CHAPTER A

INTRODUCTION

1 OBJECTIVES

This Research Project aims at establishing relationships between the costs of highway construction and maintenance, and the operational costs of vehicles that will use those highways during their useful life. These interrelationships will be incorporated in a computer-based mathematical model, which can be used to cheaply and quickly establish the costs of alternative highway construction and maintenance policies, as well as those of highway users.

Such a model would enable Brazilian authorities to optimize highway investments and vehicle operational costs, with a view to improving the allocation of limited resources for investments on infrastructure.

Within the general scope of obtaining these interrelationships, three immediate sub-objectives have been identified for this project:

- To establish the relationships between road user costs, road geometric standards and surface conditions for rural roads;
- To measure the relationship of road deterioration and maintenance costs, as a function of pavement and geometric design standards, as well as of traffic volume and composition under Brazilian climatic conditions;
- To develop new or modify and adapt existing mathematical models for Brazilian use, with parameters developed from experiments and measurements carried out to meet the preceding items.

These objectives are being achieved through the following project activities:

- A road user costs survey, where a diversified vehicle fleet, drawn from organizations operating buses, trucks, and automobiles, is monitored to determine actual user costs for a variety of operating conditions in Brazil;
- A series of experiments to measure speed and/or fuel consumption for both existing traffic and a controlled fleet of instrumented project vehicles over a range of roadway geometric, operational and environmental conditions;

- A study of the behavior of selected road test sections to establish roadway performance and maintenance requirements, as a function of different pavement and geometric design standards and maintenance levels, in the Brazilian environment.

This report presents a summary of project achievements at the midpoint, and also accomodates the early dissemination of project results. Where data were available, preliminary analyses were made and the results presented. However, the reader is reminded that all results presented in this report are preliminary in nature and are only early indicators of the types of relationships being found. Further, the influence of some of the factors being studied on the early analyses has not been fully considered.

a Existing Model

The framework for the desired model already exists as a result of a series of studies initiated by the World Bank in 1968. The Bank desired to develop an analytic model for use in evaluating alternative design, construction and maintenance strategies at the project level for low-volume roads. In the first study, the Massachusetts Institute of Technology (MIT) developed an integrated framework relating construction, maintenance and road user costs. Most of the relationships were based on information available from published literature, and could not be confirmed by empirical data.

In a subsequent World Bank cooperative effort in Kenya with the Transportation and Road Research Laboratory (TRRL), field studies produced empirical relationships which were incorporated into a revised version of the MIT model entitled Road Transport Investment Model. Following the publication of this model by TRRL in 1975, the Bank coordinated an agreement with both TRRL and MIT to produce a unified model which combined the strengths of each model, while avoiding the weaknesses of both. Therefore, the current model version, The Highway Design and Maintenance Standards Model (HDM), uses the structural framework of MIT's first model, results from field investigations in Kenya, as well as new technology published in current literature. It includes modules to predict roadway performance, construction and maintenance quantities and the impact on the costs to users operating on roads with varying characteristics. Automatic costing

with current unit prices permits an economic evaluation of the implications of alternate design and maintenance strategies on total transportation costs.

The HDM will be tested by the research team in connection with several highway projects in Brazil.

Although the HDM is operational, it is not necessarily applicable to Brazilian conditions. Many of its underlining relationships need to be verified before its results can be accepted for Brazil. Also, it has a number of acknowledged limitations, and many of these are being directly addressed in the current study. For example, road performance relationships are based on high-standard asphalt roads used in the AASHO road test and bituminous-treated, cement-stabilized base roads in Kenya. In the case of unpaved roads, relationships reflect Kenya gravel roads. Therefore, as part of this project, a series of pavement and maintenance studies are being made on typical Brazilian roads. These studies will establish performance relationships for roads in Brazil, subject to different levels of maintenance.

The relationships developed between road user costs and roadway geometrics in Kenya do not cover the wider range existing in Brazil. Further, the HDM embraces only a limited number of vehicles which are not necessarily typical of those used in Brazil. The major thrust of this study is to develop more comprehensive information and relationships on vehicle user costs. In addition to fuel consumption, special efforts are being directed to the development of tire wear, vehicle maintenance and vehicle depreciation.

Finally, the effect of congestion and traffic composition on operating costs is not based on empirical data in the HDM. Special studies and experiments in this study address these influences in greater detail.

b Scope

This study has been organized to make use of sound experimental design and survey techniques to minimize the magnitude of the data collection effort, yet ensuring where practical that quantitative statements of accuracy can be made about models developed in the study. Data are collected through controlled experiments, direct meas

urements and from information contributed by participants in the user surveys.

The study areas are in central Brazil as originally planned. One exception is the inclusion of user survey routes in the State of Mato Grosso to capture flat routes for the user survey factorial. This is illustrated in Figure 1 where the actual area covered by user survey routes is shown. The pavement and maintenance study locations are shown in Figure 2, and embrace a three-state area. Finally, the sections selected for the various controlled experiments on vehicle speed, fuel and traffic-interaction effects are indicated in Figure 3. These latter sections were located close to Brasilia, where possible, to minimize the logistics costs associated with moving the project's fleet of instrumented test vehicles.

This study which started in July 1975 is at the halfway point. Data collection started in July 1976, although this varied somewhat from sector to sector.

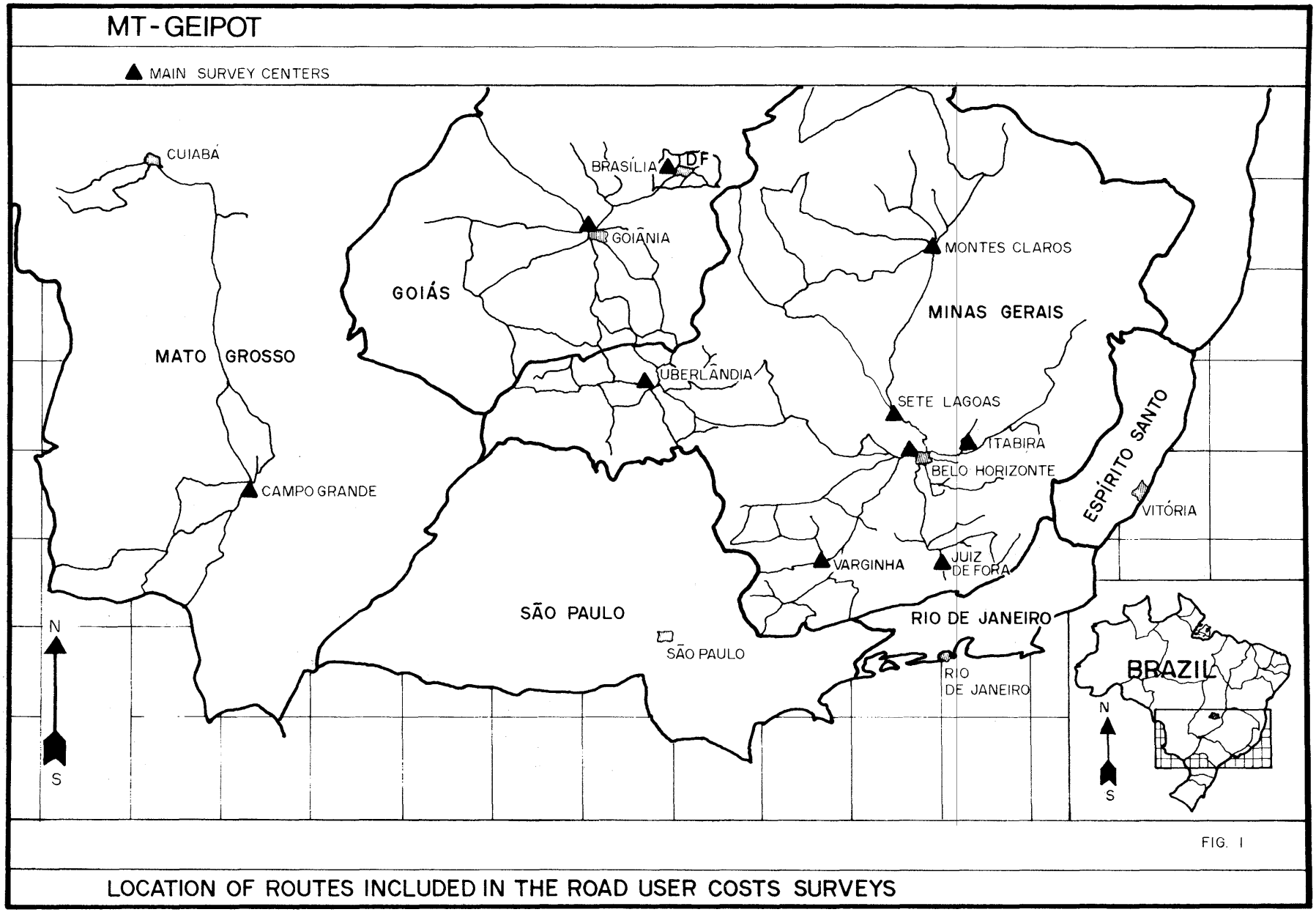


FIG. 1

LOCATION OF ROUTES INCLUDED IN THE ROAD USER COSTS SURVEYS

MT - GEIPOT

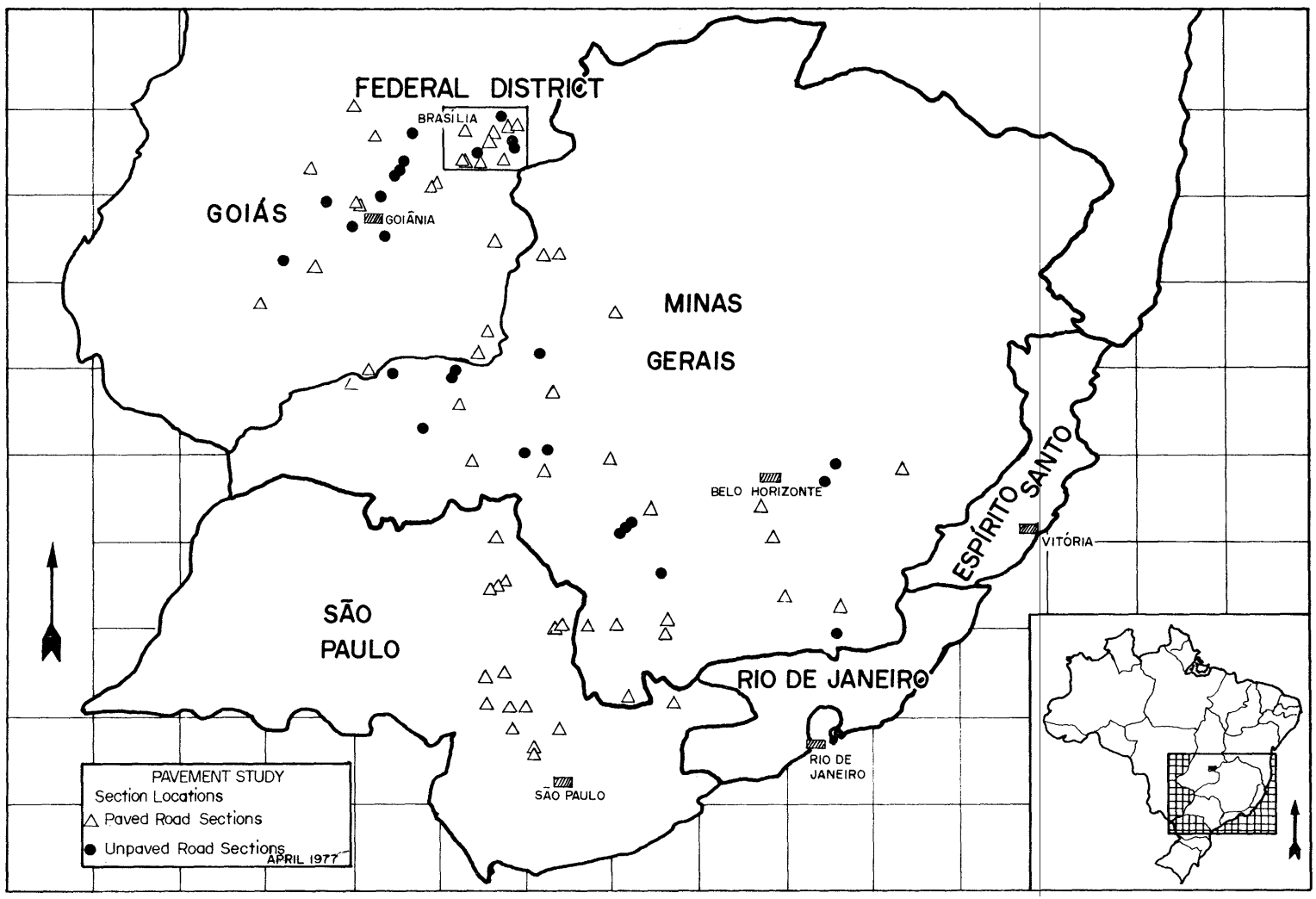
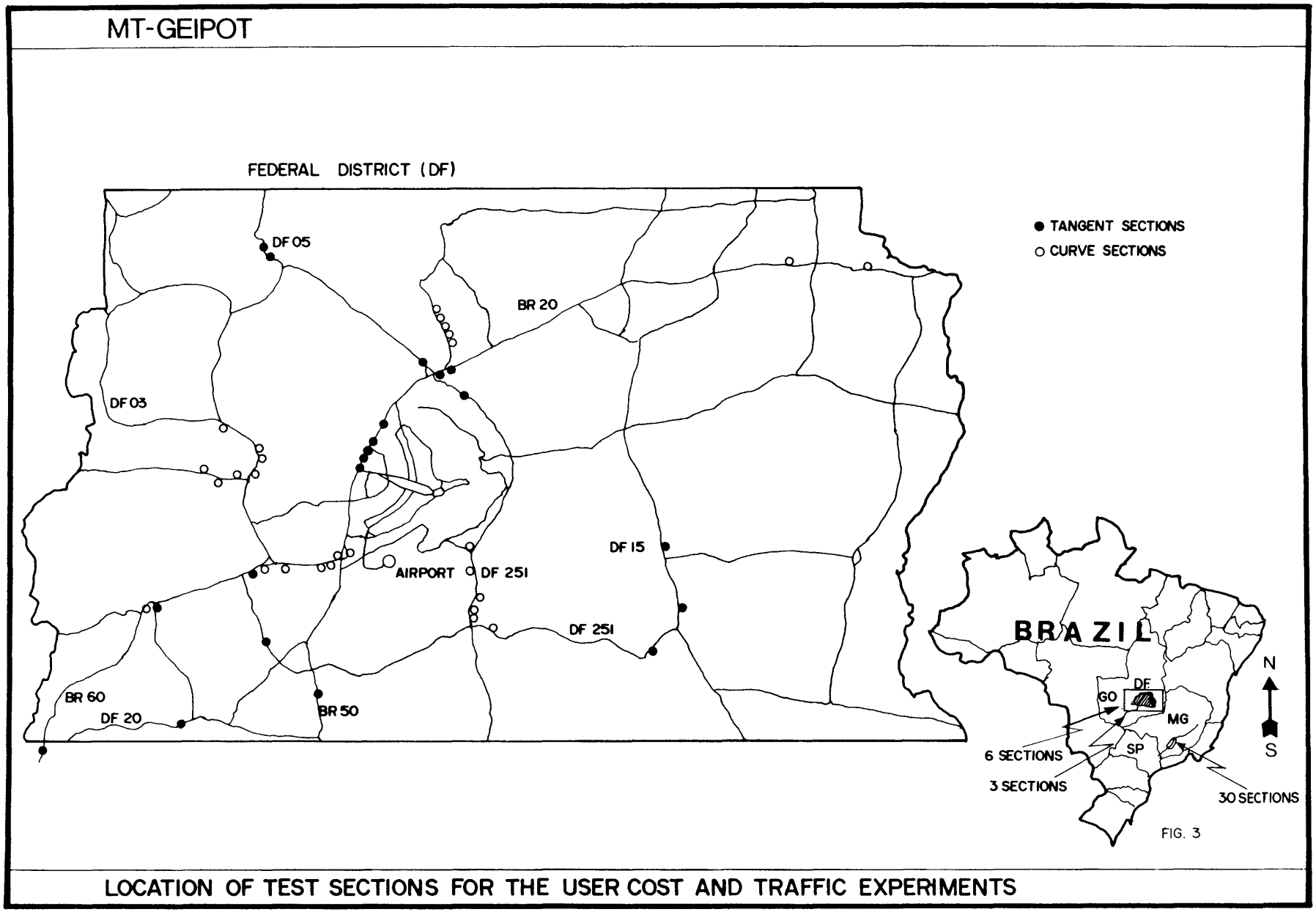


FIG. 2

LOCATION OF SECTIONS FOR THE PAVEMENT AND MAINTENANCE STUDIES



LOCATION OF TEST SECTIONS FOR THE USER COST AND TRAFFIC EXPERIMENTS