

INCENTIVES/DISINCENTIVES
FINAL REPORT

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I. SUMMARY AND RECOMMENDATIONS

Due to changes in federal regulations, an alternative to the historical method of relying on arbitrarily derived values for liquidated damages has become available. These permit the use of incentive clauses for early completion of construction while also linking "disincentives to job specific estimates of damages." In addition, the liquidated damages schedule itself must now be based on actual costs to the DOT of construction and materials inspection.

Research on this project has included investigation into the effect of incentive/disincentive (I/D) clauses on their desired goal of early completion of construction, as well as investigation into the values to be used for I/D provisions. Research also has been made into development of guidelines concerning when I/D clauses should be invoked since most projects should not use or even deserve I/D clauses. In regard to liquidated damages, investigation has been made into development of a new liquidated damages schedule based on actual costs of construction inspection to NJDOT.

The specific conclusions reached from these investigations follow:

1. In almost all contracts where an incentive clause was used, it has proved successful with the contractor receiving the maximum amount; however, very selective use has been made of them. Values of incentives used successfully have ranged from a high of \$10,000 per day to a low of \$2,500 per day.
2. Very few specific guidelines as to when an I/D provision should be used seem to exist. Most states use only general guidelines such as high delay to the traveling public, high road user costs or a long detour.

3. Estimates of road user costs are regularly used in justifying the incentive/disincentive value once chosen. However, the choice of I/D value used is rather arbitrary.
4. The AASHTO liquidated damages schedule presently in use is too low and does not recoup the costs incurred by DOTs for construction inspection. A new schedule based on actual costs to the NJDOT of construction inspection should be developed.

Based on these conclusions, the Division of Research and Demonstration makes the following recommendations:

1. Incentive/disincentive clauses are effective in encouraging early completion of construction projects and should continue to be used to this end, however, selective use should be made of them. To this end, guidelines have been developed which would aid in determining on which projects I/D clauses would be appropriate. These guidelines, which use a combination of criteria developed by the Texas Transportation Institute with an additional set of project rating criteria to form a two part decision framework, can be seen in Tables 1 and 2.
2. Estimates of road user costs should continue to be used as justification for use of incentive/disincentive clauses and they are included in the guidelines. However, the I/D values schedule (Table 3) based on estimated labor costs should be used as a guide to actual I/D values.
3. The new liquidated damages schedule (Table 4, Schedule A) should be used in order to recoup actual costs to NJDOT for construction inspection.

4. Any liquidated damages schedule used should be based on actual costs to NJDOT and should be periodically reviewed and readjusted, if necessary, to reflect these costs.
5. The NJDOT Construction Engineering Manpower Management (CEMM) System can be used with modifications for review and any necessary readjustment of both the incentive/disincentive and liquidated damages schedules.

II. INTRODUCTION

Historically, transportation agencies have depended upon liquidated damages to insure that construction jobs will be completed on schedule. These acted as a daily fine imposed on the contractor for every day which the project continued beyond the scheduled completion date. In recent years, however, due to the shift away from "new" construction and toward more reconstruction or rehabilitation jobs, more emphasis has been placed on the need to finish a job as quickly as possible in order to lessen inconvenience to the traveling public. Recent changes in federal regulations taking this new emphasis into account permit the use of incentive clauses for early completion of construction while also linking "disincentives" to job specific estimates of damages. However, there are few examples available as to the effectiveness of the incentive/disincentive clauses and no specific guidelines as to which projects these clauses should be applied.

The new I/D clauses do not replace liquidated damage since it is universally accepted that these clauses should not and cannot be applied to all jobs. However, in their investigation into the new I/D approach, many transportation agencies have detected a flaw in the traditional liquidated damages schedule. The AASHTO developed liquidated damages schedule presently in use is so low as to defeat its purpose of ensuring on-time completion. In most cases, it does not

even serve its primary purpose, which is to recoup the additional construction and materials inspection costs imposed upon the transportation agency by delayed job completion. Although federal regulations have recently been changed to allow the states to develop their own liquidated damages schedule based on actual costs of construction engineering and inspection to the transportation agency, as of yet few states have undertaken this exercise.

III. STUDY DESIGN

A threefold approach was undertaken in the conduct of this study. This approach incorporated:

- 1) investigation into the effectiveness of incentive/disincentive clauses;
- 2) investigation into development of guidelines for determining on which projects I/D clauses should be employed as well as what values should be used; and
- 3) development of a new liquidated damages schedule based on actual costs to NJDOT of construction and materials inspections.

As a first step in this study, it was necessary to assemble a data base regarding incentive/disincentive clauses and liquidated damages from which further investigation could proceed. Four tasks were identified in this area.

1. Assemble and review construction engineering costs.

For this task, Department sources would be relied on to provide costs for a cross section of projects by total contract amount for several general project types including resurfacing, bridge reconstruction, major roadway reconstruction and new construction. These costs could be used in development of both a new liquidated damages schedule and a schedule of incentive/disincentive values.

2. Contact other states and assemble and review their methods for determining where incentive clauses were to be used as well as the results of their use.

Information provided by this task would be useful in determining the effectiveness of incentive/disincentive clauses as well as in developing guidelines for use of I/D clauses and a schedule of I/D values to be used.

3. Estimate user impacts of delayed work completion.

Since federal regulations allow user costs to be used as justification for use of I/D clauses, this information would be useful both in developing guidelines and a schedule of I/D values to be used.

4. Where it is possible, identify relationships between delays in construction and actual incurred costs.

This information would be useful in developing a new liquidated damages schedule based on actual costs.

Once the initial data base assemblage tasks have been completed, the investigation would proceed to "methods development tasks" which would:

1. Prepare a decision theory framework for selecting projects which would incorporate incentive/disincentive clauses.
2. Develop both liquidated damages and incentive/disincentive schedules based on analysis of data obtained in previous stages.

Both of these method development tasks would depend upon information derived from the previously assembled data base for completion.

The final step of this investigation would be the implementation of the results. Implementation tasks would include integration of legal opinion into the decision matrix to form a procedure, circulation of the proposed procedure and incorporation of modifications to put the proposal in working form (policy and procedures, specifications, etc.).

Concurrent with the implementation tasks, a final report detailing the results would be drafted.

IV. RESULTS

The initial source of information used in this investigation was a previous survey sent to all states transportation departments which included a question concerning use of incentive/disincentive clauses. The responses to this survey were used to select those states which would be contacted for a more in-depth followup on their use of I/D clauses.

The results of analysis of other states' use of I/D clauses as well as NJDOT's own experiences with them follow. They have been divided into the three areas of investigation (Effectiveness, Guidelines and Liquidated Damages) which were mentioned previously in the study design. A fourth section has also been added documenting the results of the methods development tasks previously mentioned in the study design.

Effectiveness of Incentive/Disincentive Clauses

From analysis of the information received it was found that in almost all cases where an I/D clause was used, it had proven successful with the contractor receiving the maximum amount. In the few cases where incentives have been unsuccessful, other reasons including change in project scope, bad weather and unanticipated difficulties were deemed responsible. However, although I/D clauses were almost always successful in obtaining early project completion, very selective use was made of them. As an example, Maryland DOT, who has made comparatively more extensive use of I/D clauses, only included them in 13 contracts over a 5½ year period. In fact, all states contacted agreed that selective use should be made of them; their use mostly being limited to projects where heavy delay, travel and operational costs are anticipated to the general public or to emergency situations which require fast completion.

Information provided by the other state highway and transportation departments has shown that a range of incentive values have proven effective in

encouraging the early completion of critical construction projects. Values used have ranged from a high of \$10,000 per day to a low of \$2,500 per day. In almost all cases, the incentive and disincentive values were equal.

Guidelines for Use of Incentive/Disincentive Clauses

Although all states agree that very selective use should be made of incentive/disincentive clauses in construction contracts, very few states have more than general guidelines as to how this use should be limited. General guidelines used include anticipated high travel and operating costs to the general public, anticipated high delay to the general public, a long alternate route or detour, work on a high volume road (where high delay is anticipated) and inconvenience to the traveling public. None of these general guidelines are quantified.

Maryland DOT provided guidelines that were a little more specific by listing common situations which would warrant consideration. These are:

- 1) an existing roadway experiencing congestion with a capacity improvement planned;
- 2) a loss of capacity during construction;
- 3) a long detour route required during construction;
- 4) an interchange replacing an intersection;
- 5) an increase in facility types that will significantly decrease travel time.

The Texas Transportation Institute has also come up with more specific guidelines which involve classifying all construction projects into three categories: conventional, accelerated and incentive (I/D). The incentive category is actually a subset of the accelerated category since the project must meet all criteria for the accelerated category as well as several additional ones to be included as an incentive project. The criteria set out for a project to be classified in one of three categories is included in this report as Table 1.

As stated previously, most states use increased road user costs to the public as justification for use of an incentive/disincentive provision in a contract. Different methods are used to estimate road user costs, however, some examples follow.

Texas determines road user costs through use of the Highway Economic Evaluation Model (HEEM) which calculates a benefit/cost ratio for the planned improvement. Colorado uses the AASHTO method to estimate road user costs. However, they warn that this method seems to result in cost estimates which are too high. Maryland DOT uses a method which takes into account cost of delay, cost of energy and cost of accidents to determine road user costs used in justifying an incentive/disincentive value. Florida DOT suggests that the cost for construction engineering inspection services, delay cost to the facility users or expected improvement at high accident locations are examples for which impacts can normally be reasonably estimated. They go on to include other reasons for use of incentives/disincentives such as more circuitous access to residents or businesses during construction and impacts to community services, as examples of valid impacts which needed to be documented.

Although road user costs are used extensively by each state in justifying the incentive/disincentive value chosen, the initial choice of I/D value is rather arbitrary in most cases. Only Florida DOT has a suggested schedule of I/D values to be used. This schedule is based on estimated total cost of construction, a technique which could be of use to NJDOT. Florida DOT's table of values is included in this report as Appendix A.

Liquidated Damages

Most states contacted presently use the AASHTO developed liquidated damages schedule now in use by NJDOT. Almost all of these states, however, had problems in recouping actual construction and materials inspection costs.

There was also some reservations as to how effective the present liquidated damages schedule was in discouraging time overruns on construction projects.

A recent change in federal regulations has mandated that states develop their own liquidated damages schedules based on actual construction engineering costs and subject to periodic review by the federal government. The new liquidated damages schedules, however, are limited to only construction engineering and inspection costs. Road user costs to the public cannot be included in developing this schedule. Road user costs can, however, be included in determining the "disincentive" if an incentive/disincentive clause is invoked in a construction contract. Since normally disincentives are paired with incentives, there is very little experience with use of only a "disincentive" clause in a construction project. Most states discourage their use because of doubts as to whether such a clause would stand up in court. However, the recent revision in federal regulations allows the use of liquidated damages to cover anticipated delay related construction costs above and beyond those attributed to construction engineering provided that they can be reasonably anticipated if a delay were to occur in project completion and that they be specified separately. Use of these additional costs tends to serve the same purpose as use of a disincentive, i.e., to assure on-time completion.

Methods Development

Based on the results documented in the preceding section, three development tasks were undertaken. These were:

1. Development of a decision framework (guidelines) for selecting projects which would incorporate incentive/disincentive clauses.
2. Development of a schedule of incentive/disincentive values for various ranges of total project cost.

3. Development of a new liquidated damages schedule based on actual costs to NJDOT of construction engineering and inspection.

The results of these tasks are expanded upon in the following section.

As was shown previously, very few specific guidelines exist as to how to determine which projects should include incentive/disincentive clauses. One guideline, however, which showed some promise was that developed by the Texas Transportation Institute. This guideline developed criteria (see Table 1) which allowed all projects to be classified into one of three categories: conventional, accelerated and incentive. While still not quite specific enough, it was felt that this guideline could be useful as a basis for developing a two part decision framework for use by NJDOT in selecting which projects would incorporate incentive/disincentive clauses.

The proposed two part decision framework would use the Texas Transportation Institute criteria as a first step to classify all projects into the three categories. In addition, however, as a second step a further series of criteria would be used to objectively rate those projects included in the accelerated classification. These project rating criteria follow. For the most part, this rating system mirrors the informal process by which decisions as to use of I/D clauses are already being made. Each of the categories shown have been weighted to quantify their relative importance in the selection process. The individual ratings are then quantified to complete the rating process. The results of this rating process can be used as a means of ranking projects which most deserve to have an incentive/disincentive clause. The weights presented in Table 2 are meant to take into account the interdependence among the various items. However, these are flexible and can be changed pending further discussion.

The task of developing a schedule of incentive/disincentive values involved a different problem than that faced in developing guidelines. In this case, there

TABLE 1
TEXAS TRANSPORTATION INSTITUTE CRITERIA

Classify projects into three categories:

1. Conventional

Working periods: 1 shift; 40-60 hours work week.

Use normal contracting method.

2. Accelerated

a) High road user delay costs due to delay resulting from construction activity.

b) High traffic volumes.

c) Involves major reconstruction of existing freeway.

d) Benefits outweigh cost of incentive payments and additional construction costs.

Working periods: 2 shifts; 96 hours work week.

Deserves to have construction process speeded up over normal contracting method but not I/D.

3. Incentive (I/D)

a) Previous characteristics of accelerated projects; plus one or more of the following additional characteristics:

b) Some useful part of the project can be done well before the rest of the work and is of some significant benefit to the public.

c) Project is a prerequisite to the use of some other project, i.e., to remove a serious bottleneck or to close a gap.

d) Project is needed by a specific date to provide service to some other traffic generator.

- e) Project will involve the prolonged closure of one or more freeway lanes.
- f) Project is located on a freeway with a traffic density above 15,000 vehicles per day per lane of average weekday traffic within project limits.

Working periods: 2 shifts; 120 hours work week.

TABLE 2
PROJECT RATING CRITERIA

<u>CRITERIA</u>	<u>WEIGHT</u>	<u>RATINGS</u>
AADT within project limits	.25	5 = very high 4 = high 3 = moderate 2 = light 1 = very light
Congestion on existing roadway	.05	5 = high congestion 3 = moderate 1 = low
Loss of capacity during construction	.10	Capacity reduced from: 10 = road closed completely 8 = 4 lanes to 1; 3 lanes to 1 6 = 4 lanes to 2 4 = 3 lanes to 2 2 = 4 lanes to 3 0 = no capacity reduction
Length of detour	.05	5 = long detour required 3 = moderate detour required 0 = no detour required
Increase in average travel time during construction	.25	5 = large increase 3 = moderate increase 1 = small increase 0 = no increase
Alternate route availability	.15	5 = no alternate routes available 4 = some alternate routes available; mostly local streets or roads 3 = some alternate routes available; including arterials 2 = many alternate routes available; mostly local streets or roads 1 = many alternate routes available; including arterials
Completion date flexibility	.15	5 = none; road must be opened by specific date 3 = some; some delay of road opening can be tolerated 1 = very flexible

was much experience with use of I/D clauses available; however, in almost all cases, the I/D values used were successful. Successful values ranged from \$10,000 per day to \$2500 per day, and there was no universal correlation between I/D value used and total project cost. Only Florida DOT, as noted previously, had developed an I/D value schedule for various ranges of total project cost.

Since I/D values lower than \$10,000 per day had been successful in obtaining the desired result of encouraging early completion in other states, it seemed that lower values could be used successfully by NJDOT as well. It was decided, therefore, to use average daily work performed on the project as a logical means of determining I/D values for various ranges of total project cost.

Average total work performed per calendar day for various ranges of total project cost was obtained from NJDOT's Construction Engineering Manpower Management (CEMM) system. Since approximately 40 percent of the total daily work performed represents labor costs, the average daily work performed was multiplied by 0.4. These values were used to develop the I/D value schedule (Table 3). The minimum I/D value to be used was set at \$2,500/day since this was the minimum value used by other states. The ranges chosen were those used by AASHTO in their liquidated damages table. However, several lower ranges were combined since the daily labor cost was less than \$2,500.

This schedule should be tested to determine its effectiveness in encouraging early completion of construction projects. If proven effective, it should still be subject to periodic review and adjustment so as to stay in line with actual project costs.

The final methods development task involved the development of a new liquidated damages schedule based on actual construction engineering costs to NJDOT. Again the CEMM system was used to obtain the raw data from which average daily cost to NJDOT of construction engineering and inspection was

calculated. Average cost per calendar day of construction engineering and inspection was calculated for various ranges of total project cost. The ranges used for total project costs was taken from the AASHTO liquidated damages schedule presently in use. However, the lower three categories were combined and four upper categories were added to take into account the increase in higher total cost projects being put out for bid.

In the ranges above \$10 million total project costs, there was very little actual data available and extrapolation was necessary in order to obtain average² cost estimates for these ranges. Table 4 shows two such extrapolations.

Schedule A uses a curve fitted to the available data below \$10 million total project costs to obtain estimated costs beyond \$10 million total project cost.

The curve used is:

$$y = 440x^{0.4}$$

where:

y = average cost per calendar day to NJDOT for construction engineering and inspection, and

x = total project cost in millions

Schedule B uses the fact that NJDOT's average costs below \$10 million total project cost closely parallel Florida DOT's costs (NJDOT's costs run a range ahead of Florida DOT's) to come up with estimates in the higher ranges. In this case, Florida DOT's schedule (see Appendix B) is used for comparison because Florida is one of the few states which have already based their liquidated damages schedule on actual costs, as mandated by their legislature.

Both schedules could be on the high side since what little actual data which is available in the top ranges tends to show lower actual costs to NJDOT. For this reason, Schedule A is recommended.

TABLE 3

PROPOSED INCENTIVE/DISINCENTIVE VALUE SCHEDULE

<u>Total Project Cost</u>	<u>Average Total Work Per Calendar Day</u>	<u>Incentive/Disincentive Per Calendar Day</u>
0 - 1.0 million	\$ 3,189	\$2,500
1.0 - 5.0 million	\$ 7,657	\$5,000
5.0 - 10.0 million	\$13,589	\$7,500
10.0+ million	\$25,186	\$10,000

TABLE 4

PROPOSED LIQUIDATED DAMAGES SCHEDULES

(Liquidated Damages Per Calendar Day)

<u>Total Project Cost</u>	<u>Schedule A</u>	<u>Schedule B</u>
0 - 0.5 million	300	300
0.5 - 1.0 million	400	400
1.0 - 2.0 million	500	500
2.0 - 5.0 million	700	700
5.0 - 10.0 million	1000	1000
10.0 - 15.0 million	1200*	1250*
15.0 - 20.0 million	1375*	1500*
20.0 - 25.0 million	1500*	1750*
25.0+ million	1650*	2000*

* = extrapolated data

Again as with the suggested I/D value schedule, whatever liquidated damages schedule is finally adopted must still be subject to periodic reevaluation and adjustment since it should reflect actual costs to NJDOT of construction engineering and inspection. Since much of the raw data used to perform review and reevaluation of both the I/D value and liquidated damages schedules is contained within the CEMM system, it would seem that this system could be used, with modification, to perform these tasks.

V. DISCUSSION AND SUGGESTED RESEARCH

There are several points concerning the Methods Development Tasks work which should be further clarified.

In regard to the suggested liquidated damages schedule presented, it should be noted that these values represent the average cost per calendar day for construction engineering and inspection to NJDOT for the particular range of total project cost. This was deemed as the most defensible method of developing a new liquidated damage schedule. However, either the maximum or minimum values for each total cost range could also be used. The decision as to which values to use in any new liquidated damages table is a policy decision beyond the scope of this report.

The I/D value schedule presented by this report was set up to reflect the existing total project cost ranges in use by NJDOT. The lower ranges were consolidated into one range of total project costs less than or equal to \$1 million, with an I/D value for this range set at \$2,500 per calendar day as this was the lowest I/D value used by other states' transportation agencies. If an I/D value schedule is to be developed for other agencies, particularly where smaller projects are typical, the lower total project cost range on this schedule should be broken down and similar investigation performed to determine actual work per day costs for the new ranges. One example of such a technique would be to

develop a schedule for county use. Such a schedule would reflect actual county construction projects normally lower total cost jobs than NJDOT construction projects.

Finally, some mention has also been made in this report to the use of road user costs to justify incorporation of an incentive/disincentive clause in a construction contract. Various states have different methods for estimating these costs and there is no universally accepted method. A method for estimating road user costs, developed by the NJDOT Division of Research, is included as Appendix C.

However, further research should be made into development of a procedure for estimating road user costs which would tie set amounts of road user costs to such things as various types of construction traffic control, including lane closures, detours, etc, AADT levels and demographics of the surrounding area as well as total project cost.

APPENDIX A

FLORIDA DOT SUGGESTED INCENTIVE/DISINCENTIVE
VALUE SCHEDULE

<u>Estimated Cost of Construction</u>	<u>Incentive/ Disincentive (Per Day)</u>	<u>Maximum Calendar Days</u>
\$30,000,000 or greater	\$10,000	60
\$25,000,000 to \$30,000,000	\$ 8,000	60
\$20,000,000 to \$25,000,000	\$ 6,500	60
\$15,000,000 to \$20,000,000	\$ 5,000	60
\$10,000,000 to \$15,000,000	\$ 4,000	60
\$ 5,000,000 to \$10,000,000	\$ 3,000	60
To \$5,000,000	\$ 2,500	60

APPENDIX B

1986 FLORIDA DOT LIQUIDATED DAMAGES SCHEDULE

<u>Total Project Cost</u>	<u>Florida DOT Schedule</u>
0 - 50,000	50
50,000 - 250,000	100
250,000 - 500,000	200
500,000 - 2.5 million	300
2.5 - 5.0 million	500
5.0 - 10.0 million	750
10.0 - 15.0 million	1000
15.0 - 20.0 million	1250
20.0+ million	1250 + 5/1000 of 1% of contract cost

APPENDIX C

PROCEDURE FOR ESTIMATING ROAD USER COSTS

Costs Due to Delay to Motorists

When a construction project begins, the motoring public can expect to be delayed. Thus, they have various options which include to stop making the particular trip altogether, to change the time of the trip, to change their route for the trip, or to just endure the delay. Most motorists opt for the last option mentioned, especially during peak periods, because they must travel this section of roadway to get to work. Therefore, tremendous delays could result when a lane or lanes of a roadway are closed to traffic. We believe that on most construction jobs, delay costs to the motorist is the most important reason for including an incentive/disincentive clause in the contract.

So now that we know this delay is a major problem in construction areas, how do we put a monetary value on it? This could be a very complicated process which would include costly computer modeling, motorist interviews, and/or an intricate origin-destination study. It also could be as simple as picking a number based on the volume of the main roadway affected. Thus, we first made a determination of what information was important and therefore definitely needed to be known. The first information we needed was the volumes of all roads that are affected by the construction. This should include any side streets which may be affected by either an increase in traffic due to diversion or a detour of route. Also an origin-destination pattern is required for any trip that begins or ends within the construction area. These side street volumes and O-D data is needed due to the fact that the construction project may cause a problem on the local street system causing additional delays. Speed or travel time of the vehicles both during and after construction should be known. Remember this is

the data after construction rather than before because the difference between the travel times during construction and after construction is the extra motorist delayed caused by the construction project going beyond its completion date. All of the data should be by hour for at least the two peak periods. Finally, we must know the phases of construction, their length in time, and the lane closures and detours during each.

Now that all the data required is apparent, we can go about calculating the cost of the delay to the motoring public. The first step is to map the normal route and the route taken during each construction phase for all trips affected. This step would be relatively easy for a lane closing on a rural interstate which has no alternative route. However, for the closing of an interchange area or ramp, it may be excessively costly and time consuming. The new routes used for diverted traffic would be the detour routes developed in the construction plans. Other data needed for this step would include the volumes and possibly the origin-destination information.

The second step would be the calculation of the travel time. Since we know the volume and configuration of the roadway, we would use the procedures presented in the Highway Capacity Manual to determine the speed of the vehicles through each specific section for each construction phase. Then the speed of the vehicles through each section after the completion of construction would be calculated. The travel times would then be calculated by dividing each trip's distance by the estimated speed. The motorist's travel time delay would simply be the difference between these calculated travel times by trip, by hour, and by construction phase.

EXAMPLE OF USER COST ANALYSIS

Route: I & 9T, Section 15

Type: Bridge Reconstruction

Primary User Delay Cause: 24 hour lane closure

Assumptions:

- 1) Diversion from the route under construction will occur. Diversion will be between 25 and 50 percent.
- 2) Half of route diverters will cease make the trip entirely.
- 3) Roadway capacity and demand are per data supplied by Region II Design, the Bureau of Data Resources and the 1985 Highway Capacity Manual.

Analysis:

A sample worksheet for the 25 percent diversion scenario for eastbound volumes shows impact of HCM tables and figures on estimated capacity, queuing and delay. Cost factors described in the preceding writ-up were applied to the delay estimates to calculate motorist delay costs. A table summarizing all diversion scenario results has also been attached.

RT19T25E
01/10/86

ROUTE 1&9T Sec 1S - USER COST ANALYSIS

Eastbound Scenario 25 % Diversion

Hour	Equiv Volume	Trucks		Capacity	.75 x Vol	Vol-Cap	Queue	Maximum Delay Hr per EqVeh	\$ Costs		Hrs Delay		\$ Costs	
		14% AM	Actual						Total Delay Hours	Non Div Half of Diverted	Half of @ 15 min Per Veh	Half of Diverted		
6 - 7 AM	2900	.14	2042	1350	2175	825	825	0.61	374.41	1818.60	255	63.82	309.99	
- 8	3610	.14	2542	1350	2708	1358	2182.5	1.62	1699.07	8252.74	318	79.45	385.88	
- 9	3140	.14	2211	1350	2355	1005	3187.5	2.36	2638.78	12817.08	276	69.10	335.64	
- 10	2870	.14	2021	1350	2153	803	3990	2.96	3223.70	15658.14	253	63.16	306.78	
- 11	2340	.25	1560	1350	1755	405	4395	3.26	2906.80	16031.00	195	48.75	268.86	
- 12	2300	.25	1533	1350	1725	375	4770	3.53	3122.89	17222.73	192	47.92	264.26	
- 1 PM	2140	.25	1427	1350	1605	255	5025	3.72	3105.38	17126.16	178	44.58	245.88	
- 2	2330	.25	1553	1350	1748	398	5422.5	4.02	3606.32	19888.87	194	48.54	267.71	
- 3	2500	.25	1667	1350	1875	525	5947.5	4.41	4211.11	23224.28	208	52.08	287.24	
- 4	3000	.25	2000	1350	2250	900	6847.5	5.07	5686.67	31361.97	250	62.50	344.69	
- 5	2780	.25	1853	1350	2085	735	7582.5	5.62	5943.02	32775.77	232	57.92	319.41	
- 6	2370	.25	1580	1350	1778	428	8010	5.93	5474.70	30192.97	198	49.38	272.30	
- 7	1310	.25	873	1350	983	-368	7642.5	5.66	3037.74	16753.16	109	27.29	150.51	
- 8	1200	.25	800	1350	900	-450	7192.5	5.33	2637.33	14544.89	100	25.00	137.88	
- 9	930	.25	620	1350	698	-653	6540	4.84	1892.03	10434.56	78	19.38	106.85	
- 10	800	.25	533	1350	600	-750	5790	4.29	1461.33	8059.25	67	16.67	91.92	
- 11	810	.25	540	1350	608	-743	5047.5	3.74	1300.50	7172.26	68	16.88	93.07	
- 12	790	.25	527	1350	593	-758	4290	3.18	1092.83	6026.98	66	16.46	90.77	
- 1 AM	760	.14	535	1350	570	-780	3510	2.60	927.70	4506.02	67	16.73	81.24	
- 2	550	.14	387	1350	413	-938	2572.5	1.91	523.53	2542.90	48	12.10	58.79	
- 3	410	.14	289	1350	308	-1043	1530	1.13	263.23	1278.55	36	9.02	43.83	
- 4	380	.14	268	1350	285	-1065	465	0.34	118.64	576.25	33	8.36	40.62	
- 5	440	.14	310	1350	330	-1020	0	0.00	32.02	155.52	39	9.68	47.03	
- 6	910	.14	641	1350	683	-668	0	0.00	0.00	0.00	80	20.03	97.27	

24 Hour = 298421 885 4648

RT19TOT
01/10/86

ROUTE 1&9T Sec 1S USER DELAY COSTS

Scenario ////////	Non Diverted Vehicle Costs ////////////////////////////////////			Diverted Vehicle Costs ////////////////////////////////////			All Vehicles ////////
	Daily Dollars		Total	Daily Dollars		Total	Dollars
Percent Diversion	Eastbound	Westbound		Eastbound	Westbound		Total
25	298400	78100	376500	4600	3900	8500	385000
30	233800	40600	274400	5600	4700	10300	284700
40	114300	12100	126400	7400	6300	13700	140100
50	17100	2900	20000	9300	7900	17200	37200