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COMMUNITY-LEVEL IMPACTS PROJECTION SYSTEM (CLIPS)

by

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DISCLAIMER

PREFACE

This report describes the results of a two-year research effort to develop a methodology suitable for assessing the local socioeconomic impacts accompanying energy development in the state of Texas. CLIPS is intended to serve as a tool to assist local and state planners in anticipating and preparing for community-level socioeconomic impacts.

Support for this research has been provided by the Texas Energy Development Fund administered by the Texas Energy Advisory Council and the Center for Energy Studies at The University of Texas at Austin. Dr. Monts is a Research Associate and Mr. Bareiss is a Research Assistant at the Center for Energy Studies. The authors wish to express their appreciation to Drs. Sally C. Lopreato and Herbert Woodson for valuable suggestions and encouragement throughout the project. The quality of the report was enhanced considerably by the editorial and supervisory efforts of Ms. Katie Nesbitt.

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Chapter 1

INTRODUCTION

A. The Importance of Community-Level Impact Assessment for Texas Energy Development

It is generally agreed that the United States, and the world as a whole, entered a new energy era during the early 1970s. The oil embargo and the subsequent dramatic price increases signalled this entry. The state of Texas entered this era along with the rest of the country. The once quasi-self-sufficient energy exporter found itself in the new position of having to find new energy sources, as well as planning expanded production of old sources, in order to fuel its rapidly growing economy and population. The quest promises to be a fruitful one.

With every reward, however, there are potential costs. Sometimes such costs have to be endured in their entirety. Sometimes their severity can be mitigated. Sometimes they can be compensated for, and sometimes they can be avoided altogether.

After agreeing on rewards worthy of pursuit, the likely next-highest priority of the policy-making process is to attempt to balance the costs. Balancing costs is assisted by knowledge. If the policy-maker can anticipate the likely costs forthcoming from the pursuit of rewards, he/she can plan for them. If the plans are robust, avoidance/mitigation/compensation/endurance is facilitated. The purpose of this investigation has been to develop a knowledge instrument helpful in addressing a set of costs that have accompanied our entry into a new energy era.

Energy development, or the lack of it, is felt at many levels--individual, family, neighborhood, community, state, region, nation, and world. Furthermore, the experience at one level often influences the experience at another level. If the state of Texas hopes to reap the benefits of energy development at the state level, it likely must consider the costs at the community level.

Local communities are becoming increasingly active in the political arena. Throughout most of 1977, the Grimes County Taxpayers' Association (GCTA) successfully impeded the efforts of the Texas Municipal Power Agency (TMPA) to construct and bring into operation a lignite-fired power plant intended to provide cost-effective electricity for consumers in Garland, Denton, and Bryan (Dallas Times Herald, 1977). Why did the GCTA engage in such action at the risk of considerable expense to TMPA consumers? Their answer was that they felt they were unjustly being called upon to bear costs which were not adequately compensated for by locally derived benefits from the power plant. This event may appear to be an isolated, minor incident, but the legal code is rapidly filling with such cases (see chapter 11 and appendix 1 of Burchell and Listokin's discussion of 87 cases relating to cost-revenue impacts [1978]).

Nor does the evidence indicate that Grimes County is alone in experiencing the local costs of energy development. A recent study (Houston, 1977: p. 535) announced:

> No aspect of the confused energy development situation of the past four years rivals the problems of the communities and areas that are economically, fiscally, and environmentally impacted by energy booms. A recent Bureau of the Mines study indicates that 200 non-coastal counties west of the Mississippi are currently affected or will be within 10 years by power plant construction, coal and uranium mining, and other energy development activities.

Texas communities are not strangers to energy booms/busts. A recent Texas Department of Community Affairs document (1978a: p. 6) reported:

> The oil discovery in nearby Limestone County became one of the great oil booms of America. The population in the town of Mexia increased from 4,000 to 50,000 within days. . . . By the middle 1930's this oil boom was dead, and most of the inhabitants had left.

Less dramatic but equally troublesome have been the local impacts from recent Texas energy developments. With energy development and its accompanying rapid population growth have come serious socioeconomic problems. Rising crime rates accompanied power plant construction near Mount Pleasant. From 1970 to 1975, robberies, burglaries, and thefts rose 759 percent (Burke, 1976). One wastewater treatment plant received twice the daily wastewater it was designed to treat. During petroleum development near Carrizo Springs, eight of the ten wells that tap the Carrizo Aquifer and supply Carrizo Springs with domestic water went dry because of a drop in the water table brought about by increased demand (Stinson, 1977). With construction of the South Texas Nuclear Project in Matagorda County during 1977, roads and bridges fell into disrepair because of use by heavy construction vehicles (Houston Post, 1977). In almost all of these locations, retail prices for most local goods and services rose dramatically, and housing has become expensive or unavailable.

Nor are these experiences likely to be the end of it. By 1985, 60 percent of the electric capacity of the state is expected to be coal-fired: 31 percent Texas lignite and 29 percent imported western coal. Forty-four electricity-generating units ranging in size from 250- to 750-megawatts have been proposed for construction between 1976 and 1986 in twenty-three different localities. In addition to electric utilities, twenty different companies representing the chemical, primary metals, and building-products industries have been involved in lignite exploration and leasing activities over the last few years (Kaiser and Cooper, 1978; White and Clemons, 1977).

In the face of such prospects, the Texas Energy Advisory Council issued the following statement (1977: p. 27):

> Siting restrictions on the location of new coal facilities near urban areas will force most new facilities to locate near rural areas. The influx of workers into these areas will strain existing social and economic structures and provide a major challenge to local governments. The success of coal conversion programs will in significant measure depend on the ability of local government to meet the challenges.

The proposed energy development activities presuppose some form of local acceptance (or else stringent state action to prevent local resistance). Planning for the mitigation of local socioeconomic impacts is one obvious potential avenue to local acceptance and avoidance of stringent state action. Although by no means the only component of the planning process (see U.S. Department of Energy, 1977), an adequate mechanism for projecting impacts will be a cornerstone. CLIPS represents our initial effort to provide such a methodology.

B. The Nature and Use of CLIPS

Before describing the intricate nature of CLIPS and the history of efforts to produce CLIPS-like methodologies--an endeavor which will mire the uninitiated in a jungle of ambiguities and technicalities--we would like to address briefly the question of "what is a socioeconomic impact assessment methodology?"

Despite all its meanderings, the bottom line of a socioeconomic impact assessment methodology is people. People lead fairly dull lives in these models. They are born. Some of them enter the labor force and work. Some of them enter the labor force and don't work. Some want and can afford to own single-family homes. Some want townhouses. Some rent. A lot of them eat out at restaurants fairly often. Most get somebody else to fix their cars. Some sprinkle their lawns. Most take baths. Most pay taxes. All of them generate sewage and all of them die. The sole purpose of a socioeconomic impact assessment methodology is to interrelate these activities in a meaningful, systematic manner in an effort to produce projections of them and, it is hoped, to assist planners in meeting mundane human needs presupposed by these activities.

As implied by its title--Community-Level Impacts Projection System--CLIPS is a system. That is, it is a bunch of parts that interact with each other to produce a product. The product is a set of reports that tell the user such things as: (1) how many people are likely to live in a certain community in a particular region at a certain time; (2) how many elementary school children a specific community may anticipate during a given school year; (3) how many jobs the region may anticipate in the Logging, Sawmills, and Planing Mills industry during a given year; (4) how much the construction of sewage pumping stations and wastewater collection networks is likely to cost a community over a given number of years; (5) how many people in the regions are likely to be employed in Motor Vehicle Retailing and Service Stations in a given year; and (6) many other bits of information (see chapter 1D and Appendix B). Furthermore, the system will generate these reports under two sets of conditions: baseline and impact. Baseline is simply a projection of all these variables into the future under the assumption that no "large-scale singular economic activity" occurs in the region during the projection period. Impact projection involves the same reports, but the numbers reflect the introduction of some large-scale economic activity such as the construction of a power plant.

These reports are the products of CLIPS. The parts of the system are (1) a large mathematical model translated into three FORTRAN programs, and (2) a set of accompanying FORTRAN routines that take the information required, feed it through the model routines, and generate the reports. Such processing is a complex affair under a user-oriented format (see chapter 8). However, once the system has been set up, its use is high-school simple. All the user does is sit down at a computer terminal and respond with "yes" or "no" (and occasionally with a number) when prompted by the terminal.

The development of this "usability" feature has been one of our overriding concerns from the beginning. Even though the user cannot at present set up CLIPS (because of its site-specificity and extensive data requirements that were deemed necessary for optimizing reliability), once it is set up, its facile use is straightforward. We do not presume to dictate how CLIPS will be used, nor at what level of organization, nor for what purpose. We have tried implicitly to suggest its potential use (especially in chapter 2) by indicating in detail the specific nature of its output, stressing the relative importance we assigned in developing the output and the internal components, and issuing emphatic caveats throughout the document concerning risky assumptions and interpretations (see especially chapter 7). We anticipate that CLIPS will prove to be most immediately useful on two levels:

1. The community-level baseline and impact population projections should prove most useful at the local planning level (councils of governments, school superintendents, wastewater superintendents, police chiefs, fire chiefs, etc.) and will perhaps be used by some state agencies (Texas Department of Community affairs, Texas Highway Department, Texas Industrial Commission, etc.)
2. The socioeconomic reports might serve as guides for local planners (see chapter 7 caveats) but likely will prove more useful to state planners in charge of disbursing the funds from such programs as the Coastal Energy Impact Program

We have stressed the development of usability because we feel that such a capability is the only way of intimately integrating the planner/user into the production of projections. If a modeling system is difficult to use, the planner is much more likely to "leave it to the experts" and attempt no understanding for himself. We believe such a state of affairs is unfortunate. Even if experts must set up models, if the models are usable, the planner can generate his own reports. By going through the motions, he will gain additional understanding of the phenomena the system purports to model. Holling (1978: p. 24) noted:

> Prediction is based not upon accumulation of facts, but upon understanding--and that comes slowly. The domain of our ignorance will always be greater than that of our knowledge. The prime issue therefore is not only how to better mobilize the known but how to plan in the face of the unknown and the uncertain.

If a system's use is straightforward, the planner is much more likely to view prediction as planning ". . . in the face of the unknown and the uncertain." Future versions of CLIPS will emphasize extreme flexibility. By simply typing in "yes," "no," "0.003," "405," "1985," the user will be able to alter assumed fertility rates for 20- to 24-year-old females, the number of Iron and Steel Foundries employees who may begin work in the region in 1985, and so forth. In addition, if he so wishes, the user may assemble the theoretical framework he chooses to use to conduct the projection. If he thinks the Spatial Allocation Model is superior to the Gravity Model, he can choose it by typing "yes" or "no" to a computer prompt. Conversely, if he wants CLIPS to make most of the decisions, he will be able to tell the system at the beginning of the session, and CLIPS will generate standardized reports using its own assumptions. All these capabilities are simply a matter of computer software development.

A final note on reliability. As is discussed in section C of this chapter, CLIPS--like all previous efforts at modeling socioeconomic impacts--has not been validated. These models are all simply too new. Indeed, a recent report surmised (EIA Review, 1978: p. 2), "the most valuable next step in socioeconomic impact analysis will come through the validation of the large number of predictive models that have been developed."

We have made a painstaking effort to assemble what we deemed the most trustworthy theoretical approaches available. Moreover, the reader will find an "overview and model rationale" section for every subcomponent of CLIPS. In these sections, we attempt to review all the various approaches and to justify the one we selected. Many of the model's parameters were derived from an empirical analysis of data on Texas communities and counties. Others were borrowed. The model predicts within two hundred people the 1975 regional baseline population of the aggregate Robertson, Freestone, Limestone, Falls, and Leon counties, but this prediction is after only a five-year period. The detail of CLIPS was designed with an eye toward reliability, as was its dependence upon an extensive, site-specific data base. (For example, initial manufacturing employment in each of the 72 groups was estimated by examining, at the four-digit SIC [Standard Industrial Classification] level, the number of employees in each firm in each community throughout the region as published in the Directory of Texas Manufacturers 1976.) Beyond this, we can say no more.

C. The History of CLIPS

During the 1978 session, the Texas legislature created and funded the Texas Energy Development Fund. The objective of the fund is to support research designed to further progress in the development of alternative energy sources, including solar, biomass, wind, lignite, and so forth. In addition to encouraging basic technological research, the fund sought to support research focusing on identification of potential constraints to the development of energy sources already deemed technologically feasible. One such constraint was thought to be community-level socioeconomic problems. In response to the formal Special Projects 3 request for proposals, the Social Systems Analysis Division of the Center for Energy Studies at The University of Texas at Austin submitted a proposal and through competitive bidding received a contract to continue basic research begun during 1977 on the development of a methodology suited to assessing local socioeconomic impacts from energy development.

During March, 1978, the research began in earnest and was a primary focus of the division through the remainder of the year. The initial effort naturally emphasized a review of previous research in the area. The last six years, since the National Environmental Protection Act (NEPA), have given a rise to a voluminous literature in the area of social impact assessment, and the future promises exponential growth with the likelihood that impact assessment will become the major applied social science field. The present NEPA regulations are being interpreted thus: Potential social impacts from a project are not adequate grounds for requiring the preparation of an Environmental Impact Statement; but, if an EIS is indicated on other grounds, a social impact assessment must accompany it. The recently proposed national urban policy suggests the required preparation of Urban Impact Assessments as a cornerstone to the overall policy determination. In addition to formal requirements, impetus to social impact assessment is anticipated from the surge of local public activism in the last few years.

In response to such demand, work in this area has grown as in few others; a grasp of the range of emphases is difficult to capture. An attempt at such a grasp led Grigsby (1978: p. 34) to the conclusion:

> A review of the expanding literature and research in the field of social impact assessments (SIA) suggests that the information can be categorized in the following manner: (1) Background Literature--various articles about the idea of social impact assessment, why it should be done, and suggestions on how it should be conducted, (2) Behavioral Science Literature--a review of work in the fields of sociology, anthropology, economics, political science, and social welfare in order to extract theory or empirical evidence to identifying, predicting and/or evaluating social impacts, (3) Predictive Case Studies--reports on projects or programs in which social impact assessment has been used to predict impacts and/or to provide a basis for planning activities to mitigate projected impacts, and (4) Evaluative Case Studies--reports on projects or programs whose possible social impacts have been evaluated after some induced changes in the environment have taken place.

Because of the above-mentioned formal regulations, the third category, predictive case studies, has been the most voluminous so far. Hundreds of case studies employing hundreds of methodologies have been performed. Chalmers and Anderson (1977) sampled and surveyed sixty in the water resources, mining, power plant, and recreational areas. In the nuclear utilities area alone, Chiang and Snead (1976) surveyed ninety-four nuclear facility socioeconomic assessments.

The most striking finding of these surveys has been the diversity of methodologies employed to assess basically the same set of phenomena.

It is probably safe to say that no two employed the same formal techniques.

In the face of this diversity, recent efforts have been made to integrate and develop "comprehensive" methodologies quite similar to the one embodied in CLIPS. The national laboratories have been active. The Energy and Environmental Systems Division at the Argonne National Laboratory, after several years of research, has recently formally implemented and partially documented its Social and Economic Assessment Model (SEAM) (Stenehjem, 1978). The Los Alamos Scientific Laboratory has developed BOOM1 as a nonforecasting, policy analysis instrument (Ford, 1976). The Oak Ridge National Laboratory has developed the MULTIREGION model to assess potential county-level socioeconomic impacts from power plant siting patterns (1978).

Other organizations--local, state, and national--have entered the scene. The National Oceanic and Atmospheric Administration has produced ASCEND (a modification of BOOM1) to assist in the disbursement of national funds to states covered under the Coastal Energy Impact Program. The U.S. Department of Energy Recently published a detailed comprehensive methodology employed to assess local socioeconomic impacts from synthetic fuels development (Murphy/Williams, 1978). Using a coal severance tax for funding, the state of North Dakota created the Regional Environmental Assessment Program, whose initial task over the last few years has been the development, implementation, and refinement of the REAP Economic Demographic Model (Hertsgaard et al., 1978). To assess socioeconomic impacts from water resources development, the Bureau of Reclamation has developed the Bureau of Reclamation Economic Assessment Model (BREAM)

(Mountain West Research, Inc., 1978). The Texas General Land Office (1978) has produced the Activity Assessment Routine (AAR) to assist in the Texas Coastal Management Program.

All of these methodologies are designed to assess local socio-economic impacts from large-scale development projects (e.g., power plant construction, offshore oil development, large-scale mining activities, etc.). Most attempt to be "comprehensive" in the sense that they address a wide range of impacts. Most restrict their focus to the more immediate impacts such as jobs, population, housing, public facilities/services, income, and so forth. Some are directed toward informing policy decisions at the state and federal levels. Some emphasize local policy information. Some are heavily computerized. Some are manual. None have been validated.

Still, in the face of all these efforts, the Electric Power Research Institute (1978: p. 35) request for proposal concluded:

> There does not exist a standardized, quantitative model for consistent needs and fiscal analyses throughout the field. If developed, such a model would obviate the need to litigate questions of methodology and allow the agency review process to focus on the results of the application of such methodology.

The presumed importance of the field explains the continued efforts. The previous shortcomings are explained by the youth of the field and the complexity of the subject matter. (A comprehensive methodology embraces the disciplines of regional economics, regional demography, economic geography, civil engineering, municipal finance, computer science, applied mathematics, and the like. All of these disciplines have their own pet techniques and orientations; spanning them is a gargantuan task.)

CLIPS shares many similar features with these past modeling efforts (most notably SEAM and the REAP E-D model). From the outset, we decided upon a totally "eclectic" approach: In the face of the lack of standardization and validation, we decided that our overriding goals were reliability, usability, and flexibility, and that we would pick and choose what we considered to be the "best" components from among many approaches in an effort to optimize these criteria.

CLIPS draws its conceptual underpinnings from numerous sources, including the following:

1. The San Diego Comprehensive Planning Organization Interactive Population Employment Forecasting Model (1977)
2. The more recent San Diego Comprehensive Planning Organization, DEFM78 Forecasting Model (1978)
3. The Battelle National Laboratories DEMOS model (1977)
4. The Bureau of Reclamation's BREAM model (1978)
5. The U.S. Department of Energy's synthetic fuels socioeconomic impact assessment model prepared by Murphy/Williams Consultants (1978)
6. The U.S. Water Resources Council 1972 OBERS model (1972)
7. The U.S. Bureau of Labor Statistics, The Structure of the U.S. Economy in 1980 and 1985 (1975)
8. The Argonne National Laboratory SEAM (1978)
9. The North Dakota Regional Environmental Assessment Program Economic-Demographic model (1978)
10. Greenberg et al. "growth rate method of adjustment" (1978)

11. The University of Texas at Austin Center for Energy Studies BOOMP model (1978)

12. Ideas from other sources too numerous to cite

Of the above listed, we relied most heavily on 1, 2, 3, 5, 7, and 10.

D. Annotated Sample Session

Explanatory notes follow this listing of the terminal session and are indexed by the numbers in the left margin of the listing. In the listing of the sample terminal session all user responses are lower case, and all output by the computer system is upper case.

```
(1) UT AUSTIN - TAURUS - 18 JAN 79 - Ø9.53.54. - PORT 3Ø
(2) =eyav346//abc
    <PARITY CHECKING DISABLED>
    JOBNAME: EYAV346-3Ø4
    CHARGES THROUGH 17 JAN 79 : TIME $ 471.Ø6 SUPPLIES $ 125.ØØ

    CC:
(3) sbs=
(4) execpf 7863 rclips
    GO:

       CCCCC    LL          IIIIIIII PPPPPPP     SSSSSSS
      CCCCCCC   LL          IIIIIIII PPPPPPPP   SSSSSSSS
     CC     CC  LL             II    PP      PP SS
     CC         LL             II    PP      PP SSSSSSS
     CC         LL             II    PPPPPPPP   SSSSSSS
     CC         LL             II    PPPPPPP           SS
     CC     CC  LL             II    PP                SS
      CCCCCCC   LLLLLLLLL   IIIIIIII PP         SSSSSSSS
       CCCCC    LLLLLLLLL   IIIIIIII PP         SSSSSSS

    COMMUNITY LEVEL IMPACT PROJECTION SYSTEM - CLIPS

    ARE YOU FAMILIAR WITH CLIPS(YES OR NO)?
(5) n

    CLIPS IS AN INTERACTIVE COMPUTER PROGRAM WHICH
    PROJECTS THE SOCIOECONOMIC IMPACTS ON NEARBY
    COMMUNITIES THAT ACCOMPANY THE POPULATION GROWTH
    ASSOCIATED WITH ENERGY DEVELOPMENTS.

    WHEN USING CLIPS, YOU WILL INTERACT WITH THE
    SYSTEM PRIMARILY BY RESPONDING 'YES' OR 'NO' TO
    A SERIES OF QUESTIONS WHICH APPEAR ON THE SCREEN.
    WHEN OTHER ACTION, SUCH AS CHANGING A PARAMETER
    VALUE, IS REQUIRED, CLIPS WILL DISPLAY EXPLICIT
    INSTRUCTIONS FOR ACCOMPLISHING THE TASK.BE SURE TO
    STRIKE THE RETURN KEY ON THE TERMINAL AFTER EACH
    RESPONSE YOU GIVE TO THE SYSTEM.YOU CANNOT GO WRONG,
    SO RELAX AND INTERACT.
```

(6) HIT THE RETURN KEY TO CONTINUE

THE MODEL IS SET TO RUN FOR 20 YEARS, WHICH CURRENTLY IS ITS MAXIMUM CAPABILITY. DO YOU WANT THE MODEL TO RUN FOR FEWER YEARS (YES OR NO)?

(7) n

NOW, IF YOU WISH, YOU MAY DESCRIBE A LARGE CONSTRUCTION PROJECT PLANNED FOR YOUR REGION. IF YOU DO SO, THE MODEL WILL TAKE THE EFFECTS OF THE PROJECT INTO ACCOUNT WHEN PROJECTING THE ECONOMIC AND DEMOGRAPHIC TRENDS OF YOUR AREA.

DO YOU WISH TO DESCRIBE A PROJECT (YES OR NO)?

(8) y

ENTER THE STARTING YEAR AS A LEFT JUSTIFIED INTEGER BETWEEN 1970 AND THE LAST YEAR OF THE SIMULATION (1990 IS THE DEFAULT LAST YEAR).

YEAR:

(9) 1979

ENTER THE LENGTH OF THE PROJECT IN YEARS AS A LEFT JUSTIFIED INTEGER BETWEEN 1 AND 10.

LENGTH:

(10) 5

NOW ENTER THE PROJECT MANPOWER REQUIREMENTS YEAR BY YEAR WHEN PROMPTED BY THE PROGRAM.

YEAR 1:

(11) 170

YEAR 2:

700

YEAR 3:

800

YEAR 4:

800

YEAR 5:

400

PERMANENT OPERATING STAFF REQUIRED:

(12) 300

PROJECT MANPOWER REQUIREMENTS:

YEAR 1: 170.00
YEAR 2: 700.00
YEAR 3: 800.00
YEAR 4: 800.00
YEAR 5: 400.00

OPERATING STAFF: 300.00

ARE THESE CORRECT (YES OR NO)?
(13) Y

REGIONAL POPULATION:

YEAR	CHLD	T.A.	Y.A.	P.A.	M.A.	OLD	TOTAL
1970	1.54E+04	7.70E+03	3.27E+03	1.17E+04	1.76E+04	1.50E+04	6.96E+04
1971	1.54E+04	8.10E+03	4.19E+03	1.23E+04	1.72E+04	1.50E+04	7.21E+04
1972	1.51E+04	8.11E+03	4.77E+03	1.25E+04	1.67E+04	1.49E+04	7.21E+04
1973	1.42E+04	7.82E+03	4.99E+03	1.25E+04	1.61E+04	1.47E+04	7.04E+04
1974	1.39E+04	7.67E+03	5.30E+03	1.29E+04	1.56E+04	1.45E+04	6.99E+04
1975	1.39E+04	7.63E+03	5.63E+03	1.35E+04	1.52E+04	1.43E+04	7.02E+04
1976	1.38E+04	7.44E+03	5.79E+03	1.39E+04	1.48E+04	1.41E+04	6.99E+04
1977	1.34E+04	7.12E+03	5.73E+03	1.42E+04	1.43E+04	1.38E+04	6.86E+04
1978	1.29E+04	6.73E+03	5.54E+03	1.44E+04	1.38E+04	1.35E+04	6.69E+04
1979	1.26E+04	6.41E+03	5.39E+03	1.46E+04	1.34E+04	1.32E+04	6.56E+04
1980	1.29E+04	6.33E+03	5.48E+03	1.54E+04	1.31E+04	1.29E+04	6.61E+04
1981	1.31E+04	6.22E+03	5.50E+03	1.60E+04	1.29E+04	1.26E+04	6.63E+04
1982	1.30E+04	6.00E+03	5.34E+03	1.63E+04	1.26E+04	1.23E+04	6.55E+04
1983	1.21E+04	5.53E+03	4.84E+03	1.58E+04	1.21E+04	1.20E+04	6.23E+04
1984	1.11E+04	5.05E+03	4.35E+03	1.49E+04	1.15E+04	1.17E+04	5.86E+04
1985	1.05E+04	4.75E+03	4.04E+03	1.45E+04	1.12E+04	1.14E+04	5.64E+04
1986	1.00E+04	4.48E+03	3.77E+03	1.41E+04	1.08E+04	1.10E+04	5.43E+04
1987	9.52E+03	4.23E+03	3.53E+03	1.37E+04	1.05E+04	1.07E+04	5.23E+04
1988	9.04E+03	3.99E+03	3.30E+03	1.33E+04	1.03E+04	1.04E+04	5.03E+04
1989	8.55E+03	3.77E+03	3.09E+03	1.28E+04	9.98E+03	1.01E+04	4.83E+04
1990	8.06E+03	3.55E+03	2.88E+03	1.23E+04	9.73E+03	9.83E+03	4.63E+04

(14) HIT RETURN KEY TO CONTINUE

EMPLOYMENT BY INDUSTRY TYPE:

YEAR	BASIC	BUSINESS SERVING	HOUSEHOLD SERVING	SCHOOLS	CON-STRUCTION	TOTAL
1971	4788.	1445.	12096.	2134.	567.	21030.
1972	4869.	1455.	12338.	2200.	543.	21406.
1973	4840.	1454.	12330.	2191.	276.	21090.
1974	5636.	1470.	12051.	2099.	0.	21256.
1975	5990.	1479.	11973.	2072.	199.	21712.
1976	5973.	1480.	12020.	2080.	332.	21884.
1977	5957.	1478.	11963.	2061.	220.	21678.
1978	5942.	1471.	11761.	2001.	64.	21239.
1979	5928.	1462.	11507.	1927.	176.	20999.
1980	5916.	1458.	11388.	1890.	848.	21501.
1981	5814.	1456.	11427.	1902.	1119.	21718.
1982	5712.	1452.	11418.	1905.	1067.	21555.
1983	5610.	1441.	11168.	1846.	411.	20476.
1984	5809.	1427.	10532.	1691.	0.	19460.
1985	5708.	1411.	10114.	1588.	0.	18820.
1986	5607.	1396.	9746.	1501.	0.	18250.
1987	5506.	1382.	9403.	1422.	0.	17713.
1988	5406.	1368.	9071.	1348.	0.	17193.
1989	5306.	1354.	8743.	1277.	0.	16680.
1990	5206.	1341.	8416.	1206.	0.	16169.

HIT RETURN KEY TO CONTINUE

POPULATION BY COMMUNITIES:

YEAR	CALVERT	FRANKLIN	GROESBECK	HEARNE	MARLIN
1970	2.07E+03	1.06E+03	2.40E+03	4.98E+03	6.35E+03
1971	2.00E+03	1.15E+03	2.53E+03	5.10E+03	6.27E+03
1972	1.93E+03	1.15E+03	2.53E+03	5.10E+03	6.20E+03
1973	1.86E+03	1.09E+03	2.44E+03	5.02E+03	6.13E+03
1974	1.80E+03	1.07E+03	2.41E+03	5.00E+03	6.05E+03
1975	1.73E+03	1.08E+03	2.43E+03	5.01E+03	5.98E+03
1976	1.67E+03	1.07E+03	2.41E+03	5.00E+03	5.91E+03
1977	1.61E+03	1.03E+03	2.34E+03	4.94E+03	5.84E+03
1978	1.56E+03	9.68E+02	2.25E+03	4.85E+03	5.77E+03
1979	1.57E+03	9.84E+02	2.23E+03	4.87E+03	5.79E+03
1980	1.74E+03	1.22E+03	2.44E+03	5.18E+03	6.06E+03
1981	1.82E+03	1.34E+03	2.55E+03	5.36E+03	6.18E+03
1982	1.82E+03	1.36E+03	2.55E+03	5.38E+03	6.20E+03
1983	1.62E+03	1.10E+03	2.24E+03	5.02E+03	5.91E+03
1984	1.43E+03	8.56E+02	1.94E+03	4.65E+03	5.62E+03
1985	1.38E+03	7.79E+02	1.80E+03	4.51E+03	5.56E+03
1986	1.34E+03	7.07E+02	1.67E+03	4.38E+03	5.50E+03
1987	1.30E+03	6.40E+02	1.55E+03	4.24E+03	5.44E+03
1988	1.26E+03	5.76E+02	1.42E+03	4.10E+03	5.38E+03
1989	1.23E+03	5.14E+02	1.30E+03	3.95E+03	5.33E+03
1990	1.19E+03	4.53E+02	1.18E+03	3.79E+03	5.27E+03

HIT RETURN KEY TO CONTINUE

CALVERT CAPITAL COSTS

YEAR	SCHOOLS	STREETS	SERVICE	UTILITY	WASTE	PARKS	TOTAL
1971	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1972	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1973	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1974	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1975	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1976	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1977	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1978	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1979	0.00E+00	7.54E+03	4.50E+03	3.68E+04	0.00E+00	1.45E+03	5.03E+04
1980	0.00E+00	1.44E+05	7.32E+04	8.24E+05	1.55E+03	2.35E+04	1.07E+06
1981	0.00E+00	5.48E+04	3.12E+04	3.04E+05	0.00E+00	1.00E+04	4.01E+05
1982	0.00E+00	2.42E+03	0.00E+00	1.19E+04	0.00E+00	0.00E+00	1.44E+04
1983	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1984	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1985	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1986	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1987	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1988	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1989	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1990	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

HIT RETURN KEY TO CONTINUE

CALVERT OPERATING AND MAINTENANCE COSTS

YEAR	SCHOOLS	STREETS	SERVICE	UTILITY	OTHER	TOTAL
1971	4.48E+05	2.79E+04	1.57E+05	3.11E+05	1.52E+05	9.44E+05
1972	4.25E+05	2.79E+04	1.51E+05	3.00E+05	1.47E+05	9.05E+05
1973	3.97E+05	2.79E+04	1.46E+05	2.90E+05	1.42E+05	8.60E+05
1974	3.74E+05	2.79E+04	1.41E+05	2.79E+05	1.37E+05	8.22E+05
1975	3.54E+05	2.79E+04	1.36E+05	2.70E+05	1.32E+05	7.88E+05
1976	3.34E+05	2.79E+04	1.31E+05	2.60E+05	1.27E+05	7.54E+05
1977	3.14E+05	2.79E+04	1.27E+05	2.51E+05	1.23E+05	7.20E+05
1978	2.95E+05	2.79E+04	1.22E+05	2.42E+05	1.18E+05	6.87E+05
1979	2.92E+05	2.80E+04	1.23E+05	2.44E+05	1.19E+05	6.86E+05
1980	3.28E+05	2.98E+04	1.37E+05	2.71E+05	1.32E+05	7.66E+05
1981	3.44E+05	3.05E+04	1.42E+05	2.83E+05	1.38E+05	8.00E+05
1982	3.44E+05	3.05E+04	1.42E+05	2.83E+05	1.38E+05	7.99E+05
1983	2.98E+05	3.05E+04	1.27E+05	2.52E+05	1.23E+05	7.08E+05
1984	2.53E+05	3.05E+04	1.12E+05	2.22E+05	1.08E+05	6.17E+05
1985	2.42E+05	3.05E+04	1.08E+05	2.15E+05	1.05E+05	5.96E+05
1986	2.32E+05	3.05E+04	1.05E+05	2.08E+05	1.02E+05	5.76E+05
1987	2.22E+05	3.05E+04	1.02E+05	2.02E+05	9.89E+04	5.57E+05
1988	2.13E+05	3.05E+04	9.90E+04	1.96E+05	9.59E+04	5.39E+05
1989	2.05E+05	3.05E+04	9.61E+04	1.91E+05	9.31E+04	5.22E+05
1990	1.97E+05	3.05E+04	9.33E+04	1.85E+05	9.05E+04	5.06E+05

HIT RETURN KEY TO CONTINUE

FRANKLIN CAPITAL COSTS

YEAR	SCHOOLS	STREETS	SERVICE	UTILITY	WASTE	PARKS	TOTAL
1971	0.00E+00	0.00E+00	3.53E+04	0.00E+00	0.00E+00	1.13E+04	4.74E+04
1972	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1973	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1974	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1975	0.00E+00	1.06E+04	3.96E+03	6.51E+04	0.00E+00	1.27E+03	8.10E+04
1976	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1977	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1978	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1979	0.00E+00	9.78E+03	6.76E+03	4.76E+04	0.00E+00	2.17E+03	6.65E+04
1980	0.00E+00	2.06E+05	9.77E+04	1.20E+06	2.07E+03	3.14E+04	1.54E+06
1981	0.00E+00	1.12E+05	5.35E+04	6.51E+05	1.14E+03	1.72E+04	8.35E+05
1982	0.00E+00	9.04E+03	6.91E+03	4.39E+04	0.00E+00	2.22E+03	6.22E+04
1983	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1984	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1985	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1986	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1987	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1988	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1989	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1990	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

HIT RETURN KEY TO CONTINUE

FRANKLIN OPERATING AND MAINTENANCE COSTS

YEAR	SCHOOLS	STREETS	SERVICE	UTILITY	OTHER	TOTAL
1971	2.57E+05	1.45E+04	8.99E+04	1.78E+05	8.72E+04	5.40E+05
1972	2.53E+05	1.45E+04	8.98E+04	1.78E+05	8.71E+04	5.35E+05
1973	2.32E+05	1.45E+04	8.54E+04	1.69E+05	8.28E+04	5.01E+05
1974	2.23E+05	1.45E+04	8.41E+04	1.67E+05	8.16E+04	4.89E+05
1975	2.21E+05	1.46E+04	8.49E+04	1.68E+05	8.23E+04	4.89E+05
1976	2.14E+05	1.46E+04	8.39E+04	1.67E+05	8.14E+04	4.79E+05
1977	2.00E+05	1.46E+04	8.07E+04	1.60E+05	7.82E+04	4.56E+05
1978	1.83E+05	1.46E+04	7.59E+04	1.51E+05	7.36E+04	4.24E+05
1979	1.84E+05	1.47E+04	7.72E+04	1.53E+05	7.48E+04	4.29E+05
1980	2.32E+05	1.74E+04	9.54E+04	1.89E+05	9.25E+04	5.34E+05
1981	2.59E+05	1.88E+04	1.05E+05	2.09E+05	1.02E+05	5.92E+05
1982	2.63E+05	1.89E+04	1.07E+05	2.12E+05	1.03E+05	6.00E+05
1983	2.07E+05	1.89E+04	8.64E+04	1.71E+05	8.38E+04	4.84E+05
1984	1.55E+05	1.89E+04	6.71E+04	1.33E+05	6.51E+04	3.74E+05
1985	1.39E+05	1.89E+04	6.10E+04	1.21E+05	5.92E+04	3.40E+05
1986	1.26E+05	1.89E+04	5.55E+04	1.10E+05	5.38E+04	3.10E+05
1987	1.13E+05	1.89E+04	5.02E+04	9.96E+04	4.87E+04	2.82E+05
1988	1.01E+05	1.89E+04	4.51E+04	8.95E+04	4.38E+04	2.55E+05
1989	9.00E+04	1.89E+04	4.03E+04	7.99E+04	3.90E+04	2.29E+05
1990	7.93E+04	1.89E+04	3.56E+04	7.05E+04	3.45E+04	2.04E+05

HIT RETURN KEY TO CONTINUE

GROESBECK CAPITAL COSTS

YEAR	SCHOOLS	STREETS	SERVICE	UTILITY	WASTE	PARKS	TOTAL
1971	0.00E+00	0.00E+00	5.62E+04	0.00E+00	1.19E+03	1.81E+04	7.54E+04
1972	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1973	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1974	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1975	0.00E+00	1.69E+04	6.28E+03	1.03E+05	0.00E+00	2.02E+03	1.29E+05
1976	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1977	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1978	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1979	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1980	0.00E+00	1.89E+05	9.01E+04	1.10E+06	1.91E+03	2.89E+04	1.41E+06
1981	0.00E+00	9.89E+04	4.81E+04	5.73E+05	1.02E+03	1.54E+04	7.36E+05
1982	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1983	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1984	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1985	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1986	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1987	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1988	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1989	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1990	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

HIT RETURN KEY TO CONTINUE

GROESBECK OPERATING AND MAINTENANCE COSTS

YEAR	SCHOOLS	STREETS	SERVICE	UTILITY	OTHER	TOTAL
1971	5.67E+05	3.26E+04	1.98E+05	3.93E+05	1.92E+05	1.19E+06
1972	5.57E+05	3.26E+04	1.98E+05	3.93E+05	1.92E+05	1.18E+06
1973	5.20E+05	3.26E+04	1.91E+05	3.79E+05	1.85E+05	1.12E+06
1974	5.02E+05	3.26E+04	1.89E+05	3.75E+05	1.83E+05	1.10E+06
1975	4.96E+05	3.29E+04	1.90E+05	3.78E+05	1.85E+05	1.10E+06
1976	4.82E+05	3.29E+04	1.89E+05	3.75E+05	1.83E+05	1.08E+06
1977	4.56E+05	3.29E+04	1.84E+05	3.65E+05	1.78E+05	1.04E+06
1978	4.25E+05	3.29E+04	1.76E+05	3.49E+05	1.71E+05	9.83E+05
1979	4.13E+05	3.29E+04	1.75E+05	3.46E+05	1.69E+05	9.66E+05
1980	4.56E+05	3.53E+04	1.91E+05	3.79E+05	1.85E+05	1.06E+06
1981	4.79E+05	3.65E+04	2.00E+05	3.97E+05	1.94E+05	1.11E+06
1982	4.75E+05	3.65E+04	2.00E+05	3.96E+05	1.94E+05	1.11E+06
1983	4.07E+05	3.65E+04	1.75E+05	3.48E+05	1.70E+05	9.67E+05
1984	3.41E+05	3.65E+04	1.52E+05	3.01E+05	1.47E+05	8.30E+05
1985	3.12E+05	3.65E+04	1.41E+05	2.80E+05	1.37E+05	7.70E+05
1986	2.87E+05	3.65E+04	1.31E+05	2.60E+05	1.27E+05	7.14E+05
1987	2.62E+05	3.65E+04	1.21E+05	2.41E+05	1.18E+05	6.61E+05
1988	2.39E+05	3.65E+04	1.12E+05	2.21E+05	1.08E+05	6.09E+05
1989	2.16E+05	3.65E+04	1.02E+05	2.02E+05	9.89E+04	5.57E+05
1990	1.94E+05	3.65E+04	9.23E+04	1.83E+05	8.95E+04	5.06E+05

HIT RETURN KEY TO CONTINUE

HEARNE CAPITAL COSTS

YEAR	SCHOOLS	STREETS	SERVICE	UTILITY	WASTE	PARKS	TOTAL
1971	0.00E+00	0.00E+00	4.87E+04	0.00E+00	1.03E+03	1.56E+04	6.54E+04
1972	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1973	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1974	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1975	0.00E+00	1.46E+04	5.42E+03	8.92E+04	0.00E+00	1.74E+03	1.11E+05
1976	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1977	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1978	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1979	0.00E+00	1.09E+04	6.60E+03	5.32E+04	0.00E+00	2.12E+03	7.29E+04
1980	0.00E+00	2.79E+05	1.32E+05	1.63E+06	2.81E+03	4.26E+04	2.09E+06
1981	0.00E+00	1.52E+05	7.28E+04	8.83E+05	1.54E+03	2.34E+04	1.13E+06
1982	0.00E+00	1.30E+04	9.74E+03	6.32E+04	0.00E+00	3.13E+03	8.92E+04
1983	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1984	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1985	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1986	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1987	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1988	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1989	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1990	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

HIT RETURN KEY TO CONTINUE

HEARNE OPERATING AND MAINTENANCE COSTS

YEAR	SCHOOLS	STREETS	SERVICE	UTILITY	OTHER	TOTAL
1971	1.14E+06	6.78E+04	4.00E+05	7.93E+05	3.87E+05	2.40E+06
1972	1.12E+06	6.78E+04	4.00E+05	7.92E+05	3.87E+05	2.38E+06
1973	1.07E+06	6.78E+04	3.94E+05	7.81E+05	3.82E+05	2.31E+06
1974	1.04E+06	6.78E+04	3.92E+05	7.78E+05	3.80E+05	2.28E+06
1975	1.02E+06	6.80E+04	3.93E+05	7.80E+05	3.81E+05	2.26E+06
1976	9.99E+05	6.80E+04	3.92E+05	7.77E+05	3.80E+05	2.24E+06
1977	9.61E+05	6.80E+04	3.87E+05	7.68E+05	3.75E+05	2.18E+06
1978	9.18E+05	6.80E+04	3.81E+05	7.55E+05	3.69E+05	2.12E+06
1979	9.02E+05	6.81E+04	3.82E+05	7.57E+05	3.70E+05	2.11E+06
1980	9.62E+05	7.17E+04	4.06E+05	8.06E+05	3.94E+05	2.25E+06
1981	9.95E+05	7.37E+04	4.20E+05	8.33E+05	4.07E+05	2.32E+06
1982	9.94E+05	7.38E+04	4.22E+05	8.37E+05	4.09E+05	2.33E+06
1983	9.03E+05	7.38E+04	3.93E+05	7.80E+05	3.81E+05	2.15E+06
1984	8.13E+05	7.38E+04	3.65E+05	7.23E+05	3.53E+05	1.97E+06
1985	7.76E+05	7.38E+04	3.54E+05	7.02E+05	3.43E+05	1.91E+06
1986	7.42E+05	7.38E+04	3.43E+05	6.81E+05	3.33E+05	1.84E+06
1987	7.10E+05	7.38E+04	3.32E+05	6.59E+05	3.22E+05	1.78E+06
1988	6.77E+05	7.38E+04	3.21E+05	6.37E+05	3.11E+05	1.71E+06
1989	6.44E+05	7.38E+04	3.09E+05	6.14E+05	3.00E+05	1.64E+06
1990	6.09E+05	7.38E+04	2.97E+05	5.89E+05	2.88E+05	1.57E+06

HIT RETURN KEY TO CONTINUE

MARLIN CAPITAL COSTS

YEAR	SCHOOLS	STREETS	SERVICE	UTILITY	WASTE	PARKS	TOTAL
1971	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1972	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1973	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1974	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1975	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1976	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1977	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1978	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1979	0.00E+00	1.52E+04	1.11E+04	7.41E+04	0.00E+00	3.58E+03	1.04E+05
1980	0.00E+00	2.25E+05	1.13E+05	1.29E+06	2.39E+03	3.62E+04	1.67E+06
1981	0.00E+00	9.48E+04	5.18E+04	5.32E+05	1.10E+03	1.66E+04	6.96E+05
1982	0.00E+00	8.90E+03	5.19E+03	4.34E+04	0.00E+00	1.67E+03	5.92E+04
1983	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1984	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1985	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1986	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1987	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1988	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1989	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1990	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

HIT RETURN KEY TO CONTINUE

MARLIN OPERATING AND MAINTENANCE COSTS

YEAR	SCHOOLS	STREETS	SERVICE	UTILITY	OTHER	TOTAL
1971	1.41E+06	8.64E+04	4.92E+05	9.76E+05	4.77E+05	2.96E+06
1972	1.37E+06	8.64E+04	4.86E+05	9.64E+05	4.71E+05	2.90E+06
1973	1.31E+06	8.64E+04	4.80E+05	9.52E+05	4.66E+05	2.82E+06
1974	1.26E+06	8.64E+04	4.74E+05	9.41E+05	4.60E+05	2.76E+06
1975	1.22E+06	8.64E+04	4.69E+05	9.30E+05	4.54E+05	2.71E+06
1976	1.18E+06	8.64E+04	4.63E+05	9.19E+05	4.49E+05	2.65E+06
1977	1.14E+06	8.64E+04	4.58E+05	9.08E+05	4.44E+05	2.59E+06
1978	1.09E+06	8.64E+04	4.52E+05	8.97E+05	4.38E+05	2.53E+06
1979	1.07E+06	8.66E+04	4.54E+05	9.01E+05	4.40E+05	2.51E+06
1980	1.12E+06	8.95E+04	4.75E+05	9.42E+05	4.61E+05	2.63E+06
1981	1.15E+06	9.07E+04	4.85E+05	9.62E+05	4.70E+05	2.68E+06
1982	1.14E+06	9.08E+04	4.86E+05	9.64E+05	4.71E+05	2.68E+06
1983	1.06E+06	9.08E+04	4.63E+05	9.19E+05	4.49E+05	2.53E+06
1984	9.81E+05	9.08E+04	4.41E+05	8.74E+05	4.27E+05	2.39E+06
1985	9.54E+05	9.08E+04	4.36E+05	8.65E+05	4.23E+05	2.35E+06
1986	9.30E+05	9.08E+04	4.31E+05	8.55E+05	4.18E+05	2.31E+06
1987	9.08E+05	9.08E+04	4.27E+05	8.46E+05	4.13E+05	2.27E+06
1988	8.86E+05	9.08E+04	4.22E+05	8.37E+05	4.09E+05	2.24E+06
1989	8.65E+05	9.08E+04	4.18E+05	8.28E+05	4.05E+05	2.20E+06
1990	8.44E+05	9.08E+04	4.13E+05	8.20E+05	4.01E+05	2.17E+06

HIT RETURN KEY TO CONTINUE

DO YOU WANT A PRINTED REPORT (YES OR NO)?
(15) y
OUTPUT PRINTED.

CC:
(16) rclips again
GO:

COMMUNITY LEVEL IMPACT PROJECTION SYSTEM - CLIPS

ARE YOU FAMILIAR WITH CLIPS(YES OR NO)?
Y

THE MODEL IS SET TO RUN FOR 20 YEARS, WHICH CURRENTLY IS ITS MAXIMUM CAPABILITY. DO YOU WANT THE MODEL TO RUN FOR FEWER YEARS (YES OR NO)?

* * * * * * *

CC:
(17) lo

ACCOUNT-RUN	LN-MIN	LN-COST	TM-SEC	TM-COST
EYAV346-304	18	$0.09	16.781	$1.07

Notes:

1. To access the University of Texas Computer system, the user first dials (512) 474-5011. Then when he (she) hears a high-pitched tone in the telephone earpiece, he places the receiver in the acoustic coupler connected to his terminal and types Control-C on the terminal. Control-C is produced by holding down the CTRL key on the terminal while striking the letter C. The computer system responds with a message to tell the user that he is in communication with the system.

2. The user tells the system who he is by logging in. He types Control-bell=<his computer user number>//<his computer password> and then strikes the return key. Control-bell is produced by holding down the CTRL key on the terminal while striking the letter G. In this case his user number is eyav346 and his password is abc. The computer responds with a cryptic message about parity checking and then gives the user a brief cost summary of his previous computer usage.

3. Next the user sets a backspace character for use in correcting typing errors by typing Control-bell sbs=Control-H, then striking the return key. If the user makes a typing mistake while using the model, he simply types Control-H's to back up the terminal's cursor until he reaches the erroneous letters, then he retypes the line from that point to the end.

4. Finally the user is ready to run the model. He issues the command execpf 7863 rclips, then strikes the return key. The computer responds with "GO:" and execution of the model begins.

5. The user tells the system that he is not familiar with the model by typing n in response to the question asked by the system. The model will respond to y or n in addition to yes or no. A brief message is printed in response to his answer. AFTER TYPING IN A RESPONSE, THE USER MUST STRIKE THE RETURN KEY ON THE TERMINAL BEFORE THE SYSTEM WILL RESPOND.

6. After reading the message, the user strikes the return key to continue execution of the model.

7. The user decides to let the model run for 20 years. If he had responded y (or yes), he would have been asked to enter a number between 1 and 20, and the model would have been set to run for that number of years.

8. The user wishes to describe a large construction project that will take place in his area. If the user had desired a baseline forecast, he would have responded n (or no) and no project effects would have been included in assessing the future of the region.

9. The project is set to begin in 1979.

10. Construction lasts for 5 years (1979 - 1983).

11. For the first year (1979), 170 workers are required.

12. After completion, the plant that is being built will require a permanent operating staff of 300 people.

13. The model displays the numbers input by the user, then asks him to verify those numbers. The user tells the system that the values are correct. If he had answered n (or no), he would have been given the opportunity to change the project manpower requirements.

14. After viewing a screen full of information, the user strikes the return key to tell the system that he wishes to proceed.

15. The user requests a printed report of the model run which gives more detailed projections for his region. It will be printed in the Engineering Science Building, Room 507 and can be picked up a few minutes later. He will find the report filed in a hanging folder labelled with the last two digits of his user number (in this case: 46).

16. If the user wishes to run the model again, he types rclips again in response to the next "CC:" that appears on his terminal.

17. When the user wishes to end the session, he types Control-bell lo and then strikes the return key. (The letters lo are an abbreviation for Log Out.) The computer responds with a message showing the length and cost of the session, and the session is over.

Chapter 2

GENERAL STRUCTURE OF CLIPS

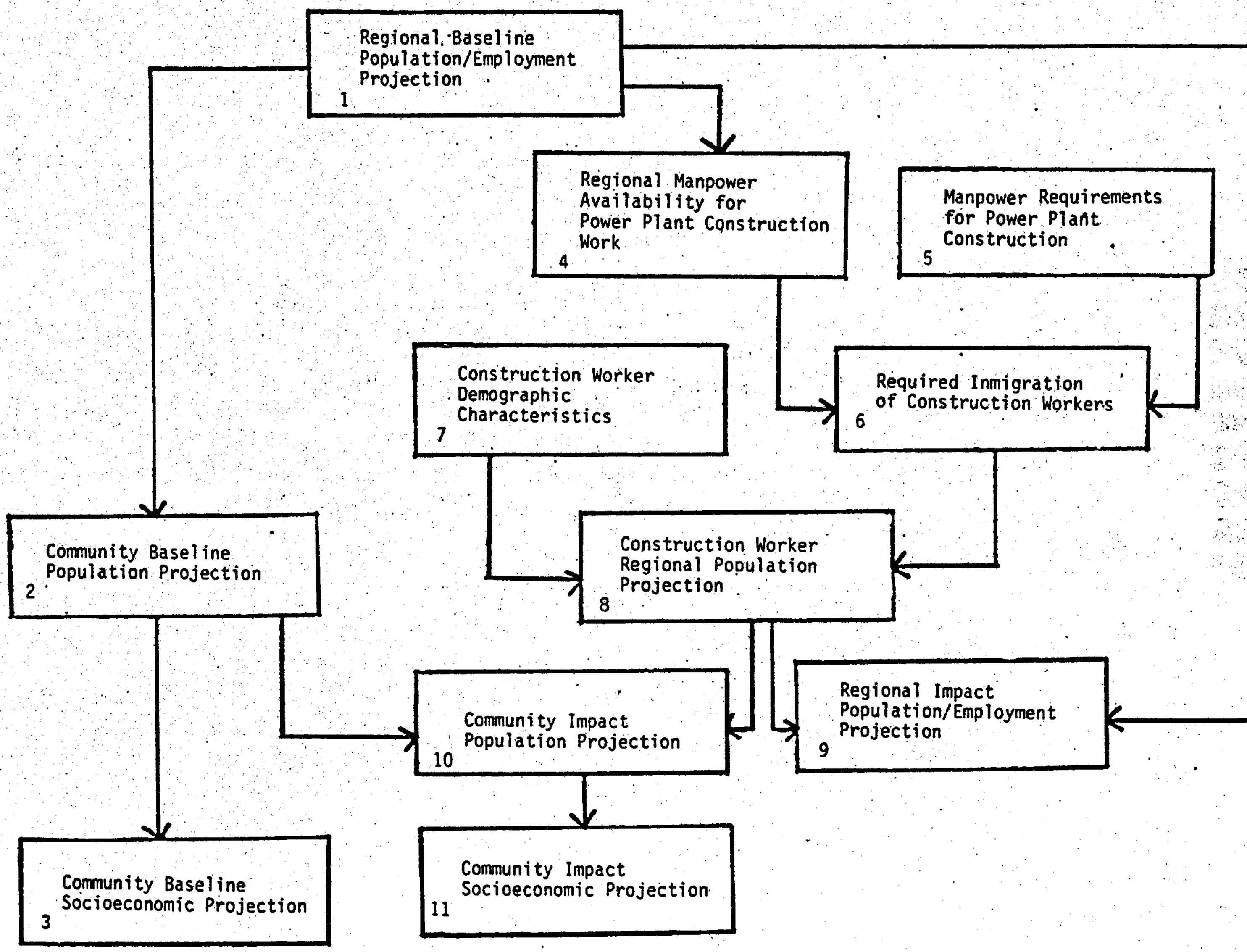
A. Introduction and Model Rationale

As discussed in chapter 1, in order to project socioeconomic impacts from an activity (e.g., the construction of a nearby power plant) on a given set of communities, it is first necessary to project what the communities would be like in the absence of the activity. For example, it is impossible to project how the activity will affect the demand for wastewater treatment facilities if it is unknown what the demand is going to be without the activity. To continue the example, suppose 500 construction workers bringing 1,000 dependents were expected to in-migrate and reside in Community A in 1987. Assuming each person would generate 50 gallons per day (gpd) sewage, one might expect that 75,000 gpd treatment capacity would have to be added to the local treatment facilities between the present and 1987 (assuming there is just enough capacity now to handle the present resident population). However, if the "normal" economic and demographic processes of the community are such that it is likely to lose 3,000 people between the present and 1987, construction of the power plant will have no impact on Community A's wastewater treatment situation (assuming present facilities meet future EPA standards).

Thus, in order to project impacts, it is incumbent upon the planner to project baseline conditions. In terms of figure 1, in order to execute box 11 (projection of community-level, socioeconomic conditions when large-scale energy activity occurs), the planner must go through

Figure 1

GENERAL STRUCTURE OF CLIPS



the same steps indicated by box 1 (projection of regional population and employment when the activity does not occur) and box 2 (projection of community population when the activity does not occur) as he does to execute box 3 (projection of community-level socioeconomic conditions when the activity does not occur). The difference in procedure is that in the case of box 11, in addition to executing a regional baseline population/employment projection (box 1) and community baseline population projection (box 2), in order to project community socioeconomic conditions in the impact case (box 11) he must also derive regional manpower availability for construction work (box 4); compare this number with reported manpower requirements for construction (box 5); from the comparison, project in-migrating construction workers into the region (box 6); relate construction worker demographic information such as children per in-migrating construction worker (box 7) to derive regional population projections (box 8); and project which communities the construction population will reside in. Be this as it may, if the planner cannot rely on the results produced in steps 1, 2, and 3, he is not likely to get very far in reliably planning for step 11.

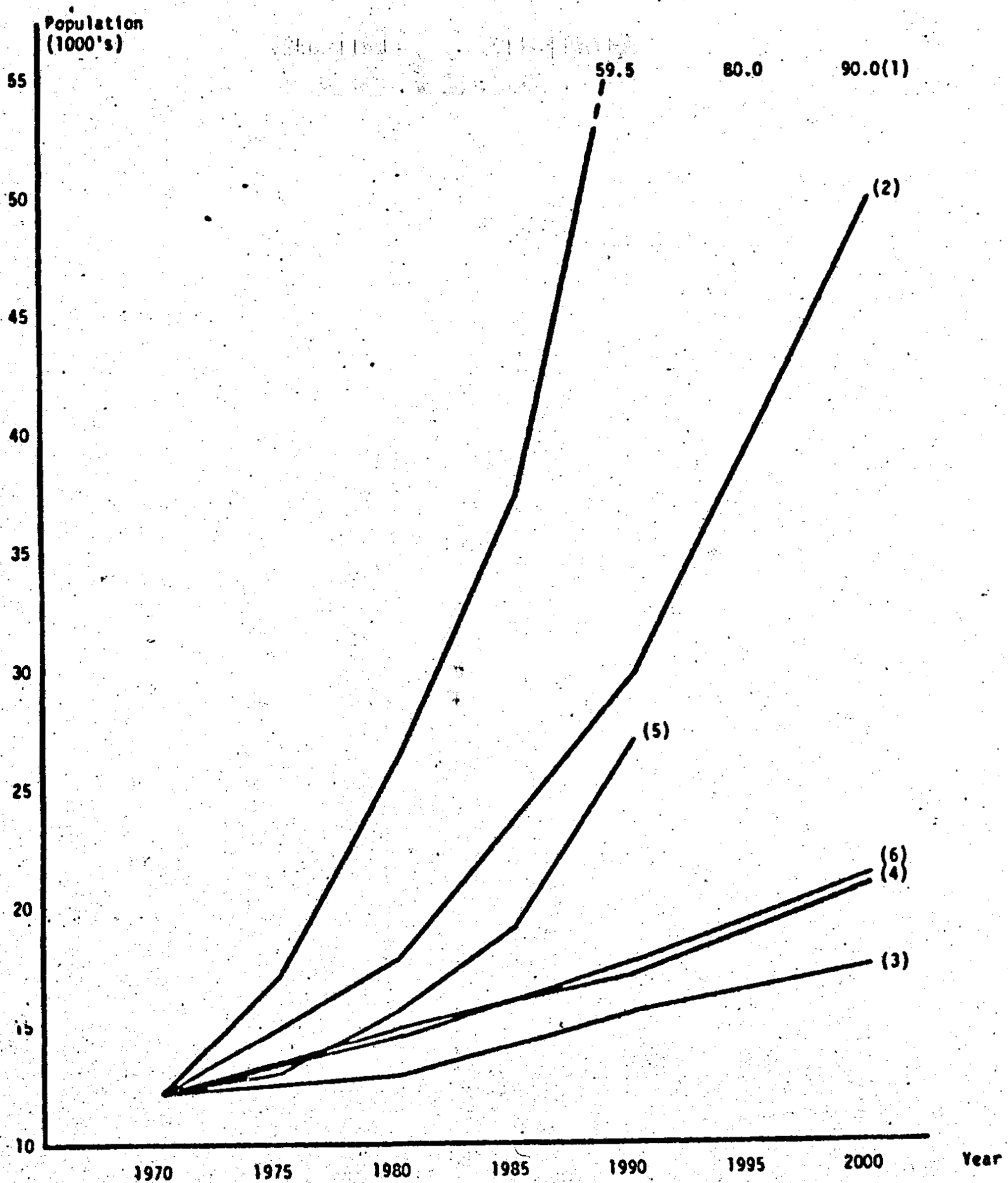
The crucial, indispensable bit of information necessary for the local planner to prepare for community-level socioeconomic impacts is the number of people likely to be residing in each community over time. If the planner can anticipate the number of people, then with additional information like housing preferences, income, per capita water demand, per capita sewage generation, elementary students per family, etc., he can derive the additional required information. Accordingly, the overriding emphasis in the construction of CLIPS has been to provide as reliable a tool as possible for projecting community population in the local impact region, under both baseline conditions and impact conditions.

Thus, again, in terms of figure 1, our overriding concern in the initial preparation of CLIPS has been to provide planners with a useable tool that will allow them to generate reliable reports indicated by boxes 2 and 10. Part 2 of CLIPS, indeed, contains a highly sophisticated model which generates detailed socioeconomic baseline and impact projections for numerous municipal facilities and services and then projects estimates for their capital costs and operating/maintenance expenditures. It must be emphasized, however, that the value of this output for local planners is fraught with limitations as will be discussed later, and our primary focus in preparing this initial version of CLIPS has been on assisting the local planner to arrive at boxes 2 and 10.

Generating baseline and impact community population projections may appear a simple enough task at first glance. However, its actual achievement is rarely straightforward. The inaccurate results of many past efforts to project small area populations over time are notorious (see figure 2). It is not the purpose of this document to review the reasons for these failures (see Greenberg et al., 1972, and Isserman, 1977, for two efforts to assess the relative merits of various small area projective techniques). Suffice it to say that the major reason has been the lack of attention given to the factors influencing the most volatile component of population change at the small area level: migration. Birth rates and death rates change slowly among substate regions.

Figure 2

EXISTING POPULATION PROJECTIONS FOR CHAMBERS COUNTY



LEGEND:

(1) Houston-Galveston Area Council, 1970-2020 Population Projections, April 1972.
(2) Team Plan Incorporated (for Chambers County, Texas), Comprehensive Planning for Chambers County, Texas, October 1972.
(3) Population Research Center, University of Texas at Austin, 1974 (unpublished).
(4) Bureau of Business Research, University of Texas at Austin (for Houston-Galveston Area Council), An Economic Base Analysis of the Gulf Coast State Planning Region, December 1974.
(5) Houston-Galveston Area Council Regional Simulation Model Population Projections, 1975 (unpublished).
(6) Texas Water Development Board, Population Projections, November 1976.

SOURCE: Southwest Center for Urban Reserach, Growth Scenarios for Chambers County Texas, 1977.

The importance of accounting for migration patterns, then, immediately suggests the use of a component technique. Greenberg et al. (1978: p. 6) state: "Population change involves three separate components: births, deaths, and migration. Models that consider the separate effects of each of these components are known as component models."

The Bureau of the Census' official Guide for Local Area Population Projections (1977: p. 11) identifies "five broad categories into which most projections can be placed: (1) mathematical extrapolation, (2) ratio, (3) cohort-component, (4) economic base and (5) land use." CLIPS in its entirety utilizes all five approaches. However, because of the need for accounting for migration in as rigorous a fashion as possible, CLIPS relies heavily on the likely enhanced potential accuracy availed by a component approach at the regional level. CLIPS supplements this procedure by employing variations of the other approaches to step down regional projections to the community level. Specifically, CLIPS employs a cohort-component demographic projection model interfaced with an economic-base employment projection model to project population and employment for the counties immediately surrounding the proposed project. After regional population has been projected, it is allocated ("stepped-down") over time to each of the communities in the region using a combined mathematical extrapolation-ratio-land-use approach.

The reader is perhaps justified in asking why this seemingly complex procedure was chosen. The major factors in the choice were potential accuracy and data availability. Greenberg et al. (1978: p. 7) note:

> The choice of a model is best made by considering its relative accuracy, the type of population data available, the quality of available data, the scale of the analysis, the length of the projection period, the purpose of the projections, and the budget and time frame implications of the projection study.

Presumably an economic-base, cohort-component approach promises the greatest potential accuracy. However, the drawback of such an approach is its total dependence on a reliable and detailed data base for its calibration. Such a data base is not forthcoming at the community level, i.e., there are no reliable, secondary published sources. Greenberg et al. (1978: p. 8) note:

> The quality and availability of basic population information are quite variable. . . . data. . . . at local levels are usually maintained by various public agencies for their own purposes. As such, the data are much more subject to bias, gaps, inaccuracies, or sudden changes in recording procedures that make their use for another purpose--population estimates and projections--difficult.

However, accurate and reliable data are available at the county level and are easily accessible in various forms for the informed user. The U.S. Bureau of the Census, the Texas Industrial Commission, the Texas Employment Commission, and various other agencies collect and maintain county-level data and publish it in easily accessible secondary forms. Thus, accuracy and data availability may be optimized by first projecting at the regional (multicounty) level and then allocating to communities.

Chapter 3

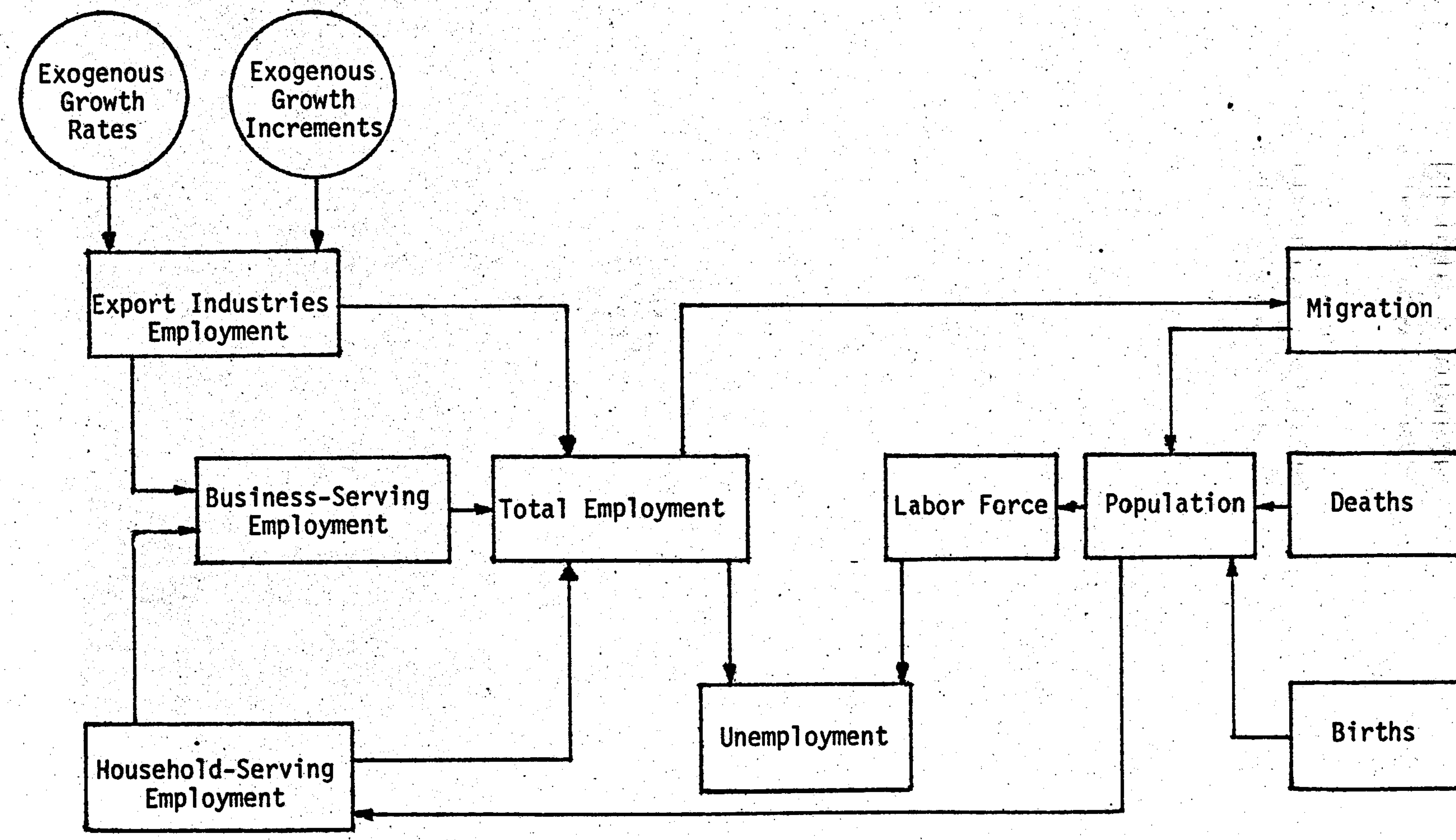
THE REGIONAL BASELINE PROJECTION SUBMODEL

A. Overview

Figure 3 is a straightforward representation of the regional baseline projection methodology. An economic-demographic model projects population and employment for the region over time. There are two basic interfaces between population and employment: (1) population determines household-serving employment and (2) changes in total employment determine migration. In addition to migration, population changes are determined by births and deaths. Changes in total employment are determined by changes in household-serving employment, business-serving employment, and export industries employment. Changes in export industries employment are determined by exogenously specified growth rates and increments (corresponding to assumed changes in demand for their goods and services from extra-local markets, e.g., international, national, and state). Unemployment at a given time is derived from total employment compared to total labor force.

Figure 3

REGIONAL BASELINE POPULATION/EMPLOYMENT PROJECTION MODEL



B. The Regional Baseline Population Projection Submodel

B1. Overview and Model Rationale

The regional baseline population projection submodel consists of a set of equations that "age" the regional population year by year by adding births, subtracting deaths, maturing a fraction of each age group each year to the next age group, and accounting for any migration that occurs annually. For example, the number of 20-to-24-year-old people expected to reside in the region in 1985 is equal to the number of 20-to-24-year-old people residing in the region in 1984 minus the number of 20-to-24-year-old people in the region who died between 1984 and 1985, minus the number of 20-to-24-year-old people who mature to the 25-to-29-year-old group between 1984 and 1985, plus the number of 20-to-24-year-old people who matured from the 15-to-19-year-old group during the interval 1984-1985, plus the number of 20-to-24-year-old people who migrated into the region between 1984 and 1985, minus the number of 20-to-24-year-old people who migrated out of the region between 1984 and 1985. In addition to changing the population directly, the 20-to-24-year-olds also give birth each year to a certain number of infants who enter the 1985 less-than-one-year-old age group.

The following age groups are used in the model:

	Age		Age
$i=1$	< 1	$i=10$	40-44
$i=2$	1-4	$i=11$	45-49
$i=3$	5-9	$i=12$	50-54
$i=4$	10-14	$i=13$	55-59
$i=5$	15-19	$i=14$	60-64
$i=6$	20-24	$i=15$	65-69
$i=7$	25-29	$i=16$	70-74
$i=8$	30-34	$i=17$	75+
$i=9$	35-39		

The cohort-component technique dates back to the early work done by Whelpton (1928) for the Scripps Foundation during the 1920s. It is generally considered to hold the most promise for accuracy in projecting, with the following assumptions: (1) reliable data are available for determining age-specific birth and death rates for the region and for initializing the number of people in each age group at the beginning year; and, (2) an adequate account is taken of factors influencing migration. The Guide for Local Area Population Projections (U.S. Department of Commerce, 1977: p. 19) noted:

> The component posing the greatest problem for local population projections is migration. . . . the most recent survey . . . from 1970 to 1975 . . . indicated that 17 percent of the population lived in a different county in 1975.

The present version of CLIPS attempts to rigorously account for migration by interfacing it with a detailed regional employment projection submodel. The migration sector of the model relies heavily on the formulation developed for the San Diego Comprehensive Planning Organization (see Econometrics Research Associates, 1978).

Future refinements of the regional baseline population projection submodel will fall in three areas: (1) further basic research on accurately estimating and testing the migration coefficients; (2) disaggregating population into age-sex-race cohorts (and perhaps into one-year age groups); and, (3) taking into account special (non-employment-related) migration, e.g., retirement, military, and college.

B2. Model Equations and Explication

1. Compute Births

$$LBCD^{t,t+1} = \sum_{i=5}^{15} (BR_i * AGEGP_i^t) \qquad 3.1$$

Live births of children between year t and year t+1 equals the summation of the age-specific birth rates for each of the ten child-bearing age groups multiplied by the number of persons in each child-bearing age group at year t.

2. Compute Growths

$$GRTH_1^{t,t+1} = AGEGP_1^t \qquad 3.2$$

$$GRTH_2^{t,t+1} = AGEGP_2^t \div 4.0 \qquad 3.3$$

For i=3 to 16

$$GRTH_i^{t,t+1} = AGEGP_i^t \div 5.0 \qquad 3.4$$

$$GRTH_{17}^{t,t+1} = 0.0 \qquad 3.5$$

The computation of the number of persons growing from one age group to the next during a given year is carried out by four separate equations. All of the infants (less than one year old) grow up to the second age group. One fourth of the people in the second age group grow to the third every year. One fifth of the people in age groups 3 to 16 grow up to the next age group every year. Age group 17 is the terminal one.

3. Compute Deaths

$$DTH^{t,t+1} = DR_1 * LBCD^{t,t+1} \tag{3.6}$$

For i=2 to 17

$$DTH_i^{t,t+1} = DR_i * AGEGP_i^t \tag{3.7}$$

The number of deaths occurring in the region between years t and t+1 is computed by two equations. First, infants dying is computed by multiplying a region-specific infant mortality rate times the number of live births of children computed. For the remaining age groups, age-specific death rates are multiplied times the number of persons in each age group at year t.

4. Compute and Distribute Migration

$$NMIG^{t,t+1} = a + b * (TJOBS^{t+1} - TJOBS^t) \tag{3.8}$$

Aggregate net migration is computed with the regression-derived linear equation relating the number of net migrants directly to the change in total jobs in the region during the interval t,t+1.

If $NMIG^{t,t+1}$ is greater than zero, indicating net in-migration into the region, the following computations are executed:

$$IMAGSH_i^{t,t+1} = (IMDF_i * NPOP_i^t) / \sum_{i=1}^{17} (IMDF_i * NPOP_i^t) \qquad 3.9$$

$$INMIG_i^{t,t+} = IMAGSH_i^{t,t+1} * NMIG^{t,t+1} \qquad 3.10$$

$$MIG_i^{t,t+1} = INMIG_i^{t,t+1} \qquad 3.11$$

Equations 3.9 and 3.10 distribute the number of in-migrants into the separate age groups. Equation 3.9 computes the relative share of in-migrants each age group will be expected to receive based upon (1) the number of people expected to be in that age group in the national population at that specific time according to the Series E U.S. Bureau of the Census Population Projections, and (2) the age-specific migration propensities expected to prevail. Equation 3.10 then distributes net in-migrants into the age groups for the region by multiplying each share times the aggregate net in-migrations computed by equation 3.8.

If $NMIG^{t,t+1}$ is less than zero, indicating out-migration out of the region, the following computations are performed:

$$OMAGSH_i^{t,t+1} = (OMDF_i * AGEGP_i^t) / \sum_{i=1}^{17} (OMDF_i * AGEGP_i^t) \qquad 3.12$$

$$OTMIG_i^{t,t+1} = OMAGSH_i^{t,t+1} * NMIG_i^{t,t+1} \qquad 3.13$$

$$MIG_i^{t,t+1} = OTMIG_i^{t,t+1} \qquad 3.14$$

Equation 3.12 computes the share of total out-migrants expected to be in each specific age group based upon (1) the age group's share of the total regional population and (2) the age group's specific out-migration propensity. Equation 3.13 then distributes net out-migrants into the different age groups by multiplying each share times the aggregate net out-migration computed by equation 3.8.

5. <u>Update Population Age Groups</u>

$$AGEGP_1^{t+1} = LBCD^{t,t+1} - DTH_1^{t,t+1} \qquad 3.15$$

For i=2 to 17

$$AGEGP_i^{t+1} = AGEGP_i^t + GWTH_{i-1}^{t,t+1} - GWTH_i^{t,t+1} - DTH_i^{t,t+1} + MIG_i^{t,t+1} \qquad 3.16$$

For year t+1, the infant population equals the number of live births in the region minus the infant deaths. For all other age groups the number of persons in the region in that age group at year t+1 equals the number of persons at year t plus the number of persons maturing from the preceding age group during the interval t to t+1, minus the number of persons growing into the succeeding age group, minus the number of persons in the age group dying, plus (or minus) the number of persons in the age group migrating.

$$RPOP^{t+1} = \sum_{i=1}^{17} (AGEGP_i^{t+1}) \qquad 3.17$$

Total regional population at time t+1 is the sum of the number of persons in each age group at time t+1.

Equations 3.1 through 3.17 constitute the regional demographic sector of CLIPS. It should be pointed out that the ordering of the equations presented here is different from the actual computational sequence for the purposes of conceptual clarity. The reader will note that the total number of jobs at t+1 ($TJOBS^{t+1}$), which is necessary to compute net migration, is not yet computed. $TJOBS^{t+1}$ is actually computed in the regional baseline employment projection submodel; and population is projected in two steps with birth, growth, and deaths temporarily stored until TJOBS is computed. It was decided that model explication would be unnecessarily encumbered if the actual computation sequence was presented.

C. The Regional Baseline Employment Projection Submodel

C1. Overview and Model Rationale

There is general consensus that modeling regional population change over time is best accomplished by employing some form of the cohort-component (nee cohort-survival) technique. Such a consensus is not forthcoming in the case of economic projections. In their excellent review, Chalmers and Anderson (1977: p. 77) noted:

> The implication is that the question of using some sort of cohort-survival simulation model is not really an issue. The general structure of these models is necessarily much the same with differences occurring in how they are refined. . . . There do appear to be, however, a variety of ways in which the economic submodel can be approached.

A major portion of the research effort in developing CLIPS has been invested in attempting to determine how best to account for baseline economic change within the potential local impact areas. The importance of this matter cannot, in our opinion, be overemphasized. As stressed in chapter 2, if the planner cannot anticipate what is likely to occur in the planning region in the absence of the proposed activity, he is unlikely to be able to plan meaningfully for its presence. Furthermore, it is our contention that past efforts to project population for small areas have produced such disparate results principally because of either the faulty account taken of economic change or, in some cases, the failure to consider the interrelations between economic and demographic change. Consider figure 3. Obviously five out of the six population projections for Chambers County, Texas, are going to be way off the mark.

Greenberg et al. (1978: p. 153) noted:

> Although no single employment projection model has been shown to be more consistently accurate than others, there are several

factors that affect the results. The accuracy and choice of the models for a particular use depend on such variables as data availability, the length of the projection period, the validity of the model's assumptions and time and budgeting constraints. Some models seem to be more appropriate than others for certain spatial configurations and some perform better for certain classes of industries.

Most of the socioeconomic impact assessments in the past have employed one of two basic appraoches: economic-base or input-output analysis. Although basic similarities, theoretical and mathematical, exist between the approaches (see Billings, 1969), more importantly there are fundamental differences that should be taken into account in choosing. After an extensive review of the assessment literature, Chalmers and Anderson (1977: p. 20) reported:

> Input-output analysis was used in only a few assessments. Its use is not widespread principally because there is usually not an I/O table available for the study area and it is expensive to generate them from primary data. In addition, the constant input proportions assumption on which I/O is based is particularly inapplicable to areas undergiong large changes in their economic structure.

Similarly, Stenehjem and Metzger (1976: p. 202) concluded:

> due to the restrictive assumptions underlying input-output analysis and the poor quality of most extant regional data, the long range forecasts derived from regional I/O tables are in Miernyk's words ". . . likely to provide only rough and broad guidelines."

and (p. 203),

> the usefulness of input-output models as the cornerstone of a general methodological approach to the assessment of the fiscal impacts of industrialization must be seriously questioned.

In our illustrative case study, the potential limitations of an I/O approach were particularly striking. In the counties adjacent to the proposed Twin Oaks power plant (Robertson, Freestone, Limestone, Falls, and Leon), more than half of the manufacturing firms presently located there had been established since 1969! Furthermore, many of these firms manufactured products previously not produced in the area. As Richardson (1972: p. 14) noted:

> input-output models are ill-equipped to explain or predict the dynamics of structural change, such as entry of new industries or the obsolescence and disappearance of old ones.

Thus, it is extremely unlikely that an I/O analysis would produce an accurate projection of economic activity in the area between 1970 and 1976, much less between 1970 and 1990 (unless, of course, its technical coefficients were updated annually, a feat that is virtually impossible).

Consider, for example, a Poultry-Dressing firm, exporting to a non-local market and employing between 250 and 499 persons located in Marlin, Falls County, during 1974. The only two Food Products firms in the region before that were (1) a local-serving Malt Beverages firm established in 1888 employing 8 to 16 persons and (2) a Prepared Feeds and Feed Ingredients for Animals and Fowls firm serving a local market employing 0 to 16 persons established in 1943. There is simply no way an I/O model with technical coefficients determined before 1974 could account for the impact of the Poultry-Dressing firm on the economy and population of the area. Furthermore, any model estimated after 1974 which aggregated these firms into a single two-digit SIC industry would be doomed to failure. Their markets and input-output structure are simply too diverse. I/O analysis and highly aggregated continuous-growth econometric models will produce reliable results only for larger areas with many firms in each industry group.

Thus, for sparsely populated regions with few interindustry linkages, ironically, a highly disaggregated economic-base model is appropriate. Furthermore, some capability for adding large discrete increments to each industry group during a given year is called for. Fortunately, in exchange for a great deal of complexity in the conceptual structure, calibration of the economic model is greatly simplified by the small size of the region. In 1976, there were only forty-nine manufacturing firms in the five-county region, and these could be classified into twenty of the seventy-two Bureau of Labor Statistics economic growth sectors (see table 1). It took two people one afternoon to set up the data and another afternoon to input it into the computer. We simply went through the Directory of Texas Manufacturers, 1976, community by community, firm by firm, and classified each firm according to (1) its BLS Economic Growth Sector number; (2) employment size; (3) whether it served local, district, state, regional, national, or international markets; and (4) date established. Local- and district-serving firms were classified as business-serving; their future employment levels, as a consequence, were derived by the model, and all the rest were classified as Basic (nee export industries).

Obviously, such an approach would get out of hand for much larger regions. Unless the user intends to spend a lot of time on data-gathering, a more highly aggregated approach would probably be more appropriate for larger regions. (Even so, less time would be required than that needed to set up the transactions table of an I/O model.)

We submit that the industrial structure of the United States has recently undergone a transformation, with considerable manufacturing employment and population dispersing to small areas (Sternlieb and Hughes, 1975). Any impact methodology that does not permit a modeling

Table 1

BUREAU OF LABOR STATISTICS ECONOMIC GROWTH SECTORS

AND PROJECTED ANNUAL EMPLOYMENT GROWTH RATES

Growth Sector	1970-1980 Annual Employment Growth Rate (percent)	1980-1990 Annual Employment Growth Rate (percent)
Food Products	0.1	-0.5
Tobacco Manufacturing	-0.7	0.0
Fabric, Yarn, and Thread Mills	0.6	-0.4
Miscellaneous Textiles and Floor Coverings	0.8	0.0
Hosiery and Knit Goods	0.3	0.0
Apparel	1.8	0.1
Miscellaneous Fabricated Textile Products	2.4	0.0
Logging, Sawmills, and Planing Mills	-0.7	-2.4
Millwork, Plywood, and Other Wood Products	0.9	0.2
Household Furniture	2.8	0.7
Other Furniture	2.6	-0.2
Paper Products	2.0	0.4
Paperboard	3.7	1.2
Printing	2.2	0.7
Chemical Products	2.7	0.2
Agricultural Chemicals	1.8	0.0
Plastic Materials and Synthetic Rubber	4.8	0.0
Synthetic Fibers	1.6	0.2
Drugs	3.6	0.5
Cleaning and Toilet Preparations	3.3	0.7
Paint	1.8	0.0
Petroleum Products	-1.7	-0.6
Rubber Products	2.4	0.7
Plastic Products	5.3	0.6
Leather, Footwear, and Leather Products	-0.1	-0.8
Glass	2.9	0.9
Cement, Clay, and Concrete Products	1.7	1.0
Miscellaneous Stone and Clay Products	2.1	0.6
Blast Furnaces and Basic Steel Products	0.7	-0.5
Iron and Steel Foundries and Forgings	0.0	0.0
Primary Copper Metals	2.6	0.0
Primary Aluminum	4.4	0.0
Other Primary and Secondary Nonferrous Metals	1.3	0.5
Copper Rolling and Drawing	0.7	-0.5
Aluminum Rolling and Drawing	-1.6	0.0
Other Nonferrous Metal Rolling and Drawing	2.5	0.8

Table 1 continued

Growth Sector	1970-1980 Annual Employment Growth Rate (percent)	1980-1990 Annual Employment Growth Rate (percent)
Miscellaneous Nonferrous Metal Products	1.9	1.8
Metal Containers	2.3	0.0
Heating Apparatus and Plumbing Fixtures	2.1	1.0
Fabricated Structural Metal	3.2	1.3
Screw Machine Products	4.0	2.1
Other Fabricated Metal Products	4.1	1.5
Engines, Turbine, and Generators	4.6	1.1
Farm Machinery	1.2	0.7
Construction, Mining, and Oilfield Machinery	2.2	0.7
Material Handling Equipment	3.4	2.1
Metalworking Machinery	3.4	0.7
Special Industry Machinery	2.5	-0.4
General Industrial Machinery	4.4	1.3
Machine Shop Products	2.3	0.9
Computers and Peripheral Equipment	10.0	1.8
Typewriters and Other Office Machines	4.1	0.0
Service Industry Machines	2.8	0.7
Electric Transmission Equipment	5.7	1.6
Electrical Industrial Apparatus	2.3	0.7
Household Appliances	0.5	1.0
Electric Lighting and Wiring	5.2	2.9
Radio and Television Sets	-1.1	0.0
Telephone and Telegraph Apparatus	1.0	0.0
Other Electronic Communication Equipment	2.8	0.0
Electronic Components	3.9	0.6
Other Electrical Machinery	0.6	1.2
Motor Vehicles	2.3	-0.5
Aircraft	1.5	1.2
Ship and Boat Building and Repair	7.2	0.6
Railroad and Other Transportation Equipment	1.2	1.3
Miscellaneous Transportation Equipment	0.1	1.4
Scientific and Controlling Instruments	4.0	1.3
Medical and Dental Instruments	4.1	2.8
Optical and Opthalmic Equipment	0.8	0.7
Photographic Equipment and Supplies	4.1	2.3
Miscellaneous Manufactured Products	0.3	0.4

Source: U.S. Department of Labor, Bureau of Labor Statistics, <u>The Structure of the U.S. Economy in 1980 and 1985</u>, 1975.

capability for handling these trends will fail.

Future refinements to this sector of CLIPS will focus on two areas:

1. The seventy-two manufacturing industry groups will be "triangularized" with total export groups at the top of the hierarchy and those with many interindustry linkages at the bottom, with appropriate coefficients interlinking them. This arrangement will permit CLIPS to handle larger regions that have many interindustry linkages between basic employment groups.
2. Refined computer software will permit the user to estimate the effects of employment increments for any industry group during any year. For example, the terminal screen will ask, at the beginning of a session, a question such as "Do you think there will be any new firms locating in the region in the Paperboard industry group?" If the user answers "yes," the terminal will ask him to estimate year and employment size (there will be default values for employment size for each industry group if the user does not care to specify).

With these capabilities, CLIPS should be able to handle most types of regions and enable the user to engage in extensive alternative scenario planning with little difficulty.

C2. Model Equations and Explication

1. Compute Basic Employment

As mentioned earlier, the projection of regional basic employment is perhaps the most sophisticated, complex, and important element in the model. In sparsely populated areas the economic base is often transformed year by year by the location of one new firm in the area. The present version of CLIPS projects basic employment in three distinct steps.

$$AGEMP^{t+1} = GTABL\ (AGEMPT,\ TIME,\ 0.,\ 20.,\ 10.) \tag{3.18}$$

$$MINEMP^{t+1} = GTABL\ (MINEMPT,\ TIME,\ 0.,\ 20.,\ 10.) \tag{3.19}$$

Agricultural employment and mining employment are projected year by year by looking up a value in an exogenously specified table which contains the U.S. Bureau of Economic Analysis (U.S. Water Resources Council, 1972) 1970, 1980, and 1990 regional projections for these employment categories. The function GTABL simply performs a linear interpolation to derive annual estimates.

Next, the model computes expected basic employment for each of the seventy-two manufacturing categories posited by BLS to have varying expected national growth rates.

$$BE_i^{t+1} = BE_i^t + (BE_i^t * BEGR_i^t) \tag{3.20}$$

Equation 3.20 computes Basic Employment growth in a given industry at time t+1 by multiplying the employment in the industry at time t times an industry-specific projected growth rate. Since BLS projects these growth rates for each industry to be different during the two decades 1971-1980 and 1981-1990, the model checks to see which decade the simulation is operating in and sets the individual BEGRs accordingly.

$$BE_i^{t+1} = BE_i^{t+1} + NEWEMP_i^{t,t+1} \tag{3.21}$$

Finally, the model allows for discrete increments to be added to the employment base in a given industry by allowing the user to specify increments a year at a time. $NEWEMP_i^{t,t+1}$ is taken from a prespecified matrix with industry groups along the rows and years along the columns, with each cell representing the employment increment expected for that industry in the given year.

$$BE^{t+1} = AGEMP^{t+1} + MINEMP^{t+1} + \sum_{i=1}^{72} (BE_i^{t+1}) \tag{3.22}$$

Equation 3.22 sums up all basic employment to produce the total basic employment expected for the region at time t+1.

2. Compute Household-Serving Employment

$$HS_i^{t+1} = a_i + b_i * RPOP^{t+1} \tag{3.23}$$

A separate linear equation with the regression-derived, industry-specific parameters, a_i and b_i, is used to estimate expected employment in each of sixteen household-serving industries.

$$HS^{t+1} = \sum_{i=1}^{16} (HS_i^{t+1}) \qquad 3.24$$

Total household-serving employment at time t+1 is the sum of the number of employment opportunities in each of the individual household-serving categories at time t+1.

3. <u>Compute Business-Serving Employment</u>

$$BS_i^{t+1} = a_i + b_i * (BE^{t+1} + HS^{t+1}) \qquad 3.25$$

Business-serving employment at time t+1 is estimated by using a separate regression-derived linear equation for each of nine employment categories with the sum of total basic employment and house-serving employment acting as the independent variable.

$$BS^{t+1} = \sum_{i=1}^{8} (BS_i^{t+1}) \qquad 3.26$$

Equation 3.26 sums employment in the eight categories to produce total business-serving employment.

4. <u>Compute Utility Employment</u>

$$UTE^{t+1} = GTABL\ (UTET,\ BE^{t+1} + HS^{t+1}_{,}\ 2518.,\ 7018.,\ 800.) \qquad 3.27$$

Utility employment is computed by a nonlinear table function with total basic and household-serving employment serving as the argument. This formulation was deemed necessary because examination of empirical data indicated that economies of scale operated in this employment sector. The reason is that small communities and rural areas typically utilize private water wells and septic tanks while larger communities have capital-intensive utilities, a situation that leads to a sharp initial increase with a gradual leveling off of employment with increasing size.

5. Compute Construction Employment

$$NFAM^{t+1} = RPOP^{t+1} \div AFS \tag{3.28}$$

$$CEMP^{t+1} = a + b * (NFAM^{t+1} - NFAM^{t}) \tag{3.29}$$

Equation 3.28 computes the number of families in the region at time t+1 by dividing the expected regional population at time t+1 by the average family size. Construction employment at time t+1 is then computed as a function of change in the number of families with the regression-derived linear equation 3.29.

6. Compute School Employment

School employment in the region at time t+1 is estimated by executing five computational sequences.

$$NSTS^{t+1} = \sum_{i=2}^{8} (SPRN_i * AGEGP_i^{t+1}) \tag{3.30}$$

$$KSTS^{t+1} = \sum_{i=2}^{8} (SPRK_i * AGEGP_i^{t+1}) \tag{3.31}$$

$$ESTS^{t+1} = \sum_{i=3}^{8} (SPRE_i * AGEGP_i^{t+1}) \quad 3.32$$

$$HSTS^{t+1} = \sum_{i=4}^{8} (SPRH_i * AGEGP_i^{t+1}) \quad 3.33$$

$$CSTS^{t+1} = \sum_{i=5}^{8} (SPRC_i * AGEGP_i^{t+1}) \quad 3.34$$

Equation 3.30 estimates the number of nursery school students by assuming that each of the age groups 2 through 8 is likely to have a constant nursery school participation rate and that the total nursery school students is the summation of each of these rates multiplied by the number of persons in each of the age groups at time t+1. Equation 3.31 performs the same computation for kindergarten students; equation 3.32, for elementary school students; equation 3.33, for high school students; and equation 3.24, for community college students.

$$PSSTDS^{t+1} = NSTS^{t+1} + KSTS^{t+1} \; ESTS^{t+1} \; HSTS^{t+1} + CSTS^{t+1} \quad 3.35$$

Equation 3.35 produces the total number of public school students by summing the numbers of nursery, kindergarten, elementary, high school, and community college students.

$$PSE^{t+1} = B0 + B1 * PSSTDS \quad 3.36$$

Equation 3.36 computes the public school employment as a function of the total number of students by using a linear equation derived by a time-series regression analysis of region-specific data supplied by the Texas Education Agency.

$$SEC^{t+1} = \sum_{i=5}^{8} (SPRC_i * AGEGP_i) * PSC \qquad 3.37$$

Enrollment in state colleges and universities at time t+1 is a function of total college enrollment (determined by age-specific college enrollment rates multiplied by the number of persons in each age group 5 through 8 and summed) times the fraction of college students attending state colleges.

$$SCE^{t+1} = B2 + B3 * exp\ (Year * NGR) + B4 * SEC^{t+1} \qquad 3.38$$

Employment in state colleges and universities is then determined by three variables: (1) time, (2) the national annual rate of growth in state higher education employment, and (3) the number of state college students.

$$SEMP^{t+1} = PSE^{t+1} + SCE^{t+1} \qquad 3.39$$

Equation 3.39 produces total school employment by summing public school employment and state college school employment.

7. Compute Total Jobs

$$TJOBS^{t+1} = BE^{t+1} + HS^{t+1} + BS^{t+1} + UTE^{t+1} + CEMP^{t+1} + SEMP^{t+1} \qquad 3.40$$

Equation 3.40 produces total jobs in the region at time t+1 by summing basic employment, household-serving employment, business-serving employment, utility employment, construction employment, and school employment.

8. Compute Labor Force

$$LF^{t+1} = \sum_{i=1}^{17} (LFPR_i * AGEGP_i^{t+1}) \qquad 3.41$$

Total regional labor force at time t+1 is produced by first multiplying age/region-specific labor force participation rates (see Texas Industrial Commission Data Catalog) by the number of persons in each age group and then summing them.

9. Compute Local Unemployment Rate

$$LUR^{t+1} = 1.0 - [TJOBS^{t+1} \div (LF^{t+1} * JPW)] \qquad 3.42$$

The local unemployment rate at time t+1 is determined by the ratio of total jobs to total labor force (labor force is modified by the variable, jobs-per-hour worker) subtracted from 1.

Chapter 4

THE COMMUNITY BASELINE POPULATION PROJECTION SUBMODEL

A. Overview and Model Rationale

The output from the submodels discussed in chapter 3 consists of detailed baseline population and employment projections for the region immediately surrounding the proposed project. (The region is usually a one- to five-county area depending on commuting patterns and county size.) Such information is useful in itself, but is not likely to provide very meaningful guidelines for planning public facilities and services. A sewage collection network rarely extends over an entire region, and the local wastewater superintendant needs information (namely, population projections) for his service area. This point was stressed in a recent Texas Department of Community Affairs document (1978b: p. 25):

> Regional models, while providing projections of income, sales, employment and population at the regional level, usually do not indicate the geographic distribution of population and economic activity within the region. This is a severe shortcoming for the local planner who wants to know what the regional analysis means to his local jurisdiction.

Thus, the task for both baseline and impact conditions is to produce reliable projections at the community level. Indeed, as emphasized in chapter 2, the only reason for projecting at the regional level is that detailed data are available at the county level that are not available at the local level. Taking advantage of the data to project regionally first and then to step-down to the community level enhances potential accuracy. Greenberg et al. (1978: p. 17) made the same point by noting:

This method can also be categorized as a stepdown procedure. It takes advantage of the fact that population projections at the large scale may represent degrees of reliability and component detail that are not possible to achieve at the small scale of analysis. Thus, the large-scale projections act as a constraint on potential population levels for aggregations of smaller geographic entities.

Complexity enters again, however, when the modeler attempts to determine specifically what procedure he should follow in stepping-down regional population projections to the community level. Greenberg et al. (1978) presented five different detailed models for accomplishing this task. The approach chosen for the present version of CLIPS is a <u>trend-extrapolation</u>, <u>density-ceiling</u>, <u>step-down</u> model.

Specifically, the CLIPS community baseline population projection submodel first projects each community's future population by assuming that it will grow at the same rate as it has in the past, regardless of what is happening in the region. If Community A has been growing at a 2 percent annual rate for the last twenty years, it is initially assumed to continue to do so. Such an approach is straightforward. However, it can produce highly inaccurate results if the future is not like the past. Thus, CLIPS provides two constraints on the simple trend-extrapolated projection: one constraint at the community level and the other emanating from the previously produced regional information.

The first constraint is called a density ceiling effect. It assumes that each community has a certain capacity for growth determined by the absolute amount of developable land, zoning ordinances, and peculiar land and housing market characteristics and, thus, "when a given density is reached population will either stabilize or decline" (Greenberg et al., 1978: p. 18). The Rand Corporation's (1975) excellent empirical study on the distribution of growth among communities in Santa Clara County, California, found that the absolute number of acres available for residential development in each community overwhelmed all other variables in explaining the distribution of intracounty growth.

Even in sparsely populated regions, such density ceiling factors are suspected to operate. The Old West Regional Commission's study (1976), Temporary/Mobile Facilities For Impacted Communities cited (p. 20):

> For example, one of the main reasons for the dramatic impact growth in the small communities of Lyman and Mountain View (located in the Jim Bridger Valley in southwestern Wyoming) was that the majority of the large construction force required for the expansion of trona processing, selected those two communities over the equidistant larger communities of Rock Springs and Green River, principally because of the existing saturated growth conditions of the latter two cities.

Much closer to home, the Texas Department of Community Affairs' Freestone County Trend Study (1978a: p. 28) concluded, "The prime factor restricting the growth of Donie is the lack of land available for housing. Most of the land is owned and controlled by estates."

As a consequence of these considerations, CLIPS allows the user to place a density ceiling which will modify future community population growth rates by adusting the assumed historical growth rate over time. At present, these density ceiling factors are strictly user-determined (i.e., the user must assume a certain ceiling for each community, and the default condition assumes there is no community-level constraint). Greenberg et al. (1978) provide a detailed procedure for empirically estimating density ceilings, but the method has not yet been incorporated into CLIPS. Even the assumed ceilings will provide the user with a capability to produce alternative scenarios which should be valuable in the planning process.

The final constraint on assumed historical community growth is accomplished by utilizing the information produced by the regional baseline population projection submodel. The regional submodel's results, because of its detail, are assumed to be accurate. If the aggregated community population (i.e., all community populations in the region added up) does not equal that projected by the regional submodel for a given year, each community's population must be adjusted appropriately until the totals are equal.

B. Model Equations and Explications

This formulation is a modification of the model by Greenberg et al. (1978: p. 61), which they discuss under the rubric "The Growth Rate Method of Adjustment:"

If the community historical population growth rate has been positive, the model initially increases the community's population according to its historical growth rate. The community growth rate is diminished each year, however, by subtracting a constant which has the effect of imposing a density ceiling and, other things being equal, producing a logistic growth pattern over time. If the community's historical growth rate has been negative (or less than one, if the incremental relationship is multiplicative), the community's population is simply updated by decreasing its last year's population. For both growing and declining communities, the annual absolute amount of population growth is computed by subtracting last year's population from the present year's unadjusted community baseline population projection.

Next, the model adds all the projected community baseline population growths to produce a total unadjusted regional population growth projection. Then the model computes each community's share of the unadjusted regional population growth by dividing the individual community's population growth between time t+1 and time t by the total regional unadjusted population growth between the same times. Next, the model determines "actual" regional population growth (that produced by the economic-demographic model described in chapter 3) by subtracting regional population at time t from regional population at time t+1.

Finally, the model determines each community's baseline population at time t+1 by multipying its projected share of the unadjusted regional population growth by the "actual" population growth, and adding this value to the community baseline population at time t.

1. <u>Compute Community Baseline Population and Community Population Growth (for communities with negative historical growth rates)</u>

$$COMBP_i^{t+1} = COMBP_i^t * CGR_i \qquad 4.1$$

$(0 < CGR < 1)$

$$COMPGTH_i^{t,t+1} = 0 \qquad 4.2$$

2. <u>Compute Community Baseline Unadjusted Population and Community Population Growth (for communities with positive historical growth rates)</u>

$$COMUBP_i^{t+1} = COMBP_i^t * CGR_i^{DCF_i^t} \qquad 4.3$$

$(1 \leq CGR < \infty)$

$$DCF_i^{t+1} = DCF_i^t - DC_i \qquad 4.4$$

$$COMPGWTH_i^{t,t+1} = COMUBP_i^{t+1} - COMBP_i^t \qquad 4.5$$

3. <u>Compute Total Unadjusted Regional Population Growth</u>

$$URPG^{t,t+1} = \sum_{i=1}^{NUMTOWN} (COMPGWTH_i^{t,t+1}) \qquad 4.6$$

(NUMTOWN = number of towns in region)

4. Compute Actual Regional Population Growth

$$ARPG^{t,t+1} = RPOP^{t+1} - RPOP^{t} \quad 4.7$$

(Note that this number can be negative.)

5. Compute Communities' Shares of Unadjusted Regional Population Growth

$$COMSH_{i}^{t+1} = COMPGWTH_{i}^{t,t+1} \div URPG \quad 4.8$$

6. Compute Actual Community Baseline Population

$$COMBP_{i}^{t+1} = COMBP_{i}^{t} + (COMSH_{i}^{t+1} * ARPG^{t,t+1}) \quad 4.9$$

Chapter 5

THE REGIONAL IMPACT POPULATION PROJECTION SUBMODEL

A. Overview and Model Rationale

Chapter 3 describes the procedures used by CLIPS to perform a regional baseline population projection. Chapter 4 describes the method used to derive from the regional population projection the requisite baseline population projection for each of the communities in the region. By linking the submodel described in chapter 7 directly to the results of the community baseline population projection submodel, CLIPS generates projections of public facilities/services requirements and costs for each of the communities under the baseline condition.

The picture is more complex under the impact condition, as indicated by figure 1. In order to derive a community's socioeconomic projection under the impact condition, CLIPS adds to the baseline community population the amount of additional community population generated by the project. Then, the submodel described in chapter 7 is called to generate socioeconimic projections. However, in order to produce additional community population generated by the project, CLIPS must go through several intermediate steps.

First, CLIPS requires information concerning the proposed project. In the present CLIPS version, this information is completely user-specified. Future versions will permit the user to specify the type of project (for example, 900-megawatt lignite-fired power plant, 1500-megawatt nuclear power plant, etc.) plus the starting date, and if the user does not wish to provide specific information, CLIPS will perform the impact assessment on a typical project of the specified type and size. The present version of CLIPS requires only annual aggregate construction and operating staff manpower requirements (that is, no occupational breakdowns are required).

Once the starting date, length of the project, and annual manpower requirements have been specified by the user, CLIPS takes over and proceeds automatically through the remaining steps. From manpower requirements, the model next annually estimates how many new construction workers are required. Then it determines how many of the new construction workers required will have to be brought in from outside the region. This step is crucial to the impact assessment. Chalmers (1978: p. 83) notes:

> No single issue is more important in the analysis of construction period impacts than determination of the extent to which the work-force is to be made up of local labor relative to the extent that new workers will have to migrate into the study area.

There are several approaches to estimating the local/nonlocal distribution ("a local worker was defined as one who had not changed his place of residence in order to work on a construction project" [Chalmers, 1978: p. 83]). One approach is to ask the developers what proportion of their work force they anticipate hiring from the local area. A second simple approach is simply to set the proportion to some constant which has been obtained on similar projects in the past. For example, in projecting socioeconomic impacts from the Clinch River Breeder Reactor Plant, the Project Management Corporation (1976: p. 8.3-2) used the following logic:

> Based upon the observations and judgments of project staff, primarily the reported experience of TVA, it is estimated that the following proportions of the four types of employees at peak construction will locate from outside the area to a new full-time or part-time residence within the area: construction craftsmen, 20 percent (16 percent full-time and 4 percent part-time); construction non-manuals, 65 percent (58 percent full-time and 7 percent part-time), operations personnel, 75 percent; and CRBRP Project Office personnel 70 percent. These influx estimates assume normal levels of competition.

The problem with assuming a constant is that the proportion is often not constant. For example, research discussed in the Old West Regional Commission's (1975) Construction Worker Profile yielded the proportions shown in table 2.

Several additional approaches have been suggested. The Construction Worker Profile drew a sample of sixty-eight communities and twelve projects and empirically derived a regression equation estimating the local/nonlocal mix with the following independent variables: size of community, size of project, distance between the community and the project, number of local workers already working on projects in the area, and presence of other communities within commuting distance. The problem with this approach is that it totally ignores both the skill mix of the local labor force and the effects of local unemployment/underemployment. An Electric Power Research Institute (1978: p. 2) report issued the following complaint:

> To date, little attention has been directed to the problems of using membership in labor union crafts to assess labor availability within commuting range for the purposes of projecting in-migration. . . . Similarly, the relationship between the level of regional construction employment/unemployment and the projection of labor availability is not at all clear at the present time.

Consideration of local skill mix and unemployment probably holds the most promise in estimating the local labor availability and, thus,

Table 2

LOCAL WORKERS AS A PERCENTAGE OF TOTAL WORKERS

Project Number and Name		Total Construction Workers	Local Construction Workers	Percentage Local
1	Coronado 1,2.3	119	48	40.3
2	Craig 1,2--Yamps Power Plant	307	129	42.0
3	Hayden 2	483	155	32.1
4	Colstrip 1,2	161	62	38.5
5	Center--Milton R. Young	73	35	47.9
6	Leland Olds	193	86	44.6
7	San Juan 1	234	184	78.6
8	Emery	130	69	53.1
9	Huntington 2	307	142	46.3
10	Jim Bridger 2,3	503	149	29.6
11	Texaco Lake Expansion	206	86	41.7
12	Sun Oil--Cordero Mine	133	57	42.9
13	Texas Gulf Sulphur	227	59	26.0
14	Wyodak	92	3	3.3
	TOTAL	3,168	1,264	39.9

Source: Old West Regional Commission, Construction Worker Profile: Final Report prepared by Mountain West Research, Inc., December 1975.

potential construction worker in-migration. The problem with the EPRI suggestion is that in rural areas construction workers craft unions often either are nonexistent or else do not maintain reliable data.

We anticipate incorporating a final approach into future versions of CLIPS which potentially solves most of the problems. First, detailed occupational breakdowns of manpower requirements will be specified. Annual estimates of boilermakers, bricklayers, carpenters, cement finishers, electricians, insulators, ironworkers, millwrights, operating engineers, painters, plumbers, pipefitters, sheetmetal workers, laborers, etc., will be required. Next, these groupings will be made compatible with those specified in the 1972 Census of Manufacturers' Table 180. This table contains fifteen craftsman groups including boilermakers, brickmasons, carpenters, electricians, etc. It also includes regional estimates of the numbers of the craftsmen employed in each two digit specified manufacturing industry (e.g., Furniture, Lumber and Wood Products, Primary Ferrous Industries, etc.). By (1) structuring the submodel to aggregate our industry groups appropriately (see chapter 3), (2) applying ratios derived from Table 180, and (3) adding terms to cover the effects of unemployment and wage differentials, we can obtain a much more accurate projection of in-migrating construction workers.

The present version of CLIPS simply assumes that 60.1 percent (see table 2) of new required construction workers will be nonlocal.

Once in-migrating workers have been determined, CLIPS derives additional demographic characteristics, e.g., the number of in-migrating construction worker children aged between 10 and 14 years old, the number of in-migrating construction spouses 25 to 29 years old. The general logic of this step is straightforward, but the detailed procedure is intricate. The reader is referred to the detailed model equations in this chapter for a thorough explication. This step leads CLIPS through box 8 of figure 1. The next procedure involves allocating regional construction worker population to individual communities, the topic of chapter 6.

B. Model Equations and Explication

1. Compute Project Construction Worker Manpower Requirements

$$CWMPR = GTABL(CWMPRT, YEAR, 1970, 1990) \qquad 5.1$$

During a given year, the total number of construction worker manpower requirements (the number of jobs which must be filled in order to complete the construction tasks planned for that year) is determined by a look-up table. The computer software is set up such that at the beginning of a simulation, the user is asked to define a project for which he wishes to model the impacts on the region and its communities. The definition requires the user to set first the date (e.g., 1982) he expects the project to begin and then its length. Next, the user is required to specify, year by year, the number of construction workers required. The model then takes over and transforms these specifications into the table CWMPRT. When the model iterates to the regional impact projection submodel each year, it simply looks up CWMPR for that year in the preconstructed table. (Note that during many years CWMPR will equal zero.)

2. Compute Required New Construction Workers

$$RNCW^{t,t+1} = CWMPR^{t+1} - CWOS^{t} \qquad 5.2$$

The number of new construction workers who must be hired between year t and year t+1 (RNCW) equals the number of construction workers required at year t+1 minus the number of construction workers already on site (CWOS) at year t. (Note that when CWOS is greater than CWMPR, workers must be laid off and RNCW becomes negative.)

3. Compute Construction Workers on Site

$$CWOS^{t+1} = CWOS^{t} + RNCW^{t,t+1} \qquad 5.3$$

Equation 5.3 computes Construction Workers On Site at year t+1 by adding Required New Construction Workers between year t and year t+1 to Construction Workers On Site at year t.

4. Compute Required New Construction Worker In-migrants

$$RNCWI^{t,t+1} = 0.601 * RNCW^{t,t+1} \qquad 5.4$$

If CWMPR is greater than CWOS, RNCW is positive and new construction workers must be hired. However, as discussed in the overview, some of these workers will be local residents and commuters and some will be brought in from outside the region as new residents. The specific ratio will depend upon many factors that determine construction worker availability in the region. The present version of CLIPS simply assumes that approximately 60 percent of new construction workers will be in-migrants.

5. Compute Construction Worker Out-migrants

$$CWOM^{t,t+1} = RNCW^{t,t+1} \qquad 5.5$$

(when $RNCW^{t,t+1} < 0$)

If CWOS is greater than CWMPR, RNCW will be negative and construction workers are laid off. When this condition occurs, the model assumes all of them out-migrate, together with their dependents.

6. Compute Construction Worker In-migrant Demographic Characteristics

In order to project regional impact population, CLIPS needs to know not only how many construction workers will be in-migrating but also what age groups these in-migrants and their dependents fall into. Most of the parameters in this section are taken from the Old West Regional Commission's Construction Worker Profile (1975).

6a. Compute Number of In-migrating Construction Worker Families

$$ICWF^{t,t+1} = RNCWI^{t,t+1} * FPCW \qquad 5.6$$

In-migrating Construction Worker Families equals Required New Construction Worker In-migrants times Families Per Construction Worker.

6b. Compute Number of In-migrating Construction Worker Children

$$ICWCH^{t,t+1} = ICWF^{t,t+1} * CHPCWF \qquad 5.7$$

The number of in-migrating construction worker children (ICWCH) equals the number of in-migrating construction worker families (ICWF) times children per construction worker family (CHPCWF).

6c. Distribute In-migrating Children into First Five Age Groups

For $i=1$ to 5

$$ICWCH_i^{t,t+1} = ICWCH^{t,t+1} * CWCHDF_i \qquad 5.8$$

The number of in-migrating construction worker children in each of the first five age groups (<1, 1-4, 5-9, 10-14, 15-19) equals the total number in-migrating (ICWCH) times the Construction Worker Children Distribution Factor for that age group. For example, it is assumed that 0.2919 of all in-migrating construction worker children will be from 1 through 4 years old.

6.d Compute In-migrating Construction Worker Adults

In-migrating construction worker adults consist of three groups: (1) single construction workers, (2) married construction workers who do not bring their families, and (3) married construction workers who do bring their families.

$$ICWS^{t,t+1} = ICWF^{t,t+1} \qquad 5.9$$

The number of in-migrating construction worker spouses (ICWS) equals the number of in-migrating construction worker families (ICWF).

$$NFCWADI^{t,t+1} = RNCWI^{t,t+1} - ICWF^{t,t+1} \qquad 5.10$$

The number of nonfamily construction worker adults in-migrating (NFCWADI) equals the total number of in-migrating construction worker families (ICWF) subtracted from the total number of new construction workers in-migrating (RNCWI).

$$CWIAD^{t,t+1} = (2.0 * ICWS^{t,t+1}) + NFCWADI^{t,t+1} \qquad 5.11$$

The total number of construction worker in-migrating adults (CWIAD) equals in-migrating construction workers with their spouses plus the number of adult workers without families.

6e. Distribute In-migrating Construction Worker Adults into the Adult Age Groups

For $i=5$ through 17

$$ICWAD_i^{t,t+1} = CWIAD^{t,t+1} * CWADDF_i \qquad 5.12$$

The number of in-migrating construction worker adults in each of the adult age groups equals the total number of in-migrating construction worker adults (CWIAD) times the Construction Worker Adult Distribution Factor. For example, 0.203 of the construction in-migrating adults are assumed to be between 20 and 24 years old.

6f. Compute Construction Worker Out-migrating Children and Adults

As discussed earlier, only when manpower requirements exceed construction workers on site does in-migration occur. When this condition occurs, RNCWI is greater than zero and CWOM is set to zero. When CWOS is greater than CWMPR, out-migration occurs. When this condition occurs, CWOM is a negative real number and RNCWI is set to zero.

When CWOM is nonzero, the model simply replaces RNCWI in equation 5.6 with CWOM and utilizes the equations (5.6 through 5.12) to compute out-migration of children and adults. The assumption is that out-migrants have the same demographic characteristics as in-migrants.

7. Compute Construction Worker Births

Equations 5.6 through 5.12 compute the number and distribution of construction worker in-migrants and out-migrants between year t and year t+1. After the initial construction year, and for the duration of the project, resident construction worker population matures, gives birth, and dies. Some construction worker elementary students become high school students. Thus, the next step for the model is to compute these vital statistics. The same equations used for the resident regional population are used for construction worker population with the assumption that the vital rates are the same.

$$CWAGEGP_{1-5} = ICWCH_{1-5} \qquad 5.13$$

$$CWAGEGP_{6-17} = ICWAD_{6-17} \qquad 5.14$$

$$CWLB^{t,t+1} = \sum_{i=5}^{15} (BR_i * CWAGEGP_i^t) \qquad 5.15$$

Construction Worker Live Births equals the summation of the age-specific birth rates times the number of construction worker population in each of the ten child-bearing age groups.

8. Compute Construction Worker Growths

$$CWGRTH_1^{t,t+1} = CWAGEGP_1^t \qquad 5.16$$

$$CWGRTH_2^{t,t+1} = CWAGEGP_2^t \div 4.0 \qquad 5.17$$

For $i=3$ through 16

$$CWGRTH_i^{t,t+1} = CWAGEGP_i^t \div 5.0 \qquad 5.18$$

$$CWGRTH_{17} = 0.0 \qquad 5.19$$

Equations 5.16 through 5.19 duplicate equations 3.2 through 3.5 for the construction worker population.

9. Compute Construction Worker Deaths

$$CWDTH_1^{t,t+1} = DR_1 * CWLB^{t,t+1} \qquad 5.20$$

For $i=2$ through 17

$$CWDTH_1^{t,t+1} = DR_i * CWAGEGP_i^t \qquad 5.21$$

Equations 5.20 and 5.21 duplicate equations 3.6 and 3.7.

10. Update Construction Worker Population Age Groups

$$CWAGEGP_1^{t+1} = CWLB^{t,t+1} - CWDTH_1^{t,t+1} + ICWCH_1^{t,t+1} \qquad 5.22$$

For $i=2$ through 5

$$CWAGEGP_i^{t+1} = CWAGEGP_i^t + CWGRTH_{i-1}^{t,t+1} - CWGRTH_i^{t,t+1} - CWDTH_i^{t,t+1} + ICWCH_i^{t,t+1} \qquad 5.23$$

For $i=5$ through 17

$$CWAGEGP_i^{t+1} = CWAGEGP_i^t + CWGRTH_{i-1}^{t,t+1} - CWGRTH_i^{t,t+1} - CWDTH_i^{t,t+1} + ICWAD_i^{t,t+1} \qquad 5.24$$

Equation 5.22 computes the number of construction worker population under one year old at year t+1 by adding births, subtracting deaths, and adding the number of in-migrating construction worker children under one year old (this last term is negative when CWOM is nonzero).

Equation 5.23 computes the number of construction worker population in age groups 2 through 5 at year t+1 by adding growths and in-migrants to, and subtracting deaths from, the number of population in that age group at year t.

Equation 5.24 performs the same computation for age groups 5 through 17.

$$CWPOP^{t+1} = \sum_{i=1}^{17} (CWAGEGP_i^{t+1}) \qquad 5.25$$

Equation 5.25 computes total construction worker population at year t+1 by summing the number of people in each age group.

11. <u>Compute Construction Worker Labor Force</u>

Since many construction worker spouses will enter the local labor market, additional labor force must be computed under impact conditions.

$$CWLF^{t+1} = \sum_{i=1}^{17} (CWLFPR_i * CWAGEGP_i^{t+1}) \qquad 5.26$$

Equation 5.26 computes the construction worker labor force available for local work by multiplying age-specific labor force participation rates by the number of construction worker people in each age group.

12. Determine Regional Impact Population Projection

$$TLF^{t+1} = LF^{t+1} + CWLF^{t+1} \tag{5.27}$$

Equation 5.27 computes the total regional labor force under impact conditions by summing the results of equations 3.41 and 5.26.

$$TRPOP^{t+1} = \sum_{i=1}^{17} (AGEGP_i^{t+1} + CWAGEGP_i^{t+1}) \tag{5.28}$$

Equation 5.28 computes total regional population under impact conditions by summing across age groups both the resident population and the construction worker population.

Chapter 6

THE COMMUNITY IMPACT POPULATION PROJECTION SUBMODEL

A. Overview and Model Rationale

Perhaps the single weakest component of the present version of CLIPS is the sector of the community impact population projection submodel which allocates construction workers to individual communities. We anticipate extensive research in this area in the immediate future.

In order to project community population under impact conditions, the community baseline population must be summed with community population brought in by the project. As Chalmers (1978: p. 92) noted:

> The inmigrating nonlocal construction workers have to be allocated to communities differently from other employment-related inmigrants because their settlement pattern will be influenced by the site of the proposed action.

Two alternative formal approaches have been suggested as modes of allocating project construction workers among neighboring communities: (1) the gravity formulation, and (2) the linear programming approach.

The gravity formulation is by far the simpler of the two and according to Hertsgaard et al. (1978: p. 71) "is the most widely accepted model of spatial allocation of in-migrating population." In its barest form the gravity model assumes that in-migrating workers will locate in the largest/closest communities and that such settlement tendencies can be captured by a mathematical function that allocates workers in direct proportion to the size of neighboring communities and inverse proportion to their distances from the work-site.

Mathematically, the function appears as follows:

$$FIMLC_i = (p_i \div D_{i,pj}) \div \left[\sum_{i=1}^{NUMTOWN} (p_i \div D_{i,pj}) \right]$$

where

FIMLC = Fraction of total in-migrants locating in Community i

P_i = Population size of Community i

$D_{i,pj}$ = Distance between Community i and the project.

The terms of this equation are typically modified by raising P and D to some power reflecting their relative strengths in the determination of settlement patterns. Moreover, several studies have gathered samples of previous projects and employed cross-sectional regression analysis to derive the equation parameters empirically (Murdock, Wieland, and Leistritz, 1979).

The problem with the gravity model is that it does not work as well as we would like it to. In practically all studies, the pattern was consistent but the overall explanatory power was low--too low for the importance it holds for the rest of the model. The reasons for this low explanatory power probably lie in the theoretical rather than the empirical realm, and as long as these theoretical shortcomings persist, no number of rigorous empirical analyses will improve prediction. The numerator of the equation, population, is a theoretical construct which is supposed to act as a "proxy" for such community attractiveness features as:

1. Availability of public amenities (utilities, schools, recreation, etc.)
2. Availability of private amenities (shopping, medical care, etc.)

3. Availability and quality of housing

4. All other attractiveness features, such as the presence of employment opportunities for other family wage earners

The problem is that the construct is simply too "packed." Housing availability and public and private amenities simply do not vary consistently enough with population size or with each other. Given its crucial importance, housing should not only be considered separately but, owing to the varying housing preference patterns and incomes of construction workers, should itself be disaggregated into at least single-family, multiple-family, and mobile home types.

The most significant contribution of Stenehjem's work (1976) at the Argonne National Laboratory has been the development of a linear programming model called the Spatial Allocation Model (SAM). SAM is based on an approach that weights the workers' preferences according to housing type, their incomes, and their willingness to commute; it also allows for supply constraints according to the availability of housing in the individual communities.

The problems with SAM so far have been twofold: (1) data dependence--for some areas, extensive housing information will simply be difficult to gather, and (2) the model has not been documented adequately to permit exportation to a computer different from Argonne's. Dr. Stenehjem has communicated to Center for Energy Studies researchers that such documentation will be forwarded to us as soon as it is available. Our present plans are to implement a SAM-like submodel and permit CLIPS users the option of comparing the results with those of the gravity model. Of course, if the housing data are not available, the user will either have to stay with the modified gravity model or to construct "guesstimated" housing data arrays. (It is possible in using the gravity model to weight the communities subjectively to try to take in features thought not adequately captured by the population term.)

B. Model Equations and Explication

1. Compute Community Attractiveness to Construction Workers

$$COMATT_i^{t+1} = (COMBP_i^{t+1} ** CSAE) * (DIST_i ** DAE) \quad 6.1$$

(** denotes exponentiation)

The residential attractiveness to project construction workers of a given community at time t+1 equals the multiplication of two terms: the community population size (COMBP) raised to the power denoted by the Community Size Attractiveness Exponent; and the commuting distance between the community and the project raised to the Distance Attractiveness Exponent (CSAE will be positive and DAE negative).

2. Aggregate Community Attractiveness

$$AGGATT^{t+1} = \sum_{i=1}^{NUMTOWN} (COMATT_i^{t+1}) \quad 6.2$$

Equation 6.2 computes the aggregate attractiveness by summing the individual community attractiveness scores.

3. Compute Community Attractiveness Ratios

$$COMATTR_i^{t+1} = COMATT_i^{t+1} \div AGATT \quad 6.3$$

Equation 6.3 computes the ratio of each community's attractiveness score to the total.

4. Allocate In-migrating Construction Workers to Individual Communities

$$IMCWC_i^{t,t+1} = RNCWI^{t,t+1} * COMATTR_i^{t+1} \qquad 6.4$$

The number of in-migrating construction workers allocated to each community (IMCWC) equals the total number of new construction workers in-migrating into the region (RNCWI) times the individual community's relative attractiveness score (COMATTR).

5. Compute Community In-migrating Construction Worker Population

$$IMCWPC_i^{t,t+1} = IMCWC_i^{t,t+1} * CWAHS \qquad 6.5$$

Equation 6.5 computes in-migrating population by multiplying workers times household size.

6. Compute Community Construction Population

$$COMCP_i^{t+1} = COMCP_i^t + IMCWPC_i^{t,t+1} \qquad 6.6$$

Community construction populations (COMCP) at time t+1 equals community construction population at time t plus in-migrants (or minus out-migrants).

Chapter 7

THE COMMUNITY-LEVEL SOCIOECONOMIC ASSESSMENT SUBMODEL

A. Overview and Model Rationale

Fiscal impact analysis attempts to measure the costs and revenues associated with developments, the goal being to determine the impact of the development on both elements and then to derive aggregate impact by subtracting overall costs from overall revenue. Such analyses must be approached with trepidation. Burchell and Listokin (1978: p. xxi), in their excellent handbook, cautioned:

> The quantification of the parameters in this field is a most complex one. On the cost side of the ledger we have been faced with the enormous variety of both residential and non-residential configurations. When, in turn, these are considered within the diversity of the United States, with cost elements varying both regionally and also substantially by the size of the governmental units involved--the very scale of cities altering some of the cost estimates--the scope of the research becomes evident.
>
> Nor is the other side of the coin--the income sector--one which the researcher can face with equanimity. The rapid changes in revenue sharing of various kinds, both on the state and federal level, have left earlier cost revenue analyses . . . hopelessly behind the realities of municipal finance.

In view of these problems, several serious caveats are in order with respect to the use of the output from the CLIPS socioeconomic assessment submodel. Most importantly, it should be stressed that this output should not be expected to substitute for what a careful analysis by a local planner would produce. Indeed, CLIPS is designed primarily as an instrument to assist the local planner in carrying out his own socioeconomic assessment. That is why so much attention has been devoted to providing reliable community-level population projections.

With such projections, those most familiar with the local area (and the types of services they personally are charged with delivering) will be able to produce far more reliable need assessments than will a generalized methodology.

The possible exception to this statement would be the case of a major investment in developing and implementing a totally site-specific methodology similar to that developed by Frank (1976). Such a methodology would require data such as the diameter, length, and material type (e.g., vitrified clay) of sewer lines, block by block, for the entire street network of the specific community, as well as the same information on the future residential, commercial, and industrial development areas in the community. Then, the modeler would have to determine where in the specific community residential development would occur and in what sequence.

Such a complex methodology as Frank's, then, is not likely to be available in the near future in a portable form (that is, one that can be transferred from community to community). Thus we are likely to have to make do with simpler, less reliable forms. The output from these simpler models can be valuable as long as its use is restricted appropriately. Such an appropriate use will likely fall into two areas: (1) to avail local planners' initial "guesstimates" of the municipal facilities/services and budgets likely to be hardest hit by specific developments; and, (2) to enable higher-level government officials to conduct programmatic socioeconomic assessments when they must have such information in order to execute impact-aid disbursements.

Models projecting municipal costs usually fall into one of two classes: average costing or marginal costing. Average costing is far more prevalent in the absence of detailed site-specific information. With the average cost approach, according to Burchell and Listokin (1978: p. 4):

> Costs are attributed to a new development according to average cost per unit of service (municipal and school district services) times the number of units the development is estimated to require. This method does not consider existing excess or deficient capacity that might exist for particular services or the possibility that a new development might fall at the threshold level, calling for major new capital construction to accommodate increased growth. Both of these deficiencies could invalidate an average cost assumption.

The marginal cost approach, on the other hand, "takes both of these potential deficiencies into account." The marginal cost approach, however, suffers in its reliance on an extensive data base, which in many cases will be difficult to put in place. (The reader will note that the other submodels of CLIPS likewise rely on an extensive data base. However, in their cases, these data are readily accessible in secondary, published form, and thus the data collection task is so simplified as to justify the dependence of the model on it in the hope of enhanced potential accuracy.)

As in the case of the remainder of CLIPS, we have pursued the modeling of socioeconomic costs in an eclectic fashion. Specifically, we have relied heavily on an average cost approach (e.g., Health Care Capital Costs in Community A between time t+1 and time t equals Per Capita Health Care Capital Costs times Community Population Growth between time t+1 and time t) when (1) data requirements were unwieldly and/or (2) initial capacity estimates were not deemed crucially influential. At some points, we have opted for a marginal cost approach (e.g., School Building Space Construction Required in Community A between time t+1 and time t equals School Building Space Required in Community A at time t+1 minus School Building Space Existing in Community A at time t.). We felt that since the construction of such facilities as school classrooms would be a major expense item, the capability to assess the effect of initial capacity was crucial even if it meant the user would have to roughly estimate beginning year classroom space.

Finally, it must be emphasized that even with these marginal costing sectors, the year-by-year estimates of the model's output cannot be interpreted literally. Sometimes a school district will choose to lag its construction schedules behind demand and permit classrooms to be temporarily overcrowded and then, in a surge, construct enough space to accommodate not only present students but anticipated demand ten years in the future. Such peaks and valleys are simply averaged out by CLIPS, and the results should be interpreted accordingly.

B. Model Equations and Explication

The CLIPS community-level socioeconomic assessment submodel relies heavily on the Murphy/Williams Urban Planning and Housing Consultants document, Socioeconomic Impact Assessment: A Methodology Applied to Synthetic Fuels (1978) prepared for the U. S. Department of Energy. Annual costs estimates throughout the submodel are derived usually by applying some disaggregated component of a multiplier to one of the following: (1) Community Population Growth during the interval t,t+1; (2) annual anticipated Houses Constructed (Single-Family, Multiple-family, or Mobile Homes) during the interval t,t+1; or, (3) the existing level of population in a given community.

Accordingly, the first step in estimating costs is to estimate additional housing requirements anticipated in each community for both the resident population and the expected construction worker population (since construction worker populations have different housing preference patterns; e.g., much higher preferences for mobile homes).

1. Compute Housing Requirements

$$PIF_i^{t+1} = COMBP_i^{t+1} * 0.92 \qquad 7.1$$

Equation 7.1 estimates the number of baseline Population In Families in Community i at time t+1, by multiplying projected Community Baseline Population for Community i at time t+1 by a constant.

$$PIOHH_i^{t+1} = COMBP_i^{t+1} - PIF_i^{t+1} \qquad 7.2$$

Next, Population In Other Households is computed by subtracting PIF from COMBP.

$$FAM_i^{t+1} = PIF_i^{t+1} \div PPF \qquad 7.3$$

Equation 7.3 computes the number of families by dividing PIF by Population Per Family.

$$OHH_i^{t+1} = PIOHH_i^{t+1} \div PPOHH \qquad 7.4$$

Equation 7.4 computes Other Households by dividing Population In Other Households by Population Per Other Household.

$$HH_i^{t+1} = FAM_i^{t+1} + OHH_i^{t+1} \qquad 7.5$$

Equation 7.5 computes total Households by adding Families and Other Households.

$$THR_i^{t+1} = HH_i^{t+1} * VR \qquad 7.6$$

Total Houses Required equals Households times the Vacancy Rate.

$$CWSFHR_i^{t+1} = INCW_i^{t,t+1} * CWSFHPP \qquad 7.7$$

Equation 7.7 computes Construction Worker Single-Family Houses Required by multiplying the number of In-migrating Construction Workers expected in Community i between time t and time t+1 by the assumed Construction

Worker Single-Family Housing Preference Proportion (0.45).

$$CWMFHR_i^{t+1} = INCW_i^{t,t+1} * CWMFHPP \qquad 7.8$$

$$CWMHR_i^{t+1} = INCW_i^{t,t+1} * CWMHPP \qquad 7.9$$

Equations 7.8 and 7.9 perform similar computations for Construction Worker Multi-Family Houses Required and Construction Worker Mobile Homes Required.

$$RPSFHR_i^{t+1} = THR_i^{t+1} * RPSFHPP \qquad 7.10$$

Resident Population Single-Family Houses Required equals Total Houses Required times Resident Population Single-Family Housing Preference Proportion (0.6).

$$RPMFHR_i^{t+1} = THR_i^{t+1} * RPMFHPP \qquad 7.11$$

$$RPMHR_i^{t+1} = THR_i^{t+1} * RPMHPP \qquad 7.12$$

Equations 7.11 and 7.12 derive Resident Population Multi-Family Houses Required and Resident Population Mobile Homes Required.

$$NSFHR_i^{t+1} = RPSFHR_i^{t+1} + CWSFHR_i^{t+1} \qquad 7.13$$

$$NMFHR_i^{t+1} = RPMFHR_i^{t+1} + CWMFHR_i^{t+1} \qquad 7.14$$

$$NMHR_i^{t+1} = RPMHR_i^{t+1} + CWMHR_i^{t+1} \qquad 7.15$$

Equation 7.13 computes the total Number of Single-Family Houses Required in Community i at time t+1 by adding RPSFHR and CWSFHR. Equations 7.14 and 7.15 perform the same computation for the other two housing categories.

$$CSFHR_i^{t,t+1} = AMAX1\ (0.,NSFHR_i^{t+1} - NSFHR_i^{t}) \qquad 7.16$$

Equation 7.16 computes the Change in Single-Family Houses Required by substracting the Number of Single-Family Houses Required at time t from the Number of Single-Family Houses Required at time t+1. The AMAX1 function simply sets the variable to zero when the change comes out negative, thus assuming no houses are demolished.

$$CMFHR_i^{t,t+1} = AMAX1\ (0.,NMFHR_i^{t+1} - NMFHR_i^{t}) \qquad 7.17$$

$$CMHR_i^{t,t+1} = AMAX1\ (0.,NMHR_i^{t+1} - NMHR_i^{t}) \qquad 7.18$$

Equations 7.17 and 7.18 compute, in like manner, the Change in Multi-Family Houses Required and the Change in Mobile Homes Required.

After housing changes have been computed, the socioeconomic submodel possesses all the information it needs to conduct a socioeconomic assessment. It then moves directly to computing annual community capital costs beginning with schools capital costs.

2. Compute Schools Capital Costs

First the model computes the number of students, elementary and high school, expected in a given community.

$$CWES_i^{t+1} = (COMCP_i^{t+1} \div CWFS) * ESPCWF \qquad 7.19$$

Equation 7.19 computes the number of Construction Worker Elementary Students in Community i at time t+1 by dividing Community Construction Population by Construction Worker Family Size and then multiplying this by Elementary Students Per Construction Worker Family. CWFS and ESPCWF, like most of the construction worker demographic information, are taken from the Construction Worker Profile (Old West Regional Comission, 1976).

$$CWHS_i^{t+1} = (COMCP_i^{t+1} \div CWFS) * HSPCWF \qquad 7.20$$

Equation 7.20 performs a similar computation for Construction Worker High School Students.

$$CSRBP_i^{t+1} = COMBP_i^{t+1} \div RPOP^{t+1} \qquad 7.21$$

In order to compute resident population students, the model first determines the Community Share of Regional Baseline Population by dividing community baseline population (COMBP) by the total regional resident population (RRPOP).

$$COMBP517_i^{t+1} = (AGEGP(3)^{t+1} + AGEGP(4)^{t+1} + 0.6 * AGEGP(5)^{t+1}) * CSRBP_i^{t+1} \qquad 7.22$$

Equation 7.22 then computes the total number of resident population age 5 to 17 expected in Community i at time t+1 by first adding the numbers of regional population in age groups 5-9 and 10-14 (plus 60 percent of age group 15-19) and then multiplying this sum by CSRBP.

$$TSE_i^{t+1} = COMBP517_i^{t+1} * 0.9 \qquad 7.23$$

To compute Total Students Enrolled, COMBP517 is multiplied by 0.9.

$$HSSTS_i^{t+1} = (TSE_i^{t+1} * FSEHS) + CWHS_i^{t+1} \qquad 7.24$$

Equation 7.24 computes high school students (HSSTS) by adding Construction Worker High School Students to the product of Total Students Enrolled and Fraction of School Enrollment in High School.

$$ELSTS_i^{t+1} = (TSE_i^{t+1} * FSEES) + CWES_i^{t+1} \qquad 7.25$$

Equation 7.25 computes Elementary Students in a like manner.

$$HSBSR_i^{t+1} = HSSTS_i^{t+1} * SBSPHS \qquad 7.26$$

High School Building Space Required (measured in square feet) equals the number of high school students times School Building Space Per High School Student.

$$ESBSR_i^{t+1} = ELSTS_i^{t+1} * SBSPES \qquad 7.27$$

Equation 7.27 computes Elementary School Building Space Required in a like manner.

$$SBSR_i^{t+1} = HSBSR_i^{t+1} + ESBSR_i^{t+1} \qquad 7.28$$

Equation 7.28 computes total School Building Space Required.

$$SBSCR_i^{t,t+1} = AMAX1\ (0.,SBSR_i^{t+1} - SBS_i^t) \qquad 7.29$$

Equation 7.29 computes the number of square feet of school building space that is required to be constructed between time t and time t+1 (SBSCR) by subtracting the existing school building space in the community at time t (SBS) from school building space required at time t+1. The AMAX1 function, again, prevents demolition.

$$SFDC_i^{t,t+1} = SBSCR_i^{t,t+1} * UCSBS \qquad 7.30$$

School Facility Development Costs equals the amount of construction required (SBSCR) times the Unit Costs of School Building Space (measured in dollars per square foot).

$$SODC_i^{t,t+1} = SFDC_i^{t,t+1} * 0.12 \qquad 7.31$$

School Other Development Costs (furnishings, parking, paving, landscaping) is computed by multiplying a constant (which can be varied by the model user) times SFDC.

$$STDC_i^{t,t+1} = SFDC_i^{t,t+1} + SODC_i^{t,t+1} \qquad 7.32$$

School Total Development Costs is the sum of SFDC and SODC.

$$SLC_i^{t,t+1} = STDC_i^{t,t+1} * 0.04 \qquad 7.33$$

Equation 7.33 computes School Land Costs.

$$SCC_i^{t,t+1} = STDC_i^{t,t+1} + SLC_i^{t,t+1} \qquad 7.34$$

Equation 7.34 computes total school capital costs (SCC) for Community i between time t and time t+1 by summing development costs and land costs.

3. <u>Compute Streets Capital Costs</u>

To compute Streets Capital Costs (STCC), the model utilizes the computed change in housing requirements and steps through several categories of street costs.

$$MSLRR_i^{t,t+1} = (CSFHR_i^{t,t+1} * MSLPSF) + (CMFHR_i^{t,t+1} * MSLPMF) + (CMHR_i^{t,t+1} * MSLPMH) \qquad 7.35$$

First the model computes the amount of minor streets (measured in linear feet) that require construction. This calculation is done in two steps by first computing residentially related contruction requirements and then deriving non-residentially-related construction requirements. Equation 7.35 says that Minor Street Length Residentially Related Requirements equals the quantity Change in Single-Family Houses Required times Minor Street Length Per Single-Family House (measured in linear feet per house) plus the quantity Change in Multi-Family Houses Required times Minor Street Length Per Multi-Family House plus the quantity Change in Mobile Homes Required times Minor Street Length Per Mobile Home.

$$MSLCR_i^{t,t+1} = MSLRRR_i^{t,t+1} * 1.1 \qquad 7.36$$

Equation 7.36 adds a 10 percent increment (for non-residentially-related minor streets) to compute total Minor Street Length Construction Required.

Next, the same type of computation (equations 7.37 through 7.40) is performed for collector streets and arterial streets.

$$CLRRR_i^{t,t+1} = (CSFHR_i^{t,t+1} * CLPSF) + (CMFHR_i^{t,t+1} * CLPMF) + (CMHR_i^{t,t+1} * CLPMH) \qquad 7.37$$

$$CSLCR_i^{t,t+1} = CLRRR_i^{t,t+1} * 1.1 \qquad 7.38$$

$$ALRRR_i^{t,t+1} = (CSFHR_i^{t,t+1} * ALPSF) + (CMFHR_i^{t,t+1} * ALPMF) + (CMHR_i^{t,t+1} * ALPMH) \qquad 7.39$$

$$ASLCR_i^{t,t+1} = ALRRR_i^{t,t+1} * 1.76 \qquad 7.40$$

Next, development costs for each type of street are computed.

$$MSDC_i^{t,t+1} = MSLCR_i^{t,t+1} * UCMS \qquad 7.41$$

Equation 7.41 computes Minor Street Development Costs by multiplying Minor Street Length Construction Required by Unit Costs Minor Streets (in dollars per linear foot).

$$CODC_i^{t,t+1} = CSLCR_i^{t,t+1} * UCCO \qquad 7.42$$

$$ARDC_i^{t,t+1} = ASLCR_i^{t,t+1} * UCAR \qquad 7.43$$

Equations 7.42 and 7.43 perform a like computation for collectors and arterials.

$$STTDC_i^{t,t+1} = MSDC_i^{t,t+1} + CODC_i^{t,t+1} + ARDC_i^{t,t+1} \qquad 7.44$$

Equation 7.44 computes total street development costs (STTDC) by summing the three development costs.

$$STLC_i^{t,t+1} = STTDC_i^{t,t+1} * 0.07 \qquad 7.45$$

Equation 7.45 computes Street Land Costs to be 7 percent of development costs.

$$STCC_i^{t,t+1} = STTDC_i^{t,t+1} + STLC_i^{t,t+1} \qquad 7.46$$

Equation 7.46 computes total street capital costs (STCC) by adding development costs and land costs.

Since operating/maintenance costs for streets depend upon the overall street mileage in the community, the model, as a final step, provides that information even though actual operating/maintenance costs are computed in another sector.

$$MSL_i^{t+1} = MSL_i^{t} + MSLCR_i^{t,t+1} \qquad 7.47$$

Minor Street Length in Community i at time t+1 equals Minor Street Length at time t plus Minor Street Length Construction Required between time t and time t+1.

$$CSL_i^{t+1} = CSL_i^t + CSLCR_i^{t,t+1} \qquad 7.48$$

$$ARSL_i^{t+1} = ARSL_i^{t+1} + ASLCR_i^{t,t+1} \qquad 7.49$$

Equations 7.48 and 7.49 perform the like computation for collectors and arterials.

4. <u>Compute Utility Capital Costs</u>

Utility Capital Costs comprises four categories: gas and electric, water facilities, storm drainage, and sanitary sewerage. Since gas and electric distribution lines, water distribution lines, and sewer collector lines typically follow street patterns, these costs are computed in a manner similar to that used to compute street costs. Treatment plant facilities are then computed as a constant proportion of distribution costs.

$$GERRDC_i^{t,t+1} = (CSFHR_i^{t,t+1} * UCGESF) + (CMFHR_i^{t,t+1} * UCGEMF) + (CMHR_i^{t,t+1} * UCGEMH) \qquad 7.50$$

Equation 7.50 computes residentially related gas and electric development costs (GERRDC) by adding three quantitites: (1) Change in Single-Family Houses Required times Unit Costs Gas and Electric Single-Family (measured in dollars per house); (2) Change in Multi-Family Houses Required times Unit Costs Gas and Electric Multi-Family; and, (3) Change in Mobile Homes Required times Unit Costs Gas and Electric Mobile Homes.

$$WFRRDC_i^{t,t+1} = (CSFHR_i^{t,t+1} * UCWFSF) + (CMFHR_i^{t,t+1} * UCWFMF) + (CMHR_i^{t,t+1} * UCWFMH) \qquad 7.51$$

$$SDRRDC_i^{t,t+1} = (CSFHR_i^{t,t+1} * UCSDSF) + (CMFHR_i^{t,t+1} * UCSDSF) + (CMHR_i^{t,t+1} * UCSDMH) \quad 7.52$$

$$SSRRDC_i^{t,t+1} = (CSFHR_i^{t,t+1} * UCSSSF) + (CMFHR_i^{t,t+1} * UCSSMF) + (CMHR_i^{t,t+1} * UCSSMH) \quad 7.53$$

Equations 7.51, 7.52 and 7.53 perform the same computation for the water distribution network, the storm drainage collection network, and the sanitary sewage collection network.

$$RRUDC_i^{t,t+1} = GERRDC_i^{t,t+1} + WFRRDC_i^{t,t+1} + SDRRDC_i^{t,t+1} + SSRRDC_i^{t,t+1} \quad 7.54$$

Equation 7.54 computes the total Residentially Related Utility Development Costs by adding the four components.

Next, distribution and collector costs for trunks and interceptors (called non-residentially-related costs) are estimated by incrementing the residentially related costs.

$$GENRRC_i^{t,t+1} = RRUDC_i^{t,t+1} * 0.23 \quad 7.55$$

$$WFNRRC_i^{t,t+1} = RRUDC_i^{t,t+1} * 0.23 \quad 7.56$$

$$SDNRRC_i^{t,t+1} = RRUDC_i^{t,t+1} * 0.23 \quad 7.57$$

$$SSNRRC_i^{t,t+1} = RRUDC_i^{t,t+1} * 0.43 \quad 7.58$$

$$NRRUDC_i^{t,t+1} = GENRRC_i^{t,t+1} + WFNRRC_i^{t,t+1} + SDNRRC_i^{t,t+1} + SSNRRC_i^{t,t+1} \quad 7.59$$

Equation 7.59 computes total Non-Residentially-Related Utility Development Costs by adding the four components computed by equations 7.55 through 7.58.

$$UTFDC_i^{t,t+1} = RRUDC + NRRUDC \quad 7.60$$

Total distribution and collector network development costs (UTFDC) equals the sum of the residentially related and the non-residentially related development costs.

Next, the model computes utility system-wide costs which include pumping stations, treatment plants, storage facilities, water wells, and long distance transmission power lines. This computation is accomplished by adding a sizable increment to UTFDC.

$$GESWDC_i^{t,t+1} = UTFDC_i^{t,t+1} * 0.33 \quad 7.61$$

Gas and Electric System-Wide Development Costs equals Utility Facility Development Costs times 0.33

$$WFSWDC_i^{t,t+1} = UTFDC_i^{t,t+1} * 0.09 \quad 7.62$$

$$SSSWDC_i^{t,t+1} = UTFDC_i^{t,t+1} * 0.44 \quad 7.63$$

Equations 7.62 and 7.63 compute system-wide costs for water facilities and sanitary sewerage.

$$USWDC_i^{t,t+1} = GESWDC_i^{t,t+1} + WFSWDC^{t,t+1} + SSSWDC_i^{t,t+1} \qquad 7.64$$

Equation 7.64 computes total Utility System-Wide Development Costs by summing the three components. (Storm drainage has no system-wide costs.)

$$UTCC_i^{t,t+1} = UTFDC_i^{t,t+1} + USWDC_i^{t,t+1} \qquad 7.65$$

Total Utility Capital Costs (UTCC) equals distribution and collector network costs plus system-wide costs.

5. <u>Compute Service Facility Costs</u>

Service Facility Costs includes five categories: library, health care, government administration, fire, and police. Since these costs are much less sensitive to community development patterns (high density versus urban sprawl), they are computed in a much simpler, aggregated manner.

$$COMPG_i^{t,t+1} = COMTP_i^{t+1} - COMTP_i^{t} \qquad 7.66$$

Equation 7.66 computes community population growth (COMPG) for Community i between time t+1 and time t by subtracting community total population (COMTP) at time t (which was earlier set equal to Community Resident Population plus Community Construction Worker Population) from COMTP at time t+1.

$$LIBCC_i^{t,t+1} = COMPG_i^{t,t+1} * PCLBCC \qquad 7.67$$

Library capital costs (LIBCC) equals COMPG times per capita library capital costs (PCLBCC), which is measured in dollars per person.

$$HCCC_i^{t,t+1} = COMPG_i^{t,t+1} * PCHCCC \qquad 7.68$$

$$GVADCC_i^{t,t+1} = COMPG_i^{t,t+1} * PCGACC \qquad 7.69$$

$$FIRECC_i^{t,t+1} = COMPG_i^{t,t+1} * PCFCC \qquad 7.70$$

$$POLCC_i^{t,t+1} = COMPG_i^{t,t+1} * PCPCC \qquad 7.71$$

Equations 7.68 through 7.71 perform the same computation for health care, government administration, fire, and police.

$$SVFDC_i^{t,t+1} = POLCC_i^{t,t+1} + FIRECC_i^{t,t+1} + GVADCC_i^{t,t+1} + HCCC_i^{t,t+1} + LIBCC_i^{t,t+1} \qquad 7.72$$

Total Service Facility Development Costs equals the sum of the five components.

$$PFLC_i^{t,t+1} = SVFDC_i^{t,t+1} * 0.08 \qquad 7.73$$

Police/Fire Land Costs equals SVFDC times 0.08.

$$OPFLC_i^{t,t+1} = SVFDC_i^{t,t+1} * 0.06 \qquad 7.74$$

Other Public Facility Land Costs equals SVFDC times 0.06. (Fire stations and police stations have to be strategically located, and thus their land costs are higher.)

$$SFLC_i^{t,t+1} = PFLC_i^{t,t+1} + OPFLC_i^{t,t+1} \qquad 7.75$$

Service Facility Land Costs equals PFLC plus OPFLC.

$$SERFCC_i^{t,t+1} = SVFDC_i^{t,t+1} + SFLC \qquad 7.76$$

Total Service Facility Capital Costs equals development costs plus land costs.

6. <u>Compute Solid Waste Collection and Disposal Capital Costs</u>

Solid wastes are assumed to be collected by garbage trucks and disposed of in sanitary land fills.

$$SWCDC_i^{t,t+1} = COMPG_i^{t,t+1} * UCSWC \qquad 7.77$$

Solid Waste Collection Development Costs equals incremental community population growth (COMPG) times Unit Costs Solid Waste Collection (measured in dollars per person).

$$SWLFC_i^{t,t+1} = SWCDC_i^{t,t+1} * 0.08 \qquad 7.78$$

Solid Wastes Land Fill Costs is computed to be 8 percent of development costs.

$$SWCC_i^{t,t+1} = SWCDC_i^{t,t+1} + SWLFC \qquad 7.79$$

Total Solid Wastes Capital Costs (SWCC) equals development costs plus landfill costs.

7. Compute Parks, Recreation, and Open Space Capital Costs

$$OSLR_i^{t,t+1} = COMPG_i^{t,t+1} * OSAPP \qquad 7.80$$

Equation 7.80 computes Open Space Land Requirements by multiplying incremental population growth (COMPG) by Open Space Acres Per Person.

$$NPLR_i^{t,t+1} = COMPG_i^{t,t+1} * NPAPP \qquad 7.81$$

$$PLAYLR_i^{t,t+1} = COMPG_i^{t,t+1} * PAPP \qquad 7.82$$

Equations 7.81 and 7.82 perform the same computation for Neighborhood Parks and Playgrounds.

$$POSLR_i^{t,t+1} = OSLR_i^{t,t+1} + NPLR_i^{t,t+1} + PLAYLR_i^{t,t+1} \qquad 7.83$$

Equation 7.83 computes total parks and open space land requirements (POSLR) by summing the three components.

$$OSDC_i^{t,t+1} = OSLR_i^{t,t+1} * UCOSD \qquad 7.84$$

Open Space Development Costs equals Open Space Land Requirements times Unit Costs Open Space Development (measured in dollars per acre).

$$NPDC_i^{t,t+1} = NPLR_i^{t,t+1} * UCNPD \qquad 7.85$$

$$PLAYDC_i^{t,t+1} = PLAYLR_i^{t,t+1} * UCPLD \qquad 7.86$$

Equations 7.85 and 7.86 perform the same computation for neighborhood parks and playgrounds.

$$POSDC_i^{t,t+1} = OSDC_i^{t,t+1} + NPDC_i^{t,t+1} + PLAYDC_i^{t,t+1} \qquad 7.87$$

Total parks and open space development costs (POSDC) equals the sum of the three components.

$$POSLC_i^{t,t+1} = POSLR_i^{t,t+1} * UCPOSL \qquad 7.88$$

Parks and Open Space Land Costs equals Parks and Open Space Land Requirements (acres) times Unit Costs Parks and Open Space Land (dollars per acre).

$$PROSCC_i^{t,t+1} = POSLC_i^{t,t+1} + POSDC_i^{t,t+1} \qquad 7.89$$

Equation 7.89 computes total parks, recreation, and open space capital costs (PROSCC) by adding land costs and development costs.

8. Compute Schools Operating and Maintenance Costs

School Operating and Maintenance Costs comprises general services costs and busing costs.

$$BUSPUP_i^{t+1} = (ELSTS_i^{t+1} * PESB) + (HSSTS_i^{t+1} * PHSB) \qquad 7.90$$

Equation 7.90 computes the number of students bused (BUSPUP) by (1) multiplying the number of elementary students (ELSTS) times the proportion of elementary students bused (PSEB), (2) multiplying the number of high school students (HSSTS) times the proportion of high school students bused (PHSB), and (3) summing the two products.

$$BSOMC_i^{t+1} = BUSPUP_i^{t+1} * PPBC \qquad 7.91$$

Busing Operating/Maintenance Costs (BUSOMC) equals the number of pupils bused (BUSPUP) times the per pupil busing costs (PPBC).

$$GSOMC_i^{t+1} = TSE_i^{t+1} * PPSC \qquad 7.92$$

Educational general service operating/maintenance costs (GSOMC) equals the total students enrolled (TSE) times the per pupil service costs (PPSC).

$$SOMC_i^{t+1} = GSOMC_i^{t+1} + BUSOMC_i^{t+1} \qquad 7.93$$

Equation 7.93 computes total school operating/maintenance costs (SOMC) by adding service and busing costs.

9. Compute Streets Operating and Maintenance Costs

$$MSOMC_i^{t+1} = MSL_i^{t+1} * UMMS \qquad 7.94$$

Equation 7.94 computes operating/maintenance costs for minor streets (MSOMC) by multiplying the total length of minor streets (MSL) by the unit maintenance costs for minor streets (UMMS), measured in dollars per linear foot.

$$COMC_i^{t+1} = CSL_i^{t+1} * UMCS \qquad 7.95$$

$$AOMC_i^{t+1} = ARSL_i^{t+1} * UMAS \qquad 7.96$$

Equations 7.95 and 7.96 perform the same computation for collectors and arterials.

$$STOMC_i^{t+1} = MSOMC_i^{t+1} + COMC_i^{t+1} + AOMC_i^{t+1} \qquad 7.97$$

Equation 7.97 computes total street operating/maintenance costs (STOMC) by summing the three categories.

10. <u>Compute Public Services Operating and Maintenance Costs</u>

Public services include recreation, library, health care, general administration, fire, and police.

$$ROMC_i^{t+1} = COMTP_i^{t+1} * PCROMC \qquad 7.98$$

Equation 7.98 computes recreation operating/maintenance costs (ROMC) by multiplying total community population (COMTP) times recreation operating/maintenance costs per capita (PCROMC).

$$LOMC_i^{t+1} = COMTP_i^{t+1} * PCLOMC \qquad 7.99$$

$$HCOMC_i^{t+1} = COMTP_i^{t+1} * PCHOMC \qquad 7.100$$

$$GAOMC_i^{t+1} = COMTP_i^{t+1} * PCGOMC \qquad 7.101$$

$$FOMC_i^{t+1} = COMTP_i^{t+1} * PCFOMC \qquad 7.102$$

$$POMC_i^{t+1} = COMTP_i^{t+1} * PCPOMC \qquad 7.103$$

Equations 7.99 through 7.103 perform the same computation for library, health care, general administration, fire, and police.

$$PSOMC_i^{t+1} = ROMC_i^{t+1} + LOMC_i^{t+1} = HCOMC_i^{t+1} + GAOMC_i^{t+1} + FOMC_i^{t+1} + POMC_i^{t+1} \qquad 7.104$$

Total public services operating/maintenance costs (PSOMC) equals the sum of the six categories.

11. <u>Compute Utilities Operating and Maintenance Costs</u>.

Utilities comprise solid waste, gas and electric, water supply, and sanitary sewerage.

$$SWOMC_i^{t+1} = COMTP_i^{t+1} * UOMCSW \qquad 7.105$$

Solid Waste Operating/Maintenance Costs equals total community population (COMTP) times unit costs (UOMCSW), measured in dollars per person.

$$GEOMC_i^{t+1} = COMTP_i^{t+1} * UOMCGE \qquad 7.106$$

$$WSOMC_i^{t+1} = COMTP_i^{t+1} * UOMCWS \qquad 7.107$$

$$SSOMC_i^{t+1} = COMTP_i^{t+1} * UOMCSS \qquad 7.108$$

$$UTOM_i^{t+1} = SWOMC_i^{t+1} + GEOMC_i^{t+1} + WSOMC_i^{t+1} + SSOMC_i^{t+1} \quad 7.109$$

Equations 7.106 through 7.108 perform the same computation for gas and electric, water supply, and sanitary sewerage. Equation 7.109 determines total utilities operating/maintenance costs by adding the four components.

Chapter 8

TECHNICAL DOCUMENTATION

A. Introduction and Design Philosophy

CLIPS is a set of three FORTRAN programs (PART1, PART2, PART3) which run sequentially on the TAURUS timesharing system of The University of Texas at Austin CDC 6600/6400 computer system. The programs are stored as absolute binaries in a disk resident permanent file set and are executed by invoking the control command macro RCLIPS which resides in the same permanent file set.

Early in the model's development phase, it was decided that an interactively run model was preferable to one which had to be run in the batch mode. The reasons for this choice were: (1) CLIPS could be accessed from off site via a dial-up TAURUS port; and (2) an interactive program could be designed to lead a user step by step through running the model with validity checks at every data input step that would insure both success in running the model and reasonable results. Making an interactive program as complex as CLIPS feasible to run on a computer system as busy as that of The University of Texas at Austin, however, requires great care in program design, especially with regard to minimizing demands for system resources such as central memory and central processor time.

In the TAURUS time-sharing environment, the memory field length required to run a program is a prime determinant of how it is scheduled for processing. Consequently, much effort was put into optimizing CLIPS for memory efficiency.

It was decided that CLIPS could best be run as a series of three small programs rather than as one large one. Similar field length reduction could be achieved by creation of one large program in overlay form, but since the model software is still in an intensive development stage and since major program extensions are envisioned, the three parts of CLIPS are maintained separately. When development work is completed, however, the model will be restructured as a set of random access overlays called by one common driver program.

To further conserve central memory, it was decided that tables of results generated by the model (such as population by cohort by year) would be stored in disk files rather than in central memory. This arrangement was made possible by the existence of an extremely fast binary I/O routine IOP which was developed at the university.

Using IOP, the memory vectors containing the results generated by one iteration of the model are written to disk files without character code conversion. Each type of result (demographic, employment, etc.) is written to a separate file where it can be easily accessed by subsequent computational or output routines. As a consequence, a minimum of fourteen local disk files (including program files) must be available for CLIPS to run. The result files are created by the UT-2D operating system as they are specified by the PROGRAM cards beginning each segment of CLIPS. File positioning is performed both by IOP under program control and by the macro RCLIPS. All disk I/O buffers are set to 1001B words, an arrangement which allows the transfer of eight sectors of information to or from disk at a time.

The net result of these two memory conservation measures is that CLIPS runs in a very small field length, and consequently it can be run interactively even during the peak usage hours of the UT computer system. PART1 runs in 17000B words, PART2 runs in 22000B words, and PART3 runs in 22400B words. (The suffix B means that the preceding number is an octal number.)

The executable code of CLIPS was carefully written to insure the generation of efficient object code for CDC 6000 series and later computers. All global variables in the model are stored in labeled common, and virtually all of them are initialized by data statements rather than by assignment statements or by read statements. The code is highly structured, and whenever possible has been written as a sequence of very short DO loops. The machine instructions generated from one of these loops will fit entirely in the high-speed access instruction stack of a CDC machine; the result is that each repetitive phase of computation is executed very quickly because the machine is not forced to wait for instructions to be fetched from memory (after the stack is initially filled).

After the development phase of the model has been completed, all heavily used computational subroutines in CLIPS will be recoded in COMPASS (CDC assembly language) and will be hand-optimized to minimize operand fetches and functional unit conflicts. This will be the final stage in insuring optimal run-time efficiency on a CDC computer. The last step will insure that in addition to being a useful tool, CLIPS will also be an inexpensive one to use.

Currently PART1 runs for 0.738 TM seconds, PART2 runs for 1.851 TM seconds, and PART3 runs for 2.799 TM seconds. (TM time is time a job spends using system hardware resources, specifically, the central processor, disks, and magnetic tape equipment.) As of January 1, 1979, the maximum cost of a twenty-year simulation run is $1.25.

B. Future Software Development

The next major phase of software development will be geared toward making CLIPS a more flexible tool for the sophisticated user. Toward this end, three major extensions of the basic model are planned:

1. The addition of a preprocessor to give a user the option of changing the initial values of any variables in the model before it is run. The preprocessor will also allow the user to vary the nature of the region's basic industrial mix over time by storing nonzero values in a new employment matrix which feeds into the basic employment subroutine. These capabilities will facilitate the study of alternative futures for a region which may be brought about by different planning strategies and by changing patterns of industrialization.
2. The addition of more flexible output routines to allow the user the option of outputting many of the intermediate variables embedded in the conceptual structure of CLIPS. This change will allow the user to explore the disaggregated components of impacts upon a region or a community. Multivariate plotting routines will also be incorporated to allow visual examination of the interrelationships among groups of variables.
3. Alternative versions of the key predictive subroutines in CLIPS will be written to conform to different theoretical formulations than those embodied in the standard version of CLIPS. The sophisticated user will be given the option of specifying that any or all of these routines will be used for computation rather than the CLIPS routines when the model is

run. This option will give the researcher or planner the ability, in effect, to configure the model to the theoretical framework which he feels is most valid for projecting the future of the region that he is studying.

The bulk of future work on CLIPS, however, will be basic research, not software development. A projective model can be no better than its conceptual underpinnings; therefore, most future work will be directed toward gaining more insight into the workings of a regional socioeconomic system and translating these insights into mathematical equations which more accurately model the complex phenomena of human society.

C. Local Disk File Usage

CLIPS uses the following local disk files:

The model:

1. RCLIPS - The control command macro which reads all needed files from permanent storage and controls execution of the model
2. BIN1 - The absolute binary generated from the FORTRAN program PART1 which does regional demographic and economic projections
3. BIN2 - The absolute binary generated from the FORTRAN program PART2 which allocates regional population to communities and then generates community reports for selected communities
4. BIN3 - The absolute binary generated from the FORTRAN program PART3 which is the hard copy report printer

Results generated by BIN1:

5. TAPE2 - Regional population projections by cohort by year
6. TAPE3 - Regional employment projections by industry group (or business type) by year
7. TAPE4 - Length of simulation run followed by construction project manpower requirements by year

Results generated by BIN2:

8. TAPE5 - Table of projected community populations by year
9. TAPE6 to TAPE(n) - Each of these files contains a report of capital and operating and maintenance costs for one community by year

D. Model Initialization

To initialize the regional model, the following information must be placed in the appropriate data statements within PART1:

1. FIVEYR - The base year regional population by five-year age groups for both the resident population and the construction worker population (which is initialized to zeros)
2. COHORTS - The regional population by seven aggregated age groups
3. NUR - The national unemployment rate
4. BE - The base year basic employment by industry type
5. TJOBS - The base year total number of jobs
6. RNFAM - The number of families living in the region during the base year
7. BBR - Age-specific birth rates
8. DR - Age-specific death rates
9. CWFM - The fraction of construction workers bringing their families
10. CHPF - The number of children per construction worker family
11. CHMULT - The fraction of children in each age group per construction worker child
12. ADMULT - The fraction of adults in each cohort per construction worker family
13. NEWEMP - A matrix of new basic employment by industry group by year which allows new industrial employment in the region during the simulation period
14. GR7080 - The growth rates of the basic industry groups from 1970-1980

15. GR8090 - The basic industry growth rates from 1981-1990

16. AGEMP - Agricultural employment for 1970, 1980, and 1990

17. MINEMP - Mining and mineral extraction employment for 1970, 1980, and 1990

18. A,B - The intercept and slope vectors for the regression-derived equations for household-serving industry employment in HSEMP

19. A,B - The intercept and slope for the regression-derived equation for construction employment in CONEMP

20. PCTPS - The percentage of students attending public schools

21. PSC - The percentage of college students attending state colleges

22. NGR - The national growth rate for higher education

23. BO,B1 - The intercept and slope for the regression-derived equation for public school employment in SCHEMP

24. B2,B3,B4 - The intercept and slopes for the state college employment equation in SCHEMP

25. SPRN - Age specific participation rates for nursery school

26. SPRK - Participation rates for kindergarten

27. SPRE - Participation rates for elementary school

28. SPRN - Participation rates for high school

29. SPRC - Participation rates for college

30. A,B - The intercept and slope vectors for the regression-derived equations for business-serving employment in BSEMP

31. UTET - Vector of utility employment by total employment

32. LFPR - Age-specific labor force participation rates

33. CWLFPR - Age-specific labor force participation rates for construction worker dependents

34. JPW - Number of jobs per worker

35. A,B - The intercept and slope for the regression-derived equation for migration in MIGRATE

36. OMR - Age-specific outmigration rates

37. IMFR - Age-specific inmigration rate factors

In addition to these, a few constant multipliers embedded in the code may have to be changed depending upon the nature of the region being simulated.

E. Components of the Model

E1. RCLIPS: Control Command Macro

RCLIPS is a control command macro which was defined using the DEFCCM processor on the UT 6600/6400 computer system (figure 4). It is read from a permanent file set and is executed by typing RCLIPS in response to a CC: on the terminal. The macro does the following things:

1. It looks for the keyword AGAIN after its name to determine if the model has been previously run during the current terminal session. If so, step 2 is skipped.
2. The binary absolute program files BIN1, BIN2, and BIN3 are read from the appropriate permanent file set.
3. BIN1 is executed.
4. BIN2 is executed.
5. BIN3 is executed
6. If an OUTPUT file has been created by BIN3, it is printed.
7. All data files are returned.
8. BIN1, BIN2, and BIN3 are rewound.

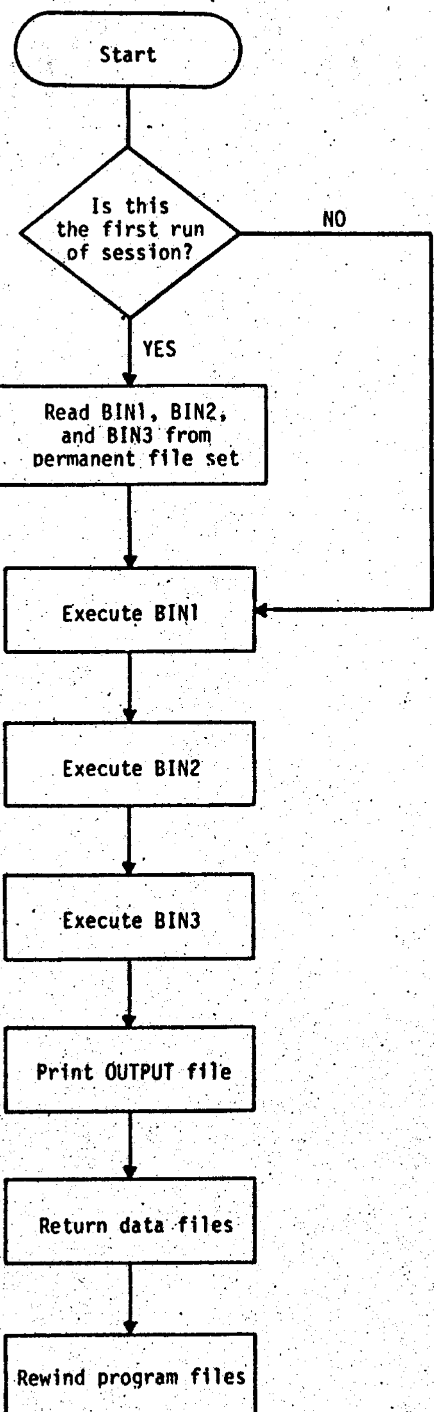
E2. PART1: Regional Economic and Demographic Model

PART1 is a regional economic and demographic projection system (figure 5). Global variable initialization is performed and then the main processing loop (of subroutine calls) is entered. After processing is completed, routines are called to display summary information tables on the user's terminal. The following subroutines are called by PART1:

1. INITRUN prints the initial message on the user's terminal and then allows the user to set the length of the simulation.

Figure 4

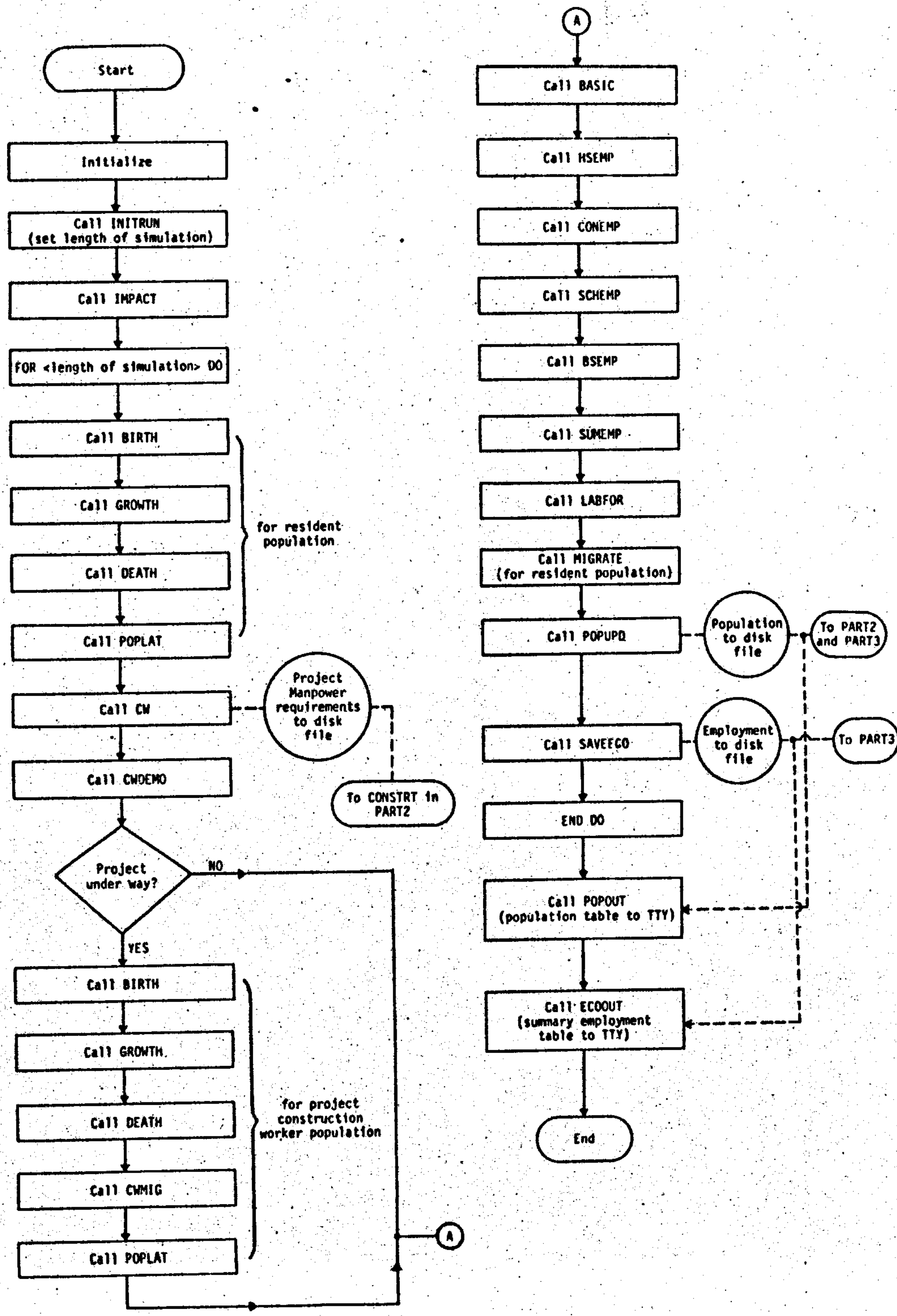
RCLIPS: CONTROL COMMAND MACRO TO RUN SIMULATION PROGRAMS



Note: BIN1, BIN2, and BIN3 are the absolute binary equivalents of the FORTRAN programs PART1, PART2, and PART3.

Figure 5

PROGRAM PART1: REGIONAL DEMOGRAPHIC AND ECONOMIC PROJECTIONS



2. IMPACT allows the user to define a large construction project planned for the region by inputting its starting date, length, and manpower requirements. In addition, a constant permanent operating staff for the constructed facility may be input.

3. BIRTH applies age-specific birth rates to the population cohorts to determine the number of live births for a given year. It is used separately for both the resident and construction worker populations.

4. GROWTH computes the number of people in a cohort aging into the next older cohort. It also is used for both the resident and construction worker populations.

5. DEATH uses age-specific death rates to compute the number of deaths in each cohort. It is used separately for both the resident and construction worker populations.

6. POPLAT performs an intermediate revision of the resident population based on births, growth, and deaths. When invoked for the construction worker population, migration is also included.

7. CW determines the number of new construction workers required if the defined project is under way. It writes this number to TAPE4.

8. CWDEMO sets a flag and then calls the demographic routines to update the construction population if the project is under way and there are nonlocal construction workers on site. Before calling POPLAT, CWDEMO calls CWMIG to migrate construction worker families in (or out at the completion of the project).

9. CWMIG computes the number of new construction migrants by age group based on required new workers, worker family size, and ratio multipliers of the number of people in an age group per construction worker family. In the waning years of the project, the number of migrants is negative, resulting in out-migration.

10. BASIC projects employment in basic industry groups using industry-specific growth rates for the periods 1970-1980 and 1981-1990. Agricultural and mining employment are interpolated by GTABL from their projected 1970, 1980, and 1990 values. New employment in an industry group is taken into account by a new employment matrix whose nonzero values in a given year are added to existing employment for the corresponding industry groups. After the defined construction project is completed, its permanent operating employment is considered to be basic and is added to mining employment.

11. HSEMP projects household-serving employment by type as a regression-derived linear function of population.

12. CONEMP projects residential construction employment as a regression-derived linear function of the change in the number of households in the region. If the project is under way, project manpower requirements are also added.

13. SCHEMP projects school employment. First the number of students is computed using age-specific school participation rates, then public school employment is calculated as a linear function of the number of students. Next state college employment (if any) is computed as a function of the number of students and the

national higher education growth rate. School employment is the sum of these two quantities.

14. BSEMP projects business-serving employment by type as a regression-derived linear function of the sum of total basic and total household-serving employment. Utility employment is interpolated using GTABL.

15. SUMEMP computes total employment in the region.

16. LABFOR uses age-specific labor force participation rates to compute the size of the labor force and to determine the local unemployment rate.

17. MIGRATE determines the number of migrants by cohort for the resident population. First net migration is computed as a regression-derived function of the change in employment opportunities in the region. If the migration is in-migration, the in-migrants are assigned to cohorts on the basis of the age structure of the national population projected for that year and each age group's propensity to migrate. If it is out-migration, the out-migrants are assigned to cohorts on the basis of the age structure of the regional population and regional propensities to migrate.

18. POPUPD adds (or subtracts) migrants from the resident population by age group and then computes the sizes of the aggregated population cohorts for display on the user's terminal. Both the five-year cohorts and the aggregated cohorts are then written to TAPE2.

19. SAVEECO writes the local unemployment rate, basic employment, household-serving employment, business-serving employment, school employment, construction employment, and total employment to TAPE3.

20. POPOUT reads the aggregate populations by cohort from TAPE2 and displays them in tabular form by year on the user's terminal.

21. ECOOUT reads the employment information from TAPE3 and writes aggregated basic, aggregated household-serving, aggregated business-serving, school, construction, and total employment by year on the user's terminal.

22. GTABL is a function called by several routines to perform linear interpolation between points in a two-dimension data matrix. It is used when the relationship between two variables cannot be expressed in functional form. (This version of GTABL bears no resemblance to the GTABL function in the GASP simulation language.)

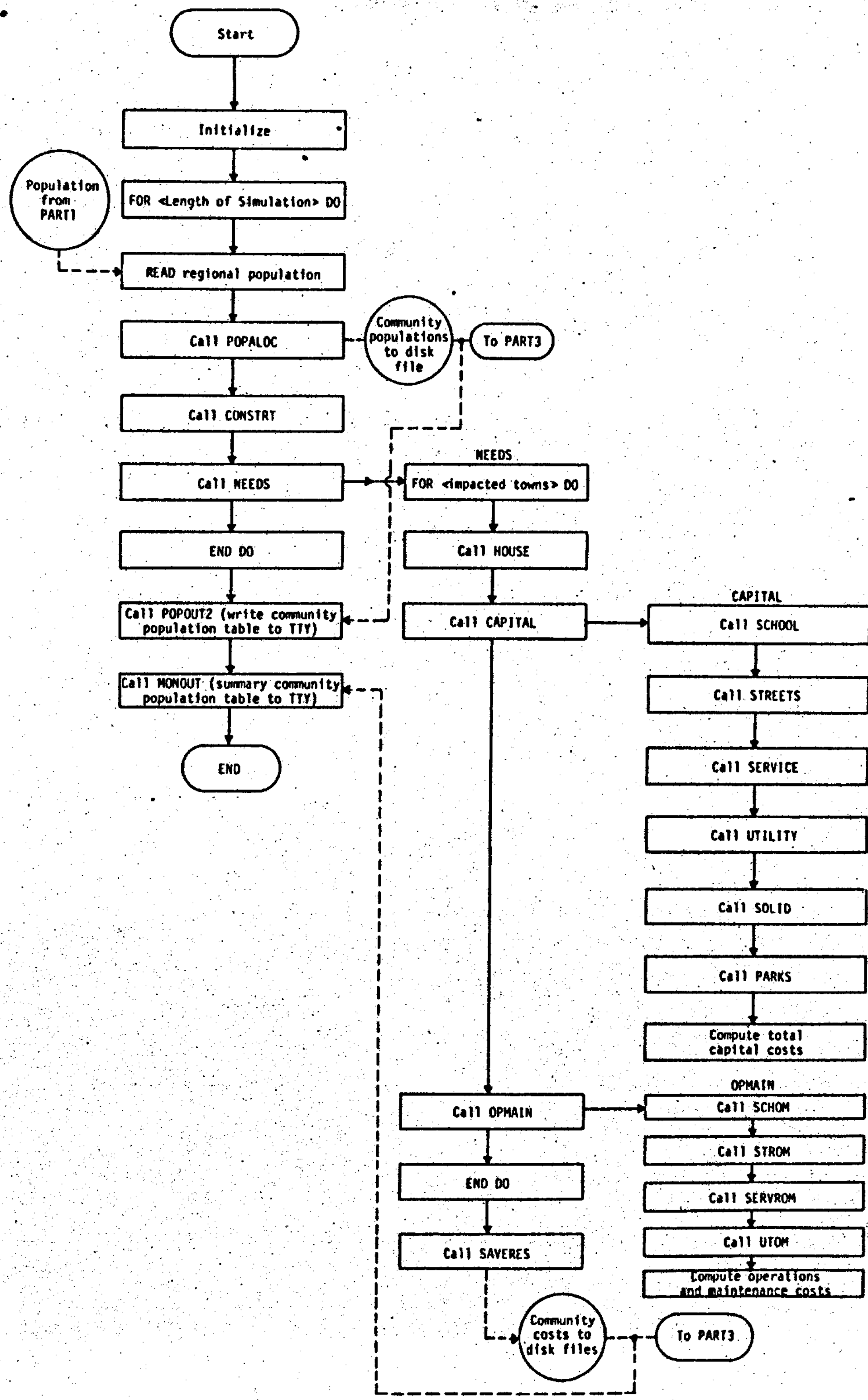
E3. PART2: Community Impact Assessment

PART2 is the community-level impact assessment system (figure 6). Given inputs of regional population by age group by year and incoming construction workers, PART2 distributes the population to communities within the region and then projects impacts on some selected communities based on their changing populations. It uses the following subroutines:

1. POPALOC allocates the resident regional population to communities. If a community has a predefined negative growth rate, its population is set to its growth rate times its previous population. If its growth rate is positive, it is allocated a

Figure 6

PROGRAM PART2: COMMUNITY-LEVEL PROJECTIONS



share of the change in regional population according to its relative size, its growth rate, and a density ceiling on its yearly growth. The density ceilings may be varied year by year to influence the relative growth rates of the growing communities.

2. CONSTRT allocates incoming construction worker families to selected communities within the region, then computes additional school enrollment and housing needs for these communities. Total community populations are updated at this point and are written to TAPE5.

3. NEEDS is the driver subroutine for the housing, municipal services, and municipal operating and maintenance costs sub-models. Yearly, it calls HOUSE, CAPITAL, and OPMAIN for each impacted community within the region. After doing this, NEEDS calls SAVERES to write projected municipal expenditures for each town to disk files TAPE6-TAPE(n).

4. HOUSE determines the number of households in a community, then projects housing requirements for the year. The types of housing demands projected are single family dwellings, mobile homes, and apartments; the projections are based on preference ratios which are different for resident population and construction population.

5. CAPITAL is the driver routine for the municipal capital expenditures section of the model. It calls SCHOOL, SERVICE, UTILITY, SOLID, and PARKS, then it computes a community's total capital costs and debt service capital costs for one year.

6. SCHOOL computes the change in school building space required as a function of the change in school population in a community. If new building space is required, its cost is estimated on a unit-cost basis. Land and facility development costs are also estimated, then total school capital costs are computed.

7. STREETS computes the changes in minor, collector, and arterial street footage required as functions of changes in the types of housing in a community. Land and development costs are computed, then summed to yield total street capital costs.

8. SERVICE computes the municipal capital cost for libraries, health care, administration, fire, and police facilities as functions of the change in community population. These are summed to yield total service capital costs.

9. UTILITY computes water, sewer, gas, and electrical capital costs as functions of the changes in types of housing in a community. These are summed to yield total utility capital costs.

10. SOLID computes solid waste disposal costs as a function of the change in a community population.

11. PARKS computes playground, open space, and neighborhood parks capital costs as a function of the change in community population.

12. OPMAIN is the driver for the municipal operating and maintenance costs section of the model. It calls SCHOM, STROM, SERVROM, and UTOM. It then computes other operating and maintenance

costs as a function of population and finally computes total operating and maintenance costs.

13. SCHOM computes general school operating and maintenance costs and busing costs as a function of the total elementary school and high school enrollments. These are summed to yield total school operating and maintenance costs.

14. STROM computes public streets operating and maintenance costs as a function of the lengths of arterial, collector, and minor streets in a community.

15. SERVROM computes recreation, library, health care, governmental, fire, and police operating and maintenance costs as functions of community population. These are summed to yield total service operating and maintenance costs.

16. UTOM computes solid waste collection, gas and electric, water supply, and sanitary sewerage operating and maintenance costs as functions of community population. These are summed to yield total utility operating and maintenance costs.

17. SAVERES writes computed capital and operating and maintenance costs to a separate disk file for each town being modeled.

18. POPOUT2 reads the aggregate community population projections from TAPE5 and writes them to the user's terminal in tabular form.

19. MONOUT reads the capital and operating and maintenance costs from the appropriate community file and generates a year-by-year municipal expenditures summary on the user's terminal for each community.

20. GTABL is a linear interpolation function and is described in the subroutine summary for PART1.

E4. PART3: Report Printer

PART3 is a hard-copy report generator which creates a line printer file containing the following:

1. Resident, construction worker, and total population by cohort by year for the region.
2. Employment by industry (or business) group, total employment, and the local unemployment rate by year for the region.
3. A breakdown of population by community by year.
4. Capital and operating and maintenance costs reports by year for selected communities within the region.

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Appendix A

SAMPLE CLIPS SESSION ILLUSTRATING
ERROR DIAGNOSTICS

The following sample run illustrates some of the common errors that may occur during a CLIPS session and the corresponding error messages that are produced by the model. Explanatory notes follow the listing of the terminal session.

```
    COMMUNITY LEVEL IMPACT PROJECTION SYSTEM - CLIPS

    ARE YOU FAMILIAR WITH CLIPS(YES OR NO)?
    Y

    THE MODEL IS SET TO RUN FOR 20 YEARS, WHICH
    CURRENTLY IS ITS MAXIMUM CAPABILITY. DO YOU
    WANT THE MODEL TO RUN FOR FEWER YEARS (YES
    OR NO)?
    Y

    ENTER NUMBER OF YEARS AS A LEFT JUSTIFIED INTEGER
    BETWEEN 1 AND 20.

    YEARS:
(1) 10.
    10.
      ^
    // ILLEGAL CHARACTER IN DATA.
    // RETYPE THE INPUT LIST VALUES.
    10

    NOW, IF YOU WISH, YOU MAY DESCRIBE A LARGE
    CONSTRUCTION PROJECT PLANNED FOR YOUR REGION. IF
    YOU DO SO, THE MODEL WILL TAKE THE EFFECTS OF THE
    PROJECT INTO ACCOUNT WHEN PROJECTING THE ECONOMIC
    AND DEMOGRAPHIC TRENDS OF YOUR AREA.
```

```
     DO YOU WISH TO DESCRIBE A PROJECT (YES OR NO)?
     Y

     ENTER THE STARTING YEAR AS A LEFT JUSTIFIED INTEGER
     BETWEEN 1970 AND THE LAST YEAR OF THE SIMULATION
     (1990 IS THE DEFAULT LAST YEAR).

     YEAR:
(2)  1797

     /// ERROR YEAR IS NOT BETWEEN 1970 AND 1990 ///

     ENTER THE STARTING YEAR AS A LEFT JUSTIFIED INTEGER
     BETWEEN 1970 AND THE LAST YEAR OF THE SIMULATION
     (1990 IS THE DEFAULT LAST YEAR).

     YEAR:
     1979

     ENTER THE LENGTH OF THE PROJECT IN YEARS AS A
     LEFT JUSTIFIED INTEGER BETWEEN 1 AND 10.

     LENGTH:
(3)  5.
     5.
      ^
     // ILLEGAL CHARACTER IN DATA.
     // RETYPE THE INPUT LIST VALUES.
(4)  50

     /// ERROR-PROJECT LENGTH IS NOT BETWEEN 1 AND 10 ///

     ENTER THE LENGTH OF THE PROJECT IN YEARS AS A
     LEFT JUSTIFIED INTEGER BETWEEN 1 AND 10.

     LENGTH:
     5

     NOW ENTER THE PROJECT MANPOWER REQUIREMENTS YEAR
     BY YEAR WHEN PROMPTED BY THE PROGRAM.

     YEAR 1:
     170

     YEAR 2:
     700
```

```
YEAR 3:
800

YEAR 4:
800

YEAR 5:
```
(5)
```
400.25

PERMANENT OPERATING STAFF REQUIRED:
300

PROJECT MANPOWER REQUIREMENTS:

YEAR 1:    170.00
YEAR 2:    700.00
YEAR 3:    800.00
YEAR 4:    800.00
YEAR 5:    400.25

OPERATING STAFF:    300.00

ARE THESE CORRECT (YES OR NO)?
n

NOW ENTER THE PROJECT MANPOWER REQUIREMENTS YEAR
BY YEAR WHEN PROMPTED BY THE PROGRAM.

YEAR 1:
170

YEAR 2:
700

YEAR 3:
800

YEAR 4:
800

YEAR 5:
400

PERMANENT OPERATING STAFF REQUIRED:
300
```

```
PROJECT MANPOWER REQUIREMENTS:

YEAR 1:     17Ø.ØØ
YEAR 2:     7ØØ.ØØ
YEAR 3:     8ØØ.ØØ
YEAR 4:     8ØØ.ØØ
YEAR 5:     4ØØ.ØØ

OPERATING STAFF:     3ØØ.ØØ

ARE THESE CORRECT (YES OR NO)?
Y

REGIONAL POPULATION:

    YEAR  CHLD      T.A.      Y.A.       P.A.      M.A.      ØLD       TOTAL

    197Ø  1.54E+Ø4  7.7ØE+Ø3  3.27E+Ø3   1.17E+Ø4  1.76E+Ø4  1.5ØE+Ø4  6.96E+Ø4
(6) 1971  1.54E+Ø4  8.1ØE+ Ø3  4
    1971  1.54E+Ø4  8.1ØE+Ø3  4.19E+Ø3   1.23E+Ø4  1.72E+Ø4  1.5ØE+Ø4  7.21E+Ø4
    1972  1.51E+Ø4  8.11E+Ø3  4.77E+Ø3   1.25E+Ø4  1.67E+Ø4  1.49E+Ø4  7.21E+Ø4
    1973  1.42E+Ø4  7.82E+Ø3  4.99E+Ø3   1.25E+Ø4  1.61E+Ø4  1.47E+Ø4  7.Ø4E+Ø4
    1974  1.39E+Ø4  7.67E+Ø3  5.3ØE+Ø3   1.29E+Ø4  1.56E+Ø4  1.45E+Ø4  6.99E+Ø4
    1975  1.39E+Ø4  7.63E+Ø3  5.63E+Ø3   1.35E+Ø4  1.52E+Ø4  1.43E+Ø4  7.Ø2E+Ø4
    1976  1.38E+Ø4  7.44E+Ø3  5.79E+Ø3   1.39E+Ø4  1.48E+Ø4  1.41E+Ø4  6.99E+Ø4
(7) 1977  1.34E+Ø4  7.12E+Ø3  5.73E +Ø3    ?
    1977  1.34E+Ø4  7.12E+Ø3  5.73E+Ø3   1.42E+Ø4  1.43E+Ø4  1.38E+Ø4  6.86E+Ø
    WAITING FOR INPUT, FL=171ØØ.
    1978  1.29E+Ø4  6.73E+Ø3  5.54E+Ø3   1.44E+Ø4  1.38E+Ø4  1.35E+Ø4  6.69E+Ø
    1979  1.26E+Ø4  6.41E+Ø3  5.39E+Ø3   1.46E+Ø4  1.34E+Ø4  1.32E+Ø4  6.56E+Ø
    198Ø  1.29E+Ø4  6.33E+Ø3  5.48E+Ø3   1.54E+Ø4  1.31E+Ø4  1.29E+Ø4  6.61E+Ø

HIT RETURN KEY TO CONTINUE

EMPLOYMENT BY INDUSTRY TYPE:

    YEAR    BASIC     BUSINESS  HOUSEHOLD SCHOOLS  CON-        TOTAL
                      SERVING   SERVING            STRUCTION

(8) 1971    4788.     s
    a
     USER ABORT.

    CC:
    lo
    ACCOUNT-RUN  LN-MIN  LN-COST  TM-SEC  TM-COST
    EYAV346-3Ø5       9    $Ø.Ø4  1Ø.371    $Ø.66
```

1. The user enters a decimal point after the number 10. Any illegal character in the user's input will produce this error message.
2. The user enters <u>1797</u> instead of <u>1979</u>. The model will not allow a project to be defined which begins before or after the years of the simulation run.
3. The user enters a decimal point after the number 5.
4. The project being defined cannot last longer than 10 years.
5. Because of the way in which the model uses the manpower requirements in its computations, numbers with fractional parts can be input without receiving an error message. Therefore, the user must take responsibility for detecting and correcting errors of this type during the subsequent verification stage of the project definition.
6. Noise in the telephone line connecting the user's terminal to the computer has caused the system to pause while displaying information on the terminal. By striking the RETURN key on the terminal, the user causes output to resume. This method of resuming the output, however, has the potentially undesirable side effect of causing the system not to pause before displaying the next output table on the terminal.
7. Again, line noise causes the terminal display to stop. This time the user handles the problem by typing <u>CONTROL-BELL ?</u> then striking the RETURN key. This action asks the system for current job-status information which is not really desired at this point but does restart the display. This method will allow the output display to pause after the current table is printed.

8. The user decides not to continue this model run. He types CONTROL-BELL s (RETURN) then CONTROL-BELL a (RETURN) to tell the system to stop output to his terminal and then to abort this run of the model. Following these commands, he logs out by typing CONTROL-BELL lo (RETURN). If he had wished to continue this terminal session he would have issued the command KEEP BIN1 BIN2 BIN3 RCLIPS (RETURN) in response to the next "CC:" appearing on his terminal; in response to following "CC:" he then would have typed RCLIPS AGAIN (RETURN) to run the model again from the beginning.

Appendix B

SAMPLE CLIPS DETAIL REPORT FOR A FIVE-YEAR BASELINE RUN

REGIONAL POPULATION 1970 :

AGE GROUP	RESIDENT	CONSTRUCTION	TOTAL
< 1	839.	0.	839.
1-4	3573.	0.	3573.
5-9	5613.	0.	5613.
10-14	6660.	0.	6660.
15-19	6370.	0.	6370.
20-24	3268.	0.	3268.
25-29	2826.	0.	2826.
30-34	2638.	0.	2638.
35-39	2872.	0.	2872.
40-44	3392.	0.	3392.
45-49	3708.	0.	3708.
50-54	4096.	0.	4096.
55-59	4815.	0.	4815.
60-64	4973.	0.	4973.
65-69	4997.	0.	4997.
70-74	4997.	0.	4997.
75+	4997.	0.	4997.
TOTAL	69643.	0.	69643.

REGIONAL POPULATION 1971 :

AGE GROUP	RESIDENT	CONSTRUCTION	TOTAL
< 1	770.	0.	770.
1-4	3701.	0.	3701.
5-9	5606.	0.	5606.
10-14	6662.	0.	6662.
15-19	6766.	0.	6766.
20-24	4189.	0.	4189.
25-29	3114.	0.	3114.
30-34	2827.	0.	2827.
35-39	2932.	0.	2932.
40-44	3394.	0.	3394.
45-49	3762.	0.	3762.
50-54	3986.	0.	3986.
55-59	4607.	0.	4607.
60-64	4840.	0.	4840.
65-69	4839.	0.	4839.
70-74	4767.	0.	4767.
75+	5350.	0.	5350.
TOTAL	72112.	0.	72112.

REGIONAL POPULATION 1972 :

AGE GROUP	RESIDENT	CONSTRUCTION	TOTAL
< 1	837.	0.	837.
1-4	3585.	0.	3585.
5-9	5457.	0.	5457.
10-14	6494.	0.	6494.
15-19	6816.	0.	6816.
20-24	4767.	0.	4767.
25-29	3374.	0.	3374.
30-34	2915.	0.	2915.
35-39	2930.	0.	2930.
40-44	3315.	0.	3315.
45-49	3697.	0.	3697.
50-54	3910.	0.	3910.
55-59	4421.	0.	4421.
60-64	4695.	0.	4695.
65-69	4692.	0.	4692.
70-74	4562.	0.	4562.
75+	5611.	0.	5611.
TOTAL	72077.	0.	72077.

REGIONAL POPULATION 1973 :

AGE GROUP	RESIDENT	CONSTRUCTION	TOTAL
< 1	862.	0.	862.
1-4	3404.	0.	3404.
5-9	5055.	0.	5055.
10-14	6144.	0.	6144.
15-19	6587.	0.	6587.
20-24	4994.	0.	4994.
25-29	3564.	0.	3564.
30-34	2940.	0.	2940.
35-39	2860.	0.	2860.
40-44	3159.	0.	3159.
45-49	3556.	0.	3556.
50-54	3761.	0.	3761.
55-59	4260.	0.	4260.
60-64	4545.	0.	4545.
65-69	4549.	0.	4549.
70-74	4378.	0.	4378.
75+	5797.	0.	5797.
TOTAL	70412.	0.	70412.

REGIONAL POPULATION 1974 :

AGE GROUP	RESIDENT	CONSTRUCTION	TOTAL
< 1	915.	0.	915.
1-4	3408.	0.	3408.
5-9	4885.	0.	4885.
10-14	5917.	0.	5917.
15-19	6484.	0.	6484.
20-24	5298.	0.	5298.
25-29	3841.	0.	3841.
30-34	3058.	0.	3058.
35-39	2867.	0.	2867.
40-44	3085.	0.	3085.
45-49	3455.	0.	3455.
50-54	3688.	0.	3688.
55-59	4103.	0.	4103.
60-64	4395.	0.	4395.
65-69	4409.	0.	4409.
70-74	4210.	0.	4210.
75+	5922.	0.	5922.
TOTAL	69940.	0.	69940.

REGIONAL POPULATION 1975 :

AGE GROUP	RESIDENT	CONSTRUCTION	TOTAL
< 1	973.	0.	973.
1-4	3523.	0.	3523.
5-9	4821.	0.	4821.
10-14	5771.	0.	5771.
15-19	6476.	0.	6476.
20-24	5629.	0.	5629.
25-29	4204.	0.	4204.
30-34	3266.	0.	3266.
35-39	2935.	0.	2935.
40-44	3065.	0.	3065.
45-49	3403.	0.	3403.
50-54	3612.	0.	3612.
55-59	3965.	0.	3965.
60-64	4247.	0.	4247.
65-69	4271.	0.	4271.
70-74	4056.	0.	4056.
75+	5998.	0.	5998.
TOTAL	70216.	0.	70216.

REGIONAL EMPLOYMENT 1971 :

BASIC		HOUSEHOLD SERVING		BUSINESS SERVING	
FOOD	0.	GROCERIES	763.	TRUCKING	59.
FABRICS	0.	CAFES	901.	RADIOTVTP	389.
TEXTILES	353.	HARDWARE	763.	BUSNES SV	96.
APPAREL	206.	GAS STATS	763.	PRINTS	43.
SAWMILLS	264.	OTHER RET	1595.	LUMBER	92.
FURNITURE	180.	BANKS	347.	OTHER DUR	78.
PAPER	16.	REAL ESTE	971.	RAILROADS	434.
PRINTING	75.	HOUSEWORK	624.	OTHER TNP	131.
SOAPS	17.	OTHER PS	1040.	UTILITIES	123.
BRICKS	76.	ENTERTAIN	194.	TOTAL	1445.
STONECLAY	179.	HEALTH	555.		
STEEL BSC	0.	OTHER ED	139.		
METAL NF	38.	WELFARE	624.		
STEEL FAB	38.	LAWYERS	624.		
METAL FAB	78.	PUBLIC AD	1297.		
MACHINES	4.	HOSPITALS	897.		
COMPUTERS	0.	TOTAL	12096.		
MOTOR VHS	16.				
TRANS EQP	37.				
MISC MFG	0.				
FARMING	2910.				
MINING	301.				
TOTAL	4788.				

CONSTRUCTION 567.

SCHOOLS 2134.

TOTAL JOBS : 21030.

LOCAL UNEMPLOYMENT RATE : .031

REGIONAL EMPLOYMENT 1972 :

BASIC		HOUSEHOLD SERVING		BUSINESS SERVING	
FOOD	0.	GROCERIES	779.	TRUCKING	59.
FABRICS	0.	CAFES	920.	RADIOTVTP	397.
TEXTILES	356.	HARDWARE	779.	BUSNES SV	96.
APPAREL	285.	GAS STATS	779.	PRINTS	44.
SAWMILLS	262.	OTHER RET	1628.	LUMBER	92.
FURNITURE	185.	BANKS	354.	OTHER DUR	78.
PAPER	17.	REAL ESTE	991.	RAILROADS	434.
PRINTING	77.	HOUSEWORK	637.	OTHER TNP	131.
SOAPS	17.	OTHER PS	1062.	UTILITIES	123.
BRICKS	78.	ENTERTAIN	198.	TOTAL	1455.
STONECLAY	182.	HEALTH	566.		
STEEL BSC	0.	OTHER ED	142.		
METAL NF	38.	WELFARE	637.		
STEEL FAB	39.	LAWYERS	637.		
METAL FAB	81.	PUBLIC AD	1324.		
MACHINES	4.	HOSPITALS	905.		
COMPUTERS	0.	TOTAL	12338.		
MOTOR VHS	17.				
TRANS EQP	37.				
MISC MFG	37.				
FARMING	2854.				
MINING	303.				
TOTAL	4869.				

CONSTRUCTION 543.

SCHOOLS 2200.

TOTAL JOBS : 21406.

LOCAL UNEMPLOYMENT RATE : .039

REGIONAL EMPLOYMENT 1973 :

BASIC		HOUSEHOLD SERVING		BUSINESS SERVING	
FOOD	0.	GROCERIES	778.	TRUCKING	59.
FABRICS	0.	CAFES	920.	RADIOTVTP	396.
TEXTILES	358.	HARDWARE	778.	BUSNES SV	96.
APPAREL	290.	GAS STATS	778.	PRINTS	44.
SAWMILLS	260.	OTHER RET	1627.	LUMBER	92.
FURNITURE	190.	BANKS	354.	OTHER DUR	78.
PAPER	17.	REAL ESTE	990.	RAILROADS	434.
PRINTING	78.	HOUSEWORK	637.	OTHER TNP	131.
SOAPS	18.	OTHER PS	1061.	UTILITIES	123.
BRICKS	79.	ENTERTAIN	198.	TOTAL	1454.
STONECLAY	186.	HEALTH	566.		
STEEL BSC	0.	OTHER ED	141.		
METAL NF	39.	WELFARE	637.		
STEEL FAB	41.	LAWYERS	637.		
METAL FAB	85.	PUBLIC AD	1323.		
MACHINES	4.	HOSPITALS	905.		
COMPUTERS	0.	TOTAL	12330.		
MOTOR VHS	17.				
TRANS EQP	37.				
MISC MFG	37.				
FARMING	2798.				
MINING	304.				
TOTAL	4840.				

CONSTRUCTION 276.

SCHOOLS 2191.

TOTAL JOBS : 21090.

LOCAL UNEMPLOYMENT RATE : .059

REGIONAL EMPLOYMENT 1979 :

BASIC		HOUSEHOLD SERVING		BUSINESS SERVING	
FOOD	375.	GROCERIES	760.	TRUCKING	60.
FABRICS	375.	CAFES	898.	RADIOTVTP	410.
TEXTILES	361.	HARDWARE	760.	BUSNES SV	97.
APPAREL	332.	GAS STATS	760.	PRINTS	45.
SAWMILLS	259.	OTHER RET	1589.	LUMBER	92.
FURNITURE	195.	BANKS	345.	OTHER DUR	78.
PAPER	17.	REAL ESTE	967.	RAILROADS	434.
PRINTING	80.	HOUSEWORK	622.	OTHER TNP	131.
SOAPS	18.	OTHER PS	1036.	UTILITIES	123.
BRICKS	80.	ENTERTAIN	193.	TOTAL	1470.
STONECLAY	190.	HEALTH	553.		
STEEL BSC	0.	OTHER ED	138.		
METAL NF	40.	WELFARE	622.		
STEEL FAB	42.	LAWYERS	622.		
METAL FAB	88.	PUBLIC AD	1292.		
MACHINES	4.	HOSPITALS	896.		
COMPUTERS	37.	TOTAL	12051.		
MOTOR VHS	18.				
TRANS EQP	37.				
MISC MFG	37.				
FARMING	2742.				
MINING	306.				
TOTAL	5636.				

CONSTRUCTION 0.

SCHOOLS 2099.

TOTAL JOBS : 21256.

LOCAL UNEMPLOYMENT RATE : .039

REGIONAL EMPLOYMENT 1975 :

BASIC		HOUSEHOLD SERVING		BUSINESS SERVING	
FOOD	375.	GROCERIES	755.	TRUCKING	60.
FABRICS	377.	CAFES	892.	RADIOTVTP	417.
TEXTILES	364.	HARDWARE	755.	BUSNES SV	98.
APPAREL	338.	GAS STATS	755.	PRINTS	46.
SAWMILLS	257.	OTHER RET	1578.	LUMBER	92.
FURNITURE	201.	BANKS	343.	OTHER DUR	78.
PAPER	18.	REAL ESTE	960.	RAILROADS	434.
PRINTING	82.	HOUSEWORK	617.	OTHER TNP	131.
SOAPS	19.	OTHER PS	1029.	UTILITIES	123.
BRICKS	82.	ENTERTAIN	192.	TOTAL	1479.
STONECLAY	194.	HEALTH	549.		
STEEL BSC	375.	OTHER ED	137.		
METAL NF	41.	WELFARE	617.		
STEEL FAB	43.	LAWYERS	617.		
METAL FAB	92.	PUBLIC AD	1283.		
MACHINES	4.	HOSPITALS	893.		
COMPUTERS	41.	TOTAL	11973.		
MOTOR VHS	18.				
TRANS EQP	37.				
MISC MFG	37.				
FARMING	2686.				
MINING	308.				
TOTAL	5990.				

CONSTRUCTION 199.

SCHOOLS 2072.

TOTAL JOBS : 21712.

LOCAL UNEMPLOYMENT RATE : .020

POPULATION BY COMMUNITIES:

YEAR	CALVERT	FRANKLIN	GROESBECK	HEARNE	MARLIN
1970	2,07E+03	1,06E+03	2,40E+03	4,98E+03	6,35E+03
1971	2,00E+03	1,15E+03	2,53E+03	5,10E+03	6,27E+03
1972	1,93E+03	1,15E+03	2,53E+03	5,10E+03	6,20E+03
1973	1,86E+03	1,09E+03	2,44E+03	5,02E+03	6,13E+03
1974	1,80E+03	1,07E+03	2,41E+03	5,00E+03	6,05E+03
1975	1,73E+03	1,08E+03	2,43E+03	5,01E+03	5,98E+03

CALVERT CAPITAL COSTS

YEAR	SCHOOLS	STREETS	SERVICE	UTILITY	WASTE	PARKS	TOTAL
1971	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
1972	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
1973	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
1974	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
1975	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

CALVERT OPERATING AND MAINTENANCE COSTS

YEAR	SCHOOLS	STREETS	SERVICE	UTILITY	OTHER	TOTAL
1971	4,48E+05	2,79E+04	1,57E+05	3,11E+05	1,52E+05	9,44E+05
1972	4,25E+05	2,79E+04	1,51E+05	3,00E+05	1,47E+05	9,05E+05
1973	3,97E+05	2,79E+04	1,46E+05	2,90E+05	1,42E+05	8,60E+05
1974	3,74E+05	2,79E+04	1,41E+05	2,79E+05	1,37E+05	8,22E+05
1975	3,54E+05	2,79E+04	1,36E+05	2,70E+05	1,32E+05	7,88E+05

FRANKLIN CAPITAL COSTS

YEAR	SCHOOLS	STREETS	SERVICE	UTILITY	WASTE	PARKS	TOTAL
1971	0.00E+00	0.00E+00	3.53E+04	0.00E+00	0.00E+00	1.13E+04	4.74E+04
1972	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1973	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1974	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1975	0.00E+00	1.06E+04	3.96E+03	6.51E+04	0.00E+00	1.27E+03	8.10E+04

FRANKLIN OPERATING AND MAINTENANCE COSTS

YEAR	SCHOOLS	STREETS	SERVICE	UTILITY	OTHER	TOTAL
1971	2.57E+05	1.45E+04	8.99E+04	1.78E+05	8.72E+04	5.40E+05
1972	2.53E+05	1.45E+04	8.98E+04	1.78E+05	8.71E+04	5.35E+05
1973	2.32E+05	1.45E+04	8.54E+04	1.69E+05	8.28E+04	5.01E+05
1974	2.23E+05	1.45E+04	8.41E+04	1.67E+05	8.16E+04	4.89E+05
1975	2.21E+05	1.46E+04	8.49E+04	1.68E+05	8.23E+04	4.89E+05

GROESBECK CAPITAL COSTS

YEAR	SCHOOLS	STREETS	SERVICE	UTILITY	WASTE	PARKS	TOTAL
1971	0.00E+00	0.00E+00	5.62E+04	0.00E+00	1.19E+03	1.81E+04	7.54E+04
1972	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1973	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1974	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1975	0.00E+00	1.69E+04	6.28E+03	1.03E+05	0.00E+00	2.02E+03	1.29E+05

GROESBECK OPERATING AND MAINTENANCE COSTS

YEAR	SCHOOLS	STREETS	SERVICE	UTILITY	OTHER	TOTAL
1971	5.67E+05	3.26E+04	1.98E+05	3.93E+05	1.92E+05	1.19E+06
1972	5.57E+05	3.26E+04	1.98E+05	3.93E+05	1.92E+05	1.18E+06
1973	5.20E+05	3.26E+04	1.91E+05	3.79E+05	1.85E+05	1.12E+06
1974	5.02E+05	3.26E+04	1.89E+05	3.75E+05	1.83E+05	1.10E+06
1975	4.96E+05	3.29E+04	1.90E+05	3.78E+05	1.85E+05	1.10E+06

HEARNE CAPITAL COSTS

YEAR	SCHOOLS	STREETS	SERVICE	UTILITY	WASTE	PARKS	TOTAL
1971	0,00E+00	0,00E+00	4,87E+04	0,00E+00	1,03E+03	1,56E+04	6,54E+04
1972	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
1973	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
1974	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
1975	0,00E+00	1,46E+04	5,42E+03	8,92E+04	0,00E+00	1,74E+03	1,11E+05

HEARNE OPERATING AND MAINTENANCE COSTS

YEAR	SCHOOLS	STREETS	SERVICE	UTILITY	OTHER	TOTAL
1971	1,14E+06	6,78E+04	4,00E+05	7,93E+05	3,87E+05	2,40E+06
1972	1,12E+06	6,78E+04	4,00E+05	7,92E+05	3,87E+05	2,38E+06
1973	1,07E+06	6,78E+04	3,94E+05	7,81E+05	3,82E+05	2,31E+06
1974	1,04E+06	6,78E+04	3,92E+05	7,78E+05	3,80E+05	2,28E+06
1975	1,02E+06	6,80E+04	3,93E+05	7,80E+05	3,81E+05	2,26E+06

MARLIN CAPITAL COSTS

YEAR	SCHOOLS	STREETS	SERVICE	UTILITY	WASTE	PARKS	TOTAL
1971	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
1972	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
1973	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
1974	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
1975	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

MARLIN OPERATING AND MAINTENANCE COSTS

YEAR	SCHOOLS	STREETS	SERVICE	UTILITY	OTHER	TOTAL
1971	1,41E+06	8,64E+04	4,92E+05	9,76E+05	4,77E+05	2,96E+06
1972	1,37E+06	8,64E+04	4,86E+05	9,64E+05	4,71E+05	2,90E+06
1973	1,31E+06	8,64E+04	4,80E+05	9,52E+05	4,66E+05	2,82E+06
1974	1,26E+06	8,64E+04	4,74E+05	9,41E+05	4,60E+05	2,76E+06
1975	1,22E+06	8,64E+04	4,69E+05	9,30E+05	4,54E+05	2,71E+06