PHASE 1 INTERIM REPORT

FACT-FINDING AND PROGRAM PLAN DEVELOPMENT

DEVELOPMENT OF METHODS TO EVALUATE AIR QUALITY CONTROL MANAGEMENT STRATEGIES FOR HYDROCARBONS AND CARBON MONOXIDE FOR THE STATE OF MICHIGAN TRANSPORTATION SYSTEM

Pacific Environmental Services, INC.

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I. INTRODUCTION

The purpose of this study is to provide the State of Michigan and its cities with the ability to assess the potential usefulness of the nineteen Reasonably Available Control Measures (RACMs) specified by EPA for reducing mobile-source emissions. Those metropolitan areas not in compliance with the EPA requirements on hydrocarbon and carbon monoxide pollution concentrations must submit implementation plans demonstrating how they will reduce emissions to meet the standards.

The presently available transportation evaluation (simulation) models have not been designed to reflect the impacts of most of the RACMs. Thus these models need to be modified, or supplied with suitably-adjusted input conditions, to make them useful for evaluating RACM impacts. Simulations of RACM implementations in sample cities, using the enhanced transportation and emissions models, can be used to provide guidance to other similar cities which need to estimate the potential effectiveness of the RACMs for themselves.

SCI (Vt) and PES will assist MDOT in developing the needed enhancements to its present model battery. The enhanced models will then be used to generate a RACM-impact data base, which will be made available to all of the non-compliant Michigan cities in the form of a handbook. The cities will be able to use the handbook for guidance in making their own choices of which RACMs to attempt to implement in order to bring themselves into compliance with the EPA standards.

This interim report provides an overview of some of the background information collected during Phase I of this project, including reports generated throughout the country describing other states' and localities' experiences with RACM evaluation and implementation, as well as information about the capabilities of the present battery of Michigan models. Recommended methods for quantifying the impacts of each of the 19 RACMs and recommended combinations of RACMs are then proposed and explained. A program plan and a schedule for the remaining work are proposed. The level of effort required to execute each task is estimated in a manner designed to facilitate revised costing to reflect deletion of any task or subtask should such a modification be desired.

II. FACTORS INFLUENCING PROGRAM PLAN DEVELOPMENT

2.1 REVIEW OF CORRESPONDING ACTIVITIES IN OTHER CITIES AND STATES

Efforts to quantify the transportation and emissions impacts of the 19 RACMs throughout the country have been reviewed. The results of telephone inquiries to the 10 EPA regions were summarized in the memorandum of February 28, 1979 (Attachment). Those telephone inquiries yielded a collection of documents describing the transportation-air quality analyses being conducted in several metropolitan areas. Those case studies are reviewed briefly here.

2.1.1 <u>Washington, D.C. Area</u> (R. H. Pratt Assoc.) [1]

This study was based on the use of a classical four-stage transportation model to evaluate the impacts of 62 transportation-control measures both individually and arranged into four "packages". The TRIMS models applied here used standard socio-economic variables for trip generation, a gravity model for trip distribution, and a minimum-path, all-or-nothing, traffic-assignment method. Work-trip modal split between highway and transit was based on travel time and cost differences, and between auto drivers and passengers was based on parking cost and density. Nonwork and non-home-based mode splits were based on manual sensitivity estimates. An attempt was made to use the Denver three-way logit mode-split model, but it was not calibrated for the Washington area. RACMs which do not directly affect travel times and costs could not be represented explicitly in this study, and estimates of their impacts had to be based on judgment and past experience. VMT were separately computed for autos and trucks, aiding the emissions inventory.

The 62 transportation-control measures were classified in order of their political acceptability and expected emissions impacts. Tables were provided showing the expected changes in travel (mode split) for 40 of the principal control measures, as well as the emissions-reduction percentages. These ranged from 0.1% for some bus operational changes to 9.6% for charging hourly parking rates throughout the day, and 8.1% for inspection and maintenance. An appendix included descriptions of the analysis methods used to evaluate the impacts of each of the 62 control measures.

2.1.2 Baltimore

The four-volume Transportation Control Plan (TCP) published in September 1978 [2] incorporates projections of transportation and air quality through 1987. Part of the procedure for identifying the RACMs to pursue was a public workshop at which the RACMs were ranked by acceptability. Baseline travel conditions were from the 1977 General Development Plan for the region, incorporating a standard four-stage demand model and capacity restraint in the traffic assignment. The VMT reductions from the various RACMs were either based on the products of previous planning studies (rail transit) or on some rough assumptions (in most cases not even sketch planning). The ride-sharing analyses in particular seemed to be based on a priori assumptions about the number of travelers who would join carpools or vanpools. Peaking effects were not well represented because of the aggregation of three hours into the peak.

The individual TSM-oriented strategies which were studied all showed HC and CO emissions reductions of less than 1%. Indeed, combining park/ride, improved rail transit, carpooling, vanpooling, bus service improvements, reductions in idling, bicycling and land use changes produced a 2.4% drop in estimated HC for 1982 (relative to 1977) and a 1.75% drop for 1987 (in summer peak hour). Inspection and maintenance alone, on the other hand, was estimated to reduce HC by 4.5% in 1982 and 13.6% in 1987.

2.1.3 New York Metropolitan Area – Tri- State [3-6]

The Tri-State Regional Planning Commission, the MPO for the New York Metropolitan Area, has performed some very detailed studies of TSM impacts for their SIP. The baseline analyses were conducted with a UTPS simulation of the region and a special modification of MOBILE1 to reflect regional conditions. The Tri-State version of MOBILE1 includes taxis as a distinct mode, and disaggregates the network by type of road, especially for separating out cold-start effects. The start-up emissions are determined using information about trip ends and VMT.

Detailed sensitivity studies with MOBILE1 demonstrated some of the critical input conditions. For example, differences in the age mix of the vehicle fleet can produce changes in emissions equivalent to several years worth of progress. The ambient humidity was shown to have a strong impact on NO_x. Truck engine sizes and gross weights strongly influence emissions, especially in later years when autos are cleaner. An apparent deficiency of MOBILE1 was its use of the ratio of truck weight to engine size to compute emissions, without separately considering truck size as well.

Short-term policy changes affecting mode splits among auto, shared-ride and transit modes were treated using pivot-point sketch-planning tools, based on demand elasticities with respect to time and cost. Changes which could not be represented by time or cost changes required some more arbitrary assumptions. Five different levels of off-street parking restriction were tested, using many simplifying assumptions, and gasoline tax increases and transit fare cuts were also evaluated. Increases in the gasoline tax of 10¢ and 30¢ per gallon produced respective regional VMT reductions of 2.11% and 6.35%, while a 40% transit fare cut reduced regional VMT by 2.73%.

The dominant emissions reduction source in the SIP was vehicle turnover, which permitted reductions in mobile-source HC emissions of 47.6% and 69.3%, respectively, in 1982 and 1987 (relative to 1977). Adding in all the other transportation-control measures increased the anticipated percentage reductions to 50.7% and 76.8% in the two future years.

2.1.4 Philadelphia (Delaware Valley Regional Planning Commission) [7 - 10]

An extremely detailed model of the Philadelphia metropolitan area has been implemented using UTPS, and has been used to evaluate some highway TSM improvements. Transit improvements were assessed by manually adjusting impedances to produce mode-split changes, because it was found not to be cost effective to do a full-scale simulation for each. A total of 374 TSM project improvements produced a system capacity improvement of only about 3%.

The 1979 SIP identified 70 actions under 16 of the RACM categories, and assigned priority, for detailed study in the spring of 1979, to 25 of them. All projects presently under construction or in the planning process were together found to produce HC reductions far below the reductions needed to meet the EPA standards. More ambitious control measures are to be simulated in the future using the detailed model.

The trip generation, distribution, and mode-split models are very complicated and highly stratified, but are still based firmly on the old sequential-choice theory. Trip generation and attraction models use zonal data on population, households stratified by car ownership, employed residents, automobile registrations, and employement in 12 categories. There are seven separate gravity models for trip distribution, depending on trip purposes and types of vehicle. The trip-interchange mode-split model uses 18 stratified diversion curves for time and cost differences, with three trip purposes, three submodes and two auto-ownership classes. Submode allocation follows a minimum impedance algorithm in the traffic assignment model. Ride sharing is represented by two correlative (linear regression) auto-occupancy models stratified by trip purpose and using driving time as the independent variable.

2.1.5 Denver [11 - 13]

The Denver area, with one of the most serious pollution problems in the country, also has one of the most advanced studies of mobile source emissions. A UTPS model of the region, with 654 zones, has been implemented and used to establish baseline conditions. Modifications are represented by sophisticated sketch-planning methods, using disaggregate demand models (which are also in the detailed UTPS model).

Trip generation is based on the number and size of households per zone, cross-classified by four income groups; while distribution depends on employment. The disaggregate demand models (logit form) are used to predict auto ownership, work-trip mode choice and non-work-trip frequency, destinations and mode choice (separately for shopping/personal business and social/recreation). These models appear to be particularly responsive to the control measures of interest, especially ride sharing. The formulation incorporates the likely use during the midday of autos left home by workers who are riding with others, for example.

The most detailed analyses for Denver were of inspection and maintenance, employer-based ride sharing, preferential treatment for high-occupancy vehicles, parking management, improved bicycle facilities and improved transit. The methods and assumptions used, and the predicted impacts, are reviewed in the appropriate later sections. The complicated interactions among the control strategies evaluated for Denver were revealed when three "packages" of alternatives were tested. For example, doubling the price of fuel was shown to have a strong impact on non-work travel, but almost no impact on work travel, producing a total VMT reduction of about 10%, with about a 5% drop in CO and HC. On the other hand, a ride sharing, transit and parking package caused significant savings in work trip VMT and emissions with small increases for non-work travel, producing a total 1% VMT saving and 1.6% HC reduction. The value of the demand model formulation was well demonstrated by the comparison between the two strategies. The most stringent of the simulated program packages (including parking restrictions, transit improvements, and tripling the fuel price) reduced VMT by 15.3% and both HC and CO by 9.0%. Because of the demand model formulation, this also reduced anticipated auto ownership by 1.4% (which seems quite reasonable).

The strongest impact on emissions (after the federal motor vehicle emission standards) was found to be the inspection and maintenance program, which was estimated to reduce HC and CO by four and eight times more, respectively, than the VMT-reducing measures alone. Other potent emissions-reduction alternatives were several different categories of retrofitting emissions controls to pre-1974 vehicles, and high altitude modifications and tuning. Each of these dominated the TSM control measures.

2.1.6 Upstate New York (Syracuse and Herkimer-Oneida Counties [Utica]) [14, 15]

The upstate New York metropolitan areas have been estimating transportation emissions reductions using the approximate methods suggested by the New York State DOT [16]. In both cities, the various RACMs were assumed a priori to induce specified percentage changes in total VMT or particular subsets of VMT. These VMT changes were passed through a capacity-restraint type of calculation to see how much they would change travel speeds (virtually always a negligible effect), and then used to compute percentage emissions changes. The crucial simplifying assumptions were in the total area-wide aggregation and the a priori estimates of VMT changes.

2.2 REVIEW OF MICHIGAN MODEL DEFICIENCIES RELATIVE TO STUDY REQUIREMENTS

The Michigan battery of transportation and emission models is not, in its present form, capable of reflecting the impacts of all

19 RACMs. Those RACMs which include use of public transit modes or ride-sharing cannot be accommodated within the road-only framework of the TRIPS package resident on the Burroughs B-7700 at Lansing. These RACMs will require use of the UTPS package on the Wayne State IBM computer, with its multi-modal capability. UTPS will need modifications and changes in its use if it is to incorporate the desired effects.

The UTPS modal split model presently implemented at Wayne State uses traditional diversion curves stratified by income and destination land use type, with travel time ratio between transit and auto as the independent variable. This formulation does not incorporate the cost of making a trip, rendering it incapable of reflecting the effects of changes in gasoline and parking costs or transit fares. Furthermore, the present model does not consider the existence of shared-ride modes (carpool, vanpool) separately. The effectiveness of these shared modes is best evaluated if they are treated separately from the auto mode, rather than being incorporated in an estimate of average auto occupancy. Data will be needed to develop and calibrate the model of ride sharing, and to recalibrate the auto-transit mode split model incorporating costs.

Inherent in the sequential trip generation-distribution-(mode-split) - traffic assignment modeling of the TRIPS (or UTPS) package is the inability to modify trip generation as transportation level of service changes. This makes the present models ineffectual for representing measures which are designed to reduce total trip-making. The gravity model used for trip distribution incorporates an impedance measure, which could be adjusted to reflect changes in level of service. In the present implementation, the predicted trip attractions are adjusted until they sum to the total of trip productions (for which the data are better). Level of service changes could be accounted for by inserting an additional correction to both productions and attractions, using changes in the impedance in the gravity model.

The current trip generation model generates vehicle trips at an assumed level of vehicle occupancy (except in Flint, where person-trips are generated). Person-trips should be used throughout so that the effects of ride sharing and transit can be captured. The auto-ownership decision is exogenous to the models as presently implemented, but should be responsive to changes in transit and ride-sharing service. An auto ownership model, incorporating the full costs of auto ownership (rather than only the perceived marginal cost for additional mileage traveled), would be a useful addition to the model battery.

Congestion effects could be captured much more realistically if the models were used to separately represent travel in the two peaks and the off-peak, rather than using a day-long average as they do now. This would not only make it possible to evaluate peak-flattening strategies such as staggering of work hours, but would also increase the fidelity of the representation of all strategies which are designed to reduce congestion and increase travel speeds. Traffic flow data disaggregated by time of day would be needed to effect the three separate model calibrations which would then be necessary.

Prediction of the pollutant emissions in a transportation network requires a more detailed representation of traffic flow than is customary in urban transportation planning models such as UTPS or TRIPS. Not only overall average travel speeds, but also the amount of idling and accelerations and decelerations should be known in order to produce good emissions estimates. This is particularly important for evaluating traffic flow improvements such as changes in signalization. The traffic assignment should be applied with capacity restraint to converge on an equilibrium flow speed. Additional corrections should be added, however, to account for the expected interruptions of the flow (at intersections, entrance and exit ramps, weaving sections, etc.). These correction factors should be developed based on the type of road, the part of the urban area where it is located and the number of signals per mile (assuming different signal cycle characteristics within the different parts of the urban area).

The current implementation of the EPA emissions program, MOBILE1, and its interface with the transportation models, TPEMIS, are too highly aggregated in several ways to adequately reflect the emissions impacts of many of the RACMs. Because intrazonal trips are not assigned to the network, they don't enter the emissions model currently. The emissions produced on the terminal (intrazonal) portions of interzonal trips should also be accounted for. Incorporation of intrazonal travel emissions requires that the average length and speed of intrazonal trips be estimated for each zone.

The present emissions model includes the implicit assumptions that a fixed portion of each link travel time is spent idling, that trucks comprise the same portion of the traffic on all links, and that fixed percentages of the VMT on each link are in the cold start, hot start and steady-state warm modes of operation. These overly aggregate assumptions should be overridden in the upgraded model system. With truck and auto traffic assigned separately, the emissions calculations can also be effected separately. The upgraded representation of traffic flow (with corrections for different levels of signalization in different parts of the urban area) permits the fixed idle percentage to be overridden. Some additional test results may be needed to complete this disaggregation, which should be a high priority item because of the significant error inherent in assuming a substantial percentage of idle time even on freely flowing expressway links. Complete separation of cold-start operations appears to be difficult to achieve in the present models, but at least those trips which are short enough to be completely cold-start can be treated as such, while the longer trips can be divided into a few length classes and the average portions of cold-start operation for each length class can then be applied to all the trips in that class.

In several cases, limited available data prevent the development of model enhancements which would further improve the ability of the Michigan models to predict emission changes. Development of an improved data base is beyond the scope of the present program, but it would be useful to have the data needed to fill the following deficiencies:

- Composition of vehicle fleets in each city (taxis, delivery trucks, corporate and government motor pools, etc.) and their typical utilization

- Utilization of trucks of various weights and engine sizes (hours/day or miles/year)

- Distributions of idling times for various categories of vehicles

- Traffic flows (directional) on key network links by time of day (AM, PM peaks and off-peak)

- Extent to which work hours are already staggered

- Carpool and vanpool operations — average size, number of users, costs to them, trip lengths, socio-economic data (time-series if possible), participation rate by employers

- Redistributions of retail activity on installation of pedestrian malls

- Bicycle rider statistics — trip purposes and lengths

- Congestion in parking lots at large employment sites (wait times)

- Emissions produced by idling vehicles

- Traffic delays as a function of road type, volume/capacity, part of urban area and density of signalized intersections (as well as type of signal progression).

III. RECOMMENDED APPROACH FOR EACH RACM

Combining the information gathered about TSM analysis work conducted elsewhere in the country and the known characteristics and deficiencies of the existing Michigan models, recommendations are developed here about the type of analysis which should be applied to each RACM. In Part II, the general approaches taken by urban areas around the country were reviewed, without detailed discussion of the analyses for each RACM. The Michigan model deficiencies were also reviewed briefly, and general suggestions for corrective measures were offered. In this section, the recommended approach to quantifying the impact of each RACM is proposed, based on the data available in Michigan and elsewhere, the results achieved by others, and the current status of the Michigan models. The references cited in this section are those concerned with development of methodologies, in contrast to the city-specific case studies reviewed in Part II. For several of the RACMs, when the methodology which is expected to yield the best return may be particularly costly, a less ambitious alternative is also offered.

Enhancements to the emissions models will be needed to address all of the RACMs accurately, and are not specifically recommended for the individual RACMs. Unless otherwise noted, the present discussion assumes each RACM to be studied alone. Therefore, UTPS is only recommended where transit modes must be considered. When any "packages" which include transit and other changes are to be evaluated, UTPS will of course be needed.

The recommended approach to each RACM can be summarized by fitting it into one of the following four categories:

(1) Not applicable to Michigan or the present study, and not to be addressed further.

(2) Estimate effect by rough manual approximations, relying on work reported in the literature.

(3) Use existing Michigan transportation simulation models to predict impacts.

(4) Use enhanced Michigan models to predict impacts.

The discussion is directed toward the out-state cities rather than Detroit. Because the separate SEMCOG models are not to be used in this project, the handbook guidelines for SEMCOG will be drawn from the existing literature, without new simulations (i.e., category 2 above).

Recommended Treatment of RACM #1

Title: INSPECTION AND MAINTENANCE

Implementation Level: Federal, state

Potential Benefits: Based on estimates from EPA programs, could be one of the most significant.

Anticipated Feasibility: Acceptable, unless cost appears too high.

Previous Approaches (literature): Assume 1% HC reduction in first year, 3% in later years [16].

Apply MOBILE1 with tabulated emissions factors [17].

Need UTPS? No

Relevant Michigan model deficiencies: Only MOBILE1 deficiencies.

Specific Measures to be Studied: Different levels of stringency in inspections.

Recommended Methodology: Apply different stringency factors in MOBILE1 for baseline travel.

Rationale: No more detailed method is available or needed, and the expense of this method is only the cost of a few extra runs of MOBILE1.

Other Viable Alternatives: Assume simple percentage reductions exogenously as in [16].

Category: Present Computer Models

Recommended Treatment of RACM #2

Title: VAPOR RECOVERY

Implementation Level: Federal, state, local

Potential Benefits: Unknown

Anticipated Feasibility: Already being implemented in some places.

Previous Approaches (literature): Reference to EPA information document in [17].

Need UTPS? No

Relevant Michigan Model Deficiencies: N/A

Specific Measures to be Studied: N/A

Recommended Methodology: Do not consider this RACM here.

Rationale: This is a stationary source effect, dependent on transportation only by a rough relationship to VMT or gallons of gasoline consumed.

Other Viable Alternatives: N/A

Category: Not Applicable

Recommended Treatment of RACM #3

Title: IMPROVED PUBLIC TRANSIT

Implementation Level: Local, with state and federal assistance.

Potential Benefits: Depends entirely on local conditions.

Anticipated Feasibility: Depends on local conditions and financial situation.

Previous Approaches: "Pivot-point" analysis based on demand elasticities [16].

Cambridge Systematics Downtown People Mover planning system for use within activity centers (manual technique) [18].

Computerized sketch-planning techniques such as COMPACT, SNAP, TASSIM, TRIMS [18].

Pivot-point analysis followed by use of detailed simulation model with mode split [17].

Disaggregate sketch-planning models [11].

Detailed multi modal network model with sequential demand modeling.

Need UPTS? Yes

Relevant Michigan Model Deficiencies: UTPS version in use has mode split by diversion curves, considering only the ratio of travel times, without costs. Bus emissions are not counted separately in emissions model, but will have to be grouped with trucks. Service changes not expressed as travel time changes are not reflected. Trip generation is not influenced by level of service.

Specific Measures to be Studied: (Must be specifically designed for each city.)

Improved routing and scheduling (frequency and coverage changes).

Express bus services and circulator-distributors.

Fare reductions

Improved "attractiveness" (shelters, amenities, passenger information systems).

Phase 1 Methodology: Use the existing mode-split model, "tricking" it into representing cost changes by converting costs into equivalent times.

Rationale: Mode split is probably the most difficult transportation system variable to predict, and deserves the most detailed representation which can be provided. Analyses which assume a mode split and then compute the resulting emissions impacts are critically sensitive to the mode-split assumption. The key issue is how changes in transit service will affect ridership, and that is where the effort should be concentrated.

Therefore Phase 2 Alternative: Model transit routes and service explicitly in UTPS, with an improved trip distribution sensitive to level of service.

Category: Present Computer Models

Recommended Treatment of RACM #4

Title: EXCLUSIVE BUS AND CARPOOL LANES

Implementation Level: Local, with state and federal help

Potential Benefits: Significant only where congestion is troublesome, but undesirable elsewhere

Anticipated Feasibility: Depends on local perception of need and of disbenefit to solo drivers (i.e., possible "diamond-lane" fiascos)

Previous Approaches (literature): Assume a peak-hour VMT percentage reduction based on literature experience for corridors, then calculate average speed increase and emissions reduction [16].

Sketch planning using SRGP method [18].

For post-1979 SIPs, corridor studies with three-way mode-split models are recommended. Use existing empirical data on auto occupancy to predict future changes [17].

Disaggregate travel demand models: a three-way mode split-model for work trips; a joint auto-ownership and work-trip mode-choice model;

and a simultaneous frequency, destination and mode-choice model for non-work trips [19, 20].

Combine a disaggregate mode-choice model and deterministic queuing model of traffic flow to obtain supply-demand equilibrium [21].

Need UTPS? Yes, if it is to be modeled directly

Relevant Michigan Model Deficiencies: No separate representation of the carpool or vanpool modes, and no calibrated demand model.

Specific Measure to be Studied: None (see below)

Recommended Methodology: Eliminate this RACM from consideration.

Rationale: This RACM is suitable only for use in large metropolitan areas having serious congestion problems. The out-state Michigan cities do not fit this description. Furthermore, their arterials and expressways do not generally have the minimum of three lanes in one direction needed to implement an exclusive lane strategy.

Other Viable Alternatives: N/A

Category: Not Applicable

Recommended Treatment of RACM #5

Title: AREA-WIDE CARPOOL AND VANPOOL PROGRAMS

Implementation Level: Local, possibly with state

Potential Benefits: Doubtful in small cities, possible in larger cities.

Anticipated Feasibility: Should be no problems

Previous Approaches (literature): See #4 for many of the same considerations, plus:

Empirical evidence indicates at most 1% of employees are diverted to pooling [17].

Disaggregate demand models similar to those suggested for RACM #4 [22].

retail activity, and thereby on trip attractions to the affected zone(s). Delete some of intrazonal circulation trips (amount depending on fraction of zone area occupied by mall).

Rationale: This approach can be accommodated within the available model structure, and appears to capture the important effects.

Other Viable Alternatives: Not necessary

Category: Present Computer Models

Recommended Treatment of RACM #7

Title: LONG-RANGE TRANSIT IMPROVEMENTS

Implementation Level: Local, with state and federal help.

Potential Benefits: Could be significant in large, congested cities.

Anticipated Feasibility: Long lead times prevent implementation soon enough to affect air quality by 1987 unless specific project is already in advanced planning stage.

Previous Approaches (literature): See RACM #3

Need UTPS? Yes

Relevant Michigan Model Deficiencies: See RACM #3

Specific Measures to be Studied:

Major expansion of bus service (frequency, coverage).

Construction of new-fixed guideway services for downtown circulation or line-haul (rail transit, LRT, AGT, etc.).

Construction of park/ride lots for transit-mode interchange.

Phase 1 Methodology: See RACM #3

Rationale: See RACM #3. Long-term fixed-facility investments in transit are known to cause redistribution of activity (BART, Washington Metro, etc.).

However, no such projects will be implemented in the out-state Michigan cities by 1987. Therefore, the land-use impact probably does not have to be considered in much detail (beyond manual adjustments).

Therefore
Phase 2 Alternative: Enhanced version of UTPS, with simulation as described for RACM #3. In addition, manually adjust trip attractions to concentrate in zones near new transit line, reflecting activity shift.

Category: Present Computer Models

Recommended Treatment of RACM #8

Title: ON-STREET PARKING CONTROLS

Implementation Level: Local

Potential Benefits: Probably minor — some congestion relief (street capacity increase) partially offset by additional VMT seeking parking.

Anticipated Feasibility: Already implemented in most Michigan downtowns. May be difficult to promote further unless off-street replacement parking is provided.

Previous Approaches: Change street capacity and parking costs in transportation network models [17].

Rough estimates of VMT and speed changes for first round of SIP submittals [17].

Possible to adjust trip end and capacity information in CAPM if resources are limited [17].

Calculate changes in link capacity with and without parking, and use the revised capacity to find the volume/capacity ratio, new average speed and estimated emissions [16].

Need UTPS? No

Relevant Michigan Model Deficiencies: Inability to precisely quantify change in circulation traffic by drivers seeking off-street parking.

Specific Measures to be Studied: Simulation with present on-street parking situation, then two more (one with parking allowed on all streets, another with no on-street parking).

Recommended Methodology: Network simulation for each case, changing capacity of streets as parking is added or removed. Assume any on-street parking to be eliminated is replaced by equivalent off-street parking, because otherwise this RACM would be politically unacceptable. Restriction of parking supply in downtown would only encourage deterioration and dispersal of activity to outlying areas.

Rationale: Network simulation is needed to capture the effect of this RACM on travel speeds, which is the way it affects emissions. That simulation should not be difficult with the present models. The extra time needed to seek off-street parking can be treated as an increase in the intrazonal access time in the affected zones.

Other Viable Alternatives: None necessary

Category: Present Computer Models

Recommended Treatment of RACM #9

Title: PARK/RIDE AND FRINGE PARKING

Implementation Level: Local, with state and federal help

Potential Benefits: Could be substantial for a congested area, given a large enough investment.

Anticipated Feasibility: Depends on existing congestion level and on availability of parking spaces already (at stadia, parks, shopping centers).

Previous Approaches (literature):

Detailed corridor demand studies, based on a background of limited empirical data and faulty prior predictions [17].

SNAP sketch-planning model [18]

Literature search to estimate ridership, which then determines auto trips and VMT saved (assuming auto-occupancy and trip-length characteristics). [16]

Need UTPS? Yes

Relevant Michigan Model Deficiencies: Lack of a three-way mode-split model incorporating transit and shared-ride private modes.

Specific Measures to be Studied:

- Shuttle service within retail core, with parking nearby (circulation for small cities).
- Carpool/vanpool and bus transit express service from parking lots at the edge of the built-up area (freeway interchanges, regional shopping centers).

Phase 1 Methodology:

- Perform a pivot-point analysis, using standard or estimated demand elasticities and a description of the best feasible level of park/ride service, to determine how many drivers would switch to park/ride. Delete their auto trips from the trip table and recompute the traffic assignment and emissions, including the new auto access trips to the park/ride facility.

Rationale: Ride-sharing and transit behavior should be modeled separately because of their very different service characteristics. The emissions impact of this RACM is determined by how many and specifically which work trips are diverted so that drivers park away from their final destinations. The model should be able to predict these diversions rather than assuming what they are exogenously.

Therefore
Phase 2 Alternative: UTPS simulation using three-way mode-split model, directly representing the park/ride interchange trips as transit and shared-ride trips. Locations of park/ride and fringe lots should be chosen based on knowledge of travel patterns in the specific cities, and transit or shared-ride services as modeled should be consistent with the scale of the urban area.

Category: Present Computer Models

Recommended Treatment of RACM #10

Title: PEDESTRIAN MALLS

Implementation Level: Local, with state and federal help

Potential Benefits: Minimal, possibly even negative, in short run. Potential for beneficial activity shift in long run.

Anticipated Feasibility: Depends on perceived commercial benefits.

Previous Approaches (literature): See RACM #6

Need UTPS? No

Relevant Michigan Model Deficiencies: No reflection of changes in trip attractions to zone of mall.

Specific Measures to be Studied: Pedestrian malls (closing of streets to traffic) in retail cores of cities.

Recommended Methodology: Same as RACM #6. Consider deletion of malls in cities where they already exist, as part of a sensitivity study. Parametrically vary the percentage of retail activity shifted to the mall, and use that to adjust attractiveness of the mall and competing retail zones.

Rationale: This approach can be accommodated within the available model structure, and the manual adjustment to zonal attractions appears to be adequate given the current state of the art in modeling transportation/land-use interactions.

Other Viable Alternatives: For short term, leave out activity shift.

Category: Present Computer Models

Recommended Treatment of RACM #11

Title: EMPLOYER PROGRAMS TO ENCOURAGE RIDE SHARING, TRANSIT, BICYCLING AND WALKING

Implementation Level: Local

Potential Benefits: Possibly significant for ride sharing.

Anticipated Feasibility: Depends on enthusiasm of local employers and their perception of benefits to them.

Previous Approaches (literature): Convert economic incentives into cost changes for the respective modes [17].

No guidance on past experience with encouraging walking and bicycling [17].

Based on past experience, assume all vanpools will run full [17].

Assume 2% of work force in vanpools, all former auto users driving 8.3 mi. [16].

Assume bicycles are used for 5% of the 15% of total trips which are eligible (under 6 minutes by car), at an average length of 2.2 mi. [16].

Need UTPS? Yes for transit and ride sharing

Relevant Michigan Model Deficiencies: None applicable to this RACM alone

Specific Measures to be Studied:

- Parking charges for solo auto drivers (disincentive).
- Employer transit-pass programs (partly subsidized).
- Employer vanpool/carpool matching programs (not clearly distinguished from RACM #5).

Phase 1 Methodology: Most of the specific measures which fit in this category can be represented under one of the other RACMs. The distinguishing feature of this RACM is the role of the employer rather than the specific form of auto disincentive or transit incentive. Using experience reported in the literature on the impacts of employer-based programs elsewhere in the country, specify the percentages of diversions of trips of each of several length classes which can be expected. Use these diversion percentages to factor down the (work) trip-table entries having destinations at major employers, and then use the new trip tables to compute revised traffic assignments and emissions.

Rationale: The transportation incentives and disincentives included here are best represented separately, under the categories of other RACMs, for purposes of model enhancement. In other words, the carpool/vanpool representations of RACM #5 should be applicable here, etc.. Several levels of employer enthusiasm could be assumed, and a parametric study with differing percentages of traveler diversions would show the sensitivity of emissions production to the degree of employer participation. The modeling capabilities developed for the other related RACMs could be useful to major employers in determining some of the EPA or state offsets they might enjoy for future expansions, based on the reductions in mobile source emissions they were able to promote.

Phase 2 Approach: Detailed simulations using enhanced models developed for related RACMs.

Category: Present (and Enhanced) Computer Models

Recommended Treatment of RACM #12

Title: BICYCLE LANES AND STORAGE FACILITIES

Implementation Level: Local, with possible state or federal help.

Potential Benefits: Limited in summer, none in winter

Anticipated Feasibility: Difficult to convince people of usefulness except for recreational purposes.

Previous Approaches (literature): Local surveys and bicycle traffic counts were suggested, since mode-shift potential is unknown [17].

Assume potential maximum diversion of 5.5% of all home-based vehicle trips (24% of home-based work trips of less than 6 minutes, for 7 months of the year), and actual diversion of 1.5% of these trips, at an average of 2 miles each [16].

Need UTPS? No

Relevant Michigan Model Deficiencies: None

Specific Measures to be Studied: Assume bicycle facilities are provided such that anyone who wants to ride a bicycle can reach his intended destination without interference (i.e., ubiquitous bicycle facilities).

Recommended Methodology: Stratify trip table (summer only) by trip length, and assume that only trips below some arbitrary maximum length (2 or 3 miles perhaps) are susceptible to diversion. Then, perform a parametric study for several different assumed percentage diversions, scaling down the trip-table entries for the short enough trips by the appropriate factors. Simulate the remaining vehicle traffic for each condition to determine the emissions changes.

Rationale: No models of the potential demand for bicycle travel have been formulated or calibrated, so there appears to be no way of a priori predicting the diversion of vehicle trips to bicycles in response to level of service changes. The sensitivity of emissions to bicycling improvements appears to be best estimated by the parametric study approach with the percentage of eligible trips assumed to be diverted being subjected to a reasonableness test. The impact of this RACM is anticipated to be so small that even if virtually all the eligible travelers were to shift to bicycles the emissions would not be significantly reduced. During the winter, it is unlikely that anyone would switch from auto to bicycle.

Other Viable Alternatives: Not necessary.

Category: Present Computer Models

Recommended Treatment of RACM #13

Title: STAGGERED WORK HOURS

Implementation Level: Local

Potential Benefits: Significant where employers are large and congestion is serious.

Anticipated Feasibility: Good where employment is concentrated at large facilities, and largely accomplished already in most Michigan cities.

Previous Approaches (literature): Do not consider in detail because of minimal broadening of peak [16].

Four-day week will have larger effect by reducing the total number of work trips; but impact on non-work trips is unknown [16].

Decreases opportunities for carpooling by unquantified amount [17].

SRGP sketch-planning method sometimes applicable [18].

Need UTPS? Not for the level of analysis feasible here.

Relevant Michigan Model Deficiencies: Deficiencies are in the flow data needed to calibrate a transportation model for separate conditions in the AM and PM peaks and the off-peak periods.

Specific Measures to be Studied: Try to compare congestion for a peak period assuming workers are all on the same work shift and then assuming that their shifts are staggered over a period of 1-1/2 hrs.

Recommended Methodology: Review available data to find peak-period VMT and trips as a fraction of total daily VMT and trips. Scale the existing daily average (work-purpose) trip table so that the peak-hour trip-generation rate would be equivalent to having all peak-period trips initiated within (a) a 15-minute period or

(b) a 1-1/2-hour period. Peak-period emissions would then be computed to be 1/4 of the total simulated in case (a) or twice the total simulated in case (b) for the unstaggered and staggered cases, respectively. For the four-day work week, daily work-trip generation would be reduced by 50% on two of the five days of the work week (Monday and Friday) for those employment categories which do not require around-the-clock shift work.

Rationale: The currently available data do not permit calibration of separate peak-period and off-peak transportation simulations, making it necessary to revert to an extreme-case sensitivity study such as that suggested here. The purpose of the suggested study is to show how much of an impact the staggering of work hours can have on emissions in the extreme. Data collected in the individual cities will show the extent to which work hours have already been staggered, indicating how present conditions compare to the two simulated extremes. A more detailed treatment is not considered justifiable because peak congestion in the out-state cities is not generally severe, and generally lasts for only a short time now.

Other Viable Alternatives: None seem applicable, given the constraints.

Category: Present Computer Models

Recommended Treatment of RACM #14

Title: ROAD PRICING

Implementation Level: Local, state or federal

Potential Benefits: Theoretically, it could be substantial but practically speaking, it is unworkable.

Anticipated Feasibility: Negligible because of illegality in Michigan and likelihood of being extremely unpopular.

Previous Approaches (literature): Direct network modeling with increased highway impedance [17] or use elasticities for a pivot-point analysis [17].

SNAP or SRGP sketch-planning procedures [18].

Assume 10% drop in VMT from $1 parking tax [16].

Need UTPS? N/A

Relevant Michigan Model Deficiencies: N/A

Specific Measures to be Studied: None

Recommended Methodology: Discard this RACM

Rationale: Road pricing is illegal in Michigan, and it would not be politically feasible to change that. In addition, it would be impractical, and quite counterproductive, to implement this RACM by the most conventional method, toll booths. Interstate-system freeways could not be tolled although others could. This would require the construction of toll booths, and the deceleration, idling, and acceleration of vehicles at the toll booths would be a source of increased pollution. Other road-pricing schemes, such as the Singapore program requiring purchase of a monthly pass to enter the controlled area, are only applicable when there is extreme local congestion for much of the day.

Other Viable Alternatives: Increase auto operating or parking costs significantly in the simulation.

Category: Not applicable

Recommended Treatment of RACM #15

Title: CONTROLS ON IDLING

Implementation Level: Local

Potential Benefits: Probably minor

Anticipated Feasibility: Hard to enforce

Previous Approaches (literature): Taxis idle about 2 hrs/day [16].

Half of registered trucks are in commercial use, and those idle 40 minutes/day. These are the major source of savings from this RACM, leading to 1-2% drop in HC from total idling ban [16].

Need UTPS? No

Relevant Michigan Model Deficiencies: Data about time spent idling are not available.

Specific Measures to be Studied: Hypothetical, perfectly enforced ban on idling by parked cars, taxis and trucks.

Recommended Methodology: If data about present idling characteristics are not available, hypothesize some typical values based on those in the literature for taxis and trucks. Use judiciously adjusted registration data (accounting for vehicles registered but not actually used in the area) to estimate fleet sizes and compute total emissions from idling now and with idling eliminated (in that case including emissions from an extra start).

Rationale: This RACM has no influence on traffic flows or VMT, and does not need detailed simulation. Limitations in the background data describing present idling behavior prohibit any more detailed treatment of this RACM.

Other Viable Alternatives: None apparent

Category: Rough Hand Calculation

Recommended Treatment of RACM #16

Title: TRAFFIC FLOW IMPROVEMENTS

Implementation Level: Local, with state and federal assistance

Potential Benefits: Could be locally significant where there are bottlenecks.

Anticipated Feasibility: Good, provided funds are available

Previous Approaches (literature): Computerized sketch planning using COMPACT, SNAP, TASSIM or TRIMS methods [18].

Changing free-flow link speeds in simulation [17].

Using CAPM, adjust signal density and arterial capacity [17].

Empirical evidence collected to show general percentage improvements from each of eight different flow improvements (from 0.5 to 4.0% of emissions) [17].

Use Highway Capacity Manual to predict speed changes resulting from capacity changes [16].

Need UTPS? No

Relevant Michigan Model Deficiencies: Lack of detail in transportation network model does not permit study of effect of changes in signal patterns, or separation of start and stop operations from steady flow.

Specific Measures to be Studied: Sub-area flow improvements (separate left and right turn lanes; left turn signal cycles, one-way pairs).

Corridor flow improvements by progressive signalization.

Recommended Methodology: Augment the capacity-restraint procedure and the emissions model to account for the differences between the average flow speed and the average speed with stops included. Apply different volume-speed relationships to the different arterial links depending on their jurisdictions (representing different kinds of signal patterns) and the density of signals per mile. These relationships will need to be developed on the basis of empirical and theoretical traffic flow work already performed. The equilibrium flow speed and idle (stopped) time results calculated for each link will have to be supplied to the emissions model so that the emissions outputs can then be separately computed.

Rationale: The typical transportation network simulation does not have to be concerned with details of traffic flow and starting and stopping. On the other hand, traffic flow simulations such as UTCS designed to investigate impacts of specific channelization and signalization changes are much too detailed for use here. The best compromise appears to be the suggested adjustments to the transportation simulation, which require some developmental work but can then be executed efficiently. It may be difficult to apply results derived by simulation of one city to predictions for another city unless the flow improvements are narrowly defined (i.e., to a certain length of one arterial, or to a certain limited-size area) and the absolute magnitude of the emissions reduction (in pounds/day) used as the output rather than an area-wide percentage reduction.

Phase 2 Alternative: Perform some detailed (UTCS-type) simulations of traffic in specific corridors or neighborhoods to get more precise estimates of speed changes. The emissions model can then be used to determine total emissions within the simulated area before and after the change. The practicality of this approach is strongly dependent on the availability at MDOT of detailed working simulations of the required road network elements.

Category: Enhanced Computer Models.

<u>Recommended Treatment of RACM #17</u>

Title: FLEET VEHICLE CONTROLS

Implementation Level: Local (i.e., fleet owners), but federal impetus will be needed to develop technological changes.

Potential Benefits: Likely to be small unless fleets are a major local pollution source.

Anticipated Feasibility: Depends on economics of alternate fuels and propulsion systems.

Previous Approaches (literature): Estimate number of vehicles, their controlled emissions, and VMT [17].

Need UTPS? No

Relevant Michigan Model Deficiencies: Lack of data about fleet vehicle composition and utilization.

Specific Measures to be Studied: Conversion of all fleet vehicles to electric propulsion, eliminating mobile source emissions but increasing stationary emissions at electric generating stations because of increased demand for electricity.

Recommended Methodology: If information about fleet vehicles can be found, use that to estimate their current contribution to emissions total, then determine amount of electrical energy they would use if all converted, and estimate the added emissions to be expected from generating stations. If the fleet vehicle data cannot be found, make several educated guesses on vehicle fleet composition and usage, and perform a sensitivity analysis to show the respective emissions changes.

Rationale: A more detailed approach does not seem to be feasible or necessary. Fleets do not comprise a large portion of the vehicles in use, and are unlikely to be a major pollution source. The suggested measure of converting <u>all</u> fleet vehicles to electric propulsion is designed as an extreme "best case." If this measure does not produce a noticeable change in emissions none of the less extreme measures will either. In the event this measure does have a significant effect, it would be advisable to investigate electric conversions of only part of the fleets, or conversions to fuels other than gasoline which produce more emissions than the all-electric alternative.

<u>Recommended Treatment of RACM #18</u>

Title: OTHER THAN LIGHT DUTY VEHICLE RETROFIT

Implementation Level: Federal, possibly state

Potential Benefits: Could be significant in later years, especially for trucks.

Anticipated Feasibility: Depends on economics, political forces.

Previous Approaches (literature): Heavy-duty vehicle I/M, retrofit of PCV valves to pre-1968 trucks [17].

Need UTPS? No

Relevant Michigan Model Deficiencies: None

Specific Measures to be Studied: See Previous Approaches above.

Recommended Methodology: Adjust age mix of vehicles in MOBILE1 so that none appear older than 1968 (move all the older ones up to 1968 standards) and apply I/M correction factors to heavy-duty vehicles.

Rationale: This is quick and simple, and captures the intended effect as well as possible.

Category: Present Computer Models

<u>Recommended Treatment of RACM #19</u>

Title: COLD-START EMISSIONS REDUCTIONS

Implementation Level: Federal, possibly state

Potential Benefits: Could be significant in winter.

Anticipated Feasibility: Depends on technology and economics.

Previous Approaches (literature): None apparent.

Need UTPS? No

Relevant Michigan Model Deficiencies: None

Specific Measures to be Studied: Technology for reducing cold-start emissions is unclear, but could be as prosaic as an electric blanket to keep the engine block from getting too cold when not in use.

Recommended Methodology: Based on expected unit emissions reductions, presumably to be quantified by EPA, adjust cold-start emission factors in MOBILE1.

Rationale: There does not appear to be much choice here, in the absence of much general knowledge about the unit emission changes which can be expected.

Other Viable Alternatives: Reducing cold-start emissions could also be interpreted to refer to reductions in the number of cold starts, which would be achieved by reducing the total number of vehicle trips (with emphasis on work trips). This could be achieved by means of several of the other RACMs.

Category: Present Computer Models.

IV. PROGRAM PLAN DEFINITION

4.1 TASK AND SUBTASK STRUCTURE

The program plan has been structured so as to simplify, to the extent possible, an inherently complicated project. The division of responsibility among the contractors and MDOT is specifically indicated, as are numerous approval milestones. Different approaches will have to be taken towards the various RACMs, and for purposes of the majority of the program plan they have been cross-classified into eight categories.

First of all, the SEMCOG and out-state applications have been separated because of their differences of scale and because no computer simulation work is to be done for SEMCOG within the scope of the present program. The second stratification of the RACMs is by the approach to be taken for this study:

(1) RACM not appropriate for use in Michigan or for analysis in the present study. These RACMs are not discussed or analyzed further, but the rationale for excluding them will be explained in the handbook.

(2) Estimate impact of the RACM using coarse manual approximations, relying either on work reported in the literature or on results obtained from unpublished studies or demonstrations.

(3) Use existing Michigan transportation simulation models to predict impacts.

(4) Develop enhancements to Michigan transportation models as required to predict impacts.

The cross-classification of the 19 individual RACMs is displayed in Figure 1.

The plan for this project, identifying the tasks and subtasks and their sequence and interactions, as well as the division of responsibilities for this project, is shown schematically

Figure 1 Cross-Classification of RACMs

CANDIDATE REASONABLY AVAILABLE CONTROL MEASURES (RACM's)	RECOMMENDED IMPACT QUANTIFICATION PROCEDURE*							
	OUTSIDE SEMCOG REG.				WITHIN SEMCOG REG.			
	Not Appropriate for Michigan Application	Utilize Other Available Imperical/Study Data Sources	Required Data Base Produced by Available Michigan Models	Required Data Base Produced by Enhanced Michigan Models	Not Appropriate for Michigan Application	Utilize Other Available Imperical/Study Data Sources	Require Data Base Produced by Available Michigan Models	Require Data Base Produced by Enhanced Michigan Models
1. Inspection/maintenance			X			X		
2. Vapor recovery	X				X			
3. Improved public transit (U)				X		X		
4. Exclusive bus and carpool lanes	X					X		
5. Area wide carpool programs (U)				X		X		
6. Private car restrictions			X			X		
7. Long range transit improvements (U)				X		X		
8. On street parking controls			X			X		
9. Park and ride and fringe parking lots (U)				X		X		
10. Pedestrian malls			X			X		
11. Employer programs to encourage car and van pooling, mass transit, bicycling and walking			X			X		
12. Bicycle lanes and storage facilities			X			X		
13. Staggered work hours		X				X		
14. Road pricing to discourage single occupancy auto trips	X					X		
15. Controls on extended vehicle idling		X				X		
16. Traffic flow improvements				X		X		
17. Alternative fuels or engines and other fleet vehicle controls		X				X		
18. Other than light duty vehicle retrofit			X			X		
19. Extreme cold start emission reduction programs			X			X		

* Assuming Emissions Models are Enhanced for Application to all RACMs
(U) Recommended Approaches Based on Supplemental UMTA Funding

in Figure 2 of the draft submitted to the State of Michigan. This program plan is summarized in the remaining paragraphs of this section.

The first task includes those activities which lead to the development of the program plan for the remaining tasks, described herein. In the second task, the specifics of the program plan are finalized, incorporating modifications agreed upon at the April 9-10 Phase I review meeting. A detailed proposal or memorandum of understanding, as appropriate, for the remaining work will be drafted. This includes specifying guidelines and objectives for the impact-evaluation handbook and choosing how to represent the impact of each RACM (level of analysis and/or model development and specific implementations of the RACM to consider). Those RACMs judged not to be appropriate for Michigan are removed at this stage.

In Task III, the information gathered from external sources about the impacts of RACM strategies when they have been implemented, and about the assumptions previous analysts have chosen to use, is organized by RACM to serve as input to the handbook and if required, as background input data for the simulations.

Task IV incorporates the efforts of the contractor and MDOT to enhance the ability of the existing MDOT models to reflect the impacts of the RACMs. This includes defining the algorithms to be used, working from concepts to equations and flow diagrams. In addition, the simulation conditions to be used in validating the model enhancements are defined. The actual coding of these enhancements and validation of their proper functioning will be carried out by MDOT staff.

The existing and enhanced computer models are used in Task V to generate the RACM impact sensitivity data needed for preparation of the handbook. The cases to be simulated are selected by mutual agreement between the contractor and MDOT, and the computer runs are executed by MDOT.

The results of the simulation runs and the literature review are assembled and analyzed in Task VI to produce parametrically varying estimates of the emissions and energy consumption impacts of each RACM. A key concern in this task is developing the clearest and most appropriate graphical means of representing the influence of each parameter.

All the work in the preceding tasks is consolidated into a handbook for assessing the RACMs in Task VII. This will include not only projected emission and energy consumption impacts, but also institutional and socio-economic implications of the selected RACM. The cities will be provided with explicit instructions in how to use the handbook materials to derive impact estimates for their own particular settings, including illustrative examples.

4.2 STATEMENT OF WORK

This statement of work describes the role of PES and of SCI (Vt) as subcontractor to PES in assisting the State of Michigan to develop methods of evaluating air quality control management strategies.

PES will furnish the necessary services and materials to accomplish the work described in the following:

Task II: Based upon the consensus arrived at during the April 9-10 Phase I review meeting (which may modify the program described herein), PES will formulate a final proposal or memorandum of understanding (as appropriate) and detailed program plan for the remaining work. This task will also include developing guidelines and objectives for the impact-evaluation handbook.

Task III: PES will organize information about RACM impacts gathered from external sources according to RACM, and will format it for use in the handbook and as supporting data for computer simulations.

Task IV: SCI (Vt) and PES will develop enhancements to the Michigan transportation models, with the cooperation of MDOT (providing information about current models and coding and debugging enhanced models). The consultants will define the needed algorithms, and provide equations and flow diagrams to represent them, as well as test cases to be used for validations. These model enhancements will, in this contract, include:

4.1 Modifications to the Michigan version of the MOBILE 1 emissions model that will incorporate a sensitivity to changed model emission characteristics in the vehicle stream arising from changed vehicle performance characteristics or changes in flow or operating conditions.

4.2 Modification of traffic assignment model to permit intrazonal travel to be included in emissions calculations, and to include disaggregation into cruise and starting/stopping modes of operation.

Should the resources for an expanded work effort become available through UMTA-related funding or from any source supplemental to the present EPA resource availability, SCI (Vt) and PES will produce the following additional model enhancement.

4.3 Modification of Wayne State UTPS mode-split model to reflect changes in travel cost as well as time and to incorporate ride sharing modes as well as transit and auto. The result will be strategy-sensitive intermodal diversion relationships for person-trip generation and distribution that can reflect changes in transportation level of service, change in travel pattern by time of day, and changes in non-work discretionary trip generation with increased auto availability.

Task V: SCI (Vt) and PES will, in cooperation with MDOT, define the set of computer runs which will be executied in order to produce the data base needed for the impact quantification handbook.

Task VI: If all computer simulation runs have been satisfactorily completed by MDOT no later than the 40th week after Work Plan approval, PES will assemble, organize, and utilize the results to produce parametric estimates of the emissions and energy consumption impacts of each RACM. Otherwise, these parametric estimates will be developed from empirical sources incorporating whatever Michigan data have beem made available to the consultants by that time.

Task VII: PES will prepare a handbook for use by Michigan cities in assessing the impacts of the RACMs for their particular settings. This handbook will contain a clear presentation of the results produced in the preceding Tasks, with instructions for how those results can be applied to different cities.

V. PROJECT SCHEDULE

A schedule chart for the complete proposed project is shown in Figure 3. This schedule is predicated on smooth progress by both contractors and MDOT in developing, implementing and executing the models. Communication problems, data unavailability, and computing problems could cause additional delays not incorporated in the chart.

The need for a more concentrated effort near the start is recognized and accommodated. Meetings at MDOT are suggested at the critical stages of model implementation, when one new model should be reaching validation and the next entering development. The final meeting, for submission of the handbook, is assumed to be held during the 46th week after acceptance of the program plan.

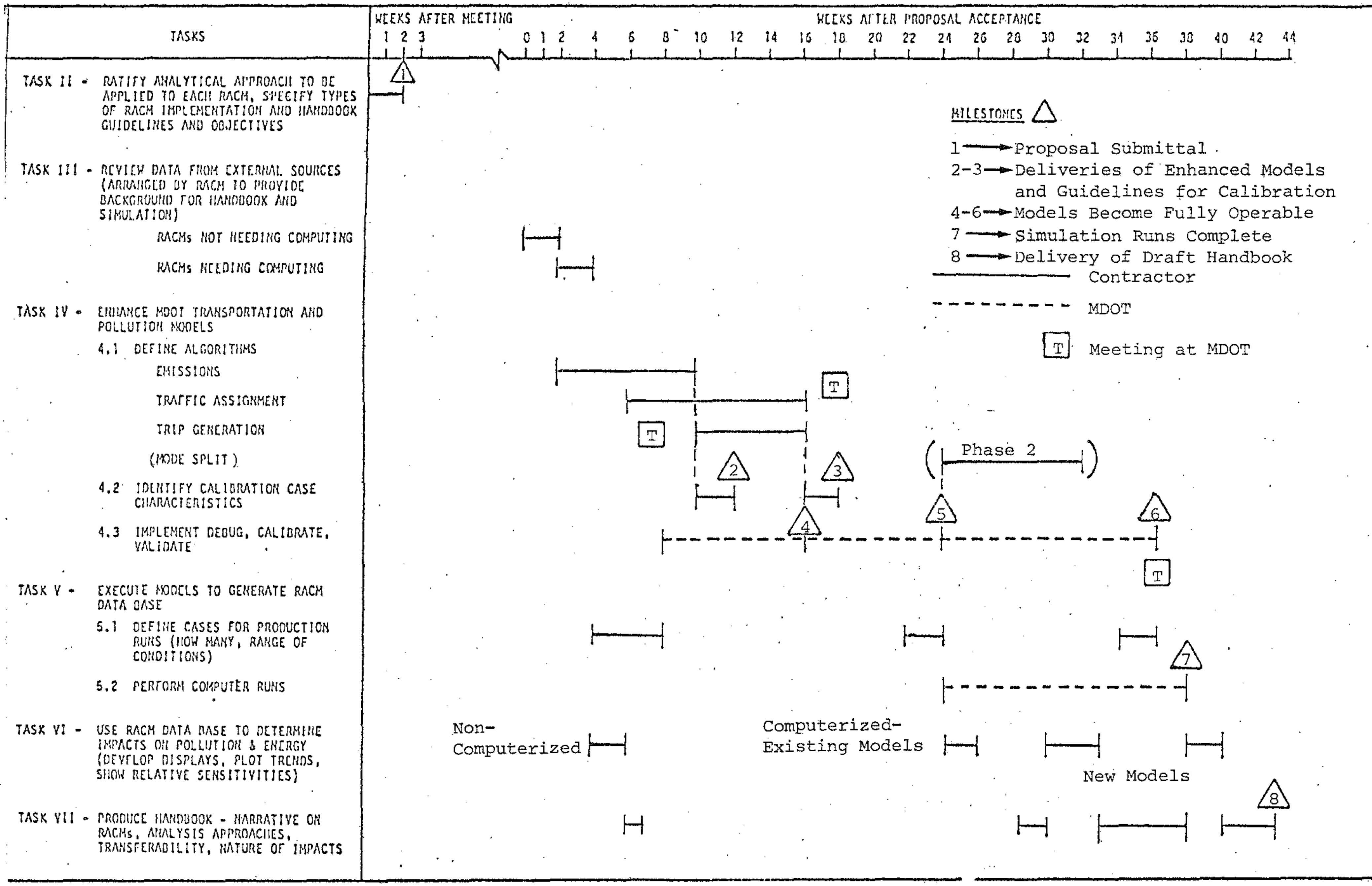

Figure 3: Project Schedule

VI. PROJECT MANAGEMENT

As prime contractor for this Task Order, PES, Inc. will provide all services described in the program plan to the degree specified in Section III of this Interim Report for a "Phase I" effort. Certain technical services have been (fixed price) subcontracted to SCI (Vt), and SCI will report technical findings to both PES and the Michigan Department of Transportation (MDOT) in accordance with the Project Schedule, affixed hereto as Section V. Mr. Chris Saricks of PES will serve as Project Manager.

Within one week of final acceptance of this or a modified program plan by MDOT, EPA, and the contractors, PES will issue a final Work Plan covering the duration of the contract. Copies of this Work Plan will be submitted to the EPA Contracts Office at Research Triangle Park, North Carolina, to the Region V EPA Project Officer, to MDOT, to SCI (Vt), and to the Southeastern Michigan Council of Governments (SEMCOG). Thereafter, any proposed changes to this Work Plan must be submitted in writing by the proposor and approved by all parties to the contract. PES will issue monthly reports of contract progress on the fifteenth of each month until completion of the work effort is certified by EPA. All parties on the mailing list drawn up at the February 1, 1979 meeting in the PES offices will receive a copy of each report.

Production of the technical services of this contract will be principally the responsibility of Messrs. Marc P. Kaplan, Sidney Weseman, and Chris Saricks of PES, and Messrs. Steve Shladover and Hal Solomon of SCI (Vt). These individuals will report to Mr. Chris Saricks and, as appropriate, directly to MDOT personnel or the Project Officer, Ms. Michelle Rocawich. During the execution of the contract, three trips have been scheduled to Lansing, Michigan by Messrs. Shladover, Kaplan, and Saricks in order to confer with and/or assist State of Michigan personnel in the evaluation of transportation measures by the

State modeling system. A maximum of one additional trip to Lansing will be made if necessary. The time expended for any interim conferences or discussions involving the prime and/or subcontractors and other parties to the contract that take place outside Lansing, Michigan, will also be charged to the contractor.

Every effort must be made by all parties to keep to the agreed project schedule. Milestones requiring input or assistance by MDOT are subject to automatic alternative conditions if input requirements are not met by specified dates. That is, impact sensitivities by "RACM" for presentation in the handbook deliverable will be based on Michigan computer runs and specifications only where milestone dates for completion of model debugging and calibration in-house at MDOT have been met. Otherwise, empirical or cross-sectional sources will be employed for each handbook RACM sensitivity as augmented by available Michigan data.

VII. COST PROPOSAL

Estimates of the number of professional man-weeks needed to accomplish each task and the model enhancement subtasks are shown in Table 1. Except for the model enhancement work, which is broken down by subtask, the remaining effort is estimated on a per RACM basis in each category. The total effort is then obtained by multiplying by the number of RACMs per category. Secretarial support costs are included as a fixed percentage of the professional man-hours costs, while handbook preparation and travel costs are added in separately.

A formal cost proposal is not included here because it is anticipated that task scopes and definitions will be modified at the meeting of April 9-10.

The attached estimates of the effort required to accomplish the stated tasks are based on the assumption that the task and subtask responsibilities of each of the study participants {EPA, MDOT, PES, AND SCI (Vt)} will be completed to the mutual satisfaction of the participants in accordance with the project schedule of Figure 3.

Table 1

Estimated Cost Buildup Chart

MICHIGAN PROJECT ESTIMATED COST BUILDUP CHART	METHOD TO QUANTIFY RACM IMPACT			
	UTILIZE OTHER AVAILABLE EMPIRICAL/STUDY DATA SOURCES OUTSIDE SEMCOG REGION (MAX OF 4 RACMS)	REQ. DATA BASE PRODUCED BY AVAILABLE MDOT MODELS OUTSIDE SEMCOG REGION (MAX OF 20 RACMS)	REQ. DATA BASE PRODUCED BY ENHANCED MDOT MODELS OUTSIDE SEMCOG REGION (MAX OF 2 RACMS)	UTILIZE OTHER AVAILABLE EMPIRICAL/STUDY DATA SOURCES WITHIN SEMCOG REGION (MAX OF 18 RACMS)
TASK DESCRIPTION				
II) MODIFY PROJECT PLAN IN ACCORDANCE WITH MDOT/EPA COMMENTS, ESTABLISH HANDBOOK OBJECTIVES AND DEFINE ELEMENTS OF EACH RACM TO BE CONSIDERED	0.1 MW/RACM	0.2 MW/RACM	0.2 MW/RACM	0.1 MW/RACM
III) REVIEW AND ANALYZE RACM SPECIFIC DATA COLLECTED FROM OTHER SOURCES AND DEVELOP IMPACT DATA BASE FOR THOSE RACM'S THAT WILL NOT BE EVALUATED THROUGH THE USE OF MDOT MODEL COMPUTATIONS	0.4 MW/RACM	0.2 MW/RACM	0.2 MW/RACM	0.2 MW/RACM
IV) DEFINE MODEL ENHANCEMENT ALGORITHMS & TEST/CALIBRATION CASE CHARACTERISTICS A. TRIP GENERATION MODEL	N/A	N/A	0.4 MWKS +	N/A
1. ABILITY TO REFLECT TRAVEL TRIP DEMAND INDUCED BY SERVICE CHANGES -Phase I Approach	N/A	N/A	1.5 MWKS AND/OR	N/A
2. ABILITY TO REFLECT NON-WORK TRAVEL/TRIP DEMAND INDUCED BY AUTO AVAILABILITY-Ph. I Approach	N/A	N/A	6 MWKS AND/OR	N/A
3. METHOD TO DISAGGREGATE PEAK (MORNING & EVENING) AND OFF PEAK TRIPS -Sequential Modeling	N/A	N/A	4 MWKS	N/A
B. TRAFFIC ASSIGNMENT MODEL	N/A	N/A	1 MWKS+	N/A
1. DISAGGREGATION OF AVERAGE SPEED ON A GIVEN LINK INTO ITS (EMISSION SENSITIVE) COMPONENTS, E.G. CRUISE, IDLE, ACCELERATION, DEACCELERATION AND/OR STOP-START CYCLES, AS A FUNCTION OF INTERSECTION DENSITY AND METHOD OF SIGNALIZATION	N/A	N/A	4 MWKS AND/OR	N/A
2. METHOD TO ACCOUNT FOR INTRAZONAL TRIPS AND INTRAZONAL COMPONENTS OF INTERZONAL TRIPS-Empirical	N/A	N/A	2 MWKS	N/A
C. DISAGGREGATE EMISSIONS MODEL - ABILITY TO PROCESS AND RESPOND TO INDEPENDENT CHANGES TO SPECIFIC TRAVEL CLASSES, E.G., AUTO-TRUCK, IDLE - FLOWING, COLD-HOT	N/A	N/A	6 MWKS*	N/A
V) DESCRIBE REQUIRED COMPUTER RUNS AND ASSIST MDOT IN USE OF TRANSPORTATION/EMISSIONS MODELS	N/A	0.3 MW/RACM	0.3 MW/RACM	N/A
VI) DEVELOP RACM IMPACT SENSITIVITIES TO TYPE AND DEGREE OF RACM IMPLEMENTATION	0.4 MW/RACM	0.4 MW/RACM	0.4 MW/RACM	0.1 MW/RACM
VII) PRODUCE AND PUBLISH RACM SELECTION/IMPACT PLANNING HANDBOOK	6 MAN-WEEKS PLUS 1 WEEK GRAPHIC ART			

- MW/RACM = MAN-WEEK PER RACM NOMINALLY DIVIDED 1 WEEK SOLOMON TO EVERY 5 WEEKS SHADOVER
- MODEL ENHANCEMENTS ARE COSTED IN TERMS OF ESTIMATED MAN-WEEKS, INDEPENDENT OF NUMBER OF RACMS TO BE PROCESSED. WHEN MORE THAN A SINGLE MODIFICATION IS TO BE MADE TO A PARTICULAR MODEL THE MAN-WEEKS ARE DIVIDED INTO "MODEL FAMILIARITY" TIME PLUS ADDITIONAL INCREMENTS OF TIME REQUIRED TO DESIGN AND HELP IMPLEMENT EACH CHANGE
- MUST ADD SEC. TIME - USE NOMINAL RATIO TO ENGINEER TIME
- HANDBOOK BASED ON 200 PAGES AND 10 COPIES OF DRAFT & FINAL
- TRAVEL: SIX PERSON-TRIPS TO LANSING, 2 DAYS EACH
- PES TASK AND COST ESTIMATE

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