

COnstruction  
COngestion  
COst  
(CO<sup>3</sup>)  
Training



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Construction Field Services Division

# What is CO<sup>3</sup>?

- A tool to help evaluate different Maintenance of Traffic Alternatives
- A spreadsheet that estimates:
  - User delay times
  - User delay costs
  - Backup lengths
- Can also model flagging operations

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A1

	A	B	C	D	E	F	G	H	I	J	K
2	<b>Construction Congestion Cost</b>										
3	<b>(CO<sup>3</sup>)</b>										
4											
5	<b>CO<sup>3</sup> Program for Modeling Congestion Costs</b>										
6	<b>During Construction</b>										
7	This model is for modeling traffic delay, user cost, and										
8	construction cost for construction and maintenance										
9	operations.										
10	CO <sup>3</sup> models traffic in one direction one or more lanes - the										
11	Standard Method										
12	This model parallels the more specialized CO <sup>3</sup> for Flagging,										
13	which is in COFlag.xls (see), which is used when traffic must										
14	be maintained by closing one lane and placing two-way traffic										
15	in a single lane.										
16	CO <sup>3</sup> was created by Robert I. Carr under a grant from the										
17	Michigan Department of Transportation for its use in providing										
18	better service to the Michigan traveling public.										
19	Copyright Robert I. Carr, 1997										
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Introduction traffic routes input impact daily constr traffic MOD

Ready NUM

Let's look at the "traffic" tab...

SummaryView

<b>Copy This Sheet</b>		period length (min)	60		<b>PROJECT INFORMATION</b>				<b>REPORT INFORMATION</b>						
Update		annual traffic growth (%)	2.50%		PROJECT TITLE	I.69 From Irish Rd to M.15			REPORT TITLE	DETAILED USER COST REPORT SUMMARY SHEET					
		years of growth			Paste Values	C.S.	25084		DIVISION	C&T					
<b>VEHICLE INPUT</b>		cars	trucks		JOB #	56984		REPORT BY	BK						
		design demand (%)	84.5%		START DATE										
		user cost per hour (\$/V hr)	\$14.83		\$26.17		REPORT DATE								
		user cost per mile, (\$/V mi)	\$0.445		\$1.54										
		user cost per cancellation, (\$/V)			NOTES: Stage 1: Maintain 1 EB lane and 2 WB lanes Stage 2: Maintain 2 lanes in each direction										
<b>METHOD INPUT</b>		<b>METHOD 1</b>		<b>METHOD 2</b>		<b>METHOD 3</b>		<b>METHOD 4</b>							
		EB Stage 1		EB Stage 2											
<b>DISTANCE AND SPEED</b>		distance	speed		distance	speed		distance	speed		distance	speed			
		work zone	method travel		3.4	see delay		3.4	see delay			see delay			
		normal travel	3.4		70.0		3.4		70.0						
		diversion	method travel		39.2	51.7		39.2	51.7						
		normal travel	12.0		70.0		12.0		70.0						
<b>SPEED DELAY</b>		threshold	range		threshold	range		threshold	range		threshold	range			
		capacity for speed delay (V/period)	1260		3060										
		speed (when D=0) (mph)	60		60										
		speed (when D=C) (mph)	37		37										
<b>DECREASE TO DEMAND</b>		threshold	range		threshold	range		threshold	range		threshold	range			
		capacity for decreases to design demand (V/period)	2100												
		canceled cars (with no delay) (%)													
		canceled trucks (with no delay) (%)													
		canceled cars (with delay) (%/min)													
		canceled trucks (with delay) (%/min)													
		diverted cars (with no delay) (%)	42.2%												
		diverted trucks (with no delay) (%)	5.0%												
		diverted cars (with delay) (%/min)													
		diverted trucks (with delay) (%/min)													
<b>OTHER USER COST INPUT</b>		Update		cars	trucks		cars	trucks		cars	trucks				
		other user cost per actual demand (\$/V)		\$0.00	\$0.00		\$0.00	\$0.00		\$0.00	\$0.00				
		user cost per diversion (\$/V)		\$20.76	\$57.12		\$20.76	\$57.12		\$0.00	\$0.00				
		Paste Values		Calculate	Calculate		Calculate	Calculate		Calculate	Calculate				
Summary		Go To:	Summary	Overall	Traffic	User Cost	Combined	Print:	This View	Summary	Overall	All	Setup		
<b>PERIOD INPUT</b>		backstop at start (V)		0	0		0	0		0	0				
		weekday	weekend		weekday	weekend		weekday	weekend		weekday	weekend			
		historical demand	design demand		capacity	capacity		capacity	capacity		capacity	capacity			
		(hr)	(V/period)		(V/period)	(V/period)		(V/period)	(V/period)		(V/period)	(V/period)			
12 A		260	622		260	622		1260	1260		3060	3060			
1 A		208	379		208	379		1260	1260		3060	3060			
2 A		182	352		182	352		1260	1260		3060	3060			
3 A		208	244		208	244		1260	1260		3060	3060			
4 A		208	208		208	208		1260	1260		3060	3060			
5 A		416	416		416	416		1260	1260		3060	3060			
6 A		909	909		909	909		1260	1260		3060	3060			
7 A		1351	1351		1351	1351		1260	1260		3060	3060			
8 A		1247	1247		1247	1247		1260	1260		3060	3060			
9 A		1117	1117		1117	1117		1260	1260		3060	3060			
10 A		1091	1407		1091	1407		1260	1260		3060	3060			
11 A		1221	1597		1221	1597		1260	1260		3060	3060			
12 P		1221	1921		1221	1921		1260	1260		3060	3060			
1 P		1377	1840		1377	1840		1260	1260		3060	3060			
2 P		1844	2030		1844	2030		1260	1260		3060	3060			
3 P		2312	2312		2312	2312		1260	1260		3060	3060			
4 P		2519	2519		2519	2519		1260	1260		3060	3060			
5 P		2493	2493		2493	2493		1260	1260		3060	3060			
6 P		1662	1840		1662	1840		1260	1260		3060	3060			
7 P		1117	1488		1117	1488		1260	1260		3060	3060			
8 P		935	1218		935	1218		1260	1260		3060	3060			
9 P		857	920		857	920		1260	1260		3060	3060			
10 P		701	785		701	785		1260	1260		3060	3060			
11 P		519	731		519	731		1260	1260		3060	3060			
Total		25973.634	29944.404		25974	29944		30240	30240		73440	73440			
<b>SUMMARY OUTPUT</b>		traffic method		EB Stage 1		EB Stage 2		weekday		weekend		weekday		weekend	
		direction		weekday		weekend		weekday		weekend		weekday		weekend	
		total user cost		\$254,016		\$299,866		\$8,079		\$9,885					
		user cost of delays		\$50,226		\$64,921		\$8,079		\$9,885					
		user cost of decreases		\$203,790		\$234,945		\$0		\$0					
		maximum backup (V)		876		906		0		0					
		maximum backup length (lane mi)		5.0		5.1		0.0		0.0					
		maximum delay (min.)		44.3		45.8		1.9		1.9					
		average delay, except diversions (min)		10.5		11.7		1.1		1.2					
		total delay, except diversions (V hr)		2877		3719		487		596					
		total vehicles canceled (V)		0		0		0		0					
		total vehicles diverted (V)		9463		10910		0		0					
		total decrease in demand (V)		9463		10910		0		0					
		% decrease in demand		36.4%		36.4%		0.0%		0.0%					
		delay per diverted vehicle (min)		35.1		35.1		35.1		35.1					
		total diversion delay (V hr)		5542		6389		0		0					
		average delay, including diversions (min)		19.4		20.3		1.1		1.2					
		total delay, including diversions (V hr)		8419		10108		487		596					
		user cost / design demand		\$9.78		\$10.01		\$0.31		\$0.33					
		delay cost / actual demand		\$3.04		\$3.41		\$0.31		\$0.33					
Aut		ON	Print	ON	No	OK	validity of output	VALID	VALID		VALID	VALID		NOT VALID	NOT VALID

- “Summary View”
- Let’s break it down
- Yellow cell = possible input
- White cell = background calculation

# General Project Level Info

PROJECT INFORMATION			REPORT INFORMATION	
PROJECT TITLE	I-69 From Irish Rd to M-15		REPORT TITLE	DETAILED USER COST REPORT SUMMARY SHEET
<b>Paste Values</b>	C.S.	25084	DIVISION	C&T
	JOB #	56984	REPORT BY	BK
	START DATE		REPORT DATE	3/11/2005
NOTES:	Stage 1: Maintain 1 EB lane and 2 WB lanes Stage 2: Maintain 2 lanes in each direction			

Briefly describe the MOT schemes to be modeled.

Modeling duration = 24 periods  
 60 minute periods = 1 day  
 Can also use 30, 15 and 10

Number of years between  
 the traffic count and the  
 time we want to model.

Passenger  
 car/commercial truck  
 distribution.

Determined/updated based  
 on FHWA Publication  
**FHWA-SA-98-079**, titled  
 "Life-Cycle Cost Analysis in  
 Pavement Design."

Cars: standard mileage rate  
Trucks: Motor Carrier  
 Annual Report (with wages  
 & benefits removed)

Approximately 2/3 diversion  
 costs (if utilized).

<b>Copy This Sheet</b>	period length (min)	60
	annual traffic growth (%)	2.50%
<b>Update</b>	years of growth	
<b>VEHICLE INPUT</b>		
	<b>cars</b>	<b>trucks</b>
design demand (%)	84.5%	15.5%
user cost per hour (\$/V hr)	\$14.83	\$26.17
user cost per mile, (\$/V mi)	\$0.445	\$1.54
user cost per cancellation, (\$/V)		

METHOD INPUT		METHOD 1	
	method title	EB Stage 1	
DISTANCE AND SPEED		distance	speed
work zone	method travel	3.4	see delay
	normal travel	3.4	70.0
diversion	method travel	39.2	51.7
	normal travel	12.0	70.0
SPEED DELAY		threshold	range
capacity for speed delay (V/period)		1260	
speed (when D~0) (mph)		60	
speed (when D=C) (mph)		37	

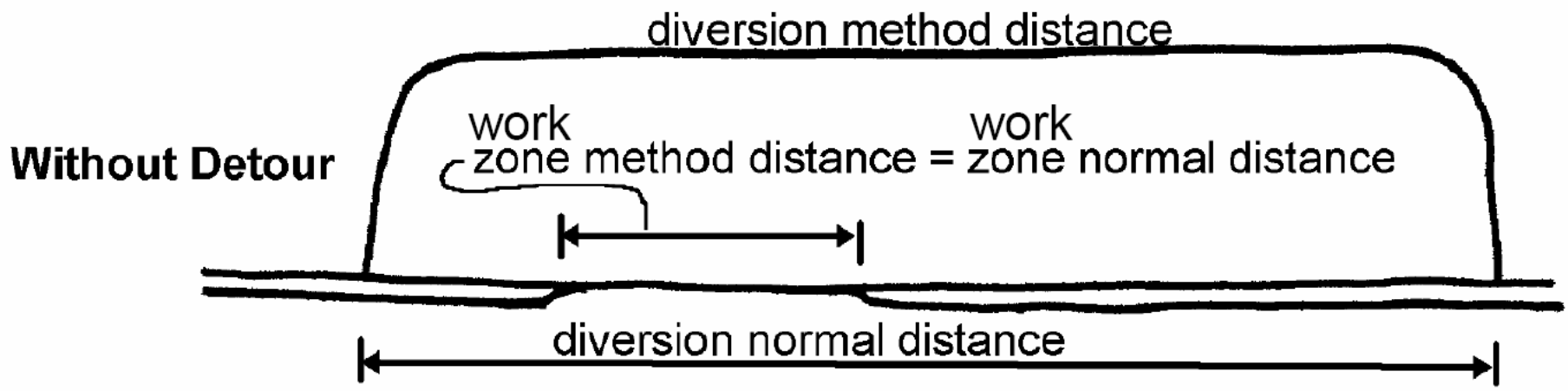
Four runs can be performed on the same sheet.

Descriptive title for each scenario.

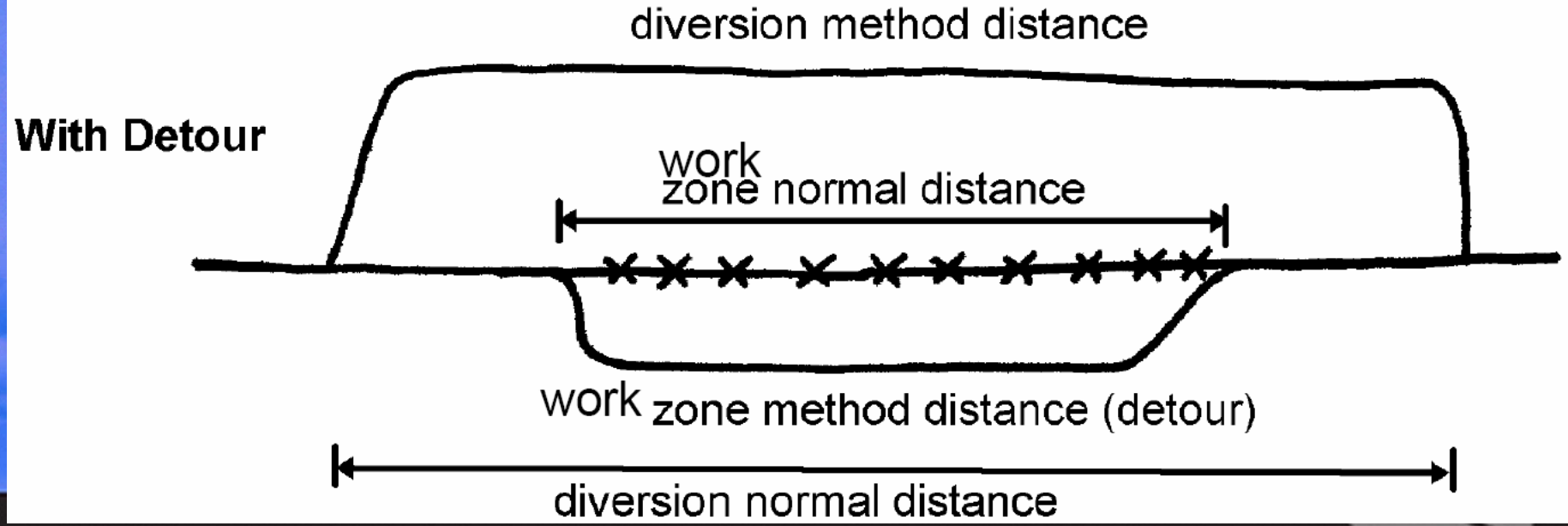
The capacity at and below which a speed delay occurs. Generally, the capacity of the work zone. (See work zone capacity table)

Speed when demand is low.

Speed when demand is near capacity. (See chart)



DISTANCE AND SPEED		(mi)	(mph)	distance	speed
work zone	method travel	3.4	see delay		
	normal travel	3.4	70.0		
diversion	method travel	39.2	51.7		
	normal travel	12.0	70.0		

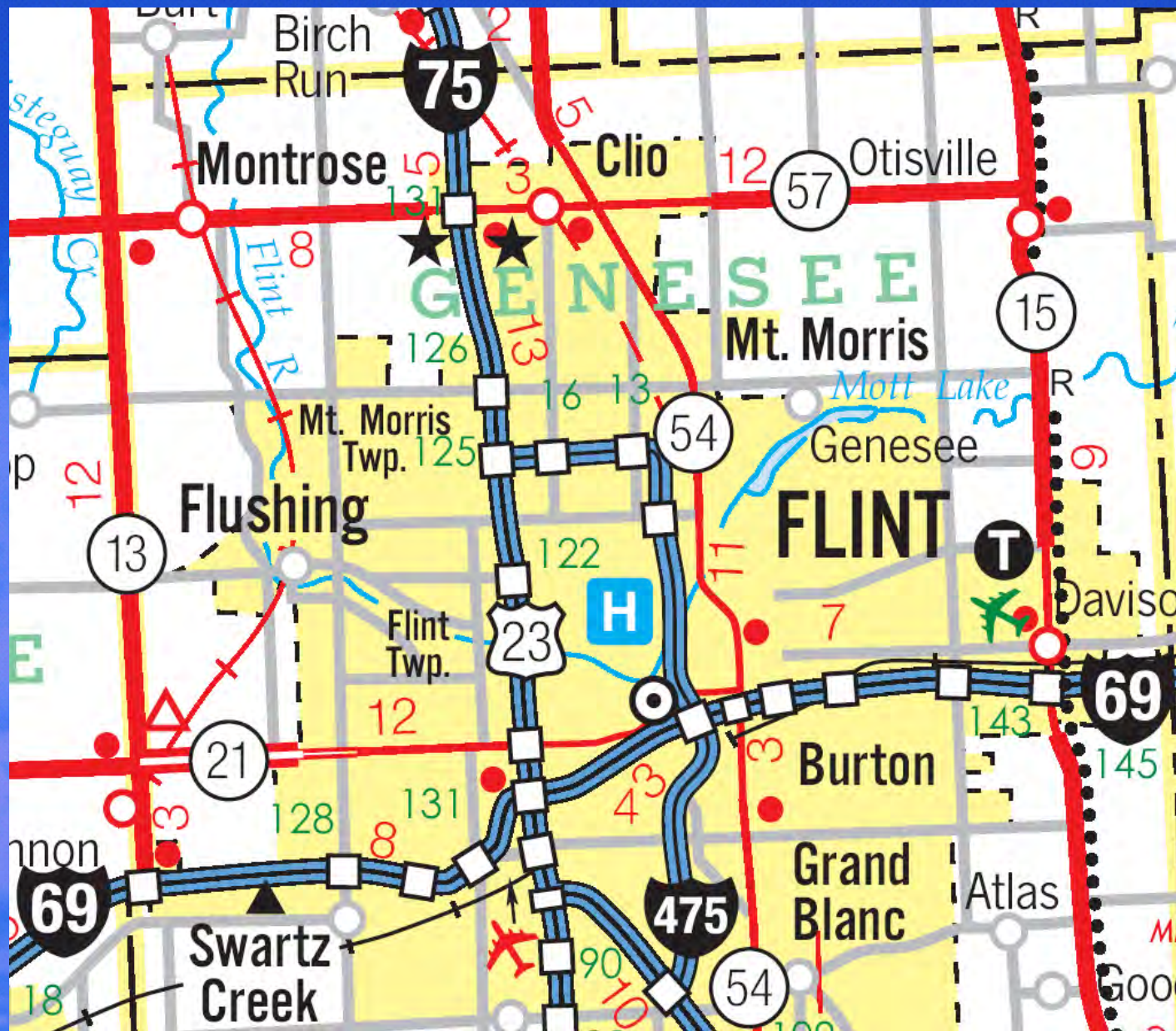




ROUTE DISTANCE, SPEED, AND TIME							Route Title: Detour around the I-69 work zone, using only State Trunkline						
Normal Travel							Method Travel						
Input				Calculated Values			Input				Calculated Values		
Route Name	% that Take Route	Distance (mi)	Speed (mph)	Travel Time (min)	Weighted Distance (mi)	Weighted Time (min)	Route Name	% that Take Route	Distance (mi)	Speed (mph)	Travel Time (min)	Weighted Distance (mi)	Weighted Time (min)
I-69	1	12.02	70	10.30	12.02	10.30	I-75 NB	1	14.225	70	12.19	14.225	12.19
							M-57 EB	1	12.522	45	16.70	12.522	16.70
							M-15 SB	1	12.409	45	16.55	12.409	16.55
Totals	1.00				12.02	10.30	Totals	3.00				39.16	45.43
Averages		12.02	70.00	10.30			Averages		39.156	51.71	45.43		
							Differences		27.14	-18.29	35.13		

The route each vehicle would travel if there were no work zone and the vehicle did not divert to an alternate route. Input the distance and average speed vehicles travel for each leg of the route.

Input the distance and average speed vehicles travel for each leg of the detour route(s) or the most probable diversion route(s). If more than one route, enter the percentage of vehicles that would take each route.



Any additional user cost per vehicle. (optional)

OTHER USER COST INPUT	Update	cars	trucks
other user cost per actual demand (\$/V)		\$0.00	\$0.00
user cost per diversion (\$/V)		\$20.76	\$57.12

Calculated from the additional detour/diversion time & distance experienced per vehicle, and based on the costs at the top of the worksheet.

DECREASE TO DEMAND	threshold	range
capacity for decreases to design demand (V/period)	2100	
canceled cars (with no delay) (%)		
canceled trucks (with no delay) (%)		
canceled cars (with delay) (%/min)		
canceled trucks (with delay) (%/min)		
diverted cars (with no delay) (%)	42.2%	
diverted trucks (with no delay) (%)	5.0%	
diverted cars (with delay) (%/min)		
diverted trucks (with delay) (%/min)		

Capacity at or below when the detour or the diversion route “kicks-in”.

Percent of cars & trucks that will cancel their trip because of the work zone.

Percent of cars & trucks that will be detoured or will divert around the work zone.

**With no Delay:** this percent of traffic will divert as long as the work zone is in operation.

**With Delay:** for every minute of delay, this percent of traffic will divert the work zone.

PERIOD INPUT			backup at start (V)		0	0
	weekday	weekend	weekday	weekend	weekday	weekend
period	historical demand		design demand		capacity	
(hr)	(V/period)	(V/period)	(V/period)	(V/period)	(V/period)	(V/period)
12 A	260	622	260	622	1260	1260
1 A	208	379	208	379	1260	1260
2 A	182	352	182	352	1260	1260
3 A	208	244	208	244	1260	1260
4 A	208	208	208	208	1260	1260
5 A	416	416	416	416	1260	1260
6 A	909	909	909	909	1260	1260
7 A	1351	1351	1351	1351	1260	1260
8 A	1247	1247	1247	1247	1260	1260
9 A	1117	1117	1117	1117	1260	1260
10 A	1091	1407	1091	1407	1260	1260
11 A	1221	1597	1221	1597	1260	1260
12 P	1221	1921	1221	1921	1260	1260
1 P	1377	1840	1377	1840	1260	1260
2 P	1844	2030	1844	2030	1260	1260
3 P	2312	2312	2312	2312	1260	1260
4 P	2519	2519	2519	2519	1260	1260
5 P	2493	2493	2493	2493	1260	1260
6 P	1662	1840	1662	1840	1260	1260
7 P	1117	1488	1117	1488	1260	1260
8 P	935	1218	935	1218	1260	1260
9 P	857	920	857	920	1260	1260
10 P	701	785	701	785	1260	1260
11 P	519	731	519	731	1260	1260
<b>Total</b>	<b>25973.63</b>	<b>29944.4</b>	<b>25974</b>	<b>29944</b>	<b>30240</b>	<b>30240</b>

Actual hourly traffic counts.

Aged hourly traffic counts, based on the growth rate and years of growth. (optional)

Press the “Compute” button for each column, located between the ‘other user cost input’ and the ‘period input’ sections of the worksheet.

SUMMARY OUTPUT		traffic method direction	EB Stage 1					
			weekday	weekend				
		total user cost	\$254,016	\$299,866				
		user cost of delays	\$50,226	\$64,921				
		user cost of decreases	\$203,790	\$234,945				
		maximum backup (V)	876	906				
You can copy these values into		maximum backup length (lane mi)	5.0	5.1				
		maximum delay (min.)	44.3	45.8				
		average delay, except diversions (min)	10.5	11.7				
		total delay, except diversions (V hr)	2877	3719				
Impact Sheet		total vehicles canceled(V)	0	0				
		total vehicles diverted (V)	9463	10910				
		total decrease in demand (V)	9463	10910				
		% decrease in demand	36.4%	36.4%				
		delay per diverted vehicle (min)	35.1	35.1				
		total diversion delay (V hr)	5542	6389				
		average delay, including diversions (min)	19.4	20.3				
		total delay, including diversions (V hr)	8419	10108				
		user cost / design demand	\$9.78	\$10.01				
		delay cost / actual demand	\$3.04	\$3.41				
Aut	ON	Prin	ON	No	OK	validity of output	VALID	VALID

From the speed delay of going through the work zone.

From the vehicles that diverted or canceled.

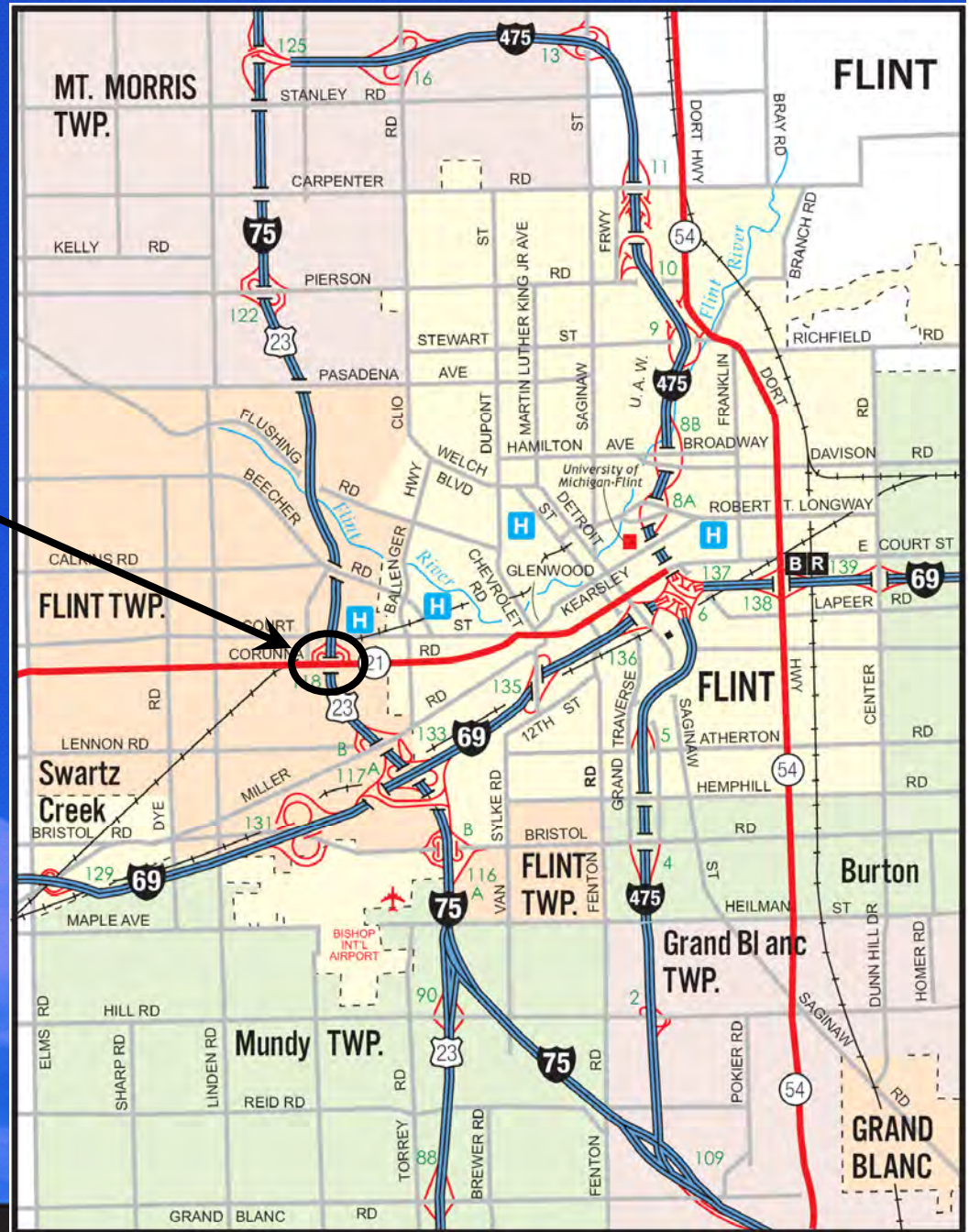
This length is per lane mile.

A check on whether the summary output shown was computed from the input shown.

All these costs & values are over the entire 24 periods!

# Example:

- I-75 @ M-21 Bridge Rehab
- What scenario will cause the least amount of traffic congestion??



# I-75 @ M-21 Inputs

## SummaryView

Copy This Sheet			PROJECT INFORMATION			REPORT INFORMATION					
Update	period length (min)	60	PROJECT TITLE	I-75 at M-21 Bridge Repair		REPORT TITLE	DETAILED USER COST REPORT SUMMARY SHEET				
	annual traffic growth (%)	2.00%	Paste Values	C.S.		DIVISION	Davison TSC				
	years of growth			JOB #		REPORT BY	SP				
	VEHICLE INPUT			START DATE		REPORT DATE	8/4/2006				
	cars	trucks	NOTES:								
	design demand (%)	94.0%									
	user cost per hour (\$/V hr)	\$14.83									
	user cost per mile, (\$/V mi)	\$0.445									
	user cost per cancellation, (\$/V)										
METHOD INPUT			METHOD 1		METHOD 2		METHOD 3		METHOD 4		
	method title		1 Ln Open w/ I-69 Detoured		1 Ln Open w/ I-69 Allowed		2 Ln Open w/ I-69 Detoured		2 Ln Open w/ I-69 Allowed		
	DISTANCE AND SPEED (mi) (mph)		distance	speed	distance	speed	distance	speed	distance	speed	
	work zone	method travel	0.5	see delay	0.5	see delay	0.5	see delay	0.5	see delay	
		normal travel	0.5	70.0	0.5	70.0	0.5	70.0	0.5	70.0	
	diversion	method travel	12.1	70.0			12.1	70.0			
		normal travel	9.9	70.0			9.9	70.0			
	SPEED DELAY		threshold	range	threshold	range	threshold	range	threshold	range	
	capacity for speed delay (V/period)		1400		1400		3400		3400		
	speed (when D~0) (mph)		55		55		55		55		
	speed (when D=C) (mph)		45		45		45		45		
	DECREASE TO DEMAND		threshold	range	threshold	range	threshold	range	threshold	range	
	capacity for decreases to design demand (V/period)		6300				6300				
	canceled cars (with no delay) (%)										
	canceled trucks (with no delay) (%)										
	canceled cars (with delay) (%/min)										
	canceled trucks (with delay) (%/min)										
	diverted cars (with no delay) (%)		25.0%				25.0%				
	diverted trucks (with no delay) (%)		25.0%				25.0%				
	diverted cars (with delay) (%/min)										
	diverted trucks (with delay) (%/min)										
OTHER USER COST INPUT			cars	trucks	cars	trucks	cars	trucks	cars	trucks	
	Update										
	other user cost per actual demand (\$/V)		\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	
	user cost per diversion (\$/V)		\$1.41	\$4.10	\$0.00	\$0.00	\$1.41	\$4.10	\$0.00	\$0.00	



# Normal & Method Travel Calc's

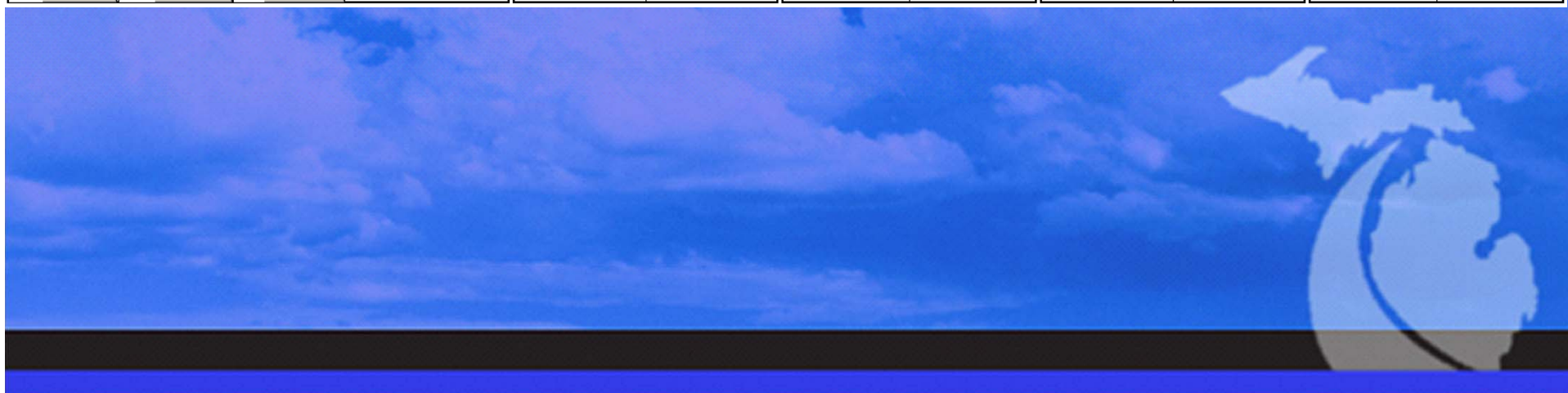
ROUTE DISTANCE, SPEED, AND TIME							Route Title:						
Normal Travel							Method Travel						
Input				Calculated Values			Input				Calculated Values		
Route Name	% that Take Route	Distance (mi)	Speed (mph)	Travel Time (min)	Weighted Distance (mi)	Weighted Time (min)	Route Name	% that Take Route	Distance (mi)	Speed (mph)	Travel Time (min)	Weighted Distance (mi)	Weighted Time (min)
EB I-69	0.5	8.25	70	7.07	4.125	3.54	EB I-69	0.5	13.714	70	11.75	6.857	5.88
WB I-69	0.5	11.57	70	9.92	5.785	4.96	WB I-69	0.5	10.394	70	8.91	5.197	4.45
<b>Totals</b>	<b>1.00</b>				<b>9.91</b>	<b>8.49</b>	<b>Totals</b>	<b>1.00</b>				<b>12.05</b>	<b>10.33</b>
<b>Averages</b>		<b>9.91</b>	<b>70.00</b>	<b>8.49</b>			<b>Averages</b>		<b>12.054</b>	<b>70.00</b>	<b>10.33</b>		
							<b>Differences</b>		<b>2.14</b>		<b>1.84</b>		

# Volume & Capacity

PERIOD INPUT			backup at start (V)		0	0	0	0	0	0	0	0
direction:	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB
period	historical demand		design demand		capacity		capacity		capacity		capacity	
(hr)	(V/period)	(V/period)	(V/period)	(V/period)	(V/period)	(V/period)	(V/period)	(V/period)	(V/period)	(V/period)	(V/period)	(V/period)
12 A	2016	1902	2016	1902	1400	1400	1400	1400	3400	3400	3400	3400
1 A	965	1159	965	1159	1400	1400	1400	1400	3400	3400	3400	3400
2 A	540	694	540	694	1400	1400	1400	1400	3400	3400	3400	3400
3 A	477	363	477	363	1400	1400	1400	1400	3400	3400	3400	3400
4 A	463	257	463	257	1400	1400	1400	1400	3400	3400	3400	3400
5 A	419	267	419	267	1400	1400	1400	1400	3400	3400	3400	3400
6 A	771	431	771	431	1400	1400	1400	1400	3400	3400	3400	3400
7 A	1536	794	1536	794	1400	1400	1400	1400	3400	3400	3400	3400
8 A	2522	1130	2522	1130	1400	1400	1400	1400	3400	3400	3400	3400
9 A	3184	1627	3184	1627	1400	1400	1400	1400	3400	3400	3400	3400
10 A	4048	2174	4048	2174	1400	1400	1400	1400	3400	3400	3400	3400
11 A	4921	3205	4921	3205	1400	1400	1400	1400	3400	3400	3400	3400
12 P	4529	4280	4529	4280	1400	1400	1400	1400	3400	3400	3400	3400
1 P	4932	4446	4932	4446	1400	1400	1400	1400	3400	3400	3400	3400
2 P	4877	4350	4877	4350	1400	1400	1400	1400	3400	3400	3400	3400
3 P	4970	4699	4970	4699	1400	1400	1400	1400	3400	3400	3400	3400
4 P	4823	4860	4823	4860	1400	1400	1400	1400	3400	3400	3400	3400
5 P	5159	5030	5159	5030	1400	1400	1400	1400	3400	3400	3400	3400
6 P	4830	4366	4830	4366	1400	1400	1400	1400	3400	3400	3400	3400
7 P	4513	4350	4513	4350	1400	1400	1400	1400	3400	3400	3400	3400
8 P	4426	4584	4426	4584	1400	1400	1400	1400	3400	3400	3400	3400
9 P	4527	4612	4527	4612	1400	1400	1400	1400	3400	3400	3400	3400
10 P	3441	4021	3441	4021	1400	1400	1400	1400	3400	3400	3400	3400
11 P	2723	2912	2723	2912	1400	1400	1400	1400	3400	3400	3400	3400
<b>Total</b>	<b>75612</b>	<b>66513</b>	<b>75612</b>	<b>66513</b>	<b>33600</b>	<b>33600</b>	<b>33600</b>	<b>33600</b>	<b>81600</b>	<b>81600</b>	<b>81600</b>	<b>81600</b>

# Results

SUMMARY OUTPUT				traffic method		1 Ln Open w/ I-69 Detoured		1 Ln Open w/ I-69 Allowed		2 Ln Open w/ I-69 Detoured		2 Ln Open w/ I-69 Allowed	
				direction		NB	SB	NB	SB	NB	SB	NB	SB
total user cost				\$8,212,869	\$5,631,128	\$0	\$0	\$275,127	\$83,665	\$2,469,529	\$1,559,961		
user cost of delays				\$8,183,192	\$5,605,021	\$0	\$0	\$245,449	\$57,558	\$2,469,529	\$1,559,961		
user cost of decreases				\$29,678	\$26,106	\$0	\$0	\$29,678	\$26,106	\$0	\$0		
maximum backup (V)				28919	23817	0	0	2081	742	15796	12198		
maximum backup length (lane mi)				164.3	135.3	0.0	0.0	11.8	4.2	89.8	69.3		
maximum delay (min.)				1299.6	1081.0	0.0	0.0	37.0	13.3	339.0	275.5		
total delay, except diversions (V hr)				527594	361372	0	0	15825	3711	159218	100575		
average delay, except diversions (min)				558.2	434.6	0.0	0.0	16.7	4.5	126.3	90.7		
total vehicles canceled(V)				0	0	0	0	0	0	0	0		
total vehicles diverted (V)				18903	16628	0	0	18903	16628	0	0		
total decrease in demand (V)				18903	16628	0	0	18903	16628	0	0		
% decrease in demand				25.0%	25.0%	0.0%	0.0%	25.0%	25.0%	0.0%	0.0%		
delay per diverted vehicle (min)				1.8	1.8	0.0	0.0	1.8	1.8	0.0	0.0		
total diversion delay (V hr)				579	509	0	0	579	509	0	0		
total delay, including diversions (V hr)				528,173	361,881	0	0	16,404	4,220	159,218	100,575		
average delay, including diversions (min)				419.1	326.4	0.0	0.0	13.0	3.8	126.3	90.7		
user cost / design demand				\$108.62	\$84.66	\$0.00	\$0.00	\$3.64	\$1.26	\$32.66	\$23.45		
delay cost / actual demand				\$144.30	\$112.36	\$0.00	\$0.00	\$4.33	\$1.15	\$32.66	\$23.45		
Auti	ON	Prin	ON	Noi	OK	validity of output		VALID	VALID	NOT VALID	NOT VALID	VALID	VALID



SummaryView - Flagging Operation

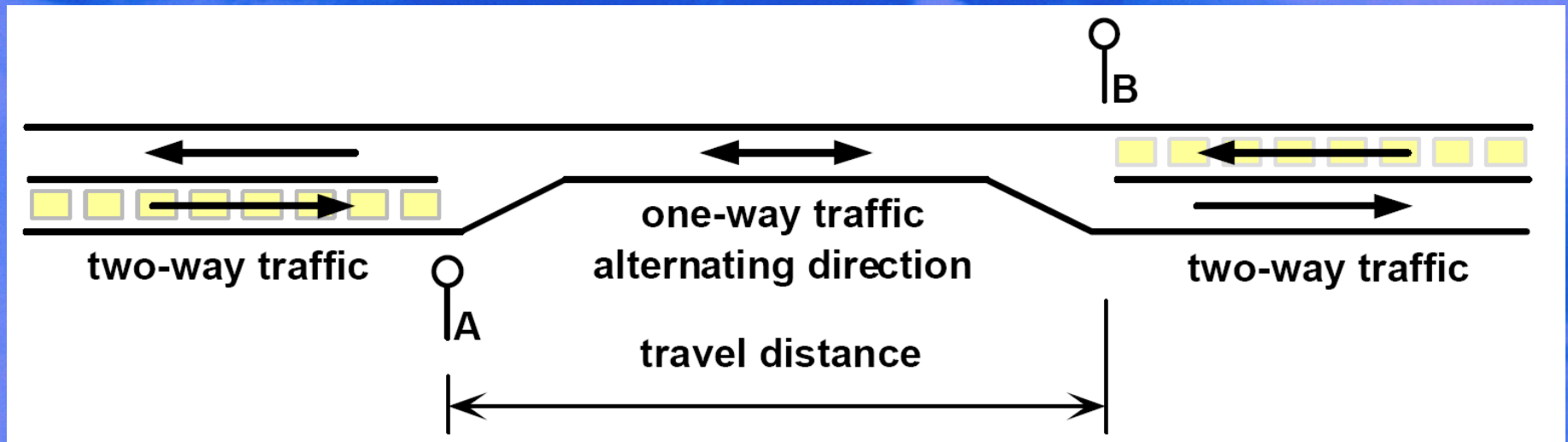
Copy This Sheet		period length (min)	60	PROJECT INFORMATION				REPORT INFORMATION							
Update		annual traffic growth (%)	1.50%	PROJECT TITLE	US-41M-28 from Humboldt to the Peshekee River Bridge			REPORT TITLE	DETAILED USER COST REPORT SUMMARY VIEW						
VEHICLE INPUT		cars	trucks	Paste Values	C.S.	52041	DIVISION	C&T							
		design demand (%)	90.0%	JOB #	75463			REPORT BY	BK						
		user cost per hour (\$/V hr)	\$14.83	START DATE				REPORT DATE	11/8/2006						
		user cost per mile, (\$/V mi)	\$0.445	NOTES: Perform all construction part-width under flag control.											
		user cost per cancellation, (\$/V)	\$1.54												
METHOD INPUT				METHOD 1		METHOD 2		METHOD 3		METHOD 4					
method title				8am to 5pm		7am to 6pm		7am to 7pm							
DISTANCE AND SPEED INPUTS (mi) (mph)				distance	speed	distance	speed	distance	speed	distance	speed				
work zone				3.7	35	3.7	35	3.7	35						
method travel				3.7	55	3.7	55	3.7	55						
normal travel															
diversion															
method travel															
normal travel															
FLAG OPERATION INPUTS															
vehicle headway at gate (sec)				3		3		3							
dead time at gate when direction changes (sec)				15		15		15							
allowable gate closed time (min.)				17		18		18							
DECREASE TO DEMAND															
canceled cars (with no delay) (%)															
canceled trucks (with no delay) (%)															
canceled cars (with delay) (%/min)															
canceled trucks (with delay) (%/min)															
diverted cars (with no delay) (%)															
diverted trucks (with no delay) (%)															
diverted cars (with delay) (%/min)															
diverted trucks (with delay) (%/min)															
OTHER USER COST INPUT															
other user cost per actual demand (\$/V)				\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00				
user cost per diversion (\$/V)				\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00				
Paste Values				Compute		Compute		Compute		Compute					
Summary	Go To:	Summary	Overall	Traffic	User Cost	Combined	Print:	This View	Summary	Overall	All	Setup			
PERIOD INPUT (V/period)		Demand													
		(Backup at Start of Flagging)				Flag Periods (Capacity at End of Flagging)				Demand					
direction:	NB	SB	Both Directions		(Bsof) Flag	demand	(Bsof) Flag	demand	(Bsof) Flag	demand	(Bsof) Flag	demand			
period	historical	design	(Ceof)	actual	(Ceof)	actual	(Ceof)	actual	(Ceof)	actual	(Ceof)	actual			
12 A	15	15	30	30											
1 A	8	8	15	15											
2 A	3	3	5	5											
3 A	5	5	10	10											
4 A	0	0	0	0											
5 A	10	10	20	20											
6 A	13	13	25	25											
7 A	55	55	110	110			Flag	110	Flag	110					
8 A	150	150	300	300	Flag	300	Flag	300	Flag	300					
9 A	150	150	300	300	Flag	300	Flag	300	Flag	300					
10 A	133	133	265	265	Flag	265	Flag	265	Flag	265					
11 A	153	153	305	305	Flag	305	Flag	305	Flag	305					
12 P	185	185	370	370	Flag	370	Flag	370	Flag	370					
1 P	190	190	380	380	Flag	380	Flag	380	Flag	380					
2 P	173	173	345	345	Flag	345	Flag	345	Flag	345					
3 P	203	203	405	405	Flag	405	Flag	405	Flag	405					
4 P	205	205	410	410	Flag	410	Flag	410	Flag	410					
5 P	198	198	395	395	Flag	395	Flag	395	Flag	395					
6 P	220	220	440	440			Flag	440	Flag	440					
7 P	140	140	280	280					Flag	280					
8 P	120	120	240	240											
9 P	95	95	190	190											
10 P	48	48	95	95											
11 P	38	38	75	75											
Total	2505	2505	5010	5010	0	3475	0	4025	0	4305	0	0			
SUMMARY OUTPUT				traffic method		8am to 5pm		7am to 6pm		7am to 7pm					
				Flagging		Flagging		Flagging							
total user cost				\$9,617		\$11,168		\$11,913							
user cost of delays				\$9,617		\$11,168		\$11,913							
user cost of decreases				\$0		\$0		\$0							
maximum backup (V)				0.0		0.0		0.0							
maximum backup length (lane mi)				0.0		0.0		0.0							
maximum delay (min.)				19.1		19.5		19.5							
average delay, except diversions (min)				10.4		10.4		10.4							
total delay, except diversions (V hr)				502		700		746							
total vehicles cancelled(V)				0		0		0							
total vehicles diverted (V)				0		0		0							
total decrease in demand (V)				0		0		0							
% decrease in demand				0%		0%		0%							
delay per diverted vehicle (min)				0.0		0.0		0.0							
total diversion delay (V hr)				0		0		0							
average delay, including diversions (min)				10.4		10.4		10.4							
total delay, including diversions (V hr)				502		700		746							
user cost / design demand				\$1.92		\$2.23		\$2.38							
delay cost / actual demand				\$2.77		\$2.77		\$2.77							
work zone method travel time (min.)				6.4		6.4		6.4							
speed delay (min.)				2.3		2.3		2.3							
maximum capacity (V/hr)				427		495		495							
gate delay at maximum capacity (min.)				8.5		9.0		9.0							
maximum gate and speed delay (min.)				19.1		19.5		19.5							
maximum backup delay (min.)				0.0		0.0		0.0							
Auto	ON	Print	ON	Nov	OK	validity of output						VALID	VALID	VALID	NOT VALID

• CO<sup>3</sup> Flag

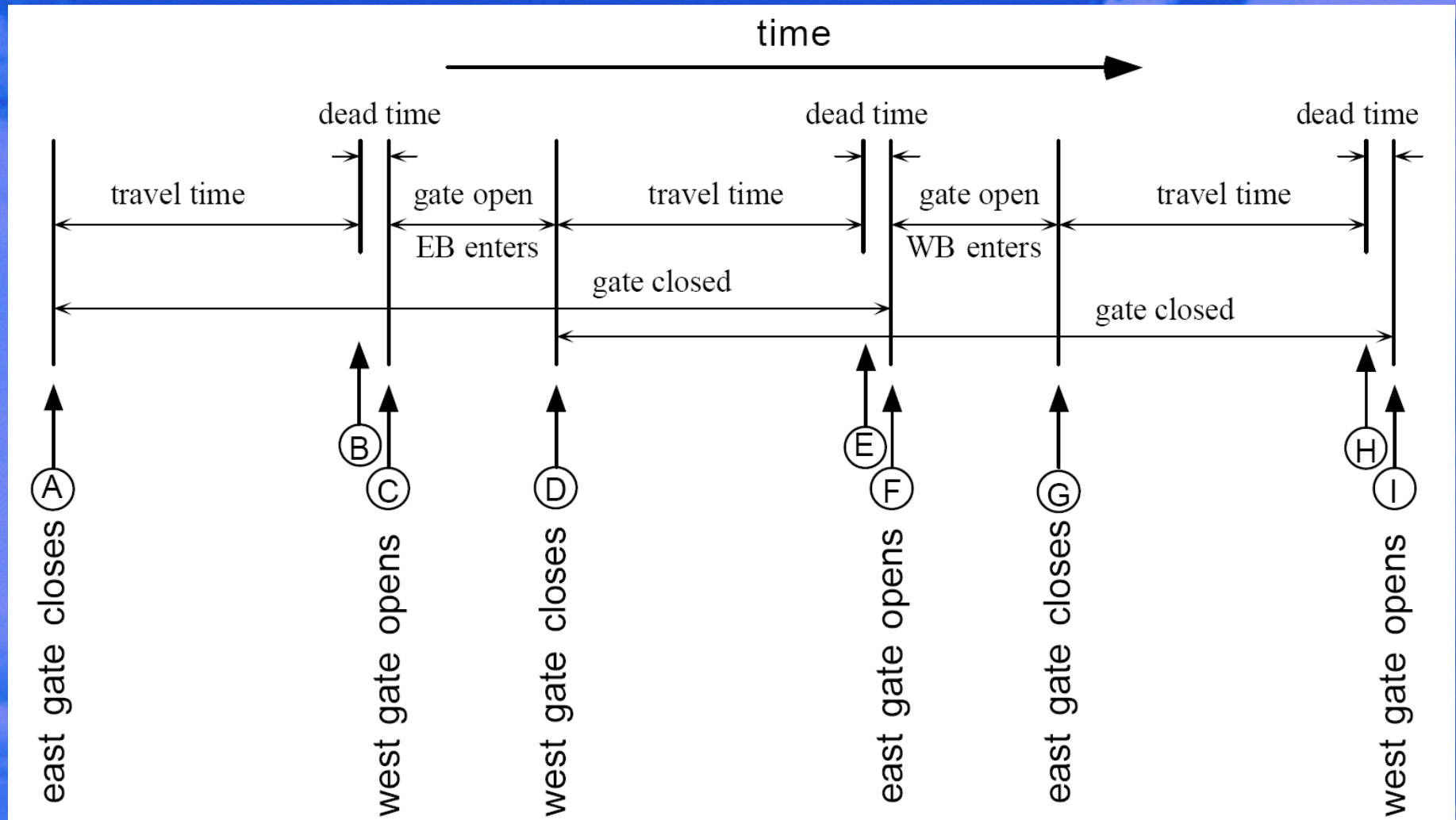
• “Flag View”

• Let's break it down too

# Basic Flagging Operation



# Gate Operation versus Time



# “Flag Input” Tab

PROJECT INPUT AND DOCUMENTATION		Project:	US-41/M-28 from Humboldt to the Peshekee River Bridge	
FLAGGING OPERATION		By:	BK	
<a href="#">Copy This Sheet</a>		Other:		
METHOD INPUT		METHOD #		
method title		8am to 5pm		
VEHICLE INPUT		cars	trucks	
①	design demand (%)	90.0%	10.0%	
①	user cost per hour (\$/V hr)	\$14.83	\$26.17	default
①	user cost per mile, (\$/V mi)	\$0.45	\$1.54	default
④	user cost per cancellation, (\$/V)			
ROUTE TITLES		Standard		
DISTANCE AND SPEED INPUT		distance	speed	
①	work zone method travel	1.0	35	3,239 miles of total construction, perform in three, 1 mile segments
①	work zone normal travel	1.0	55	
①	diversion method travel			
①	diversion normal travel			
FLAG OPERATION INPUT				
②	vehicle headway at gate (sec)	3		default
②	dead time at gate when direction changes (sec)	15		default
③	allowable gate closed time (min.)	5		
WORK ZONE TRAVEL		General Comments:		
	method travel time (min)	1.71		
	normal travel time (min)	1.09		
	speed delay (min)	0.62		
	gate delay at D~0 (min)	1.96		
	gate delay at maximum capacity (min)	2.50		
	gate and speed delay at D~0 (min)	2.59		
	gate+speed delay at max capacity (min)	3.12		
	maximum capacity (V/hr)	424		

Time from the last vehicle entering the work zone at gate 'A', to when a vehicle can again enter at gate 'A'

A good place to start is 3 to 4 times

Time each vehicle requires to enter the work zone when the gate is opened

Time from last vehicle leaving the work zone to when the first waiting vehicle enters the work zone

# General Project Level Info

## SummaryView - Flagging Operation

<b>Copy This Sheet</b>	period length (min)	60	<b>PROJECT INFORMATION</b>		<b>REPORT INFORMATION</b>	
	annual traffic growth (%)	1.50%	PROJECT TITLE	US-41/M-28 from Humboldt to the Peshekee River Bridge	REPORT TITLE	DETAILED USER COST REPORT
<b>Update</b>	years of growth					SUMMARY VIEW
<b>VEHICLE INPUT</b>		<b>cars</b>	<b>trucks</b>	<b>Paste Values</b>	C.S.	52041
design demand (%)	90.0%	10.0%	JOB #	75463	DIVISION	C&T
user cost per hour (\$/V hr)	\$14.83	\$26.17	START DATE		REPORT BY	BK
user cost per mile, (\$/V mi)	\$0.445	\$1.54	NOTES: Perform all construction part-width under flag control.			
user cost per cancellation, (\$/V)						





PERIOD INPUT (V/period)			(Backup at Start of Flagging) Flag Periods (Capacity at End of Flagging)				Demand					
direction:	NB	SB	Both Directions		(Bsof) Flag	demand	(Bsof) Flag	demand	(Bsof) Flag	demand	(Bsof) Flag	demand
period	historical		design		(Ceof)	actual	(Ceof)	actual	(Ceof)	actual	(Ceof)	actual
12 A	15	15	30	30								
1 A	8	8	15	15								
2 A	3	3	5	5								
3 A	5	5	10	10								
4 A	0	0	0	0								
5 A	10	10	20	20								
6 A	13	13	25	25								
7 A	55	55	110	110			Flag	110			Flag	110
8 A	150	150	300	300	Flag	300	Flag	300	Flag	300	Flag	300
9 A	150	150	300	300	Flag	300	Flag	300	Flag	300	Flag	300
10 A	133	133	265	265	Flag	265	Flag	265	Flag	265	Flag	265
11 A	153	153	305	305	Flag	305	Flag	305	Flag	305	Flag	305
12 P	185	185	370	370	Flag	370	Flag	370	Flag	370	Flag	370
1 P	190	190	380	380	Flag	380	Flag	380	Flag	380	Flag	380
2 P	173	173	345	345	Flag	345	Flag	345	Flag	345	Flag	345
3 P	203	203	405	405	Flag	405	Flag	405	Flag	405	Flag	405
4 P	205	205	410	410	Flag	410	Flag	410	Flag	410	Flag	410
5 P	198	198	395	395	Flag	395	Flag	395	Flag	395	Flag	395
6 P	220	220	440	440			Flag	440			Flag	440
7 P	140	140	280	280								
8 P	120	120	240	240								
9 P	95	95	190	190								
10 P	48	48	95	95								
11 P	38	38	75	75								
Total	2505	2505	5010	5010	0	3475	0	4025	0	3475	0	4025

Sum of traffic for both directions

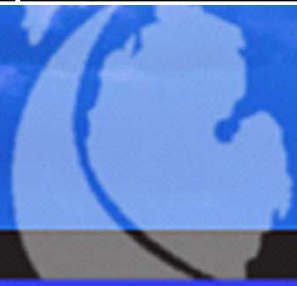
'Aged' sum of traffic (optional)

Type 'Flag' for each period that a flagged work zone is in effect

SUMMARY OUTPUT		traffic method	8am to 5pm Flagging	7am to 6pm Flagging	8am to 5pm Flagging	7am to 6pm Flagging				
total user cost			\$2,777	\$3,225	\$4,324	\$5,022				
user cost of delays			\$2,777	\$3,225	\$4,324	\$5,022				
user cost of decreases			\$0	\$0	\$0	\$0				
maximum backup (V)			0	0	0	0				
maximum backup length (lane mi)			0.0	0.0	0.0	0.0				
maximum delay (min.)			5.6	5.7	8.6	8.8				
average delay, except diversions (min)			3.0	3.0	4.7	4.7				
total delay, except diversions (V hr)			174	202	271	315				
total vehicles canceled(V)			0	0	0	0				
total vehicles diverted (V)			0	0	0	0				
total decrease in demand (V)			0	0	0	0				
% decrease in demand			0%	0%	0%	0%				
delay per diverted vehicle (min)			0.0	0.0	0.0	0.0				
total diversion delay (V hr)			0	0	0	0				
average delay, including diversions (min)			3.0	3.0	4.7	4.7				
total delay, including diversions (V hr)			174	202	271	315				
user cost / design demand			\$0.55	\$0.64	\$0.86	\$1.00				
delay cost / actual demand			\$0.80	\$0.80	\$1.24	\$1.25				
work zone method travel time (min.)			1.7	1.7	2.8	2.8				
speed delay (min.)			0.6	0.6	1.0	1.0				
maximum capacity (V/hr)			424	616	470	470				
gate delay at maximum capacity (min.)			2.5	3.0	4.0	4.0				
maximum gate and speed delay (min.)			5.6	5.7	8.6	8.8				
maximum backup delay (min.)			0.0	0.0	0.0	0.0				
Auto	ON	Prin	ON	No	OK	validity of output	VALID	VALID	VALID	VALID

You can copy these values into

Impact Sheet.



# Additional Resources

- PR Finder Application
  - <http://www.mcgi.state.mi.us/prfinder/>
- WIM data, PTR & other traffic counts
  - <http://mdotnetintra/TMIS/Home.aspx>  
(link to WIM/PTR & ADT Maps at top of page)
- Traffic.com: access to count data
- MPO Web-sites (local road counts)

Note: Some of the above information is only available to MDOT staff



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**System Operations Advisories**

- 2012  
[SOA 2012-01 NTCIP PCMS SP](#) PDF
- 2011  
[SOA 2011-07 Elimination of Lights on Plastic Drums](#) PDF  
[SOA 2011-06 Uniformed Law Enforcement in Work Zones](#) PDF  
[SOA 2011-05 CO3 & Excel Macros](#) PDF  
[SOA 2011-04 Channelizing Devices in Work Zones](#) PDF  
[SOA 2011-03 Temporary Sign Supports Wood Posts](#) PDF  
[SOA 2011-02 / 3M 780 Temporary Tape](#) PDF  
[SOA 2011-01 Lights on Plastic Drums](#) PDF
- 2010  
[SOA 2010-08 WZ Speed Limits](#) PDF  
[SOA 2010-07 Temporary Concrete Barrier](#) PDF  
[SOA 2010-06 Handhole Cover](#) PDF  
[SOA 2010-05 Traffic Regulating Instruction Manual](#) PDF  
[SOA 2010-04 CO3 Traffic Regulating Analysis](#) PDF  
[SOA 2010-03 Temporary Sign Support Wood Posts](#) PDF  
[SOA 2010-02 Construction Congestion Cost \(CO3\) Software](#) PDF  
[SOA 2010-01 Channelizing Devices in Work Zones](#) PDF
- 2009  
[SOA 2009-03 Work Zone Enforcement](#) PDF  
[SOA 2009-02 Temporary Traffic Signals](#) PDF  
[SOA 2009-01 Lights on Drums](#) PDF
- 2008  
[SOA 2008-01 Work Zone Signing for Injure/Kill a Worker](#) PDF

**Related Content**

- Traffic and Safety Advisories
- BOH - Instructional Memorandums
- Construction Advisories

# Questions?



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