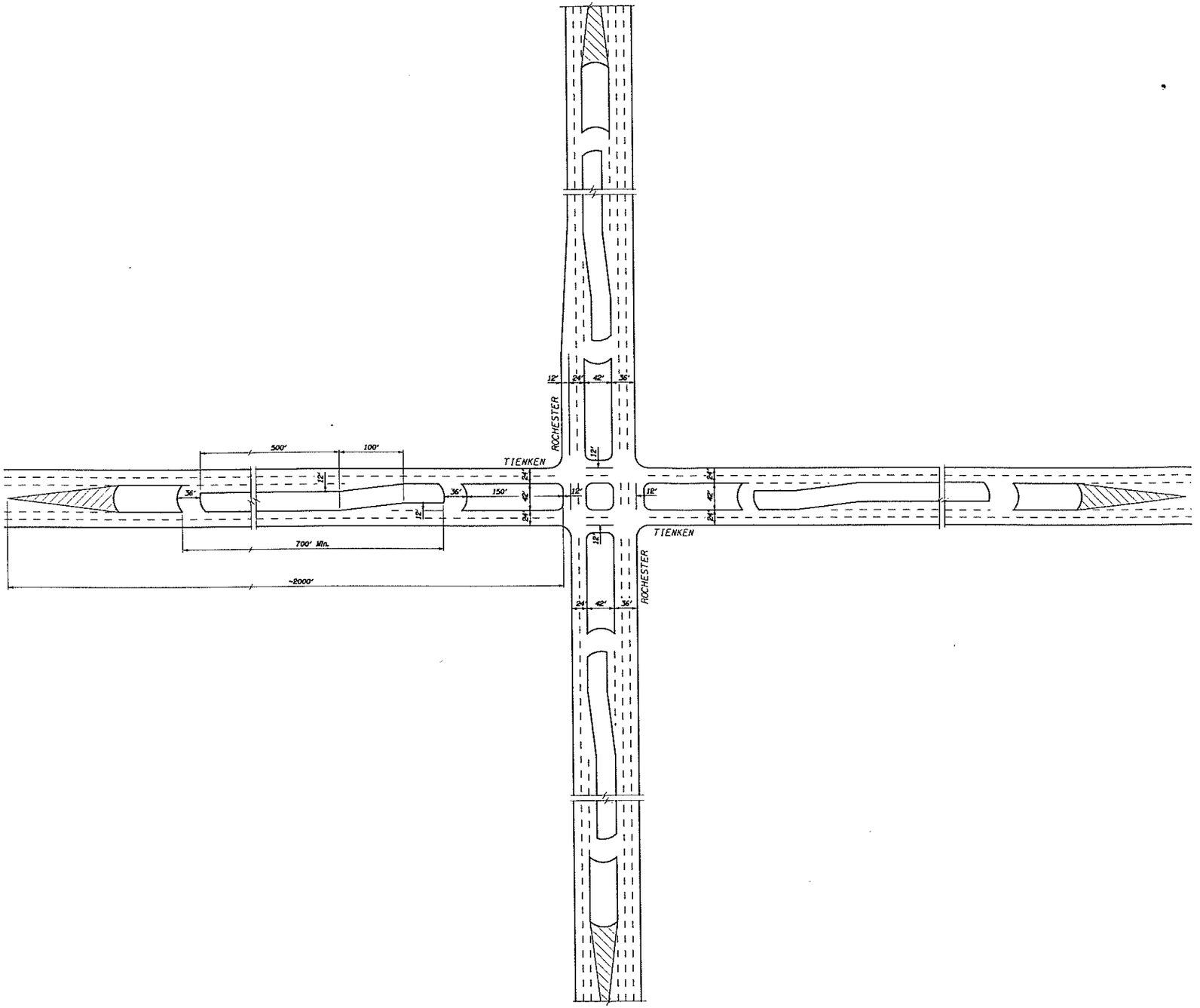


NOTE:

ALL LANES ARE 12' WIDE

T = TURNING LANE LENGTH

JOB NO. 19990197	HUBBELL, ROTH & CLARK, INC.	FIGURE NO.
DATE DECEMBER 1999	CONSULTING ENGINEERS 555 HULET DRIVE P.O. BOX 824 BLOOMFIELD HILLS, MICH. 48303-0824	13



INTERSECTION OF ROCHESTER & TIENKEN
(PROPOSED BOULEVARD)

NOTE: ALL DIMENSIONS ARE SYMMETRICAL
WITH THE EXCEPTION OF SB RIGHT

ORCHARD, HILTZ & McCLIMENT, INC.	JOB NO. 19990197	HUBBELL, ROTH & CLARK, INC.	SHEET NO. 14
	DATE DECEMBER 1999	CONSULTING ENGINEERS 555 HULET DRIVE P.O. BOX 824 BLOOMFIELD HILLS, MICH. 48303-0824	

Table 3-3
ALTERNATIVES FOR
TIENKEN/ROCHESTER BOULEVARD (80 SEC. CYCLES)

MOVEMENT DESCRIPTION	VERSION	LANE DESCRIPTIONS																TOTAL # OF LANES	AM PEAK		PM PEAK		NOTES
		NORTHBOUND				SOUTHBOUND				EASTBOUND				WESTBOUND					LOS	ACCEPTABLE LOS	LOS	ACCEPTABLE LOS	
		LT	TH	RT	TH-RT	LT	TH	RT	TH-RT	LT	TH	RT	TH-RT	LT	TH	RT	TH-RT						
Left turns must go thru	1		3	1			2	2			1		1		1		1	12	B	Yes	C+	Yes	Boulevard – all 4 approaches
Left turns must go right	2		3	1			2	2			1		1		1		1	12	C+	Yes	C+	Yes	Boulevard – all 4 approaches
Left turns must go right	2a		3		1		2	1			1		1		1		1	10	C+	Yes	D+	No	Boulevard – all 4 approaches
Left turns must go right	2b		2	1			2	1			1		1		1		1	10	C+	Yes	D	No	Boulevard – all 4 approaches
Left turns must go right	2c		3	1			1		1		1		1		1		1	10	D+	No	C+	Yes	Boulevard – all 4 approaches
Left turns must go right	2d		3	1			2	1			1		1		1		1	11	C+	Yes	C+	Yes	Boulevard – all 4 approaches
50% thru/50% right for left turns	3		3	1			2	2			1		1		1		1	12	B	Yes	C+	Yes	Boulevard – all 4 approaches
50% thru/50% right for left turns	3a		3	1			2	1			1		1		1		1	11	C+	Yes	C+	Yes	Boulevard – all 4 approaches
50% thru/50% right for left turns	3b[2]		2		1		2	1			1		1		1		1	10	C+	Yes	C+	Yes	Boulevard – all 4 approaches
50% thru/50% right for left turns	3c		2		1		1		1		1		1		1		1	9	D+	No	C	Yes	Boulevard – all 4 approaches
50% thru/50% right for left turns	3d		1		1		1		1		1		1		1		1	8	D+	No	E+	No	Boulevard – all 4 approaches
50% thru/50% right for left turns	3e		2	1			2	1			1		1		1		1	8	C+	Yes	D+	No	Boulevard – all 4 approaches
Rochester – no left onto Tienken	4		3	1			2	2			1		1		1		1	12	C+	Yes	C+	Yes	Tienken – Boulevard only
Rochester – no left onto Tienken	4a		3	1			2	1			1		1		1		1	11	C+	Yes	C+	Yes	Tienken – Boulevard only
Rochester – no left onto Tienken	4b		2	1			2	1			1		1		1		1	10	C+	Yes	D	No	Tienken – Boulevard only
Rochester – no left onto Tienken	4c		2		1		2	1			1		1		1		1	9	C+	Yes	D+	No	Tienken – Boulevard only
Tienken – no left onto Rochester	5		3	1			2	2			1		1		1		1	12	B	Yes	C+	Yes	Rochester – Boulevard only
Tienken – no left onto Rochester	5a		2	1			2	1			1		1		1		1	10	C+	Yes	D	No	Rochester – Boulevard only
Tienken – no left onto Rochester	5b[1]		2		1		2	1			1		1		1		1	10	C+	Yes	C	No	Rochester – Boulevard only
Tienken – no left onto Rochester	5c		3	1			2	1			1		1		1		1	11	B	Yes	C+	Yes	Rochester – Boulevard only

Source: Signal 97

1 Recommended Interim Solution
2 Recommended Long Term Solution

Table 3-4
TIENKEN AND ROCHESTER
INTERSECTION LOS (LEVEL OF SERVICE)
EXISTING CONDITIONS VS. FUTURE TRADITIONAL INTERSECTION
VS. FUTURE BOULEVARD

	Eastbound			Westbound			Northbound			Southbound			Intersection LOS	Intersection Delay (sec)
	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right		
AM Peak – Existing	F	D	C	D	D	D	F	D	D	D	B	B	F	>60
AM Peak – Proposed	C	C	B	C	C	C+	C	B+	B+	C	C+	B+	C+	21.3
AM Peak – Blvd.	-	C+	C+	-	C+	C+	-	B+	B+	-	C+	B	C+	20.7
PM Peak – Existing	D	D	D	E	E	E	C	C	C	D	D	C	D	31
PM Peak – Proposed	C	C+	C+	C	C+	B	C	C+	B	C	C+	B	C+	25.7
PM Peak – Blvd.	-	C	C	-	C+	C+	-	C	C	-	B	C+	C+	26.0

Source: SIGNAL 97

Existing Assumptions:

- NB-1 left, 1 thru, and 1 thru-right lanes
- SB-1 left, 2 thru, and 1 right lanes
- EB-1 left, 1 thru, and 1 right lanes
- WB-1 left and 1 thru-right lanes
- AM Cycle length = 110 sec.
- PM Cycle length = 80 sec.

Proposed Future Assumptions:

- Increase number of lanes
- NB, EB & WB-2 left, 3 thru and 2 right lanes
- SB-2 left, 2 thru, and 2 right lanes
- Cycle length = 60 sec.

Recommended Boulevard Option 3B:

- EB & WB-1 thru and 1 thru-right lanes
- NB-2 thru and 1 thru-right lanes
- SB-2 thru and 1 right lanes
- Cycle length = 80 sec.

3.2.5.1 Options for Boulevard on Tienken

The proposed boulevard design conflicts with the Master Thoroughfare Plan Update for Tienken. The cross section for Tienken is no longer a residential boulevard that fits within a 120 feet ROW. In trying to resolve this conflict, the HRC team examined several typical cross section designs. Table 3-5 shows the different options for the green space and median widths if you assume that the safety path remains eight feet wide and there are four through lanes at 12 feet wide.

Table 3-5

ALTERNATIVE BOULEVARD DESIGNS FOR TIENKEN

Option	Right-of-Way Width	Median Width	North Side Green Space	South Side Green Space
1	120'	30'	9'	9'
2	120'	40'	4'	4'
3	130'	30'	14'	14'
4	130'	40'	9'	9'
5	140'	30'	19'	19'
6	140'	40'	14'	14'
7	150'	30'	24'	24'
8	150'	40'	19'	19'

If the City of Rochester Hills wants to limit the ROW to the adopted plan width of 120 feet, then the HRC team suggests that they consider options 1 or 2. If the median width is reduced to 30 feet, then restrictions will have to be placed on trucks and buses using the U-turns and crossovers on Tienken.

3.2.5.2 Immediate Interim Improvements

Recognizing that the proposed boulevard improvements make take many years to fund and implement, the HRC team investigated two interim solutions for Rochester and Tienken. The immediate interim improvements included adding a right turn lane for northbound Rochester and a right turn lane for westbound Tienken. A capacity analysis was conducted for the PM Peak Hour using 2015 traffic volumes. The overall intersection is a LOS F and all approaches have a LOS F except the southbound approach which is a LOS D. Given these results, this interim solution is not recommended.

3.2.5.3 Interim Improvement Option for Tienken

The Master Thoroughfare Plan Update recommends a boulevard design for the Rochester Road corridor. To create a similar boulevard for Tienken Road would result in a spot improvement for that corridor. At the request of the City and RCOC, HRC analyzed an interim improvement referred to as Alternative 5b in Table 3-2. The improvement includes a boulevard on Rochester Road with the same geometric design as the long range solution and three lane road on Tienken with right lane flares and tapers. See Figure 15. All left turns at the intersection would be made through the crossovers on Rochester Road north and south of Tienken. A capacity analysis of this option was conducted for the PM Peak hour using 2015 traffic volumes. The overall intersection is a LOS D and approaches range from LOS E from the northbound and eastbound approaches, a LOS C for the westbound approach and a LOS B for the southbound approach. These are acceptable levels of service for an interim solution.

The benefits of implementing an interim solution are many:

1. The interim improvement will improve traffic flow in the short term and will facilitate the long term solution of converting Tienken to a four lane boulevard as traffic volumes increase.

2. The interim improvement will provide time to resolve the issues of ROW and grading with area residents, especially those most affected by the cutting of the hill near Bedford Square.

3. The cost of implementing the interim improvement is substantially less than the cost of the long-term solution, because the improvements to Tienken have been minimized. The interim improvement is estimated to cost $6.82 million as compared to $12.2 million for the dual boulevard. However, approximately $2 million in costs are transferred to the project that will widen Tienken Road.

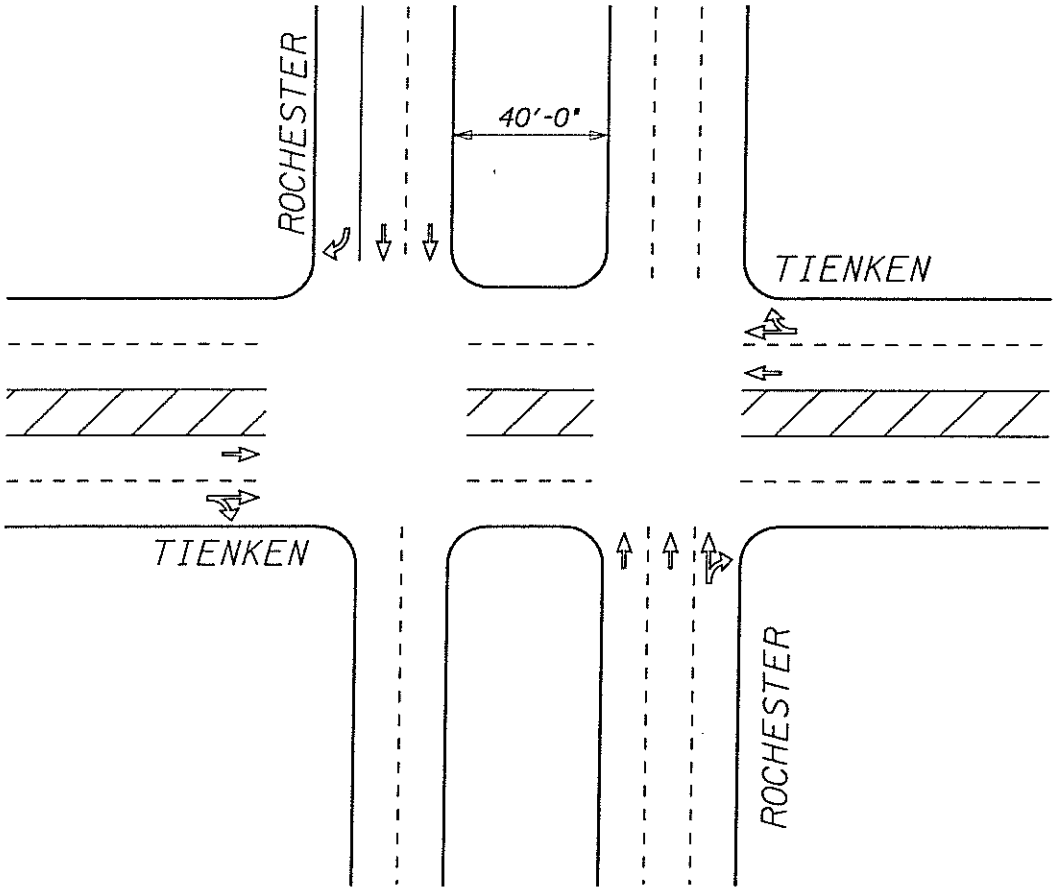
INTERSECTION OF ROCHESTER & TIENKEN (PROPOSED INTERIM IMPROVEMENT)

VERSION 5b

Tienken - no left onto Rochester

N

SCALE: 1" = 50'



NOTE:

ALL LANES ARE 12' WIDE

JOB NO. 19990197	HUBBELL, ROTH & CLARK, INC.	FIGURE NO. 15
DATE December/1999	CONSULTING ENGINEERS 555 HULET DRIVE P.O. BOX 824 BLOOMFIELD HILLS, MICH. 48303-0824	

USER NAME • mradulski DESIGN FILE • f:\1999\19990\19990197\cadd\traffic\ver5bcpy.dgn PLOT NAME • N/A STROKE TIME • 16-DEC-1999 10:39

3.2.6 Right-of-Way Required

Currently, the right-of-way width within the corridor of Tienken and Sheldon Roads, varies from 66 feet to 120 feet. It is assumed the City of Rochester Hill's Master Plan right-of-way width of 120 feet will be obtained for all areas within the corridor except within the boulevard limits with the following exceptions:

130-150 feet of right-of-way required for boulevard section on Tienken Road

66 feet easement or 86 feet of right-of-way for two lane section on Tienken Road (Historic District Only)

The recommended ROW width of 150 feet for Rochester Road will accommodate the proposed boulevard improvements. The recommended ROW width of 86 feet on Sheldon Road will also accommodate the proposed improvements.

Numerous strips of right-of-way will be required to be obtained (see Table 3-6). To meet the City's right-of-way objective. The tables below identifies property in which right-of-way would need to be acquired:

Table 3-6
ADDITIONAL RIGHT-OF-WAY REQUIRED

Address or Tax ID	Side of Road	Existing ROW	Maximum Proposed ROW
777 Great Oaks	South	33'	60'
1050 Livernois	North	33'	60'
950 Tienken	North	33'	60'
15-03-351-016	North	33'	60'
15-03-503-005	North	33'	60'
480 Tienken	North	33'	60'
460 Tienken	North	33'	60'
15-03-451-018	North	33'	60'
400 Tienken	North	33'	60'
380 Tienken	North	33'	60'
330 Tienken	North	33'	75'
310 Tienken	North	33'	75'

ADDITIONAL RIGHT-OF-WAY REQUIRED (CON'D)

Address or Tax ID	Side of Road	Existing ROW	Maximum Proposed ROW
300 Tienken	North	33'	75'
294 Tienken	North	33'	75'
15-03-477-026	North	33'	75'
210 Tienken	North	33'	75'
190 Tienken	North	33'	75'
327 Tienken	South	60'	75'
315 Tienken	South	60'	75'
303 Tienken	South	60'	75'
291 Tienken	South	60'	75'
279 Tienken	South	60'	75'
267 Tienken	South	60'	75'
255 Tienken	South	60'	75'
243 Tienken	South	60'	75'
231 Tienken	South	60'	75'
219 Tienken	South	60'	75'
207 Tienken	South	60'	75'
191 Tienken	South	60'	75'
175 Tienken	South	60'	75'
161 Tienken	South	60'	75'
147 Tienken	South	60'	75'
1459 Rochester	South	60'	75'
1497 Rochester	South	60'	75'
1480 Rochester	South	33'	75'
150 Tienken	North	33'	75'
70 Tienken	North	33'	75'
50 Tienken	North	60'	75'
6980 Rochester	North	60'	75'
6875 Rochester	North	33'	75'
247 Tienken	North	33'	75'

ADDITIONAL RIGHT-OF-WAY REQUIRED (CON'D)

Address or Tax ID	Side of Road	Existing ROW	Maximum Proposed ROW
251 Tienken	North	33'	75'
15-11-101-030	South	33'	75'
15-11-101-002	South	33'	75'
15-11-101-003	South	33'	75'
15-11-101-004	South	33'	75'
192 Tienken	South	33'	75'
204 Tienken	South	33'	75'
15-11-102-002	South	33'	75'
226 Tienken	South	33'	75'
238 Tienken	South	33'	75'
250 Tienken	South	33'	75'
266 Tienken	South	33'	75'
15-02-376-009	North	60'	75'
432 Tienken	South	33'	75'
444 Tienken	South	33'	75'
456 Tienken	South	33'	75'
15-11-127-013	South	33'	75'
15-11-127-014	South	33'	75'
482 Tienken	South	33'	75'
6385 Sheldon	West	33'	46'
6312 Sheldon	West	33'	46'
15-02-200-006	East	33'	46'
6175 Sheldon	East	33'	46'

3.2.7 Grading Issues

Several locations were identified as having grading requirements which may require the placement of a retaining wall or guardrail. These locations are shown on the plans in Volume 3 and are noted below:

1. To meet safety requirements for sight distance, the Tienken Road profile was adjusted from Sta. 481+00 to 482+00 (crest of hill). This would require the intersection of Bedford Square Road and Tienken Road to be raised approximately 2.5 feet.

2. Due to the grade adjustment described above, the residential driveways directly east of Bedford Square (485+00 to 485+50) would need to be lowered approximately 3.5 feet (see additional comments below).

3. Due to some steep existing slopes, retaining walls may be required from 471+60 to 472+40 and from 474+25 to 475+00 to accommodate the placement of the proposed bike path.

4. Due to the existing conditions in the vicinity of the existing Stoney Creek Bridge, guardrail may be required from 546+80 to 549+00 on the north side, and from 548+20 to 549+00 on the south side.

5. Due to the proximity of the two existing garages on the north side east of the Stoney Creek Bridge, provisions will need to be made to place a minimum width walk and grade down to the existing entrance to the garage if it is desired to salvage these structures. Guardrail may also need to be placed as the structures are inside the safe clear zone for the speed and slope proposed. Because of the proximity of the garages to the travelway, it may be desirable to relocate these structures to a safer distance from the roadway.

The most extensive location that will be impacted within the corridor will be the area outlined in number two above. The portion of roadway between Livernois Road and Rochester Road opposite of Bedford Square Road requires cutting the crest of the existing hill approximately 5 feet. There are a number of residential driveways accessing Tienken Road on the south side. Due to the cut and offset required for the proposed roadway and proximity of these residences to the proposed right-of-way, it is highly likely that a number of homes between Winry Street and Pine Street will need to be purchased to construct this portion of the boulevard. It is estimated that 8-10 homes would be purchased to construct the boulevard (See Table 3-7). Another option would be to create a frontage road in the same section to provide access to the homes without having to take them. This option can be seen in Volume 3, plan drawing 10A.

Table 3-7
CORRIDOR GRADING IMPACTING RESIDENTIAL HOMES

315 Tienken	255 Tienken
303 Tienken	243 Tienken
291 Tienken	231 Tienken
279 Tienken	219 Tienken (possible take)
267 Tienken	207 Tienken (possible take)

There would also be the need to acquire temporary grading permits during construction. These permits would be required to grade beyond any acquired right-of-way. Table 3-8 lists the locations identified where grading permits would be required.

Table 3-8
TIENKEN ROAD GRADING PERMIT LOCATIONS

Address or Tax ID	Location
1050 Livernois	NE corner of Livernois/Tienken
950 Tienken	North side of Tienken, east of Livernois
15-03-351-016	North side, west of the Paint Creek Trail
15-03-327-001	North side, east of Kings Cove
15-03-326-004	NW corner of Cliffview/Tienken
480 Tienken	NE corner of Cliffview/Tienken
460 Tienken	North side, east of Cliffview
15-02-401-002	North side, east of Sheldon
919 Tienken	North side, east of the Stoney Creek Bridge

3.3 Pedestrian Needs Analysis

3.3.1 Paint Creek Trail Crossing Alternatives

Even though the trail crossing over Tienken Road did not warrant a pedestrian traffic signal, the HRC Team investigated a number of alternatives for improving the safety of the pedestrians crossing Tienken Road. The alternatives included:

1. Install LED flashing crosswalk systems
2. Require pedestrians to cross at a signalized intersection (Livernois & Tienken)
3. Install a pedestrian refuge island in the center turn lane (assumes that Tienken is built as a three lane road)
4. Separate the traffic flows with a pedestrian bridge

3.3.1.1 Alternative No. 1

HRC investigated in-pavement flashers to warn drivers that pedestrians are crossing the street. One system is manufactured by Light Guard Systems, Inc. and includes an automatic activation system using break beam technology in bollards. A pedestrian button normally activates the second system, by Traffic Safety Corp., but they are also combining the flashers with an automatic, overhead pedestrian detection system. This company has indicated that they have developed a special in-pavement can that protects the LED light from snowplows and that this product has been tested in Maryland under winter conditions. Both systems are popular in California and are becoming popular in Florida. The in-pavement flashers have been installed on streets up to six lanes wide.

The cost to install a LED flashing crosswalk at this location was estimated to be $22,000. This assumed that 8 in-pavement flashers; 2 Motion detection bollards; 1 controller unit; and contractor installs and makes the power connection.

The engineering community has mixed opinions about the pedestrian flasher system. Many traffic engineers have observed motorists stopping for the flashers but still treat them as a supplemental warning device. Empirical studies are limited to conditions in California. There are no installation criteria or warrants at this time. The flashers give the perception of safety for the crossing pedestrian but do not carry the weight of law to require drivers to yield or stop. Therefore, until installation criteria are developed that are supported by field studies and the industry, this option is not recommended.

3.3.1.2 Alternative No. 2

Requiring pedestrians to detour to a signalized intersection in order to cross Tienken at a safer point is not a practical alternative. Even though various barriers can be erected to discourage crossing at the trail, the nearest signalized intersection is Livernois, which is about 2,000 feet away. The likelihood of compliance would be low and the risks to pedestrians would increase if they attempted to circumvent the barriers.

The cost to implement would be at least $22,000 for the installation of 500 l.ft. of 4 ft. vinyl coated chain link fence. This option should be reconsidered when and if a traffic signal at Kings Cove / Oakbrook is ever installed.

3.3.1.3 Alternative No. 3

Assuming that Tienken is widened to a three-lane road, a pedestrian refuge island can be created in the left turn lane. There is room between the driveways to Oakbrook Ridge. The refuge island would allow pedestrians to cross the road in stages and reduce the amount of gap time needed to cross. This option would increase the safety of the pedestrian crossing and reduce the potential for crashes. This option will be relatively easy to implement when the Tienken Road is redesigned and would add approximately $10,000 to the cost of the road improvement. The HRC Team recommends that this option be implemented.

3.3.1.4 Alternative No. 4

The last alternative is to physically separate the traffic streams by grade. What was considered was an ADA approved ramp and pedestrian bridge over Tienken Road. This option is the safest for pedestrians and allows pedestrian traffic to cross Tienken without stopping. This option will also be the most costly to implement and may require the acquisition of additional ROW for the Paint Creek Trail to accommodate merging users who either parked in the lot by Hillside Creek or came from the safety path network. The estimated construction cost of the pedestrian overpass is $500,000. This cost assumes that the bridge meets ADA requirements; meets RCOC setback requirements; structure spans 88 ft, is 12-14 ft wide, is steel with concrete deck, and has restricted weight load; and the ramps are dirt fill. The usage levels and crash experience do not justify the expense of building an overpass at this time.

3.3.2 Pedestrian Safety Path Options in the Historical District

3.3.2.1 Traditional Sidewalk Option

The HRC Team is not recommending any improvements to the segment of Tienken Road between the Stoney Creek Bridge and the Washington/Runyon roundabout. However, the City of Rochester Hills desires to complete the pedestrian path network along the corridor to provide continuity and access to/from the Historical District. As shown in Figure 5 in Chapter 1, there are currently no sidewalks or safety paths in the Historical District.

There are several problems to address in locating paths through this sensitive area. Adequate Right-of-Way is one issue along with the closeness of the residential structures to the ROW line. Another issue is the elevation difference on the north side of the road. Lastly, the amount of grading just to accommodate a sidewalk is extensive.

From Van Hoosen to the Washington/Runyon roundabout, the ROW is 86 ft. From the Stoney Creek Bridge to Van Hoosen, the ROW is a 33 ft. easement. There are two properties (919 Tienken and 947 Tienken) with garages within the ROW. The property at 919 Tienken is also considerably lower than the elevation of the road. Several properties appear to have historical markers in the front yards and other properties have significant trees or landscaping.

On the north side of Tienken Road from the Stoney Creek Bridge to the Washington/Runyon roundabout, we are recommending only a five-foot sidewalk and small greenbelt in order to minimize the amount of grading needed to accommodate a path. Installing even a minimum greenbelt and five-foot sidewalk, this improvement will negatively impact the two homeowners with a garage in the ROW. Access to both will be via a steeply graded driveway. This grade is possible if it is important to salvage this structure. However, a guardrail may also be needed because both garages are inside the safe, clear zone for speed and slope. It may be desirable to relocate these two structures to a safer distance from the roadway. This would allow the grading to be less steep and remove the need for a guardrail. Moving the structures, however, does not lessen the impact of the grading on the front lawns of the homeowners.

The city of Rochester Hills owns the property between the Stoney Creek Bridge and Van Hoosen on the south side of Tienken Road. There will not be ROW or elevation problems with installing an eight-foot safety path and greenbelt along this segment that matches the rest of Tienken Road. The safety path can also be connected to the parking lot of the Rochester Hills Historical Museum, which would be a desirable destination for users of the path.

For the balance of the south side of Tienken Road between Van Hoosen and the Washington/Runyon roundabout, it would be better to match the treatment on the north side – a minimum greenbelt and five-foot side walk. Grading to accommodate the sidewalk does not extend noticeably beyond the sidewalk. The city and local residents should consider annual plantings in the greenbelt as an alternative to sod. The plantings would be a visual reminder to motorists that they are passing through a special neighborhood in the City.

3.3.2.2 Safety Path Through the Alley

As an alternative to locating sidewalks along Tienken Road and disturbing the appearance of the historic homes, the city could improve the alley for a non-motorized safety path. Currently, there is a little-used alley in the Historic District running parallel to Tienken from Van Hoosen to Washington. The existing ROW is 20 ft. wide and 842.5 ft. long.

A field inspection reveals that the alley is gravel at Van Hoosen. It is 9 feet wide for approximately 83 feet and then widens to approximately 14 feet for 107 feet. The alley then blends into an unimproved trail for the remainder of the ROW. There are two residential driveways that are accessed via the gravel portion of the alley.

This path would connect to the safety path on the south side of Tienken on City property via a new safety path along the west side of Van Hoosen. If this option were used, motor vehicle traffic to and from the existing driveways should be minimized. This option will cost approximately $12,000 less to implement and may be more acceptable to the residents of the Historic District. This alternative is shown in Volume 3, plan drawing 26.

3.4 Program of Improvements and Cost Estimates

3.4.1 Suggested Improvement Program

The recommended improvements for the Tienken Road corridor have been organized into a program of five projects shown in the attached Figure 16. The costs of each project and their priority ranking for implementation are discussed in the next subsections.

3.4.2 Corridor Design and Construction Costs

The overall estimated cost of the improvement program is shown in Table 3-9. The probable cost of construction is based on the future corridor improvement program. Where costs could not be calculated, estimated costs are shown from the best available resources. The boulevard portion of the estimate was obtained based on costs from similar boulevard projects on a prorated basis based on the length of the project.

Table 3-9
ESTIMATE OF PROGRAM COSTS

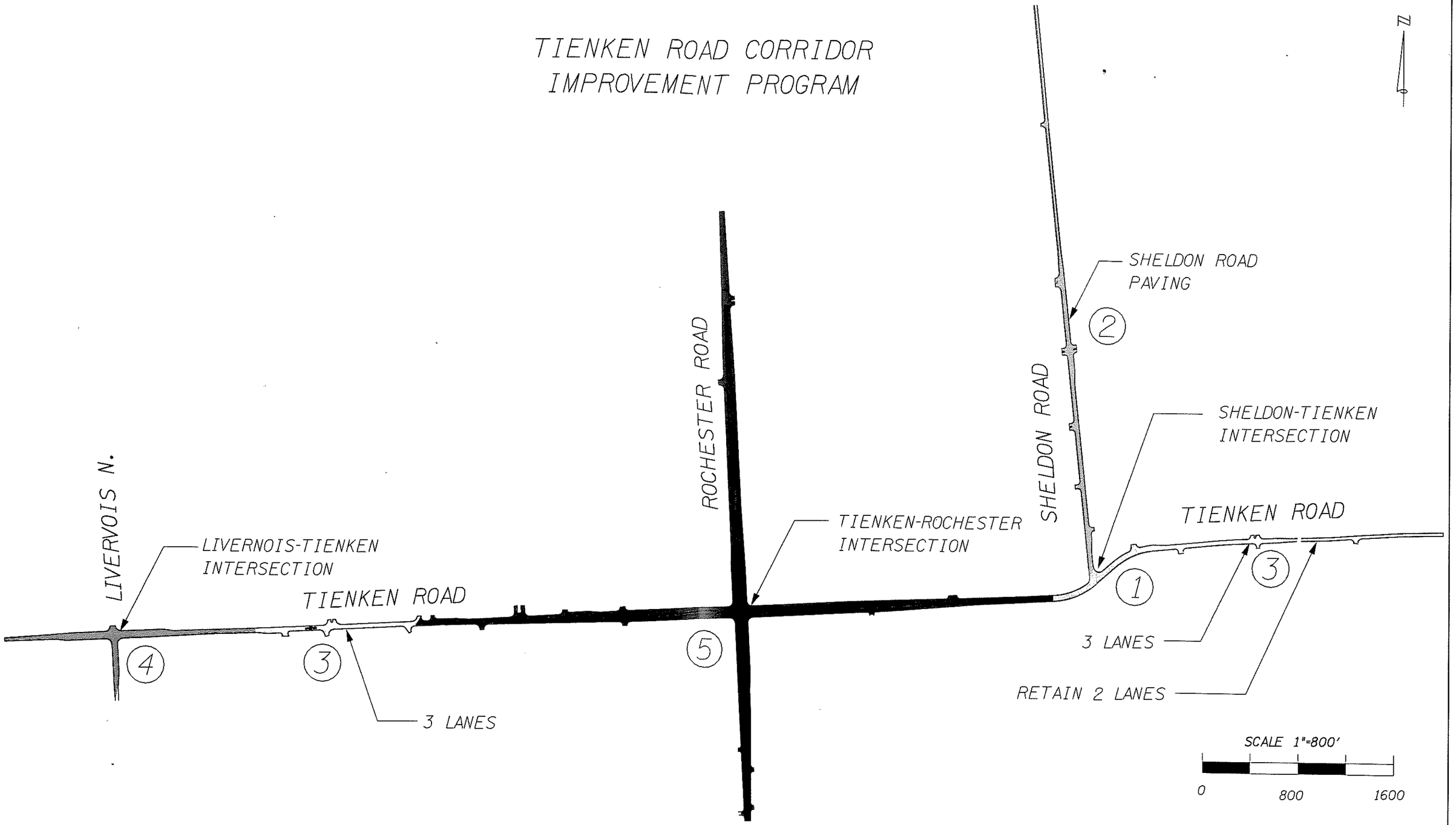
Project	Estimated Cost	Project Location	Project Description	Funding Source
Tienken/Sheldon	$1.52 Million	Intersection	Widen the intersection approaches to provide a center lane for left turns, additional capacity for through traffic on Tienken or construct a modern roundabout	Local
Sheldon Road	$2.67 Million	Tienken to Mead	Widen to three lanes for a distance of 3,400 ft., two lanes thereafter	Local
Tienken Road	$2.46 Million	Livernois to Stoney Creek Bridge	Widen to three lanes, creating a center lane for left turns	STP & TE
Tienken/Livernois	$920,000	Intersection	Add turn lanes on the approaches to improve capacity	CMAQ
Tienken/Rochester	$12.2 Million	Intersection	Widen Rochester approaches to a six lane boulevard and widen Tienken approaches to a four lane boulevard	STP or Cat-A
Total	$19.77 Million			

The Tienken Road estimate includes widening Tienken Road to a three lane roadway between Livernois and the Stoney Creek Bridge, 10,200 feet of boulevard roadway section on both Rochester Road and Tienken Road, replacing or improving signals on three intersections, replacing the bridge over the Paint Creek, lowering the water main on a stretch of Tienken Road where design speed warrants sizable lowering of the existing roadway, constructing 150 feet of retaining walls to eliminate grading problems, and placing a combination of 8 feet wide bituminous pathway and 5 feet wide concrete sidewalks to fill in the gaps between Livernois Road and Washington/Runyon. The portion of the safety path east of the Stoney Creek Bridge and running through the Historical District is a good candidate for a Transportation Enhancement grant. Additional funding will be required to obtain the necessary right-of-way.

The Sheldon Road estimate again includes a combination of a two and three lane roadway, the addition of large diameter proposed drain work, the placement of a 12' x 6' box culvert near Tienken Road, and constructing 8 feet wide pathways to fill the gaps in between Mead Road and Tienken Road. Additional funding will be required to obtain the necessary right-of-way.

Also included in the probable cost of construction for both estimates is work to widen and enclose parts of several drains on Tienken Road and Sheldon Road. These estimates of cost were taken from a previous HRC study of the Stoney Creek Drainage District. The drain items include mainline storm from Mead Road to Tienken Road along Sheldon Road, placing the 12' x 6' box culvert, and constructing 1850' of 90" storm sewer to enclose an existing open drain.

TIENKEN ROAD CORRIDOR IMPROVEMENT PROGRAM



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SHEET NO. 16 OF

3.5 Ranking of Projects

In the Southeast Michigan metropolitan area, the primary way that the transportation system is upgraded is through the sequential addition of appropriate projects to SEMCOG's Transportation Improvement Program (TIP). The projects are submitted to the TIP based on ranking of current system deficiencies. For example, if safety was the only criteria for ranking the projects, there would be one priority list. The HRC team ranked the five projects using the same criteria that SEMCOG and the Michigan Department of Transportation would use to evaluate projects for safety funding. The analysis utilized the loss values from the National Safety Council's statistics. The results in terms of the safety benefit/cost ratios and subsequent rankings of the projects are shown in Table 3-10. This analysis is based on the cost of the proposed improvement, number of accidents for a three year period and the severity of the accidents. These factors may not be the only criteria.

Table 3-10
SAFETY BENEFIT/COST ANAYLSIS

Project	Safety Benefit/Cost Ratio	Ranking Based on Safety B/C Ratio
Tienken/Livernois Intersection	11.8:1	1
Sheldon Road	1.3:1	2
Tienken/Rochester Intersection	0.11:1	3
Tienken Road	0.07:1	4
Tienken/Sheldon Intersection	0.003:1	5

A ranking system provides guidance to the local decision-maker but it does not make the final choice as to which projects are a priority for the community. The City of Rochester Hills will be evaluating the projects based not only on which ones improve traffic operations and remove any current deficiencies but also which projects promote non-motorized travel, minimize any adverse environmental impact and support the continued economic development of the area.

Many of projects do address correcting known safety deficiencies. These include reducing the accident potential with geometric improvements such as:

- at Rochester and Tienken, which is a high crash location, eliminate left turns by creating a boulevard on all approaches
- on the segment of Tienken between Livernois and Rochester, which is also a high-crash location, 1) improve the sightlines, by modifying the vertical alignment, 2) reduce rear-end crashes by provide a continuous left turn lane and 3) improve the safety for pedestrians by creating a pedestrian refuge island at the Paint Creek Trail crossing
- at Sheldon and Tienken, to handle extreme peak hour demands, 1) install a warranted signal or a modern roundabout and 2) improve pavement markings
- on the segment of Sheldon between Tienken and Mead, improve sightlines by 1) modifying the vertical alignment, 2) providing a left turn lane for approximately 3,400 feet north of Tienken, and 3) clearing the Right of-Way of obstructions.

Two of the projects seek to reduce current or forecasted peak hour LOS E or F. Locations which would benefit from geometric improvements to increase the efficiency of the intersection include:

- Rochester and Tienken, with a LOS F in the AM Peak Hour
- Livernois and Tienken, with a LOS F in the AM and PM Peak Hour

Two of the projects address correcting inadequate facilities. These locations include:

- The segment of Tienken, between Livernois and Rochester, includes a two lane bridge that needs to be replaced but is not ranked high enough yet to qualify for critical bridge funding.
- Sheldon Road between Tienken and Mead is a two-lane gravel road with no shoulders. Analysis shows that this road needs to be paved with curb and gutters in order to accommodate future traffic volumes and to remedy poor drainage.

Most of the projects will have environmental benefits after implementation. These include:

- By improving the efficiency of the intersection operation through the geometric changes proposed above, air quality will be improved at Tienken and Rochester, Tienken and Livernois and Tienken and Sheldon.

- By completing the safety path along both sides of Tienken and Sheldon Roads, non-motorized travel will be encouraged and facilitated. Every project includes a scope of work for constructing a portion of the path network.

- By constructing curbs and gutters along the roads near the Paint Creek and Stoney Creek waterways, the amount of sediment running off into the creeks is substantially reduced and silt build-up downstream is minimized.

- There are two options for implementing a safety path through the Historic District. The final decision will need local public input. Converting the alley into a path is expected to have a minimal negative impact on the district and would be a good candidate for special funding under the Transportation Enhancement grant program.

Lastly, there are sometimes factors which can weigh into the evaluation of projects and make them more attractive to the local decision makers. In this study, one such factor was the participation of Rochester Community Schools. The school district is constructing a new 1,500 student high school in the northeast corner of Sheldon and Tienken Roads. It will open in August 2000. It is located across the street from the newly opened Hart Middle School and adjacent to the Clear Creek subdivision, which is under construction. Rochester Community Schools has an important investment in infrastructure in this part of the corridor and is concerned about the safety of students, staff and parents who are and will be traveling to the two schools. Discussions about cost participation may result in the improvements to the intersection of Sheldon and Tienken being a high priority to implement.

In accordance with the goals of the city of Rochester Hills as described above, the HRC team has provided an initial prioritization of the projects. See Table 3-11.

Table 3-11

RECOMMENDED PROJECT RANKING

Project	Need for Improvement Rank	Estimated Cost
Tienken/Sheldon Intersection	1	$1.52 Million
Sheldon Road	2	$2.67 Million
Tienken Road	3	$2.46 Million
Tienken/Livernois Intersection	4	$920,000
Tienken/Rochester Intersection	5	$12.2 Million

Our recommended ranking is subject to further refinement during the public hearing process.

Whether the rankings change or not, the HRC team recommends that the City of Rochester Hills begin the process of submitting these projects for inclusion into the 2025 Regional Transportation Plan so that they can be funded in a future Transportation Improvement Program.