Enhancement of DVRPC'S Travel Simulation Models

TASK 5

TRANSIT/HIGHWAY NETWORK INTERFACE

PREPARED FOR
DELAWARE VALLEY REGIONAL PLANNING COMMISSION

BY

BARTON-ASCHMAN ASSOCIATES,INC.
AND CAMBRIDGE SYSTEMATICS, INC.

APRIL 1997

Delaware Valley Regional Planning Commission

Enhancement of DVRPC'S Travel Simulation Models

TASK 5

TRANSIT/HIGHWAY NETWORK INTERFACE

PREPARED FOR
DELAWARE VALLEY REGIONAL
PLANNING COMMISSION

BY

BARTON-ASCHMAN ASSOCIATES,INC.
AND CAMBRIDGE SYSTEMATICS, INC.

APRIL 1997

Delaware Valley Regional Planning Commission
The Bourse Building
111 S. Independence Mall East
Philadelphia, PA 19106-2515

This report has been prepared by Barton-Aschman Associates, Inc. and Cambridge Systematics, Inc., in partial fulfillment of the contract between the Delaware Valley Regional Planning Commission and Cambridge Systematics, Inc. to enhance DVRPC's travel simulation models. The preparation of this report was funded through federal grants from the U.S. Department of Transportation's Federal Highway Administration (FHWA) and the Pennsylvania and New Jersey Departments of Transportation. Cambridge Systematics, Inc. however is solely responsible for its findings and conclusions, which may not represent the official views or policies of the funding agencies.

Created in 1965, the Delaware Valley Regional Planning Commission (DVRPC) is an interstate, intercounty, and intercity agency which provides continuing, comprehensive and coordinated planning for the orderly growth and development of the Delaware Valley region. The region includes Bucks, Chester, Delaware, and Montgomery counties, as well as the City of Philadelphia in Pennsylvania; and Burlington, Camden, Gloucester, and Mercer counties in New Jersey. The Commission is an advisory agency which divides its planning and service functions between the Office of the Executive Director, the Office of Public Affairs, and three line Divisions: Transportation Planning, Regional Planning, and Administration. DVRPC's mission for the 1990s is to emphasize technical assistance and services, and to conduct high priority studies for member state and local governments, while determining and meeting the needs of the private sector.

The DVRPC logo is adapted from the official seal of the Commission and is designed as a stylized image of the Delaware Valley. The outer ring symbolizes the region as a whole while the diagonal bar signifies the Delaware River flowing through it. The two adjoining crescents represent the Commonwealth of Pennsylvania and the State of New Jersey. The logo combines these elements to depict the areas served by DVRPC.

DELAWARE VALLEY REGIONAL PLANNING COMMISSION

Publication Abstract

TITLE	Date Published:	April, 1997
Transit/Highway Network Interface	Publication No.	96014

Geographic Area Covered:

Delaware Valley Region

Key Words:

Travel demand models, Transit modeling, Transit network, Transit/highway network

ABSTRACT

This report documents the recommended procedures and assumptions for the integration of the highway and transit networks in the DVRPC travel model system. The primary goal of this effort is to enhance the mode choice and transit assignment procedures to consider the influence of congested highways on bus and, in some cases, light rail operations.

The enhancement is implemented in TRANPLAN using the INET program to calculate transit running times as a linear function of highway speeds. The report discusses relevant INET variables and parameters and describes in detail how various elements of the transit system are represented. These include the transit lines, roadways network, rail links, walk and auto access links, highway and non-highway speed assumptions, and coding of fares.

For More Information Contact:

Delaware Valley Regional Planning Commission
Regional Information Services Center
The Bourse Building
111 South Independence Mall East
Philadelphia, PA 19106-2515
Telephone: (215) 592-1800 FAX: (215) 592-9125

Table of Contents

List of Tables

List of Figures

Executive Summary

This report documents the recommended procedures and assumptions for the integration of the highway and transit networks in the DVRPC travel model system. The primary goal of this effort is to enhance the mode choice and transit assignment procedures to consider the influence of congested highways on bus and, in some cases, light rail operations. The enhancement is implemented in TRANPLAN using the INET program to calculate transit running times as a linear function of highway speeds.

The transit lines are described in terms of identification codes, headway, route, and operating times. Identification includes mode (local bus, regional rail, walk access, etc.), line number, route identifier, route number, and operating company/division. The headway represents the actual time between transit vehicles for each line. The route specification indicates the specific path as a series of node numbers of each line, including identification of passenger transfer/access points. Operating times include A.M. peak, P.M. peak, and off-peak periods.

The transit network includes both links that are part of the highway network and links that are not. Links that are not in the highway network include both transit links - rail and busway - and transit access links. The access links include both walk access and auto access links and represent both connections to zone centroids and walk transfer links.

Transit link speeds are determined in a variety of ways. Some links have specific speeds coded for route segments. For some links on certain modes, default mode speeds are used in the absence of link-specific speeds. For links that are coincident with highway network links, a set of highway/transit speed functions are used. These functions define transit speed based on a relationship to highway speed, which is based on mode, highway facility type, area type, and the highway speed.

The fare coding was performed by matching the links in the new transit network to those in the original network and using the fare for each corresponding link in the original network.

1.0 Introduction

This report documents the procedures and assumptions used to integrate the highway and transit networks in the travel demand models used by the Delaware Regional Planning Commission (DVRPC). The primary goal of this effort is to enhance the transit model to consider the influence of congested highways on bus transit operations. This enhancement is implemented in TRANPLAN using the INET program to calculate transit running times as a linear function of highway speeds. Separate transit networks were prepared for A.M. peak, P.M. peak, and off-peak periods, reflecting variations in service coverage and frequency.

The report discusses relevant INET variables and parameters, and describes in detail how various elements of the transit system are represented. There are five major sections in this report:

- Section 2.0, "Transit Lines," describes the modes and their representation in INET.
- Section 3.0, "Highway Network," summarizes the critical highway network files and variables used by INET.
- Section 4.0, "Optional Links," explains the representation of non-highway links in the transit network, including rail lines, walk links, and auto access to transit.
- Section 5.0, "Transit Speeds," documents the procedures used to generate the highway/transit speed curves, and the non-highway transit speeds.
- Section 6.0, "Fare Coding," describes the coding of various fare structures and transfer charges.

2.0 Transit Lines

Transit lines are described in terms of four keywords in the **&ROUTE** and **&PARAM** cards:

- Identification;
- Headway;
- Route; and
- Operating Times.

Certain limitations in the INET software substantially complicated the coding process. In TRANPLAN, the maximum number of lines allowed for each mode is 255. There are well over 255 bus service patterns in the SEPTA local bus system alone, so two modes (4 and 5) are needed for these buses. To accurately represent transfers and fare differences, the transit fare model requires that New Jersey Transit buses be kept separate from SEPTA buses. Also, since it is desirable to separate express buses into their own mode to reflect operational differences, additional express modes are required.

Either of these change increase the total number of modes beyond eight, the limit for TRANPLAN/INET under the standard single-digit mode format. All input was reconfigured into the 2-digit mode format. With the constraint of an eight-mode maximum removed, it is possible to further disaggregate the modes. Intercity buses now have their own mode, as do AMTRAK and New Jersey regional rail. Fifteen modes (twelve transit and three approach) are now used in the model.

One objective of this project is to create a transit network that enhances the visual representation of bus and rail routes. Care has been taken to follow actual streets and rail lines as much as possible, and to minimize the level of abstraction so that the highway and transit networks are as consistent as possible. Steps in achieving this objective include eliminating the "shadow network," previously used to represent intercity bus and rail lines, routing these lines on highway or transit links wherever possible.

Unfortunately, TRANPLAN/INET does not preserve shape nodes (nodes that are not transit stops) when building a transit network. INET does have an option to keep all nodes available for plotting purposes only, but this option is not implemented in the current TRANPLAN version. However, addition of this feature is expected with the next version of TRANPLAN.

2.1 Identification

Each transit line is uniquely identified by its mode and line numbers. An alphanumeric identifier describes the route coverage, while the reporting group corresponds to the actual route designation for a set of INET line definitions. All of these variables are located in the **&ROUTE** cards.

- **Mode (M) -** By using the 2-digit mode format in TRANPLAN and INET, the 8-mode limit can be circumvented. Modes 4-15 are transit modes. Pennsylvania local bus and trolley bus are represented by two modes (4 and 5) since the total number of lines exceeds the 255-line per mode limit. Modes used are:

    1. Walk;
    2. Auto 1 (penalty);
    3. Auto 2 (access);
    4. Pennsylvania local bus (first 250 lines);
    5. Pennsylvania local bus (next 250 lines);
    6. New Jersey local bus;
    7. Pennsylvania express bus;
    8. New Jersey express bus;
    9. Intercity bus;
    10. Subway/surface light rail;
    11. Subway/elevated heavy rail;
    12. SEPTA regional rail;
    13. PATCO;
    14. NJ rail transit;
    15. AMTRAK.

One significant difference in the revised modal categories is the separation of express bus service from local service. This change was made to more accurately represent the operational differences between express and local bus service, especially in determining transit speeds on the highway network.

- **Line Number (L) -** Unique INET number assigned to each coded transit line. There is a 255-line limit per mode.

- **Identifier (ID) -** Alphanumeric description of route by termini.

- **Reporting Group (RG) -** Relates INET lines to "real world" route number.

- **Interline Group (IG) -** Not used.
- **Company (C) -** Existing company codes were used to group lines for reporting purposes:

  1. SEPTA City Transit Division
  2. SEPTA Victory Transit Division
  3. SEPTA Frontier Transit Division
  4. NJT Mercer Division
  5. Not used
  6. DRPA
  7. All other NJT
  8. Pottstown Urban Transit
  9. SEPTA Regional Rail Division
  10. AMTRAK
  11. Intercity Bus

2.2 Headway

Headways can be specified in the **&ROUTE** cards in four ways:

- **Actual Headway (H) -** Designated headway in minutes for a particular line. Headways are calculated from schedules and are averaged for each peak period.
- **Nominal Headway (NH) -** Not used.
- **Maximum Headway (MH) -** Not used.
- **Headway Factor (FH) -** Not used.

2.3 Route

The route of each line is described by an ordered series of node numbers from the highway and non-highway networks. The links defined by these nodes form a path representing a particular route or route segment. These keywords are located in the **&ROUTE** cards. In many cases, more than one route itinerary is needed to represent a single "real-world" transit line that includes route deviations, interlining, alternating stops, or mixed express/local service.

- **Node Number (N) -** Negative node numbers indicate a passenger access or transfer point, where lines or modes intersect. These are the only points at which passenger demand activity occurs.
- **Direction Indicator (ONEWAY) -** Logical variable denotes whether transit service (or non-transit flow) direction is one-way ("T") or two-way ("F").
- **Reference Line (RL) -** Not used.
- **Reference Mode (RM) -** Not used.

2.4 Operating Times

Characteristics of operating times are coded by mode on &PARAM cards.

- **Service Period (PERIOD) -** Designates beginning and ending times of the interval being represented:
  - A.M. Peak = 6:00 A.M. - 9:00 A.M.;
  - P.M. Peak = 3:30 P.M. - 6:30 P.M.; and
  - Off-Peak = 11:00 A.M. - 1:00 P.M.
- **Minimum Layover (LAY) -** Not used.
- **Layover Percentage (LPC) -** Not used.

3.0 Highway Network

The highway network is contained in the file **HNET.TEM**. This file provides the framework for the transit network, as well as information needed to determine transit speeds on highway links. The **$PARAM** keyword *CART* in the **TSYSIN.TEM** file identifies the location of the highway link attribute in **HNET.TEM** defining auto travel times. The three other critical variables in **HNET.TEM**, and the information they contain, are:

- **Assignment Group** – Functional classification;
- **Link Group 1 –** Area type; and
- **Link Group 2 –** Number of lanes.

4.0 Optional Links

Links that are used by transit modes/routes, but which are not part of the highway network, are included in the **&DATA** cards (Optional Link Files), as are non-transit links used to access the transit network. Field 4 defines the mode. Subsequent fields describe link length, travel speed, and direction. Only distances have been coded on most links since various lines can run at different speeds on a given links. Speeds are determined from the highway/transit speed curves; from default mode speeds in the **&PARAM** cards; from route segment speeds (or elapsed times) coded in the appropriate **&ROUTE** cards; or from specific speeds coded on individual optional link **&DATA** cards.

4.1 Transit Links

Transit-only links are included in the **&DATA** cards in **TSYSIN.TEM**. Transit links are included in the **&DATA** cards for:

- **The Chestnut St. "Busway" -** Modes 4, 5, and 7. The bus-only section of Chestnut Street is included at the end of the optional links file, with a constant speed of 20-mph explicitly coded on each link. Alternatively, link travel times could be coded directly for each link.

- **All Off-street Subway/Surface LRT Lines -** Mode 10. Several lines in Mode 10 (Subway/Surface LRT) run on both highway and transit links. Speed Curves #11 and #12 are used to determine travel times for the highway links. The optional links represent the subway portion of the routes, and each has been coded with a travel time or speed derived from the appropriate schedules. Speeds (or elapsed times) for these segments of the routes could also be specified in the **&ROUTE** cards for each line.

- **Subway/Elevated Heavy Rail Transit Lines -** Mode 11.

- **All Passenger/Commuter Rail Lines -** Modes 12 through 15.

- **Some Segments of Intercity Bus Lines -** Mode 9. Due to limits on the number of links allowed per route, several long, non-stop route segments running over the highway network were replaced with optional links coded at 60-mph.

4.2 Non-Transit Links

Transit-access links are defined in the **&DATA** cards in **TYSYSIN.TEM**. There are two types of non-transit links:

- **Walk Access –** Mode 1. These include both centroid connectors and transfer links.
- **Auto Access –** Mode 2 (and 3). Mode 2 are auto penalty links. Mode 3 are auto access links.

One of the most difficult elements of this task was re-creating the access and transfer links. The old transit network only approximated the highway network, and the two networks were numbered independently (except for centroids and external stations). There was no way to determine a direct equivalency between the two sets of nodes and links, and, given the number of non-transit links, manual matching or re-creation was not feasible. A combination of approaches was used:

- **Walk Access to Rail –** Since centroids are numbered the same in both networks, the A-node could be determined. The new rail network uses old transit network node numbers whenever possible (the old transit network coordinates were adjusted for consistency, and 15,000 was added to all of the old node numbers to eliminate duplication), and so B-nodes could be readily identified in most cases.
- **Walk Access to Bus –** Since nodes in the new bus network had different numbers and coordinates from the original network, B-nodes could not be identified directly. A coordinate matching program was used to find the nearest new highway transit node, but since the original bus network did not correspond precisely with the highway network, there were many erroneous matches that had to be identified and corrected manually.
- **Auto Penalty –** These are, in effect, "dummy" links connecting to centroids and arbitrary B-nodes that form one end of auto access link. These were re-created by adding 15,000 to the B-node number.
- **Auto Access –** These links were re-created in the same way as the walk access links, except that the new auto-penalty link B-node is the auto-access link A-node.
- **Walk Transfer –** Equivalent nodes identified by the coordinate matching program were used to re-create these links. Manual checks and modifications were subsequently required.

5.0 Transit Speeds

INET relies on a hierarchy of methods to determine transit link travel times (or speeds):

- **Route Elapsed Time –** INET first looks for the elapsed time keyword (ET) in the **&ROUTE** card. If found, this value is used to calculate transit link travel times/speeds for the designated segments.

- **Route Speed –** If elapsed time is not specified, the **&ROUTE** card is searched for the speed keyword (S). If located, this value is used to calculate transit link travel times/speeds along designated route segments.

- **Mode Speed –** If no route speed keyword is found, INET looks next for a default mode speed, S(M), in the **&PARAM** card. "S" is a constant speed used to calculate travel times/speeds on any link traversed by mode "M." It can be overridden only by the **&ROUTE** keywords described above.

- **Link Speed –** If a default mode speed is not found, INET searches the **&DATA** optional link cards traversed by the transit line. If a value is located in the time field (columns 33-37), but not the speed field, this value becomes the transit link traversal time, from which a constant speed can be derived. If a value is coded in the speed field (Columns 28-32) and area and facility type are available, this speed is treated as a highway speed, and the highway/transit speed function is used to calculate the link traversal time and speed. Otherwise, the coded speed is treated as a constant.

- **Highway/Transit Speed Functions –** If no other speed or travel time information is found, INET relies on user-defined speed curves to select an appropriate speed based on a combination of mode, facility type, area type, and highway speed. These curves define a transit speed based on pre-determined relationships with highway speeds. The shape of the curves and the application of them are defined in the **&DATA** cards in **TSYSIN.TEM.** The other information is located in **HNET.TEM.**

5.1 Highway Links

The highway/transit speed function is used for all buses operating on the highway network (modes 4 through 9). Speed curves are also used for the on-street portions of mode 10 (Subway/Surface LRT) routes, which are treated as local buses for this purpose. Four variables determine the appropriate speed curve:

- Mode;
- Congested highway speed;

- Facility type (functional classification); and
- Area type.

The highway/transit speed curves were estimated by comparing peak and off-peak highway speeds with transit speeds required to meet schedule times along corresponding links. Only a relatively small sample size was available, since the only valid route segments are those defined by time points at either end of a set of homogenous links contained in the network. For this application, homogenous links are defined as sharing the same area and facility types. Most of the bus route segments defined by schedule timepoints traverse several links of varying facility or area types; have locations not definable on the model network; or include roads not represented in the network. Collector streets (facility type 5) in particular are under-represented in the network.

Several assumptions were required to deal with the limited availability of samples in some facility/area categories. Speed curves from other models were also investigated, particularly to help identify differences between local and express bus characteristics. Local and express services operate similarly in the CBD/fringe areas, and on freeways and expressways. In most other cases, express buses exhibit higher speeds than local buses, especially at the upper end of the speed range.

Area type 2 (fringe) links exhibited characteristics very similar to those in area type 1 (CBD), so both categories share speed curves. No meaningful differences in speed relationships were observed between facility types 3 and 4, and so separate curves are not required. Several combinations of facility and area types were similar enough to use the same speed curve.

Transit speeds on freeways and expressways (facility types 1 and 2) are generally consistent with overall highway speeds, especially since most transit service on these facilities is express. These facilities all use speed curve #2. Speed curve #1 is set up to represent walk links, but could be used for another purpose, if the constant 2.5-mph speed defined in the **&PARAM** cards is used. Curves #12 - #15 are available for future use.

Transit/highway speed relationships in INET are defined in terms of "low" and "high" transit and highway speeds for each curve. For a given highway speed, a corresponding transit speed can be identified from the appropriate speed curve. The "high" transit speed is the maximum for that combination of mode, area type, and facility type. Linearity is assumed from 0 to the "low" speed and from the "low" speed to the "high" speed.

The speed curves associated with each facility type/area type combination are shown in Table 5.1. The definitions of the eleven speed curves are shown in Table 5.2, and the curves are represented graphically in Figures 5.1 through 5.11.

Table 5.1 Category Samples and Speed Curves Used For On-Street Transit

(Number of Samples -Speed Curve Used for Local and Express**)*

	Area Type 1 (CBD)	Area Type 2 (Fringe)	Area Type 3 (Urban)	Area Type 4 (Suburban)	Area Type 5 (Rural)
Facility Type 1 (Freeway)	*{-}* [#2, #2]	*{-}* [#2, #2]	*{-}* [#2, #2]	*{-}* [#2, #2]	*{-}* [#2, #2]
Facility Type 2 (Expressway)	*{-}* [#2, #2]	*{-}* [#2, #2]	*{-}* [#2, #2]	*{-}* [#2, #2]	*{-}* [#2, #2]
Facility Type 3 (Principal Arterial)	*{3}* [#3, #3]	*{1}* [#3, #3]	*{5}* [#5, #6]	*{5}* [#8, #9]	*{2}* [#10, #11]
Facility Type 4 (Minor Arterial)	*{0}* [#3, #3]	*{1}* [#3, #3]	*{4}* [#5, #6]	*{3}* [#8, #9]	*{0}* [#10, #11]
Facility Type 5 (Collector)	*{0}* [#4, #4]	*{0}* [#4, #4]	*{1}* [#7, #8]	*{1}* [#8, #9]	*{0}* [#10, #11]

* Local: Local bus and on-street LRT (modes 4,5,6, and 10).

** Express: Express and intercity bus (modes 7, 8, and 9).

Table 5.2 Highway/Transit Speed Curve Definitions

(Speeds in MPH)

Curve #	Low Highway	Low Transit	High Highway	High Transit
1	0.0	2.5	70.0	2.5
2	30.0	30.0	70.0	65.0
3	12.0	5.0	36.0	15.0
4	10.0	5.0	32.0	12.0
5	18.0	7.0	40.0	15.0
6	18.0	12.0	40.0	25.0
7	12.0	6.0	30.0	12.0
8	18.0	11.0	45.0	20.0
9	18.0	14.0	45.0	30.0
10	24.0	15.0	50.0	24.0
11	24.0	18.0	50.0	35.0

Figure 5.1 DVRPC Speed Curve No. 1

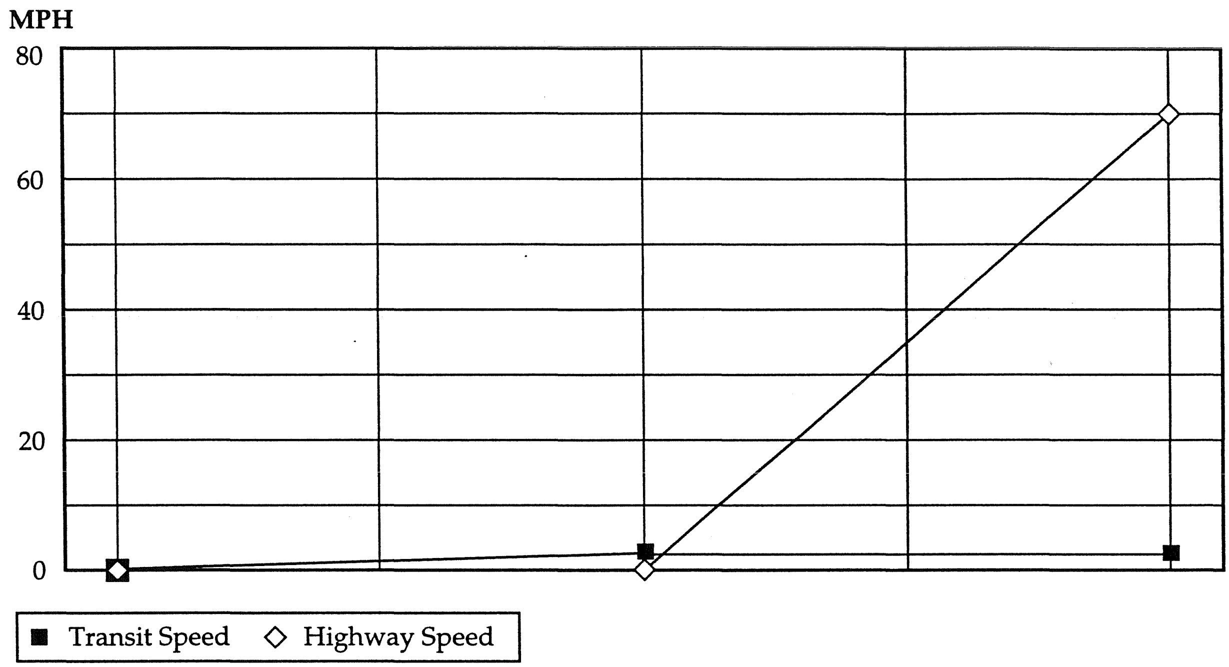


Figure 5.2 DVRPC Speed Curve No. 2

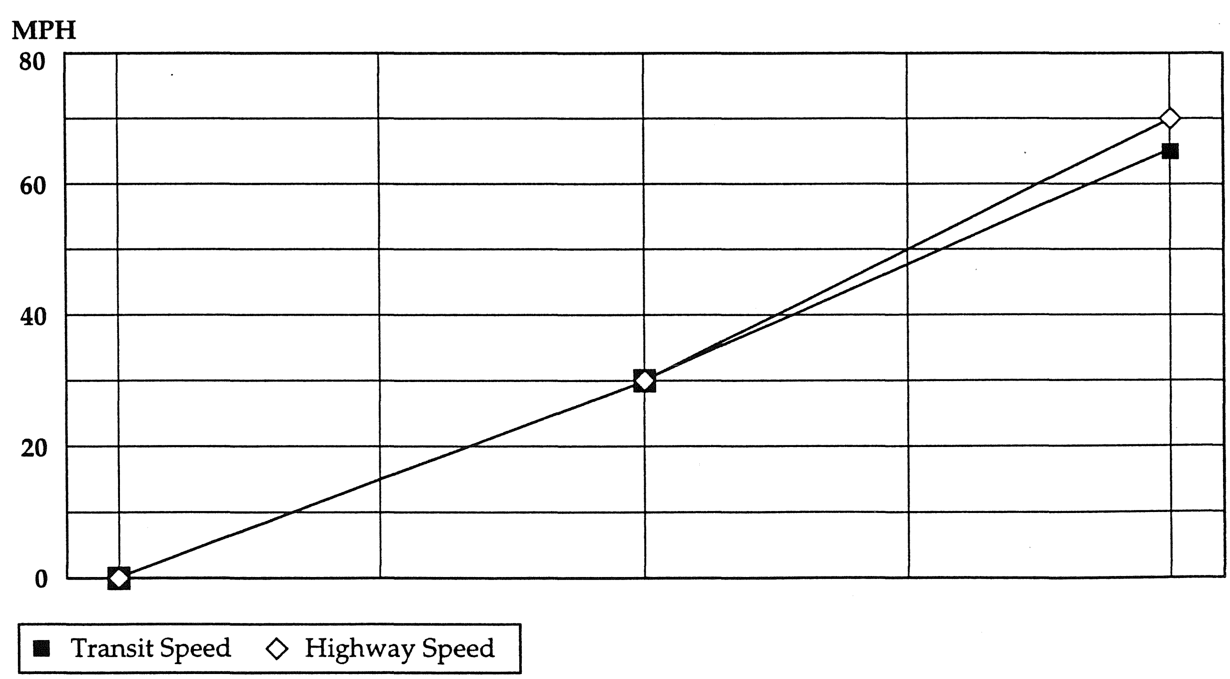


Figure 5.3 DVRPC Speed Curve No. 3

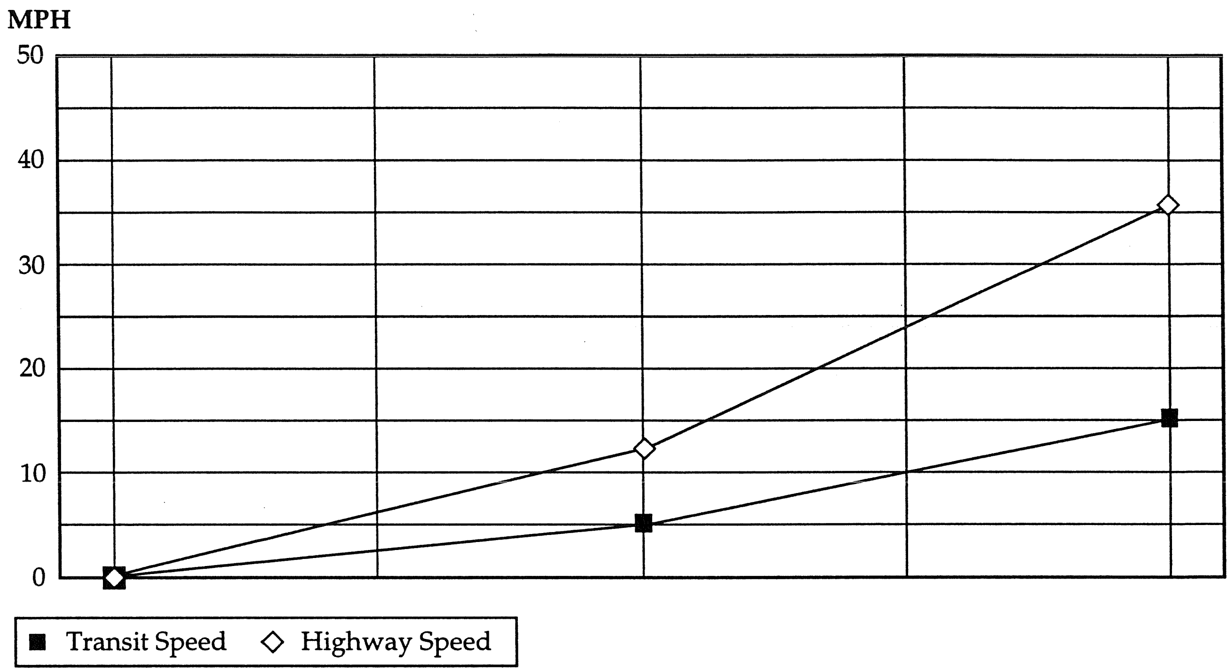


Figure 5.4 DVRPC Speed Curve No. 4

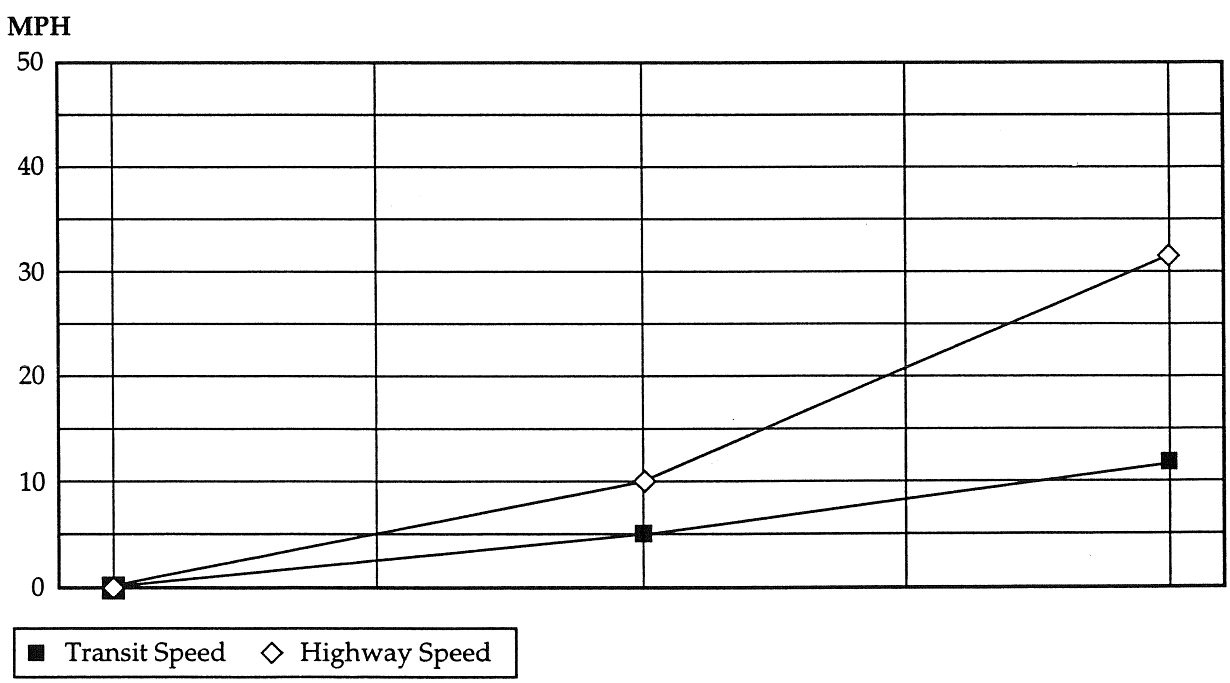


Figure 5.5 DVRPC Speed Curve No. 5

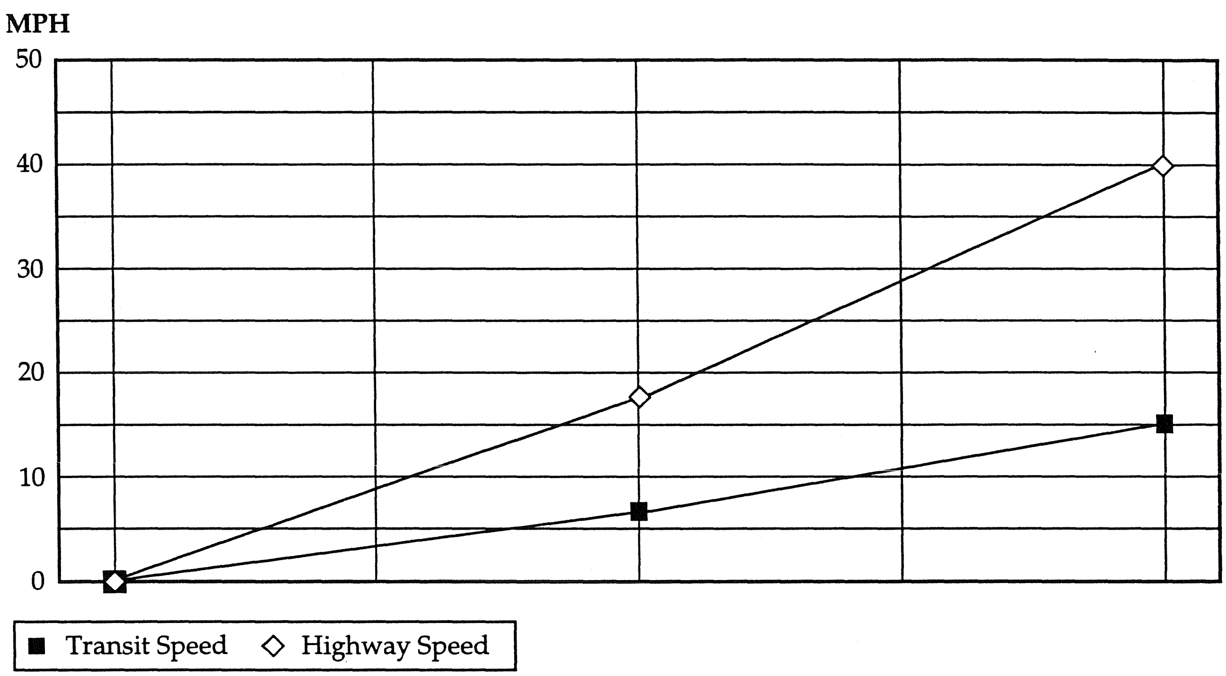


Figure 5.6 DVRPC Speed Curve No. 6

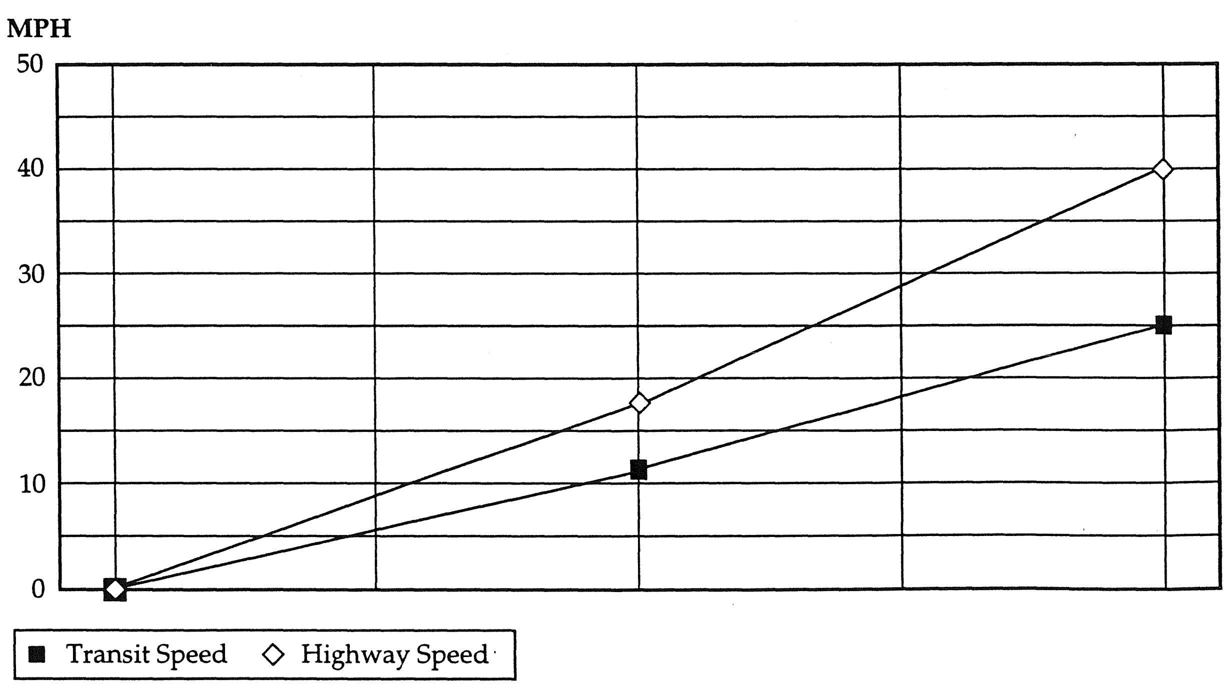


Figure 5.7 DVRPC Speed Curve No. 7

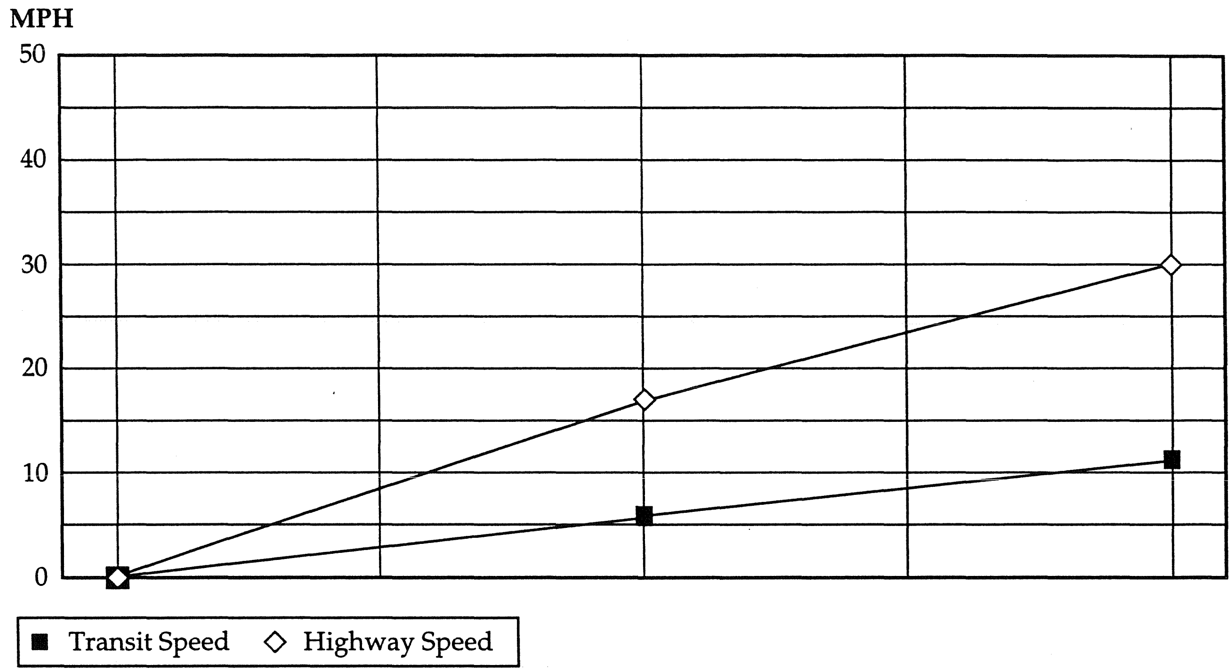


Figure 5.8 DVRPC Speed Curve No. 8

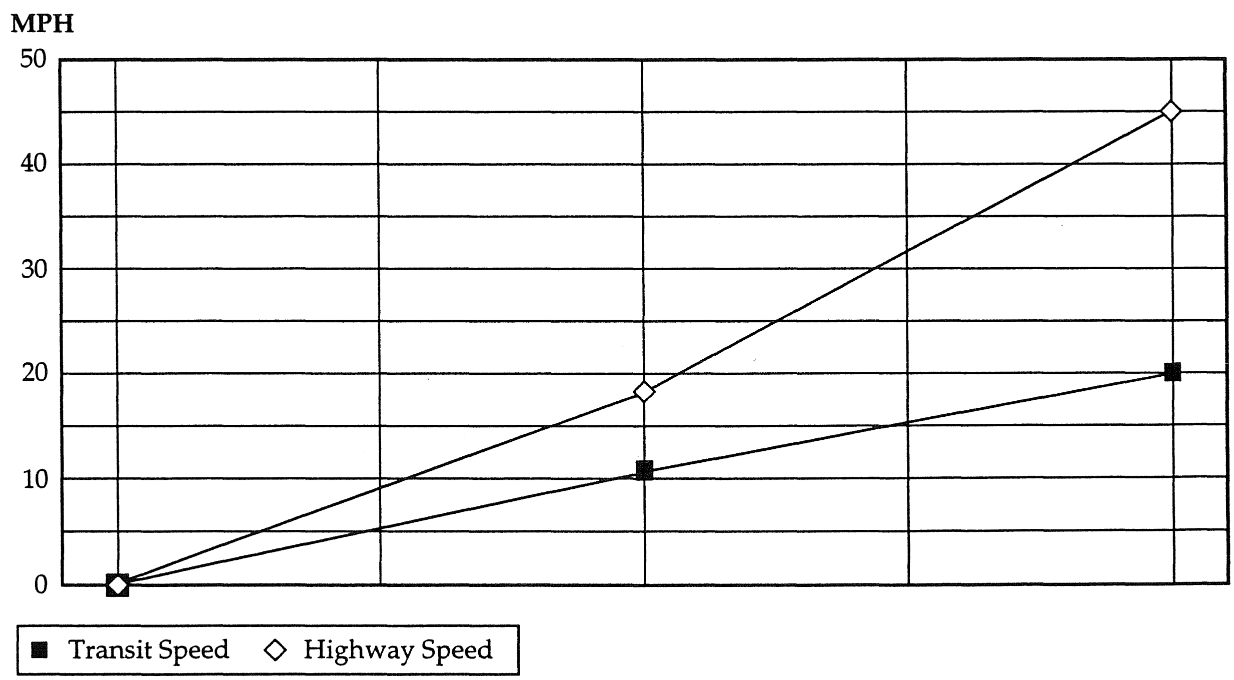


Figure 5.9 DVRPC Speed Curve No. 9

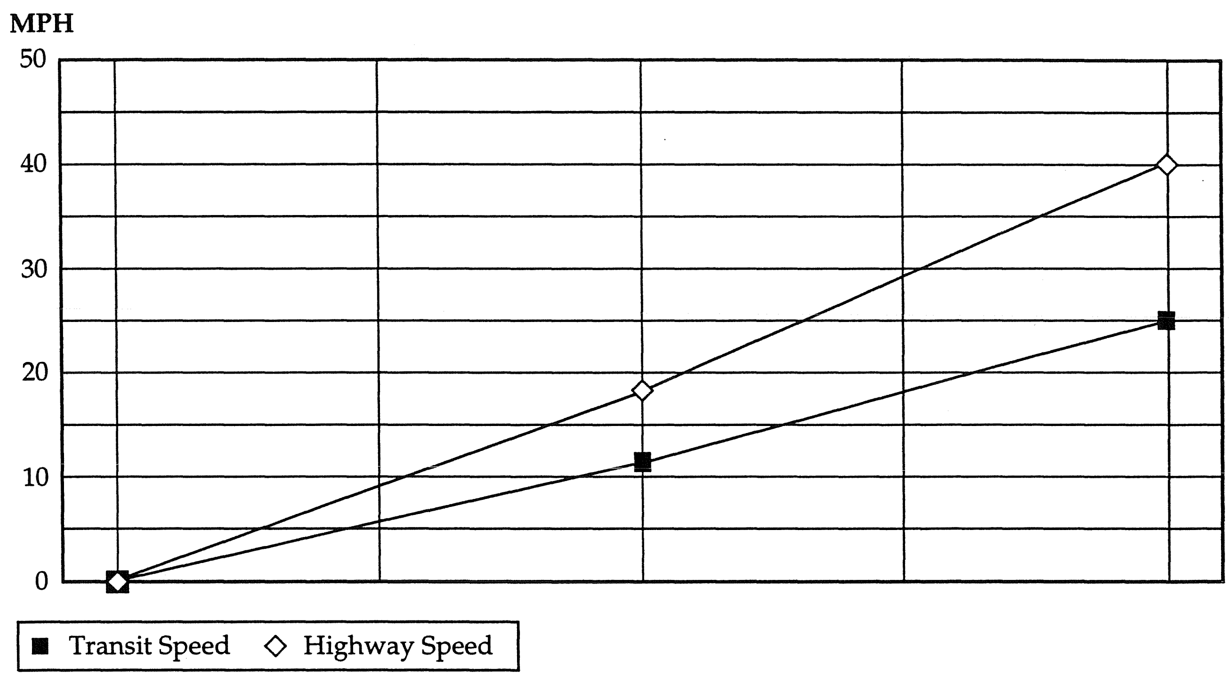


Figure 5.10 DVRPC Speed Curve No. 10

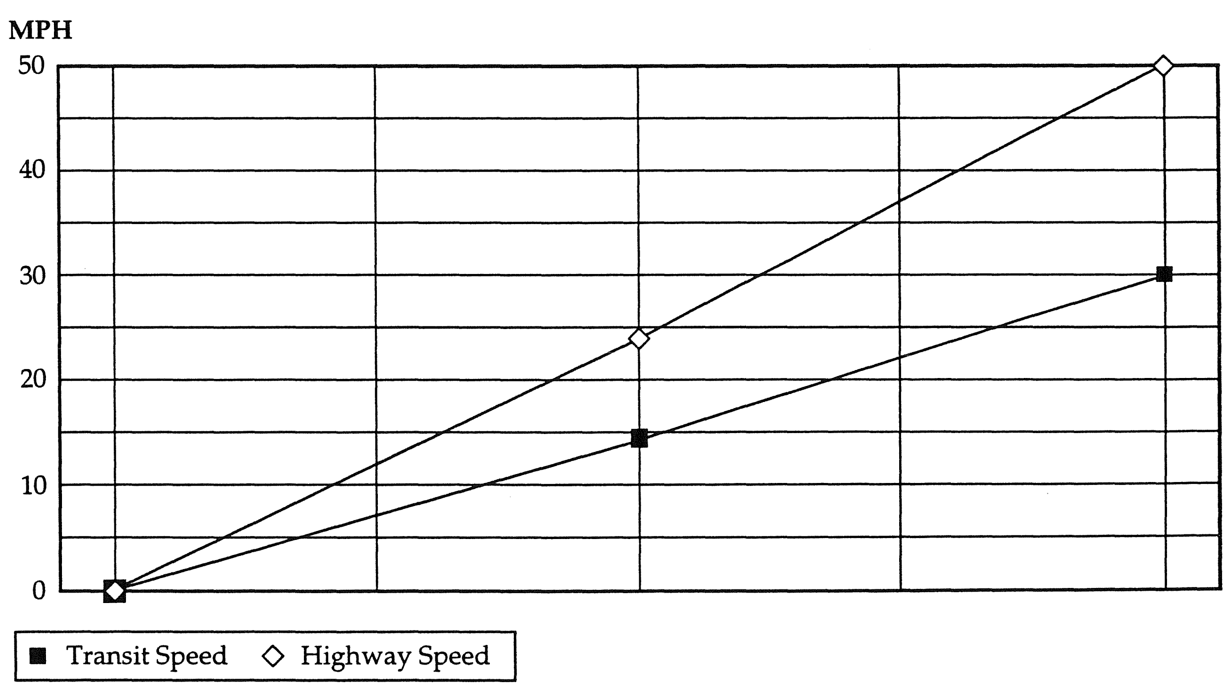
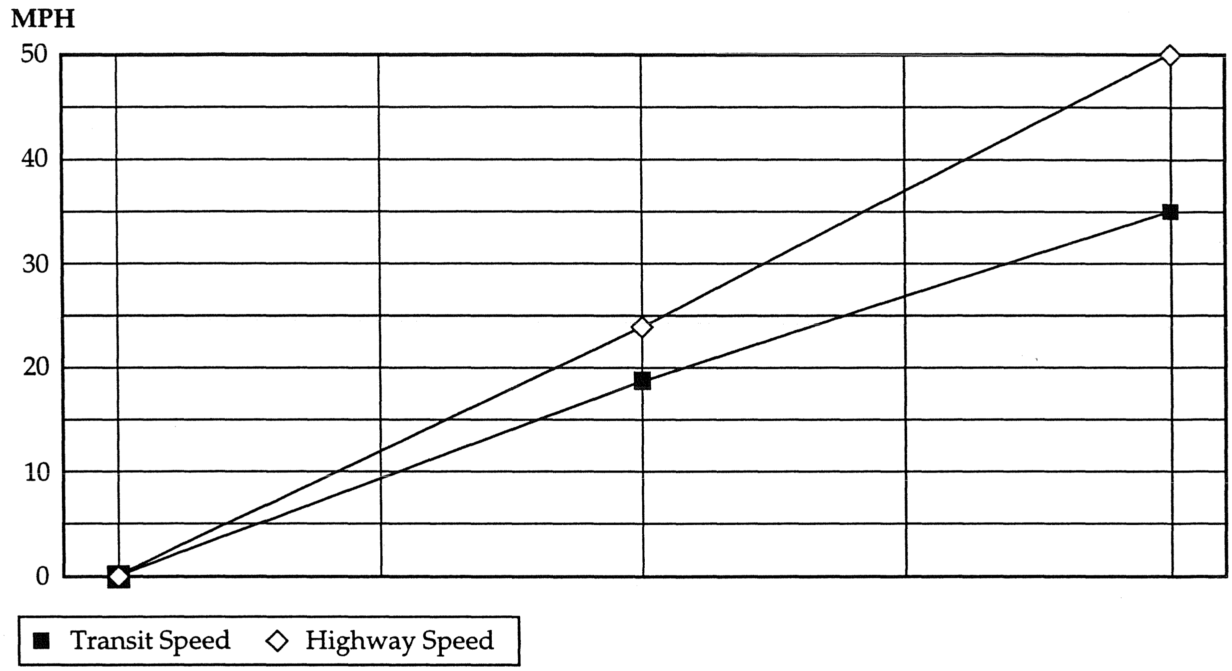


Figure 5.11 DVRPC Speed Curve No. 11



5.2 Non-Highway Links

Speeds for the following modes/routes are determined as noted:

- **Walk (Mode 1) –** Constant speed of 2.5-mph specified in **&PARAM** cards.
- **Auto Access (Modes 2 and 3) –** Speed given as constant 20-mph in **&PARAM**.
- **Bus on Busway (Modes 4, 5, 7) –** Speed specified in **&DATA** optional link records. These are the last eleven optional links in the file (nodes 4801-4828), and a speed of 20-mph is assumed. Travel times could be coded in place of speeds, if desired.
- **Intercity Bus Lines (Mode 9) –** Speeds derived from highway/transit speed curves.
- **Subway/Surface LRT (Mode 10) –** Speeds or travel times for each off-street link are calculated from route schedules and coded in the **&DATA** optional links. Speeds for on-street portions of routes are determined from speed curves #11 and #12.
- **Subway/Elevated Heavy Rail Transit (Mode 11) –** Speeds or travel times for each link are calculated from route schedules and coded in the **&DATA** optional links. Typically, travel times are used unless an accurate and reasonable time could not be determined from the schedules, in which case an appropriate travel speed (derived from similar links in the line) is used.
- **SEPTA Regional Rail (Mode 12) –** Speeds or travel times for each link are calculated from route schedules and coded in the **&DATA** optional links.
- **PATCO Transit (Mode 13) –** Speeds for each link are calculated from route schedules and coded in the **&DATA** optional links.
- **NJ Transit Regional Rail (Mode 14) –** Speeds or travel times for each link are calculated from route schedules and coded in the **&DATA** optional links. On links shared with modes 11 or 12, coded speeds/travel times are used if consistent with mode 14. When speeds on shared links vary significantly between modes, the mode 14 link speeds are determined using the elapsed time or speed keywords in the appropriate **&ROUTE** cards, overriding the link-specific values.
- **AMTRAK (Mode 15) –** Speeds or travel times for each link are calculated from route schedules and coded in the **&DATA** optional links. On links shared with other modes, coded speeds/travel times are used if consistent with mode 15. When speeds on shared links vary significantly between modes, the mode 15 link speeds are determined using the elapsed time or speed keywords in the appropriate **&ROUTE** cards, overriding the link-specific values.

6.0 Fare Coding

In order to preserve the fare coding from the existing DVRPC transit network, equivalent fare links must be identified in the new network. This is complicated by the fact that a totally new network has been created, with new node numbers and coordinates. A list of all the old fare links was generated by mode. In many cases, there is no link in the new network corresponding to a link in the old network. A combination of approaches were used in attempting to recreate the fare coding:

- **Highway Links -** Plots of the old bus network were plotted, with fare links annotated. These plots were compared to plots of the new bus network, and corresponding fare links were identified in the new network, where possible.
- **Rail Links -** Plots of the old rail networks were plotted, with fare links annotated. These plots were compared to plots of the new rail network. In most cases, corresponding fare links in the new network could be readily identified.
- **Walk Links from Centroid Connectors -** Equivalent links were re-created for all walk access links.
- **Walk Transfer Links -** Corresponding links were re-created for all walk transfer links.
- **Auto Access Links -** Equivalent links were re-created for all auto access links.

One concern was the methodology for defining the combined impedence variable (DVFARE). In order to run the DVFARE program, the transit network output from INET (in ASCII link and line card format), must have fares coded for the appropriate links. This can be accomplished using a dBase program that reads fares from the fare link files and inserts them into the corresponding records and fields in the INET output network. TRANPLAN's "BUILD TRANSIT NETWORK" function can then be executed to create the final network in TRANPLAN format. Since the number of modes has increased beyond the current limit of eight in DVFARE, a revision to DVFARE will be needed.

7.0 References

U.S. DOT Federal Highway Administration, 1986. *Urban Transportation Planning System Program INET Writeup.*

Urban Analysis Group. *URBAN/SYS Version 8.0 User Manuals,* 1995.

Corradino Group. *Southeast Regional Planning Model IV (SERPM-IV): Model Validation Report,* 1996.