**US Army Corps of Engineers**
Engineer Institute for Water Resources

# Forecasting Municipal and Industrial Water Use

## IWR MAIN System User's Guide for Interactive Processing and User's Manual

**Research Report 83R-3**

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This two volume report presents the necessary information to use the computerized procedure for estimating municipal water requirements.

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# FOREWORD

This two volume report comprises the necessary information to effectively use a computerized procedure for estimating and forecasting municipal water requirements. The procedure, known as the IWR MAIN System, is a flexible and comprehensive planning tool for separately estimating residential, commercial/ institutional, industrial, and public-unaccounted water sectors in a community. Within these sectors, requirements are further estimated for individual categories of water users, such as metered-sewered residencies, flat rate-sewered residences, commercial establishments, institutions, three-digit Standard Industrial Classification manufacturing categories, public usage and free service as well as unaccounted use. Estimates are made of mean annual, maximum day, and peak hour requirements.

Volume I contains the users guide for interactive processing. It is the procedure by which a user creates or modifies data parameter files, modifies the library of water usage coefficients, runs the IWR MAIN Model, and selectively prints reports generated by the model.

Volume II is the users manual. It documents the computer program and presents instructions for data preparation.

# FORECASTING MUNICIPAL AND INDUSTRIAL WATER USE:

# IWR MAIN System User's Guide for

# Interactive Processing

# and

# User's Manual

prepared for

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## INTRODUCTION

The IWR MAIN System is an interactive system which enables a user to accomplish the following tasks:

1. Create or modify a Data Parameter File
2. Modify the Library of Water Usage Coefficients
3. Run the IWR MAIN Model with your Data Parameter File and Library of Water Usage Coefficients
4. Selectively print reports generated by the Model

There are three procedures to use, each of which perform separate functions:

IWREDIT - create or modify a Data Parameter File
IWRRUN - modify the Library of Water Usage Coefficients and run the IWR MAIN Model
IWRPRNT - selectively print reports generated by the Model

The remainder of this chapter describes the procedures, how to use the procedures, and what a user may expect to encounter while executing the procedures.

## IWREDIT

The IWREDIT procedure is designed to prompt a user through the creation of an IWR MAIN Data Parameter File within the guidelines of the IWR MAIN.

Additionally, a completed Data Parameter File may be modified.

Because a Data Parameter File may be very long, the MANDATA program has a feature which allows a user to stop ("quit") during a creation session and resume creation at the point where he had previously stopped.

Thus, the IWREDIT procedure may be used four ways:

1. Create (initial session to create a Data Parameter File)
2. Resume creating
3. Add projection data to a "current use only" Data Parameter File
4. Update

When a completed Data Parameter File exists, the user has an opportunity to route it to a high speed terminal (RJE) for printing.

The Data Parameter File may consist of three types of data--Muncipal, Local Historical, and Projection--depending upon whether it is to be used for estimating current water requirements only or forecasting water usage requirements.

The Municipal Data is the basic data for the file and includes portions of or all of the following subgroups:

CITYDATA

| | | |
|---|---|---|
| METRSEWR<br>METRSEPT<br>FLATSEWR<br>FLATSEPT | - | RESIDENTIAL |
| COMMPARM<br>COMMEMPL | - | COMMERCIAL |
| INDPARAM | - | INDUSTRIAL |
| PUBPARAM<br>PUBANAVE<br>PUBMAXDY<br>PUBPEKHR | - | PUBLIC/UNACCOUNTED |

When CITYDATA and one or more of the next 10 subgroups listed are the sole input to the IWR MAIN System, the current water requirements of the urban area are estimated.

Projection of water usage parameters requires the use of Local Historical and Projection data in addition to Municipal Data.

Local Historical includes the following subgroups:

POPULATN
ALLHOMES
MEDHOMES
HIGHOMES
SKOLYEAR
ELEMSKOL
HIGHSKOL
TSERVICE
MEDICALS
INDHISTY

Projection data includes the following subgroups:

| | | |
|---|---|---|
| NEWYEAR | | |
| HNUMHOMS | | |
| HCOMPARM | - | Used for projection by extrapolation |
| HINDPARM | | |
| HPUBPARM | | |
| NUMHOMES | | |
| CONFPARM | | |
| COMFEMPL | | |
| INDPROJT | - | Used for projections made external to the IWR MAIN System |
| PUBPARAM | | |
| PUBANAVE | | |
| PUBMAXDY | | |
| PUBPEKHR | | |

## CREATING A DATA PARAMETER FILE

IWR MAIN Data Parameter Program Phases:

### Phase 1 - Planning the Terminal Session

The user will encounter several questions which will determine how the terminal session will proceed and for which data subgroups the user will be prompted.

- First, the user will indicate what kind of a session it will be--initial session to create a new Data Parameter File, resume creating a Data Parameter File, update an old Data Parameter File, or add projection data to a "current use only" Data Parameter File.

- The user must select the "type of run" intended for the Data Parameter File--estimate current water usage, or forecast water requirements.

- The user must specify the kind of data he is prepared to enter:
  - -- residential
  - -- commercial/institutional
  - -- industrial
  - -- public/unaccounted

- The user then chooses the prompt mode: brief mode (only the subgroup and parameter name will print) or expanded mode (the names and an explanation will print). The mode can be changed at almost any time by entering "SW" (for "switch").

- The user can stop processing by responding "QUIT" to any prompt for data.

An example of this part of a session follows where the "I" represents a request for user input by the program:

```
  INDUSTRIAL WATER REQUIREMENTS


  ENTER HELP FOR AN EXPLANATION OF THE IWR MAIN SYSTEM
  ENTER CONT TO CONTINUE PROCESSING
I

  ARE YOU CREATING A NEW FILE, RESUMING CREATING A NEW FILE, ADDING
  PROJECTION DATA TO A CURRENT USE ONLY FILE, OR CHANGING AN OLD FILE

      1 - NEW
      2 - RESUME
      3 - ADD PROJECTION DATA TO CURRENT USE ONLY
      4 - UPDATE

I 1

  SELECT TYPE OF RUN

      1 - ESTIMATE CURRENT WATER USAGE
      2 - FORECAST WATER REQUIREMENTS OR HELP

I

  DO YOU PLAN TO ENTER
      1 - RESIDENTIAL DATA
      2 - COMMERCIAL/INSTITUTIONAL DATA
      3 - INDUSTRIAL DATA
      4 - PUBLIC/UNACCOUNTED DATA

  ENTER NUMERICAL SELECTION SEPARATED BY COMMAS OR HELP

I

  DO YOU WISH TO VERIFY THE DATA SELECTIONS YOU MADE - Y OR N

I

  SELECT DESIRED MODE OF OPERATION
      1 - BRIEF    ONLY THE SUBGROUP AND PARAMETER NAME WILL PRINT
      2 - EXPANDED      THE NAMES AND EXPLANATION WILL PRINT

I

  THE MODE OF OPERATION CAN BE CHANGED AT ANY TIME BY ENTERING SW
  (SWITCH)

  YOU CAN EXIT THE PROGRAM BY REPSONDING TO QUIT TO ANY PROMPT

  BEGIN DATA ENTRY FOR IWR MAIN PARAMETERS
```

## Phase 2 -- Municipal Data - CITYDATA

- The user will be prompted for the following parameters

  Name
  CDAT
  LATD
  LONG
  POPU
  PDEN
  POPP
  EMPL
  EMTC
  ICOM
  TSER
  CCBN or CCBL and CCAL

- Name, CDAT, LATD, LONG and POPU are required.

- PDEN, POPP, EMPL, EMTC, ICOM, and TSER are optional for a current use only data file, required for a forecast data file

- CCBN or CCBL and CCAL are optional for a current use only data file, required for a forecast. If an entry is made for CCBN, no prompts will occur for CCBL and CCAL. If zero is entered for CCBN, the user will be prompted for CCBL and CCAL. Zero may then be entered for CCBL if it is not a forecast data file. Sample of CITYDATA prompts (in expanded mode) follows:

NAME OF STUDY AREA MAX 24 CHAR

I

CDAT CALENDAR YEAR OF BASE YEAR DATA

I

LATD LATITUDE IN DEGREES

I

LONG LONGITUDE IN DEGREES

I

POPU POPULATION IN BASE YEAR

I

PDEN BASE YEAR POPU DENSITY PERSONS/SQ MILE

I

POPP FRACTION OF BASE YEAR POPU IN AGE 20-39

I

EMPL BASE YEAR TOTAL EMPLOYMENT

I

EMTC BASE YEAR EMPLOYMENT S.I.C. 400-499

I

ICOM PER CAPITA INCOME IN 1980 $ (BASE YEAR)

I

TSER BASE YEAR EMPLOYMENT S.I.C. 700-899

I

CCBN NATL CONSTRUCTION COST INDEX BASE YEAR $ ZERO MAY BE ENTERED

I

## Phase 3 - Municipal Data - Residential Subgroups

- If the user chooses residential data during the planning phase, he will be asked to choose the residential subgroups he wants to use: FLATSEWR, FLATSEPT, METRSEWR, and METRSEPT.

- For each residential subgroup chosen, the user will be asked to enter from 1-25 sets of the following parameters:

  VALN
  VALX
  ANPR
  ASMT
  DENS
  NUMB
  PEPL
  SMPR

- The low, medium, and high ranges of home values are defined as follows:

| | |
|---|---|
| Low | $ 0 - 25,499 |
| Medium | $25,500 - 50,999 |
| High | $51,000 and greater |

- VALN and VALX must both fall within one range and may not overlap with another VALN/VALX set within the residential subgroup being used.

- The following matrix shows which parameters require values greater than zero for each residential subgroup.

0 = Optional

* = Value greater than zero required

| | FLATSEWR | FLATSEPT | METRSEWR | METRSEPT |
|---|---|---|---|---|
| VALN | * | * | * | * |
| VALX | * | * | * | * |
| ANPR | not used | not used | * | * |
| ASMT | 0 | 0 | 0 | 0 |
| DENS | 0 | 0 | 0 | 0 |
| NUMB | 0 | 0 | 0 | 0 |
| PEPL | * | * | 0 | * |
| SMPR | not used | not used | * | * |

A sample of residential prompts for the METRSEWR subgroup follows:

```
  SELECT AT LEAST ONE SUBGROUP
      1 - FLATSEWR      FLAT RATE-SEWERED AREAS
      2 - FLATSEPT      FLAT RATE-SEPTIC TANK AREAS
      3 - METRSEWR      METERED-SEWERED AREAS
      4 - METRSEPT      METERED-SEPTIC TANK AREAS

  ENTER NUMBERS SEPARATED BY COMMAS OR HELP
I

  DO YOU WISH TO VERIFY THE SELECTIONS YOU MADE - Y OR N
I

 .FROM 1-25 SETS OF DATA CAN BE ENTERED
  EACH SET REPRESENTS A PROPERTY VALUE RANGE
  I.E. $25000-30000

  METRSEWR

  VALN   LOWER LIMIT PROPERTY VALUE RANGE DOLLARS
I

  VALX   UPPER LIMIT PROPERTY VALUE RANGE DOLLARS
I

  ANPR   MARGINAL PRICE OF WATER
I

  ASMT   ASSESSMENT FACTOR
  OPTIONAL ENTER 0 TO USE DEFAULT VALUE OF 1
I

  DENS   HOUSING DENSITY UNITS PER ACRE
  OPTIONAL ENTER 0 TO SKIP
I

  PEPL   PERSONS PER HOUSING UNIT
  OPTIONAL ENTER 0 TO SKIP
I

  SMPR   MARGINAL PRICE OF WATER SUMMER USE
I

  DO YOU DESIRE TO ENTER ANOTHER SET - Y OR N
I
```

## Phase 4 - Municipal Data - Commercial Subgroups

- If the user chooses commercial data during the planning session, he will be prompted for the COMMPARM subgroup.

- The user may opt to be prompted for all commercial categories and enter a value greater than zero for those he wishes to use, or the user may enter only the category names and values for those he wishes to use. In the second case, when the user has no more category names to enter, he enters "DONE." Example:

```
    NAME
I   BARB
    VALUE
I   999
    NAME
I   DONE
```

- If a forecast type file is being created, the COMMEMPL subgroup is required and the user must provide values greater than zero for each category used in COMMPARM (except SKLL and SKLH).

- The user may add up to 22 categories for COMMPARM named C001 to C022.

A sample of the commercial prompts follows:

```
  SELECT MODE OF OPERATION FOR COMMPARM
      1 - USER SELECT PARAMETERS BY NAME
      2 - TERMINAL WILL PROMPT FOR ALL PARAMETERS
I  1

  YOU WILL BE ASKED FOR THE PARAMETER NAME FIRST AND THEN THE VALUE
  ENTER DONE WHEN FINISHED


  NAME
I
  VALUE
I
  NAME
I


  DO YOU WISH TO ADD USER SPECIFIED CATEGORIES
  C001 UP TO A MAX OF C022 - Y OR N


I
```

## Phase 5 - Municipal Data - Industrial Subgroup

- If the user chooses industrial data during the planning session, he will be prompted for the INDPARAM subgroup.

- The user selects the three-digit SIC Code category by name and by entering a value greater than zero.

- When the user provides categories not used by the program, he must choose an unused category name between I200 and I399.

- Enter "DONE" when there are no more category names to enter.

A sample of the industrial section follows:

```
  THE USER MUST TYPE DESIRED CATEGORY NAME I201 THRU I399
  THEN THE USER WILL BE PROMPTED FOR THE AVERAGE EMPLOYMENT IN BASE YEAR
  THE USER MAY ADD CATEGORIES

  TYPE DONE WHEN FINISHED

  ENTER CATEGORY NAME - I FOLLOWED BY S.I.C. CODE
I

  AVERAGE EMPLOYMENT IN BASE YEAR
I
```

Phase 6 - Municipal Data - Public/Unaccounted Subgroups

- If the user chooses public/unaccounted data during the planning session, he will be prompted for the following subgroups:

  PUBPARAM
  PUBANAVE
  PUBMAXDY
  PUBPEKHR

- PUBPARAM - The user may optionally enter a value for AIRP and then add user specified categories if he wishes.

- The user will be asked if he wants to use PUBANAVE, PUBMAXDY, and PUBPEKHR to specify actual values of water usage. If the user responds "Y" (yes), he will be prompted for LOSS and FSER and any categories used in PUBPARAM.

  To skip any parameter, enter zero. However, since PUBANAVE, PUBMAXDY, and PUBPEKHR are used together as a set, any category in PUBANAVE for which the user enters a positive value will require a positive value in PUBMAXDY and PUBPEKHR.

  A sample of the public/unaccounted section follows:

```
  PUBLIC
  PUBPARAM

  AIRP    AVERAGE # PASSENGERS/DAY
I

  DO YOU WISH TO ADD USER SPECIFIED CATEGORIES
  P001 UP TO A MAX OF P027
  Y OR N
I

  DO YOU WISH TO USE PUBANAVE, PUBMAXDY, AND PUBPEKHR TO SPECIFY ACTUAL
  VALUES OF WATER USAGE
  Y OR N
I

  PUBANAVE     ANNUAL AVG USE GALLONS/DAY
  ENTER ZERO TO SKIP ANY PARAMETER

  AIRP    AVERAGE # PASSENGERS/DAY
I

  LOSS DISTRIBUTION WATER LOSS     GPD
I

  FSER    FREE SERVICE WATER  GPD
I

  PUBMAXDY     MAX DAY REQUIREMENTS GAL/DAY
  LOSS    DISTRIBUTION WATER LOSS  GPD
I

  PUBPEKHR     PEAK HOUR REQUIREMENTS GAL/DAY
  LOSS    DISTRIBUTION WATER LOSS  GPD
I

  FSER FREE SERVICE WATER     GPD
I
```

## Phase 7 - Local Historical Data

When the IWR MAIN System is used to forecast municipal water requirements, data must be provided to establish the historical trends of certain parameters. These trends are among the information used by internal growth models to project future values of water use parameters. When all sectors or categories built into the IWR MAIN System are not being used for a particular community, it may be possible to reduce the number of subgroups of Local Historical Data required.

The Local Historical subgroups are:

| | | |
|---|---|---|
| POPULATN | - | resident population in number of persons |
| ALLHOMES | - | number of occupied residential units |
| MEDHOMES | - | fraction of single unit owner-occupied residences in medium value range |
| HIGHOMES | - | fraction of a single unit owner-occupied residences in high value range |
| SKOLYEAR | - | number of shool years completed by persons 25 years and older |
| ELEMSKOL | - | elementary (grades K-8) school enrollment |
| HIGHSKOL | - | high (grades 9-12) school enrollment |
| TSERVICE | - | total services employment (S.I.C. 700-899) |
| MEDICALS | - | medical services employment (S.I.C. 800-809) |
| INDHISTY | - | industrial employment history |

The following list indicates when a subgroup is optional and when it is required:

| | | |
|---|---|---|
| POPULATN | - | required |
| ALLHOMES | - | optional, except if residential data or the SKLH or SKLL category of COMMPARM is used |
| MEDHOMES | - | optional, except if residential data is used |
| HIGHOMES | - | optional, except if residential data is used |
| SKOLYEAR | - | optional, except if residential data is used |
| ELEMSKOL | - | optional, except if SKLL or SKLH is used in COMMPARM |

HIGHSKOL - optional, except if SKLH is used in COMMPARM

TSERVICE - optional, except if any commercial category other than SKLL and SKLH is used

MEDICALS - optional, except if HOSP, MEDL or NURS is used in COMMPARM

INDHISTY - optional, except if industrial data is used

Whenever a subgroup is optional, a message will print to tell the user.

Each subgroup within the Local Historical section, except INDHISTY, have the same data identification names, YEAR and DATA. At least two separate sets of YEAR/DATA must be provided for each subgroup, and up to five separate years can be accommodated.

The INDHISTY subgroup consists of the following data identification names:

YEAR, POPU, ICOM, EMPL, I200, I210, I220,
I230, I240, I250, I260, I270, I300, I330,
I340, I370, I400

The INDHISTY subgroup requires at least two, but not more than five sets of data, each beginning with the YEAR identification name. YEAR, POPU, ICOM, and EMPL all require a value greater than zero. The following matrix displays the remaining identification names and when a value greater than zero is required.

| INDHISTY Data Identification Name | May be used if an SIC code in this range was used in INDPARAM | Requires a value greater than zero if an SIC code in this range was used in INDPARAM |
|---|---|---|
| I200 | 200-219 | 200-209 |
| I210 | 200-219 | 210-219 |
| I220 | 220-239 | 220-229 |
| I230 | 220-239 | 230-239 |
| I240 | 240-279 | 240-249 |
| I250 | 240-279 | 250-259 |
| I260 | 240-279 | 260-269 |
| I270 | 240-279 | 270-279 |
| I300 | 300-309 | 300-309 |
| I330 | 330-349 | 330-339 |
| I340 | 330-349 | 340-349 |
| I370 | 370-379 | 370-379 |
| I400 | 350-379 | |

The following is a sample of the Local Historical section:

```
      LOCAL HISTORICAL DATA
      FROM 2-5 YEARS OF DATA MAY BE PROVIDED FOR EACH SUBGROUP
      FIRST THE SUBGROUP NAME WILL PRINT AND THEN YOU WILL BE PROMPTED
      FOR UP TO 5 SETS OF YEAR AND DATA
      YEAR IS ALWAYS CALENDAR YEAR
      DATA DESCRIPTIONS ARE PROVIDED

      POPULATN
      DATA IS RESIDENT POPU IN NUMBER OF PERSONS
      YEAR
I
      DATA
I
      YEAR
I
      DATA
I
      DO YOU WISH TO ENTER ANOTHER YEAR
      Y OR N
I
      ALLHOMES
      DATA IS NUMBER OF OCCUPIED RESIDENTIAL UNITS
      YEAR
I
      DATA
I
      YEAR
I
      DATA
I

      DO YOU WISH TO ENTER ANOTHER YEAR
      Y OR N
I

      MEDHOMES  MARKET VALUE 25500-50999   1980 DOLLARS
      DATA IS FRACTION OF SINGLE UNIT OWNER-OCCUPIED
      YEAR
I
      DATA
I
      YEAR
I
      DATA
I

      DO YOU WISH TO ENTER ANOTHER YEAR
      Y OR N
I
```

```
    HIGHOMES  MARKET VALUE 51000 AND GR     1980 DOLLARS
    DATA IS FRACTION OF SINGLE UNIT OWNER-OCCUPIED
    YEAR
I
    DATA
I
    YEAR
I
    DATA
I

    DO YOU WISH TO ENTER ANOTHER YEAR
    Y OR N
I

    SKOLYEAR
    DATA IS SCHOOL YEARS COMPLETED BY ADULTS 25+ OLD
    YEAR
I
    DATA
I
    YEAR
I
    DATA
I

    DO YOU WISH TO ENTER ANOTHER YEAR
    Y OR N
I

    ELEMSKOL
    DATA IS NUM ATTENDING K-8 GRADE
    OPTIONAL - DO YOU WISH TO USE THIS SUBGROUP - Y OR N
I

    HIGHSKOL
    DATA IS NUM ATTENDING 9-12 GRADE
    OPTIONAL - DO YOU WISH TO USE THIS SUBGROUP - Y OR N
I

    T SERVICE
    DATA IS TOTAL EMPLOYMENT S.I.C. 700-899
    YEAR
I
    DATA
I
    YEAR
I
    DATA
I

    DO YOU WISH TO ENTER ANOTHER YEAR
    Y OR N
I
```

```
    MEDICALS
    DATA IS TOTAL EMPLOYMENT S.I.C. 800-809
    YEAR
I
    DATA
I
    YEAR
I
    DATA
I

    DO YOU WISH TO ENTER ANOTHER YEAR
    Y OR N
I

    INDHISTY  INDUSTRIAL HISTORY

    YEAR      CALENDAR YEAR
I
    POPU      NUM PERSONS IN STUDY OR EMPLOYMENT AREA
I
    ICOM      PER CAPITA INCOME IN STUDY EMPLOY. AREA
I

    EMPL      TOTAL EMPLOYMENT IN STUDY OR EMPLOY AREA
I

    THE FOLLOWING EXPRESSED IN PERSONS EMPLOYED IN STUDY AREA ONLY

    I200      S.I.C. 200-209
I
    YEAR      CALENDAR YEAR
I
    POPU      NUM PERSONS IN STUDY OR EMPLOYMENT AREA
I
    ICOM      PER CAPITA INCOME IN STUDY EMPLOY. AREA
I
    EMPL      TOTAL EMPLOYMENT IN STUDY OR EMPLOY AREA
I
    I200      S.I.C. 200-209
I
    I210      S.I.C. 210-219
I

    DO YOU WISH TO ENTER ANOTHER YEAk
    Y OR N
I
```

## Phase 8 - Projection Data

Projection of water usage parameters can be carried out in any of four ways:

1. Projection by internal growth models
2. Projection by extrapolation of local historical data
3. Use of projections made external to the IWR MAIN System
4. Combination of the above

- The user will be asked to specify which projection method(s) he will use.

```
     SELECT TYPE OF FORECAST
          1 - INTERNAL GROWTH MODELS
          2 - EXTRAPOLATION OF LOCAL HISTORICAL DATA
          3 - DIRECT EXTERNAL PROJECTIONS OR
          HELP

     ENTER NUMERICAL SELECTION SEPARATED BY COMMAS, OR HELP
  I  1,2,3
```

- Projection by internal growth models utilizes only the NEWYEAR subgroup with categories YEAR, POPU, and ICOM required. The YEAR category identifies the entire set of projection data - up to 24 sets or projections may be entered.

```
     NEW YEAR PROJECTION DATA MAX 24 PROJECTIONS
     YEAR       CALENDAR YR GR THAN BASE YEAR
  I
     POPU       POPULATION
  I
     ICOM       PER CAPITA PERSONAL INCOME
  I
     ACRE       ACRES OF RESIDENTIAL LAND
     OPTIONAL   ENTER ZERO TO SKIP
  I
     DENS       UNITS/GROSS RESIDENTIAL ACRE
     OPTIONAL   ENTER ZERO TO SKIP
  I
     TSER       PERSONS EMPLOYED SIC 700-899
     OPTIONAL   ENTER ZERO TO SKIP
  I
```

- A user may choose all three forecast types and selectively use the extrapolation and direct external projection types in a particular NEWYEAR group.

- When local historical data for a specific parameter is to be extrapolated, the appropriate historical record is provided in the following subgroups:

  HNUMHOMS
  HCOMPARM
  HINDPARM
  HPUBPARM

  At least two, but not more than seven, data points will cause that parameter to be projected by extrapolation of the historical data provided. Within these subgroups, data points are grouped in sets identified by a YEAR, so up to seven sets of YEAR/DATA points may be entered (two are required).

- If the user selects extrapolation of local historical data as a forecast method, he will be asked if he wishes to utilize it for the NEWYEAR set he is currently creating:

  ```
  DO YOU WISH TO ENTER LOCAL HISTORICAL DATA FOR
  EXTRAPOLATION FOR THIS NEW YEAR  -  Y OR N
I
  ```

  If the response is yes ("Y"), he will be asked if he wishes to use each available subgroup in its turn. Example:

```
   DO YOU WISH TO USE HNUMHOMS SUBGROUP FOR THIS
   NEWYEAR  -  Y OR N
I  Y
   USE EITHER THE LO (LOW), MD (MEDIUM), AND HI ( HIGH) CATEGORIES
   AND ENTER ZERO FOR THE TL (TOTAL) CATEGORY, OR ENTER ZERO FOR
   THE LOW, MD, AND HI CATEGORIES AND ENTER A VALUE FOR TL

   REQUIRES 2-7 SETS OF DATA


   YEAR CALENDAR YEAR
I
   FWLO       FLATSEWR  LOW
I
   FWMD       FLATSEWR  MED
I
   FWHI       FLATSEWR  HIGH
I
   FWTL       FLATSEWR  TOTAL
I
   YEAR CALENDAR YEAR
I
   FWLO       FLATSEWR  LOW
I
   FWMD       FLATSEWR  MED
I
   FWHI       FLATSEWR  HIGH
I
   FWTL       FLATSEWR  TOTAL
I
   DO YOU WISH TO ENTER MORE HNUMHOMS DATA  -  Y OR N
I
```

- Notes on extrapolation subgroups:

  HNUMHOMS - the user will be prompted for parameters depending upon the residential subgroups selected in the Municipal Data.

  HCOMPARM - the user will be prompted for those categories used in Municipal Data (COMMPARM) and may enter zero to skip any category.

  HINDPARM - the user will be prompted for SIC categories used in Municipal Data (INDPARAM) and may enter zero to skip any category.

  HPUBPARM - the user will be prompted for any category used in Municipal Data (PUBPARAM) and may enter zero to skip any category.

- Projection of specific parameters may be made external to the IWR MAIN System and provided to the system directly by placing the projected values under the proper subgroup heading in the following list:

  NUMHOMES
  COMFPARM
  COMFEMPL
  INDPROJT
  PUBPARAM
  PUBANAVE
  PUBMAXDY
  PUBPEKHR

- If the user selects direct external projections as a type of forecast method, he will be asked if he wishes to use it for the NEWYEAR set he is currently creating:

  DO YOU WISH TO ENTER DIRECT EXTERNAL DATA
  FOR THIS NEWYEAR - Y OR N

If the user responds yes, he will be asked if he wishes to use each available subgroup in its turn:

Example:

```
    DO YOU WISH TO USE NUMHOMES SUBGROUP FOR THIS NEW YEAR - Y OR N
  I
```

o Notes on direct external projections subgroup:

| | | |
|---|---|---|
| NUMHOMES | - | the user will be prompted depending upon the residential subgroups used in Municipal Data |
| COMFPARM<br>COMFEMPL | - | the prompts will be for categories used in Municipal Data (COMMPARM); enter zero to skip any category |
| INDPROJT | - | the prompts will be for SIC categories used in Municipal Data (INDPARAM); enter zero to skip any category |
| PUBPARAM<br>PUBANAVE<br>PUBMAXDY<br>PUBPEKHR | - | AIRP, LOSS, FSER, and user added categories P001-P027 may be used. However, P001-P027 must appear in PUBPARAM before it can be used in the others. Also, as PUBANAVE, PUBMAXDY, AND PUBPEKHR are used as a set, an entry in PUBANAVE will require entries in PUBMAXDY and PUBPEKHR. |

o When a NEWYEAR set is complete, the user is asked if he wishes to enter another NEWYEAR set:

```
    DO YOU WISH TO ENTER ANOTHER FORECAST YEAR - Y OR N
  I
```

o Summary of Projection Data subgroups:

NEW YEAR

HNUMHOMS
HCOMPARM
HINDPARM - Extrapolation of local historical data
HPUBPARM

NUMHOMES
COMFPARM
COMFEMPL
INPROJT - Direct external projections
PUBPARAM
PUBANAVE
PUBMAXDY
PUBPEKHR

## RESUME CREATING A DATA PARAMETER FILE.

When a user is creating a data parameter file, he has the ability to stop processing at almost any point and resume processing at the same point in a later session. An "echo" file is created which the program uses to position itself in the data entry process. (See "Executing the IWREDIT Statement" for more detail.)

o To resume processing, indicate that the current session is a "RESUME" session and the program will resume processing and prompting at the point the user previously stopped.

Example:

```
          ENTER HELP FOR AN EXPLANATION OF THE IWR MAIN SYSTEM
          ENTER CONT TO CONTINUE PROCESSING
     I

          ARE YOU CREATING A NEW FILE, RESUMING CREATING A NEW FILE,
          ADDING PROJECTION DATA TO AN ESTIMATE FILE, OR CHANGING AN OLD
          FILE
               1 - NEW
               2 - RESUME
               3 - ADD PROJECTION DATA TO ESTIMATE
               4 - UPDATE
     I  2

          THE PROGRAM WILL NOW RESUME PROMPTING YOU AT THE TERMINAL TO
          COMPLETE THE CREATION OF THE DATA PARAMETER FILE

          CDAT
     I
```

## ADD PROJECTION DATA TO A "CURRENT USE ONLY" DATA PARAMETER FILE

If a user wishes to add projection data to a Data Parameter File which is comprised of Municipal Data only, he chooses "3 - Add Projection Data to a 'Current Use Only' Data Parameter File" in the planning section of the session.

The program will proceed to prompt the user for Local Historical data and Projection data in the same manner described on pages 17 through 28 of this chapter. However, the process of adding projection data to a current use only data file must be completed in one session. (Note: As long as one set of NEWYEAR parameters has been created, a data parameter file for projections is considered complete. The Update function of this procedure may be used to add additional NEWYEAR sets or subgroups within a NEWYEAR set.)

## UPDATE A DATA PARAMETER FILE

Three types of changes can be made to a Data Parameter File:

1. change existing parameter values
2. add new subgroups and parameters
3. delete existing subgroups and parameters

Note: To change a file that contains Municipal Data only into a Data Parameter File for forecasting water usage, see "Add Projection Data to a 'Current Use Only' Data Parameter File" on Page 29.

The user must make all modifications he intends to make to the Municipal Data and Local Historical subgroups before modifying the NEWYEAR (extrapolation and direct external projection) subgroups.

## Changing Municipal and Local Historical Data

To change a parameter within a Municipal Data subgroup, first enter the subgroup name:

```
   ENTER SUBGROUP NAME OR DONE
I
```

Then enter the parameter identification name

```
   ENTER PARAMETER NAME OR DONE OR PRINT
I
```

If you enter a parameter name, the program will print the parameter name and current value and prompt you for the new data:

```
   ECHO LATD      42.000
   ENTER DATA CHANGE
I
```

If you enter PRINT, the entire subgroup will print at the terminal. If you enter DONE, you will be returned to the subgroup level to choose another subgroup or indicate that you are DONE updating Municipal and Local Historical data.

If there are constraints on the type of change the user may make, a message will print at the terminal. For example, in the CITYDATA subgroup, all parameters are required for a forecast Data Parameter File. Therefore, only changing values is allowed--a parameter may not be deleted. The following message will print:

```
   ONLY PARAMETER DATA CHANGES ARE ALLOWED
   FOR THIS SUBGROUP
```

To add a parameter, first enter the appropriate subgroup name, and the name of the parameter. For example, a user wishes to add the parameter HOSP to the COMMPARM subgroup:

```
   ENTER SUBGROUP NAME OR DONE
I  COMMPARM
   ENTER PARAMETER NAME OR DONE OR PRINT
I  HOSP
   ECHO      HOSP      0.000
   ENTER DATA CHANGE
I  (user enters value)
```

To delete a parameter, enter zero when prompted for the data change.

Changes to residential subgroup parameters require the user to make three levels of identification: subgroup, VALN set and parameter name. Since residential subgroups consist of 1-25 sets of parameters, the program needs to know in which set the change is to be made.

Example:

```
METRSEWR                ----------------- Subgroup
VALN          10000.000
VALX          13000.000
ANPR             10.000
NUMB           2250.000
SMPR             10.000
VALN          14000.000 ----------------- Set identifier
VALX          17000.000
ANPR             10.000
NUMB           2275.000 ----------------- Parameter to change
SMPR             10.000
```

To change NUMB in the $14000-17000 range set, the user must answer the following prompts:

```
   ENTER SUBGROUP NAME OR DONE
I  METRSEWR
   ENTER VALN VALUE TO IDENTIFY SET OR ENTER 0 IF DONE
I  14000
   ENTER PARAMETER NAME OR DONE
I  NUMB
```

When the user answers DONE, he will still be in the METRSEWR subgroup with the ability to access other VALN sets. When the user enters zero to identify the VALN set, he will be returned to the subgroup level.

To add a new set to a residential subgroup, enter the new VALN value to the prompt for VALN value to identify set. The program will respond:

```
   VALN WITH VALUE _____ NOT FOUND
   DO YOU WISH TO ADD A SET - Y OR N OR DONE
I
```

To delete an entire VALN set, identify the subgroup, VALN value to identify set and then specify VALN as the parameter to change. Enter zero when prompted for the "data change" and the entire VALN range set will be deleted.

To change any Local Historical subgroup except INDHISTY, first enter the subgroup name. Local Historical subgroups (except INDHISTY) consist of 2-5 sets of YEAR/DATA parameters, so the set must be identified by the YEAR. Then you may make changes to YEAR or DATA.

Example:

```
   ENTER SUBGROUP NAME OR DONE
I  MEDICALS
```

If there are currently 2-4 entries in the subgroup, the next prompt is:

```
   DO YOU WISH TO ADD A YEAR TO THIS SUBGROUP - Y OR N
I
```

If there are currently no entries in this subgroup, the prompt is:

```
   SUBGROUP MEDICALS WAS NOT FOUND
   DO YOU WISH TO ADD THIS SUBGROUP - Y OR N
I
```

Note: At least two sets of YEAR/DATA must be maintained or the entire subgroup is deleted. Therefore, where appropriate add YEAR/DATA sets before attempting to delete a set.

To delete a YEAR/DATA set, enter zero for the YEAR CHANGE.

For subgroup INDHISTY the same set identification that is used for other Local Historical subgroups applies, with the additional requirement of identifying the parameter name. The user must identify the subgroup, then identify the set by the YEAR parameter and then identify the parameter within that YEAR set. To change the YEAR (or delete the whole YEAR set), the user will identify the calendar YEAR of the set and then specify YEAR as the parameter to change.

Example:

```
   ENTER SUBGROUP NAME OR DONE
I  INDHISTY
   ENTER CALENDAR YEAR OR DONE OR PRINT
I  1970
   ENTER PARAMETER NAME OR DONE
I  YEAR
```

## Changing Projection Data

Note: To change a "current use only" file (one that contains Municipal Data only) into a "forecast" file, see "Add Projection Data to a Current Use Only Data Parameter File" on page 29.

Projection by extrapolation and direct external projection subgroups are organized in sets along with the NEWYEAR subgroup. The entire set is identified by the YEAR parameter within the NEWYEAR subgroup. YEAR is the calendar year for which the forecast is desired. For each calendar year a forecast is desired, a NEWYEAR set is constructed and contains the following:

| | |
|---|---|
| Required: | NEWYEAR |
| | YEAR |
| | POPU |
| | ICOM |
| Optional: | HNUMHOMS |
| | HCOMPARM |
| | HINDPARM |
| | HPUBPARM |
| | NUMHOMES |
| | COMFPARM |
| | COMFEMPL |
| | INDPROJT |
| | PUBPARAM |
| | PUBANAVE |
| | PUBMAXDY |
| | PUBPEKHR |

Any type of modification requires that the forecast year be identified first:

```
ENTER CALENDAR YEAR OF NEW YEAR TO IDENTIFY SET OR ZERO IF DONE
I
```

This makes the forecast year available for modification.

To enter a new NEWYEAR set, enter the new forecast calendar year and the program will prompt you through the projection subgroups.

Once the forecast year is identified, the user is prompted for the subgroup within the set.

```
ENTER SUBGROUP NAME OR DONE
```

To add a subgroup or change a parameter within a subgroup, identify the subgroup name. Note: NEWYEAR is a subgroup. To access YEAR, POPU, ICOM, ACRE, DENS, and TSER categories, identify the subgroup as NEWYEAR.

To delete an entire forecast year, identify NEWYEAR as the subgroup and YEAR as the category to change. Enter zero for the YEAR change and the entire set will be deleted.

After the user has identified the forecast year and subgroup, he needs to identify the parameter to change. The projection by extrapolation subgroup consists of 2-7 sets of data, so the set needs to be identified. The set is identified by the YEAR parameter. When the set is identified, the user enters the parameter to change.

Example of a projection by extrapolation subgroup:

```
NEWYEAR
YEAR      ---------------------- identify forecast year
POPU
ICOM
ENDD
HCOMPARM  ---------------------- identify subgroup
YEAR
BARB
BEUT
YEAR      ---------------------- identify set within subgroup
BARB      ---------------------- identify parameter to change
BEUT
ENDD
ENDYEAR
```

The user must move up through the levels of identification when proceeding to a different set, subgroup, or forecast year.

## OPTION TO PRINT THE DATA PARAMETER FILE AT A HIGH SPEED TERMINAL

When the IWREDIT program finishes executing and a completed Data Parameter File has been generated (or updated), the user will be asked if he wishes to have the Data Parameter File printed at a high speed terminal (RJE).

Example:

```
   DO YOU WISH TO PRINT THE DATA PARAMETER FILE
   AT A HIGH SPEED PRINTER  -  Y OR N
I  Y
   ENTER THE 6-DIGIT RJE USER NUMBER THAT FILE
   SHOULD BE ROUTED TO
I
   82/12/7.  10.10.15. FILE IWRFILE IS NOW JOB XXXXXXX
```

## EXECUTING THE IWREDIT STATEMENT

Make the IWREDIT procedure available with the command

```
GET,IWREDIT/UN=CECELB
```

The form of IWREDIT is

```
IWREDIT[,D=IWRDATA,E=IWRECHO]
```

D = specifies the name of the Data Parameter File. The default name is IWRDATA.

E = specifies the name of the "echo" file. The default name is IWRECHO.

To execute IWREDIT using the default file names, simply enter

```
IWREDIT
```

This assumes the following:

- If the user is starting the creation of a Data Parameter File and completes all entries, the Data Parameter File will be saved with the filename IWRDATA. If the user "quits" processing before making all entries, an "echo" file will be saved with the filename IWRECHO.

- If the user is resuming the creation of a Data Parameter File, an "echo" file with the filename IWRECHO will be used to bring the program to the point where the user had previously stopped. If the user "quits" again before completing the Data Parameter File, the new "echo" file will be saved with the filename IWRECHO. If the user completes the Data Parameter File, it will be saved with the filename IWRDATA.

- If the user is updating a Data Parameter File, IWRDATA is the filename of the data file. The modified Data Parameter File will be named IWRDATA and replace the old IWRDATA.

To execute IWREDIT substituting user specified names, enter IWREDIT with the correct "=" parameter and filename.

| FILE | USER ASSIGNED NAME | RESULT DEPENDING UPON TYPE OF SESSION | | |
|---|---|---|---|---|
| | | CREATE | RESUME | UPDATE |
| Data Parameter File | MYDATA | o a completed DPF* will be named MYDATA and saved | o a completed DPF will be named MYDATA and saved | o the system will require a DPF named MYDATA for the update process<br>o the updated DPF will be named MYDATA and replace the old MYDATA |
| "Echo" File | MYECHO | o if a user stops before completing the DPF, the echo file will be saved with the name MYECHO | o the system will search for file MYECHO to resume the create process<br>o if a user stops again before completing the DPF, the echo file will be named MYECHO and replace the old MYECHO | |

* DPF = Data Parameter File

Examples:

To execute IWREDIT and name a Data Parameter File MYDATA and to provide a contingency name of MYECHO for an echo file in case of stopping before completing the Data Parameter file, enter

```
IWREDIT,D=MYDATA,E=MYECHO
```

To execute IWREDIT with the intention of updating the Data Parameter File named MYDATA, enter

```
IWREDIT,D=MYDATA
```

## IWRRUN

The IWRRUN procedure consists of three steps:

1. Run the Library modification program to ensure that required additions to the Library of Water Usage Coefficients are made and to allow the user to change coefficient values. At the completion of this step, a copy of the Library complete with user additions/modifications, called the Working Library of Water Usage Coefficients, is available to the IWR MAIN Model for processing.

2. User option to print the Working Library of Water Usage Coefficients at a high speed terminal.

3. User option to execute the IWR MAIN Model.

The IWR MAIN procedure, IWRRUN, uses several files and your input from the terminal to generate a Working Library of Water Usage Coefficients and to run the IWR MAIN Model.

IWR MAIN Data Parameter File:

> The input data file for the IWR MAIN system to the Model which contains the data required to evaluate existing as well as forecast water usage for the community under study. (Unless a user has specified a name of his choice, this file is named IWRDATA.)

Library of Water Usage Coefficients:

> The Library of Water Usage Coefficients indigenous to the IWR MAIN System.

User Library of Coefficients:

> User additions/modifications to the commercial/ institutional, industrial, and/or public/unaccounted subgroups of the Library of Water Usage Coefficients. This file has the same format as the Library of Water Usage Coefficients and is generated by the IWRMAIN Library program so user modifications can be saved for re-use. (Unless the user specifies a name of his choice, the file is named USERLIB.)

## THE LIBRARY MODIFICATION PROGRAM

The Library of Water Usage Coefficients provides data inputs to the IWR MAIN System. These data include residential equation constants, coefficients of usage for many different types of establishments and industries, and climatic information. This library allows the user to make water usage computations without having to re-research the data values.

It is anticipated that some of the users of the IWR MAIN System may find it necessary to change the Library because it does not contain up-to-date usage coefficient values nor adequate category definitions that satisfy specific requirements. These users may make changes to the Library. The Library may be altered and modified by following steps in the interactive IWR MAIN Library program.

There are 28 general purpose commercial/institutional categories built into the Library. An additional 22 categories can be added by the user to correspond to categories added in the IWR MAIN Data Parameter File.

There are 105 industrial categories identified by their three-digit SIC codes. The user may add 95 categories between I200 and I399 not already used.

The Library contains three public/unaccounted water use categories. Additional space is available for 27 more categories.

## IWR MAIN LIBRARY MODIFICATION PROGRAM PHASES

### Phase 1 - Existing User Library of Coefficients

- If you have saved a User Library from a previous IWR MAIN session, the program will read the file and change the Working Library of Coefficients (your copy of the Library of Water Usage Coefficients) to reflect your modifications, if any.

- You will have an option to have the existing User Library printed at the terminal during the session.

Using the sample User Library of Coefficients on page 47-a, the following illustrates the changes made to the Library of Water Usage Coefficients, COMLABEL subroup:

Note the change to category HOSP and the addition of categories C003 and C007.

Before:

```
COMLABEL
BARB BARBER SHOPS        BEUT BEAUTY SHOPS        DPOT BUS-RAIL DEPOTS
CARW CAR WASHES          CHUR CHURCHES            CLUB GOLF-SWIM CLUBS
BOWL BOWLING ALLEYS      COLG COLLEGES RESID.     HOSP HOSPITALS
HOTL HOTELS              LNDM LAUNDROMATS         LNDY LAUNDRY
MEDL MEDICAL OFFICES     MOTL MOTELS              MOVI DRIVE-IN MOVIES
NURS NURSING HOMES       OFFN NEW OFFICE BLDG.    OFFO OLD OFFICE BLDG.
JAIL JAIL & PRISONS      EATN RESTAURANTS         EATO DRIVE-IN REST-NT
NITE NIGHT CLUBS         SALE RETAIL SPACE        SKLL SCHOOL, ELEM.
SKLH SCHOOL, HIGH        THTR THEATERS            YMCA YMCA-YWCA FACIL.
GASS SERVICE STATIONS
ENDD
```

After:

```
COMLABEL
BARB BARBER SHOPS       BEUT BEAUTY SHOPS       DPOT BUS-RAIL DEPOTS
CARW CAR WASHES         CHUR CHURCHES           CLUB GOLF-SWIM CLUBS
BOWL BOWLING ALLEYS     COLG COLLEGES RESID.    HOSP MED CENTERS
HOTL HOTELS             LNDM LAUNDROMATS        LNDY LAUNDRY
MEDL MEDICAL OFFICES    MOTL MOTELS             MOVI DRIVE-IN MOVIES
NURS NURSING HOMES      OFFN NEW OFFICE BLDG.   OFFO OLD OFFICE BLDG.
JAIL JAIL & PRISONS     EATN RESTAURANTS        EATO DRIVE-IN REST-NT
NITE NIGHT CLUBS        SALE RETAIL SPACE       SKLL SCHOOL, ELEM.
SKLH SCHOOL, HIGH       THTR THEATERS           YMCA YMCA-YWCA FACIL.
GASS SERVICE STATIONS   C003 3NEWLABEL          C007 7NEWLABEL
ENDD
```

- If there is no existing User Library, this phase of the program will be skipped.

```
COMLABEL
HOSP MED CENTERS      C003 3NEWLABEL        C007 7NEWLABEL
ENDD
COMMUNIT
HOSP BED              C003 3NEWUNITS        C007 7NEWUNITS
ENDD
COMMAVEG
HOSP          346.000 C003          333.000 C007          777.000
ENDD
COMMAXDY
HOSP          551.000 C003          333.000 C007          777.000
ENDD
COMMPEAK
HOSP          912.000 C003          333.000 C007          777.000
ENDD
INDLABEL
I210 I210LABEL        I232 I232LABEL        I388 I388LABEL
ENDD
INDMXDAY
I210          210.000 I232          232.000 I388          388.000
ENDD
INDPEKHR
I210          210.000 I232          232.000 I388          388.000
ENDD
PUBLABEL
P006 6NEWLABEL
ENDD
PUBCOFAA
P006          666.000
ENDD
PUBCOFMD
P006          666.000
ENDD
PUBCOFPH
P006          666.000
ENDD
ENDI
```

SAMPLE USER LIBRARY OF COEFFICIENTS

## Phase 2 - The IWR MAIN Data Parameter File Will be Checked for User Added Categories

- o If a user added category is found, the Working Library is checked to see if the required coefficient entries exist.

- o You have the option of having all user added categories found in the data parameter file print at the terminal. If no entries are required by the Library for a particular user defined category the following message will print:

  DATA FILE SUBGROUP COMMPARM USER ADDED PARAMETER NAME C003
  NO LIBRARY FILE UPDATE REQUIRED FOR C003

- o When information is required by the Library for a user defined category you will be prompted for the following:

  - New category label
  - Parameter unit label (commercial additions only)
  - Mean annual usage coefficient
  - Maximum day usage coefficient
  - Peak hour usage coefficient

- o You will have an option of being prompted in brief or expanded mode. A sample of each mode follows, using category name C005 and being prompted for the new category label as an example.

Brief: COMLABEL
C005
I (you enter category name)

Expanded: COMLABEL NEW COMMERCIAL CATEGORY LABEL
C005 ENTER CATEGORY NAME MAX 16 CHARACTERS

I (you enter category name)

The mode of prompting can be changed at any time by entering "SW"

- If no Library entries are required the following message will print:

  THERE ARE NO LIBRARY FILE UPDATE REQUIREMENTS

Phase 3 - Optional printing of current User Library or entire commercial/institutional, industrial and public/unaccounted portions of the Working Library of Coefficients at the terminal

- Printing the entire Working Library will require several minutes. You will have an opportunity to route a copy of the Working Library at the completion of the Library program.

## Phase 4 - Changes to the Working Library of Coefficients

- It is expected that users will be making changes to only the commercial, industrial and public/unaccounted portions of the Library. Changes to the residential equation constants and the climatic data are possible but not likely to occur. These changes, if necessary, should be done with the help of the program manager.

- If you wish to make changes, you will first be prompted for the subgroup name. The valid subgroup names follows:

Commercial Subgroups -

COMLABEL
COMMUNIT
COMMAVEG
COMMAXDY
COMMPEAK

Industrial Subgroups -

INDLABEL
INDANAVE
INDMXDAY
INDPEKHR

Public/Unaccounted Subgroups -

PUBLABEL
PUBCOFAA
PUBCOFMD
PUBCOFPH

o Next you will be prompted for the category name and then the category name and current coefficient will be printed. Example:

```
ENTER PARAMETER NAME OR DONE HELP

I   HOSP   (you entered category name)
ECHO HOSP HOSPITALS
ENTER CORRECTED DATA
(Note:  If you are being prompted in expanded mode the prompt
will be more detailed.)

I (you enter new category description)
```

## Phase 5 - Deletions from the Working Library of Coefficients

- Only user added categories may be deleted.

- The user added category must not be required by the IWR MAIN data parameter file being used in the terminal session.

- If you wish to delete a user added category not required by the current data parameter file you will be prompted for the subgroup name.

- You will then be prompted for the category name. If it is a valid category name it will be deleted from all related subgroups. Otherwise, error messages will be printed.

Example:

```
    ENTER SUBGROUP NAME OR DONE OR HELP
I   COMLABEL

    ENTER PARAMETER NAME OR DONE OR HELP
I   C007

    ERROR - C007 IS A USER ADDED PARAMETER
NEEDED BY THE CURRENT DATA PARAMETER FILE.  TO DELETE THIS PARAMETER NAME
YOU NEED TO FIRST DELETE THE PARAMETER NAME FROM THE DATA PARAMETER
FILE.

    ENTER PARAMETER NAME OR DONE OR HELP
I   C003

C003 HAS BEEN DELETED FROM COMLABEL, COMMUNIT, COMMAVEG, COMMAXDY AND
COMMPEAK SUBGROUPS
```

- The deletion phase of the Library program may be used to keep your User Library current.

Phase 6 - User Library is Saved

- At the completion of the program, if there were any user additions of modifications to the Library of Water Usage Coefficients, the User Library will be saved as a permanent file and a message will print at the terminal.

  Example:

  NEW USER LIBRARY FILE USERLIB REPLACED

  The User Library file is saved with the filename USERLIB unless the user has specified another name when executing the IWRRUN statement.

## Phase 7 - Other Program Features

- "Quit" - by responding "QUIT" to any prompt after you receive the message that "QUIT" is an option, you will exit the Library program. All modifications you have made to that point become part of your User Library and thus will be saved and can be used to automatically update the Library of Water Usage Coefficients in a future session.

- "Run the Model Directly" - In the event a user does not wish to modify the Library of Water Usage Coefficients and the Data Parameter File being used will not require additions to the Library (or any required additions will be satisfied by a User Library of Coefficients), the user may choose to skip several phases of the Library program and run the model directly. Only five messages will print at the terminal.

  Example:

```
DO YOU WISH TO RUN THE MODEL DIRECTLY - Y OR N
I Y
THE IWR MAIN DATA PARAMETER FILE IS NOW BEING SEARCHED FOR
LIBRARY FILE UPDATE REQUIREMENTS


THERE ARE NO LIBRARY FILE UPDATE REQUIREMENTS


NEW USER LIBRARY FILE USERLIB REPLACED (where appropriate)


DO YOU WISH TO PRINT THE LIBRARY OF COEFFICIENTS AT A HIGH SPEED
TERMINAL - Y OR N
I N
IWR MAIN REPORT FILE IWRREPT REPLACED
```

  However, if Library update requirements are detected, the program will prompt the user for those categories and the program will run in its entirety.

## OPTION TO PRINT THE WORKING LIBRARY OF WATER USAGE COEFFICIENTS AT A HIGH SPEED TERMINAL

When Step 1 is finished and a Working Library of Water Usage Coefficients is completed, the user will be asked if he wishes to have the Working Library printed at a high speed terminal (RJE).

Example:

```
   DO YOU WISH TO PRINT THE LIBRARY OF COEFFICIENTS AT A HIGH SPEED
   TERMINAL  -  Y OR N
I  Y
   ENTER THE 6-DIGIT RJE USER NUMBER THAT REPORTS SHOULD BE ROUTED TO
I
   82/12/7.  10.35.15 FILE TAPES IS NOW JOB XXXXXXX
```

## EXECUTE THE IWR MAIN MODEL

If a Working Library of Water Usage Coefficients is completed, the user will be asked if he wishes to run the model now.

Example:

```
    DO YOU WISH TO RUN THE MODEL  -  Y OR N
  I
```

If the user responds "Y," the Model will run. Upon successful completion of the run, a message will print at the terminal indicating that the reports generated have been saved.

```
        IWR MAIN REPORT FILE IWRREPT REPLACED
```

The reports are saved with the filename IWRREPT unless the user has specified another name when executing the IWRRUN statement.

## EXECUTING THE IWRRUN STATEMENT

First make the procedure available with the command

```
GET,IWRRUN/UN=CECELB
```

The form of IWRRUN is .

```
IWRRUN[,D=IWRDATA,L=USERLIB,RF=IWRREPT]
```

D = specifies the Data Parameter File. IWRDATA is the default name.

L = specifies the User Library of Coefficients. USERLIB is the default name.

RF = specifies the report filename. IWRREPT is the default name.

To execute IWWRUN using the default fienames, simply enter

```
IWRRUN
```

This assumes that the user's Data Parameter File is name IWRDATA and that if a User Library of Coefficients exists, it is named USERLIB. If a User Library of Coefficients is generated by the Library program, it will be saved with the name USERLIB. If the Model is run, the report file will be saved with the name IWRREPT.

To execute IWRRUN substituting unique file names, enter IWRRUN with the correct "=" parameter and file names.

Example:

| File | User Assigned Name |
|---|---|
| Data Parameter File | MYDATA |
| User Library of Coefficients | MYLIB |
| Report File* | MYREPT |

* The user wishes to save the reports generated with a unique name.

```
IWRRUN,D=MYDATA,L=MYLIB,RF=MYREPT
```

## IWRPRNT

The IWRPRNT procedure enables a user to selectively print IWR MAIN System reports at an 80 character terminal, 132 character terminal, or routes reports to a high speed printer.

The procedure requires the file where the IWR MAIN System reports are saved.

## PROCESSING REPORTS

The Print program will tell the user the contents of the report file by year and report number and provide a list of report titles with reference numbers.

Example:

```
      YOUR REPORT FILE CONTAINS THE FOLLOWING REPORTS:

          YEAR                    REPORT NUMBER
                    1   2   3   4   5   6   7   8   9
          1980      1   0   0   0   1   1   1   1   1
          1990      1   0   0   0   1   1   1   1   1
          2000      1   0   0   0   1   1   1   1   1
          2010      1   0   0   0   1   1   1   1   1
          2020      1   0   0   0   1   1   1   1   1
          2030      1   0   0   0   1   1   1   1   1
          FORECAST SUMMARY FOR ALL YEARS:  REPORT 10

      DO YOU NEED A LIST OF REPORT TITLES WITH REFERENCE NUMBERS?
      ANSWER Y OR N:
    I Y

  REF. NO.  REPORT TITLE

     1      RESIDENTIAL WATER REQ. - METERED AND SEWERED AREAS
     2      RESIDENTIAL WATER REQ. - FLAT RATE AND SEWERED AREAS
     3      RESIDENTIAL WATER REQ. - METERED AND SEPTIC TANK AREAS
     4      RESIDENTIAL WATER REQ. - FLAT RATE AND SEPTIC TANK AREAS
     5      RESIDENTIAL WATER REQ. - SUMMARY OF ALL AREAS
     6      COMMERCIAL WATER REQ. - CATEGORIES AND SUMMARY
     7      INDUSTRIAL WATER REQ. - CATEGORIES AND SUMMARY
     8      PUBLIC/UNACCOUNTED WATER REQ. - CATEGORIES AND SUMMARY
     9      MUNICIPAL SUMMARY REPORT
    10      FORECAST SUMMARY REPORT
    11      ALL REPORTS FOR THE SPECIFIED YEAR
```

The user will be prompted for a selection of reports. The user may select reports for a single year or for a range of years. First, enter the year(s), and then the report number(s).

```
   ENTER YEAR OR YEAR RANGE:
I
   ENTER REPORT NUMBER(S) SEPARATED BY COMMAS
I
```

Year values must contain four digits; range values must be separated by commas.

```
   Single year        -   1990
   Range of years     -   1990, 2010
```

Report number specifications must be numeric and separated by commas. (Note: 11 selects all reports for that year.)

```
   ENTER REPORT NUMBER(S) SEPARATED BY COMMAS
I  1,3,9
```

To terminate the yearly report loop, respond "N" as follows:

```
   DO YOU WANT MORE YEARLY REPORTS?  ANSWER Y OR N:
I  N
```

The user will receive a separate prompt for the Forecast Summary Report - Report 10:

```
   DO YOU WANT REPORT 10?  ANSWER Y OR N
I
```

To cancel, then reenter an entry, either:

BACKSPACE THEN ENTER YOUR CORRECT RESPONSE, OR HIT THE BREAK KEY, THEN ENTER YOUR CORRECT RESPONSE AFTER YOUR TERMINAL HAS POSITIONED TO THE NEXT LINE:

Example:

```
   ENTER YEAR OR YEAR RANGE:
I  1980  *DEL*    (SYSTEM RESPONDS *DEL* TO BREAK)
1990               (NEW RESPONSE WILL BEGIN IN COL. 1)
```

If the user enters the carriage return only, with no data value, the current year/report request will be nullified, as follows:

```
   ENTER YEAR OR YEAR RANGE SEPARATED BY COMMAS
I  2010
   ENTER REPORT NUMBER(S), SEPARATED BY COMMAS
I                (BLANK RESPONSE)
   NO REPORTS SELECTED FOR YEAR(S) 2010 -    0
   DO YOU WANT MORE YEARLY REPORTS:  ANSWER Y OR N:
I
```

After the reports have been selected, the user will choose where to print them:

```
   DO YOU WISH TO
        1 - PRINT REPORTS AT TERMINAL,  80 CHARACTER WIDTH
        2 - PRINT REPORTS AT TERMINAL, 132 CHARACTER WIDTH
        3 - SEND REPORTS TO 132 CHARACTER RJE TERMINAL
        ANSWER 1,2 OR 3
I  1
```

A message will print at the terminal to indicate successful processing of the selected reports:

```
   ALL REPORT REQUESTS HAVE BEEN PROCESSED
```

If the reports are to print at your terminal, they will follow the above message. If the reports have been sent to a high speed RJE, a job message will print:

```
82/12/7.  10.36.10  FILE TAPE2 IS NOW JOB XXXXXXX
```

## EXECUTING THE IWRPRNT STATEMENT

First make the procedure available with the command

```
GET,IWRPRNT/UN=CECELB
```

The form of IWRPRNT is

```
IWRPRNT[,RF=IWRREPT]
```

RF = specifies the report file.
IWRREPT is the default name.

To execute IWRPRNT using the default filename, enter:

```
IWRPRNT
```

This assumes file IWRREPT is the name of the file containing the reports the user wishes to print.

To execute IWRPRNT substituting a name other than IWRREPT, enter

```
IWRPRNT,RF=MYREPT
```

File MYREPT must contain the reports the user wishes to print.

# IWR MAIN USERS REMINDER CHART

FUNCTION

Generate (start or resume) or update a Data Parameter File

COMMANDS

```
Get,IWREDIT/UN=CECELB
IWREDIT[,D=IWRDATA,E=IWRECHO]
```

D = specifies the Data Parameter File name. The default name is IWRDATA. The user may specify a unique name and substitute it for IWRDATA.

E = specifies the echo file* name. The default name is IWRECHO. The user may specify a unique name and substitute it for IWRECHO.

Note: The D= and E= parameters need only be used when the user is specifying file names other than the default names.



* An "echo" file is created when the user is generating a Data Parameter File. If the user stops processing before completing the Data Parameter File, the "echo" file is used to resume processing at the point the user stopped.

VOLUME II

# FORECASTING MUNICIPAL AND INDUSTRIAL WATER

# IWR MAIN SYSTEM

# USER'S MANUAL

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## PREFACE

This User's Manual was adapted from the work originally performed by Hittman Associates, Inc. in 1969. This report documents the IWR MAIN System computer program and presents instructions for the use of the system in forecasting municipal water requirements as modified by the Corps of Engineers Institute for Water Resources.

The IWR MAIN System is fully operational on the Corps Central Library. The System has been made "user friendly"; i.e., an interactive mode is provided for both input and output requirements as specified by the user. See Volume I of this document for the interface.

# I. INTRODUCTION AND SUMMARY

The IWR MAIN System is a tool for estimating and forecasting municipal water requirements. The IWR MAIN System is designed for the use of urban planners, water resource planners, and water utilities, improving their ability to develop sound and realistic plans involving the supply and allocation of municipally supplied water. Although a computer program is used to perform the necessary computations, the IWR MAIN System itself is a set of formalized procedures and approaches which have been developed specifically for use in planning municipal water supply. The word MAIN is an acronym meaning Municipal And Industrial Needs. The designation IWR indicates that the IWR MAIN System replaces earlier MAIN I and II Systems, which were developed by Hittman Associates Inc., in 1962.

The IWR MAIN System is a flexible and comprehensive planning tool. Water requirements are estimated separately for the residential, commercial/institutional, industrial, and public-unaccounted sectors of the community. Within these sectors, requirements are further estimated for individual categories of water users, such as metered-sewered residences, flat rate-sewered residences, commercial establishments, institutions, three-digit Standard Industrial Classification (S.I.C.) manufacturing categories, etc. Estimates are made of mean annual, maximum day, and peak hour requirements. These features not only assure greatly improved information concerning the nature of future water demands, but they permit the final estimate to be responsive to changes in the mix of water-using activities which occur in the normal growth of metropolitan areas.

Research performed by the Corps of Engineers, The Johns Hopkins University, as well as data gathered by the Bureau of the Census, American Water Works Association, Hittman Associates, Inc., and other groups, has resulted in a series of mathematical models of water requirements which permit the IWR MAIN System to make accurate estimates of water demands in the various categories as a function of specified water demands in the various categories as a function of specified water use parameters. These water use parameters are factors such as home value, persons per household, retail floor space, industrial employment in each three-digit S.I.C. category, etc. Forecasts of water requirements result from projecting the value of the water use parameters by a variety of methods. The IWR MAIN System user can tailor the operation of the system to a specific community by selecting the projection method for each category and utilizing the many internal constraints and adjustments. These are designed to produce a consistent, balanced projection of the values of all water use parameters at some future time. The water requirements models then estimate the detailed forecast of water demand for that year.

Methods were developed for projecting water use parameters by utilization of existing forecasts, by extrapolating local historical trends, or by using growth models. The growth models were developed by extensive analysis of data from more than 50 Standard Metropolitan Statistical Areas (SMSA's) throughout the conterminous United States. These analyses disclosed that the projected

growth of the individual water use parameters can be expressed as a function of various demographic and socio-economic factors whose values are available at the present time.

This volume, entitled "Forecasting Municipal and Industrial Water Requirements: The IWR MAIN System User's Manual" describes the forecasting effort. The IWR-MAIN System computer program and the Library of Water Usage Coefficients, also required by the system, are described in detail and listed in appendices. Examples of data preparation and output reports are given. The IWR MAIN System has been designed, and the user's manual written, so that no special training or experience is required on the part of the user.

The IWR MAIN System came about as a direct research effort of the Corps of Engineers to assess municipal and industrial water use forecasting approaches. This research work recognized the efforts of Hittman Associates and recommended the modification of MAIN II for Corps uses rather than develop new methods. The resulting system is a dynamic one, highly flexible and adaptable to individual communities, yet structured in such a way as to readily accommodate results of future research as they become available. A convenient and reliable tool in the hands of the experienced water resource planner, the IWR MAIN System represents a significant advance in the technology of water supply planning.

# II. USE OF THE IWR MAIN SYSTEM

## A. General Considerations

The IWR MAIN System has been designed for use by water resource planners. The following sections describe the capabilities and data requirements of the system, and, in particular, the options available to the user. In general, the results obtained from the use of IWR MAIN will reflect the skill and judgement of the water resource planner who assembles the input and selects the options to be employed. Although the computations carried out by the computer program are long and complex, the resulting forecasts remain dependent upon the assumptions made by the IWR MAIN System user.

IWR MAIN differs from other forcasting techniques in several important respects. The assumptions required are largely confined to the nature of expected growth in various segments of the community under study. The use of well documented mathematical models for computing expected water use eliminates the need for broad assumptions regarding per capita water requirements. Furthermore, the effect of various growth projections on the water requirements can be tested by repeated iteration of IWR MAIN with input data suitably altered. This use of IWR MAIN, described later in more detail, is convenient and inexpensive.

The details of the IWR MAIN System have been designed for the maximum convenience of the intended user, the water resource planner. The IWR MAIN System computer program and the IWR MAIN Library of Water Usage Coefficients are available through the U.S. Corps of Engineers Institute for Water Resources, Washington, D.C. This manual describes the data requirements of the basic IWR MAIN System as well as each of the various options incorporated in the system. Data sources and preparation details are presented.

The output of the IWR MAIN System computer program is a series of printed displays summarizing the values of the various water use parameters and the related estimates of water use. These displays are generally self-explanatory and are discussed in detail in Chapter IV.

It should also be noted that additional categories of water users can be added to the IWR MAIN System with modifying the computer program. Space is provided in the Commercial/Institutional, Industrial, and Public/Unaccounted Submodels for additional categories. It is only required that the appropriate labels and coefficients be placed in the Library of Water Usage Coefficients where requested by the input monitor in the interactive mode.

## B. Estimating Current Water Requirements with the IWR MAIN System

The IWR MAIN System can be used to estimate the current water requirements of an urban area by providing the appropriate Municipal Data. Section II.D. discusses sources for this data and Chapter V presents the details of its preparation. For east of identification, the Municipal Data consists of data subgroups:

Municipal Data

OPTIONS
CITYDATA
METRSEWR
METRSEPT
FLATSEWR
FLATSEPT
COMMPARM
INDPARAM
PUBPARAM
PUBANAVE
PUBMAXDY
PUBPEKHR
COMMEMPL (not required for current estimates)

All subgroups in the IWR MAIN System, together with brief definitions, are shown on Table II-1. The purpose of each subgroup and the data requirements for each are discussed in detail in Chapter V. When the projection capability is not being used, the number of data points required in the CITYDATA subgroup is reduced.

When OPTIONS, CITYDATA, and one or more of the next 10 subgroups listed are the sole input to the IWR MAIN System, the current water requirements of the urban area are estimated. A series of reports are generated, presenting detailed estimates for each sector of water use, e.g., metered and sewered residential, commercial/institutional, public/unaccounted, etc. A summary is also prepared, showing the total estimates of municipal water requirements for the average day, maximum day, and peak hour. Where no data are provided in a particular subgroup, no report will be generated. In every case, the estimates will be for the year in which the input data were gathered.

The use of the IWR MAIN System to estimate current water requirements corresponds exactly to the earlier MAIN I System. A number of minor changes have been made in the computational models and in output format.

The Library of Water Usage Coefficients contained in the IWR MAIN System corresponds to the one associated with the MAIN II System. The only point of difference is that the Library issued with the IWR MAIN System has had the

advantage of several updates and corrections which have been made since the original issue of the MAIN II Library. Appendix D of this manual lists the contents of the current library.

## C. Projecting Water Requirements with the IWR MAIN System

The most important capability of the IWR MAIN System is the projection of urban water requirements, based on currently available data. In order to user IWR MAIN for this purpose, three types of data must be prepared: Municipal Data, Local Historical Data, and Projection Data. The data subgroups contained under each of these headings are summarized below:

| Municipal Data | Local Historical Data | Projection Data |
|---|---|---|
| OPTIONS | POPULATN | NEWYEAR |
| CITYDATA | NONWHITE | NUMHOMES |
| METRSEWR | ALLHOMES | COMFEMPL |
| METRSEPT | MEDHOMES | COMFPARM |
| FLATSEWR | HIGHOMES | INDPROJT |
| FLATSEPT | SKOLYEAR | PUBPARAM |
| COMMPARM | ELEMSKOL | PUBANAVE |
| INDPARAM | HIGHSKOL | PUBMAXDY |
| PUBPARAM | TSERVICE | PUBPEKHR |
| PUBANAVE | MEDICALS | HNUMHOMS |
| PUBMAXDY | INDHISTY | HCOMPARM |
| PUBPEKHR | | HINDPARAM |
| COMMEMPL | | HPUBPARM |

MUNICIPAL DATA

| | |
|---|---|
| | Run Specifications |
| OPTIONS | Run and output options |
| CITYDATA | Municipal identification data |
| | Residential Submodel - Current Data |
| METRSEWR | Metered and sewered residences |
| METRSEPT | Metered and septic tank residences |
| FLATSEWR | Flat rate and sewered residences |
| FLATSEPT | Flat rate and septic tank residences |
| | Commercial/Institutional Submodel - Current Data |
| COMMPARM | Commercial/Institutional parameters |
| COMMEMPL | Commercial/Institutional employment |
| | Industrial Submodel - Current Data |
| INDPARAM | Industrial parameters (employment) |
| | Public/Unaccounted Submodel - Current Data |
| PUBPARAM | Public/Unaccounted parameters |
| PUBANAVE | Public/Unaccounted annual average water requirements |
| PUBMAXDY | Public/Unaccounted maximum day water requirements |
| PUBPEKHR | Public/Unaccounted peak hour water requirements |

LOCAL HISTORICAL DATA

| | |
|---|---|
| POPULATN | Population history |
| NONWHITE | Fraction population nonwhite history |
| ALLHOMES | Number of housing units history |
| MEDHOMES | Fraction housing units in medium value group history |
| HIGHOMES | Fraction housing units in high value group history |
| SKOLYEAR | Median years school completed by adults history |
| ELEMSKOL | Elementary school enrollment history |
| HIGHSKOL | High school enrollment history |
| TSERVICE | Total services employment history |
| MEDICALS | Medical services employment history |
| INDHISTY | Industrial employment history |

Table II-1. Classification of IWR MAIN System Data Subgroups

PROJECTION DATA

| | |
|---|---|
| | Forecast Data and Key Projections |
| NEWYEAR | Key projections and other data |
| | Optional Projections by Extrapolation of Historical Data |
| HNUMHOMS | Residential Submodel - number of homes in value groups and categories |
| HCOMPARM | Commercial/Institutional Submodel - parameters |
| HINDPARM | Industrial Submodel - parameters (employment) |
| HPUBPARM | Public/Unaccounted Submodel - parameters |
| | Optional Projections by Supplying Externally Projected Values |
| NUMHOMES | Residential Submodel - number of homes in value groups and categories |
| COMFPARM | Commercial/Institutional Submodel - parameters |
| COMFEMPL | Commercial/Institutional Submodel - employment |
| INDPROJT | Industrial Submodel - parameters (employment) |
| PUBPARAM | Public/Unaccounted Submodel - parameters |
| PUBANAVE | Public/Unaccounted Submodel - annual average water requirements |
| PUBMAXDY | Public/Unaccounted Submodel - maximum day water requirements |
| PUBPEKHR | Public/Unaccounted Submodel - peak hour water requirements |

Table II-1. Classification of IWR MAIN System Data Subgroups (Continued)

Sections II.D, II.E, and II.F describe sources for the required information and Chapter V discusses the preparation of the data obtained. The Municipal Data required are identical with that required for estimating current water requirements, except that several additional data points which are needed for CITYDATA subgroup, and the COMMEMPL subgroup must also be provided.

The Municipal Data used must consist of the OPTIONS, and CITYDATA subgroups and one or more of the remaining 11 subgroups, as required. Typically, a city might require data for one of the residential subgroups (METRSEWR, METRSEPT, FLATSEWR, and FLATSEPT), the commercial subgroups (COMMPARM and COMMEMPL), the industrial subgroup (INDPARAM), and the public/unaccounted subgroups (PUBPARAM or, alternatively, PUBANAVE, PUBMAXDY, and PUBPEKHR). If data for one of these categories are not used in the Municipal Input, certain subgroups in the Local Historical Data may not be required. The subgroups of Projection Data required depend on the forecasting options selected. This selection is discussed in detail in Chapter III. For the present, it is sufficient to know that three options are available:

(1) Projection by internal growth models

(2) Projection by extrapolation of local historical data

(3) Use of projections made external to the IWR MAIN System

The NEWYEAR subgroup is required for each projection year regardless of the projection options selected, but the remainder of the Projection Data subgroups are related to specific options. The requirements for each projection option are detailed in Chapter III.

The IWR MAIN System may be used to simultaneously project water requirements for up to 24 separate years in addition to the base year. The 24 years may include the same year repeated several times with different projection options or alternative data points. In this case, each iteration counts as a separate year. The output reports produced by the IWR MAIN System include a set of detailed reports for each year named, including the base year. These reports are described in detail in Chapter IV. They include a detailed breakdown of residential, commercial/institutional, industrial, and public/unaccounted water usage as well as a summary for each year. In addition, an overall summary is provided, listing annual average, maximum day, and peak hour water requirement estimates for each year. Where no input is provided for a specific segment of water usage, no report is printed.

## D. Municipal Data Sources

The Municipal Data requirements of the IWR MAIN System consist of a series of data subgroups related to the residential, commercial/institutional, industrial, and public/unaccounted sectors of the community. The data

required are values of a number of economic and demographic parameters which have been found to be closely related to water usage. The parameters are to be evaluated at a base year, or as close to that year as possible. When the IWR MAIN System is used to estimate current water requirements, the estimate will be for the base year used in data gathering. When the projection capability is utilized, all projections will be calculated from the base year.

The following section discusses some of the information sources which may be used to obtain the required information. A summary of information sources available in most communities and which may be useful in assembling the required data is shown in this section as Table II-2. Chapter V lists, in detail, the exact data requirements for each subgroup.

### 1. Municipal Identification Data

These data consist of such information as the name of the urban area, the latitude and longitude of the area in degrees, population of the community, and other data. This information is used by the System for identification on the printed reports, interpolating climatic data, computing public-unaccounted usages, etc.

One of the data required in this subgroup is the value of the Deparment of Commerce Composite Construction Cost Index for the base year, that is, the year for which the home values used in the Residential Data are calculated. This value is used to correct home values to the price levels assumed by the water use equations. When local changes in building costs are believed to differ appreciably from the Department of Commerce index, or when other indices may be considered more appropriate, the values of a different index may be provided for both the base year and for 1980, as described in Section V.D.

### 2. Residential Data

The residential segment of an urban area is divided into four categories or groups, each of which is subdivided still further. The categories are designated by the method by which the residents pay their water bills (metered or flat rate) and the method of waste disposal (public sewer or septic tank). The System uses categories made up of combinations of these functions: metered and sewered, metered and septic tank, flat rate and sewered, and flat rate and septic tank.

It is assumed that the people living in apartments and apartment buildings who do not pay a water bill will use water at the same rate as flat rate home owners. Therefore, apartments should be classified in the flat rate-sewered category, with each apartment considered a separate residential unit, provided they are not individually metered.

| Source | Type of Information or Data |
|---|---|
| Local Public Library | General reference source |
| Regional or Local Planning Office | General advice and suggestions |
| Department of Public Works | General advice and suggestions |
| Chamber of Commerce | General advice and suggestions |
| U.S. Census Bureau "Block Statistics" | Many residential parameters |
| Board of Election Supervisors | Population distribution |
| Water Supply Utility | Water rates (prices) and jurisdiction |
| Real Estate Board | Housing and apartment data |
| Deparment of Assessment | Property Values |
| Bureau of Building Inspectors | Residential data, office buildings, and retail space |
| Department of Correction | Prison population |
| Department of Education | School and college enrollment |
| Department of Health | Data for barber shops, beauty shops, restaurants, bars, hotels, motels, hospitals and nursing homes |
| Council of Churches | Church membership |
| Blue Cross | Data for hospitals and nursing homes |
| Board of Liquor License Commissioners | Data for bars, night clubs, and taverns |
| Barber Schools | Barber shop data |
| Beautician Schools | Beauty shop data |
| American Petroleum Institute | Gas station data |
| Restaurant Chains | Conventional and drive-in restaurant data |

Table II-2. Typical Sources of Parameter Data

| Source | Type of Information or Data |
|---|---|
| Movie Theatre Chains | Threatre and drive-in movies |
| Bus and Rail Depots | Transportation terminal size |
| Car Wash Equipment Suppliers | Data on car washes |
| Bowling Equipment Suppliers | Data on bowling alleys |
| Laundry Suppliers | Data for commercial laundries |
| Laundry Equipment Suppliers | Laundromat data |
| YMCA Type Facilities | Data for YMCA, YWCA, etc. |
| U.S. Census Bureau "Census of Business" | Many commercial parameters |
| Department of Employment Security | Office, retail, and industrial employees by S.I.C. number |
| U.S. Census Bureau "Census of Manufacturers" | Industrial Populations |
| U.S. Department of Commerce, Bureau of the Census Statistical Abstract of the United States | Municipal Identification Data, Construction cost Indices, other data for SMSA and states |

Table II-2. Typical Sources of Parameter Data (Continued)

Within each of these subcategories, the residences should be grouped into home value ranges. (Value of an apartment is the value of the apartment building divided by the number of units in the building.) This may be the retail market value (including land and building) or the assessed property value. In the latter case, the assessment factor must be obtained from the Tax Assessor's Office. The parameters that are needed for each home value range are: the number of dwelling units, the housing density in terms of dwelling units per acre of residential land (including streets), population density in terms of average number of persons per dwelling unit, the annual average price of water, and the summer price of water, both in cents per 1000 gallons. Table II-3 shows which parameters are needed in each of the subgroups.

It has been shown during testing that a convenient way to find the categories and subgroups of home value is by political subdivisions. The U.S. Bureau of the Census has maps of every major metropolitan area in the United States showing census wards and tracts. It is common to find that the values of the homes within each of these political subdivisions are all nearly the same and that the housing density is fairly uniform. A user could acquire these Census Bureau maps and use them to locate the subcategory areas. The maps can also be planimetered to determine actual residential land area.

Some metropolitan areas are serviced by more than one water supply facility with different rate structures. The jurisdictional boundary limits of these suppliers should be indicated on the maps to properly assign water use prices to the subcategories and value range groupings.

The user may find the data needed on values of residences in the tax assessor's files. A possible source of data on population distribution might be the Board of Election Supervisors. Of course, the Census Bureau does issue block statistics reports on major metropolitan areas but only for the years of the census. These reports contain all data except prices that can be used by the residential submodel of the IWR MAIN System.

### 3. Commercial and Institutional Data

The commercial and institutional segment of a community is subdivided into categories of commercial and institutional establishments. The user will need to collect values of appropriate water use parameters for each of the categories such as the number of barber chairs in all the barber shops for the city or the number of hospital beds in all the hospitals, etc.

The IWR MAIN System has a built-in set of 28 general purpose commercial and institutional categories. A complete list of these categories can be found in Table II-4. The System does have space for an additional 22 unassigned commercial categories which are available to the user.

Values for commercial and institutional parameters could be acquired from various local municipal agencies and from major central commercial

| Residential Parameters | Subgroups | | | |
|---|---|---|---|---|
| | Metered Sewered | Metered Septic Tank | Flat Rate Sewered | Flat Rate Septic Tank |
| Value ranges for dwelling units | x | x | x | x |
| Number of dwelling units in each value range | x | x | x | x |
| Housing density | x | x | x | x |
| Population density | | x | x | x |
| Annual price of water | x | x | | |
| Summer price of water | x | x | | |
| Assessment factor (when assessed value used) | x | x | x | x |

Table II-3. Parameters Required for Analysis of Each Residential Subgroup

| Data Identification Name | Category Name | Parameter Units |
|---|---|---|
| BARB | Barber Shops | Barber Chairs |
| BEUT | Beauty Shops | Station |
| DPOT | Bus, Rail Depots | Square Feet |
| CARW | Car Washes | Inside Square Feet |
| CHUR | Churches | Member |
| CLUB | Golf, Swim Clubs | Member |
| BOWL | Bowling Alleys | Alley |
| COLG | College Residences | Student |
| HOSP | Hospitals | Bed |
| HOTL | Hotels | Square Feet |
| LNDM | Laundromats | Square Feet |
| LNDY | Laundries | Square Feet |
| MEDL | Medical Offices | Square Feet |
| MOTL | Motels | Square Feet |
| MOVI | Drive-in Movies | Car Stall |
| NURS | Nursing Homes | Bed |
| OFFN | New Office Buildings | Square Feet |
| JAIL | Jail and Prison | Person |
| EATN | Restaurants | Seat |
| EATO | Drive-In Restaurants | Car Stall |
| NITE | Night Clubs | Person Served |
| SALE | Retail Space | Sale Square Feet |
| SKLL | School, Elementary | Student |
| SKLY | School, High | Student |
| YMCA | YMCA, YWCA | Person |
| GASS | Service Stations | Inside Square Feet |
| THTR | Theatres | Seat |
| OFFO | Old Office Buildings | Square Feet |

Table II-4. List of Commercial and Institutional Categories as Contained in the IWR MAIN System

organizations and suppliers. Examples of municipal agencies that might have data are: Department of Education, Department of Health, Department of Correction, Fire Department, Liquor Board, Planning Office, Bureau of Building Inspectors, and other similar agencies. The user may find additional commercial parameter data from these central business sources: Chamber of Commerce; American Petroleum Institute; wholesale distributors of supplies and equipment for bowling centers, laundries, car washes, movies, barber shops, beauty shops, and restaurants; the Council of Churches; transportation terminals; and the local yellow pages directory. The U.S. Census Bureau report on "Census of Business-Selected Services Area Statistics" also contains data which the user may find useful in estimating parameter values when data from other sources are not available.

4. Industrial Data

The IWR MAIN System has been designed to allow the user to separate the industrial segment of his community by type of industry. These industrial (manufacturing) categories are grouped by three-digit S.I.C. (Standard Industrial Classification) codes. A list of those categories that are built into the System with usage coefficients is shown in Table II-5.

To use this part of the System, the user need only find the total number of employees in each three digit S.I.C. category. This information is usually compiled by the local office of the Department of Employment Security. There are also Census Bureau reports on "Census of Manufacturers - Location of Manufacturing Plants..." which may be useful for approximating industrial populations.

5. Public-Unaccounted Data

The IWR MAIN System contains two public water use categories: free service and airports, and one category of distribution losses. Water usage is computed based on per capita usage coefficients (see Table VI-4) where the municipal population is the parameter used for free service and distribution losses and the average daily airport passenger count is the parameter for the airports.

The user is not restricted to accepting the System's computations for public/unaccounted usage but he may input his gallons-per-day usage values for the categories if he knows them.

The System also contains space for 27 additional unassigned categories if the user wishes a further breakdown of free service such as street cleaning, firefighting, zoos, museums, parks, municipal buildings, and other categories.

| S.I.C. No. | Industrial Category |
|---|---|
| 201 | MEAT PRODUCTS |
| 202 | DAIRIES |
| 203 | CANNED, FROZEN FOOD |
| 204 | GRAIN MILLS |
| 205 | BAKERY PRODUCTS |
| 206 | SUGAR |
| 207 | CANDY |
| 208 | BEVERAGES |
| 209 | MISC. FOODS |
| 211 | CIGARETTES |
| 221 | WEAVING COTTON |
| 222 | WEAVING, SYNTHETICS |
| 223 | WEAVING, WOOL |
| 225 | KNITTING MILLS |
| 226 | TEXTILE FINISHING |
| 228 | FLOOR COVERINGS |
| 228 | YARN, THREAD MILLS |
| 229 | MISC. TEXTILES |
| 230 | WHL. APPAREL INDUSTRY |
| 242 | SAW-PLANING MILLS |
| 243 | MILLWORK |
| 244 | WOOD CONTAINERS |
| 249 | MISC. WOOD |
| 251 | HOME FURNITURE |
| 259 | FURNITURE FIXTURES |
| 261 | PULP MILLS |
| 262 | PAPER MILLS |
| 263 | PAPERBOARD MILLS |
| 264 | PAPER PRODUCTS |
| 265 | PAPERBOARD BOXES |
| 266 | BLDG. PAPER MILLS |
| 270 | WHL. PRINT INDUSTRY |
| 281 | BASIC CHEMICALS |
| 282 | FIBERS, PLASTIC |
| 283 | DRUGS |
| 284 | SOAP, TOILET GOODS |
| 285 | PAINT, ALLIED PRODUCTS |
| 286 | GUM, WOOD CHEMICALS |
| 287 | AGRICULTURE CHEM. |
| 289 | MISC. CHEMICALS |
| 291 | PETROLEUM REFINING |
| 205 | PAVING, ROOFING |

| S.I.C. No. | Industrial Category |
|---|---|
| 301 | TIRES AND TUBES |
| 302 | RUBBER FOOTWEAR |
| 303 | RECLAIMED RUBBER |
| 306 | RUBBER PRODUCTS |
| 307 | PLASTIC PRODUCTS |
| 311 | LEATHER TANNING |
| 321 | FLAT GLASS |
| 322 | PRESSED, BLOWN GLASS |
| 323 | PRODUCTS OF PURCHASED GLASS |
| 324 | CEMENT, HYDRAULIC |
| 325 | STRUCTURAL CLAY |
| 326 | POTTERY PRODUCTS |
| 327 | CEMENT, PLASTER |
| 328 | CUT STONE PRODUCTS |
| 329 | NON-METALLIC MINERALS |
| 331 | STEEL ROLLING |
| 332 | IRON, STEEL FOUNDRIES |
| 333 | PRIME NON-FERROUS |
| 334 | SECONDARY NON-FERROUS |
| 335 | NON-FERROUS ROLLING |
| 336 | NON-FERROUS FOUNDRIES |
| 339 | PRIME METAL INDUSTRIES |
| 341 | METAL CANS |
| 342 | CUTLERY, HARDWARD |
| 343 | PLUMBING, HARDWARE |
| 344 | STRUCTURE, METAL |
| 345 | SCREW MACHINE |
| 346 | METAL STAMPING |
| 347 | METAL SERVICE |
| 348 | FABRICATED WIRE |
| 349 | FABRICATED METAL |
| 351 | ENGINES, TURBINE |
| 352 | FARM MACHINERY |
| 353 | CONSTRUCTION EQUIPMENT |
| 354 | METALWORK, MACHINERY |
| 355 | SPEC. INDUSTRY MACHINERY |
| 356 | GENERAL IND. MACHINERY |
| 357 | OFFICE MACHINES |
| 358 | SERVICE IND. MACH. |
| 359 | MISC. MACHINES |
| 361 | ELECTRIC DIST. PRODUCTS |

Table II-5. List of Industrial Categories as Contained in the IWR MAIN System

| S.I.C. No. | Industrial Category |
|---|---|
| 362 | ELECTRIC INDUSTRIAL APPARATUS |
| 363 | HOME APPLIANCES |
| 364 | LIGHT-WIRING FIXTURES |
| 365 | RADIO-TV RECEIVING |
| 366 | COMMUNICATION EQUIPMENT |
| 367 | ELECTRONIC COMPONENTS |
| 369 | ELECTRIC PRODUCTS |
| 371 | MOTOR VEHICLES |
| 372 | AIRCRAFT AND PARTS |
| 373 | SHIP AND BOARD BUILDING |
| 374 | RAILROAD EQUIPMENT |
| 375 | MOTORCYCLE, BIKE |
| 381 | SCIENTIFIC INSTRUMENTS |
| 382 | MECHANICAL MEASURING DEVICES |
| 384 | MEDICAL INSTRUMENTS |
| 386 | PHOTOGRAPHIC EQUIPMENT |
| 387 | WATCHES, CLOCKS |
| 391 | JEWELRY, SILVER |
| 394 | TOYS, SPORT GOODS |
| 396 | COSTUME JEWELRY |
| 398 | MISCELLANEOUS MANUFACTURING |
| 399 | MISCELLANEOUS MANUFACTURING |

Table II-5. List of Industrial Categories as Contained in the IWR MAIN System (Continued)

6. Commercial Employment

When the IWR MAIN System is used to project water requirements, additional data are required for the commercial/institutional sector of the community. Every category except schools and colleges must be provided with the base year employment as well as the parameter values discussed earlier. These commercial employments are usually readily available from sources such as the local Department of Employment Security or equivalent, the Census Bureau report "Census of Business - Selected Services Area Statistics," or the Census Bureau publication "County Business Patterns." Normally these data are easily collected at the same time as the previously described parameter data.

## E. Local Historical Data Sources

When the IWR MAIN System is used to forecast municipal water requirements, Local Historical Data, and Projection Data must be provided as well as the Municipal Data. The Local Historical Data are used to determine the historical rate of change of certain factors which have been found to be correlated with the change in the water use parameters. These rates of change are used by the internal growth models to project values of parameters. The factors for which historical data are required consist of several demographic variables, such as population, median years of school completed by adults, fraction of population that is nonwhite, etc. Data are also required on changes in housing value, school enrollment, and certain categories of employment.

In general, all data required for the Local Historical Data group can be obtained from the various published reports of the Bureau of the Census, U.S. Department of Commerce. It is recommended that the data points collected cover at least 10 years for each variable, but in certain cases it may be desirable to reduce this to exclude unrepresentative or unreliable data. At least two but not more than five data points may be provided for each factor. Where the historical change of a factor is not linear, sufficient data points should be provided to adequately describe the actual change.

The data relating to population and characteristics of population are best obtained from the decennial censuses, published under the titles Census of Population and Census of Housing. Where more recent data are required than that available from the last census, the Statistical Abstract of the United States, published annually, contains recent estimates of many of these variables for states and Standard Metropolitan Statistical Areas (SMSA's). Estimates prepared by local planning agencies may also be used, but care should be taken to ensure that all data used for a given factor are consistent with respect to factor definition and geographic unit.

The changes in home value required are available from the Census of Housing, but several cautions must be observed. The 1950 and 1960 censuses report home value for owner-occupied, single family homes only. Due to the

unavailability of data for other classes of residences, the growth models contained in the IWR MAIN System were derived from this class of data only. Historical data collected should be limited to the same class of housing, since other types of housing, particularly multifamily housing, can be expected to have somewhat different value-time characteristics. Housing value groups are defined as follows:

| Housing Value Group | 1980 Dollars |
|---|---|
| Low | 0 to 25,500 |
| Medium | 25,500 to 51,000 |
| High | 51,000 and up |

The Census of Housing contains information on the number of homes in each of a number of value ranges, each range expressed in current dollars. These ranges must be converted to 1980 dollars and assigned to one of the three value groups in the manner described in Section V.I.

Employment data may be obtained from the Census of Business and from the Census of Manufacturers, published periodically by the Bureau of the Census, U.S. Department of Commerce. In addition, data for counties, independent cities, and Standard Metropolitan Statistical Areas (SMSA's) may be obtained from the appropriate issue of "County Business Pattersn," published annually by the Bureau of the Census. Local employment security offices frequently have historical data on employment readily available, organized by major political subdivision. If data from several sources are employed, care should be taken to ensure consistency. There are several ways of obtaining basic data on employment and they tend to yield somewhat different results. Most annual data and data from state and local agencies are based on employer's tax returns and may differ to the extent that various Federal, state, and local tax laws differ in their coverage of particular employers or occupations.

All of the publications and reports discussed are normally available in any reasonably complete reference library. Census Bureau publications may be obtained directly from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., when unavailable locally. Other data sources include local planning agencies and local employment security offices.

## F. Projection Data Sources

In addition to the Municipal Data and Local Historical Data, the use of the IWR MAIN System for forecasting water requirements entails the preparation of Projection Data. These data define the basic assumptions upon which the projection will be made. The data described previously creates the base for the projection and defines various trends to be taken into account, but the

Projection Data determines the manner in which the projection will be carried out. Three kinds of Projection Data may be prepared:

(1) Key Projections

(2) Future Values of Parameters

(3) Historical Records of Parameters

Of the Key Projections, population and per capita personal income projections are required. Other key projections and the other classes of Projection Data are optional and used in connection with the various optional projection methods discussed in the next chapter.

In general, Key Projections and Future Values of Parameters may be obtained from local planning agencies or developed by the IWR MAIN System user. Certain Key Projections, such as population and personal income, are available from the published sources for many areas. The National Planning Association has prepared 1975 projections of these factors for each Standard Metropolitan Statistical Ara (SMSA) and the Statistical Abstract of the United States contains 1975 population projections for many SMSAs. Other projections, such as manufacturing employment, are available from the National Planning Association reports. Circulation of these reports is limited to member agencies and reference libraries, but they are generally available from these secondary sources.

## G. Library Input

As mentioned earlier, part of the IWR MAIN System is composed of the Library of Water Usage Coefficients. This Library contains such data as the residential equation constants, climatic data, category identification labels, and usage coefficients for the commercial/institutional, industrial, and public/unaccounted submodels.

A complete detailed description of the Library contents and use is given in Chapter VII of this report. An actual listing of the Library contents is presented in Appendix C.

# III. SELECTION OF PROJECTION METHODS

## A. General Considerations

The IWR MAIN System forecasts municipal water requirements by projecting the value of each of up to 400 parameters. These projected parameters are then used to estimate water requirements, employing a series of mathematical models of water usage. Forecasts can be made for each of up to 20 projection years, each forecast being independently derived from the base year. This chapter will discuss the methods used to project future values of the various water usage parameters.

Projections of water usage parameters can be carried out in any of three ways:

- o Projection by internal growth models
- o Projection by extrapolation of local historical data.
- o Use of projections made external to the IWR MAIN System

In general, for each projection year, and for each parameter, the projection method may be selected independently of other parameters and other years. For example, the first projection method may be employed for a given commercial parameter in one projection year, the second in another and the third in still another, even though other options were being selected for other commercial parameters.

In addition, the user may provide certain constraints to be used by the system, such as an external projection of manufacturing employment, which, while not a parameter itself, will be used as a constraint on the sum of all individual employments in the manufacturing category. The overall result of these options is great flexibility in the use of the IWR MAIN System in forecasting municipal water requirements under a wide variety of local conditions and forecasting assumptions. The ability to re-iterate independent forecasts of the same year with several sets of projection options facilitates testing assumptions and estimating the sensitivity of water requirements to variation in individual parameters.

Selection of the options to be employed is determined by the input data provided. Data must be provided for the following subgroups in every case.

| Municipal Data | Local Historical Data | Projection Data |
|---|---|---|
| OPTIONS | POPULATN | NEWYEAR * |
| CITYDATA | NONWHITE | |
| METRSEWR | ALLHOMES | |
| METRSEPT | MEDHOMES | |

| Municipal Data | Local Historical Data | Projection Data |
|---|---|---|
| FLATSEWR | HIGHOMES | |
| FLATSEPT | SKOLYEAR | |
| COMMPARM | ELEMSKOL | |
| INDPARAM | HIGHSKOL | |
| PUBPARAM | TSERVICE | |
| COMMEMPL | MEDICALS | |
| | INDHISTY | |

*Required data is YEAR, POPU (population projection), and ICOM (per capita personal income projection only

With these data, the IWR MAIN System will project all parameters by means of the internal growth models. These projections may be modified by any of several optional constraints, however. Within the NEWYEAR subgroup, projected values of housing density, residential land acreage, or total services employment may be provided. Under subgroup INDPROJT, which follows NEWYEAR in the input deck, a value for total manufacturing employment may be provided, if desired.

When the local historical data for a specific parameter are to be extrapolated, the appropriate historical record is provided under the proper subgroup heading in the following list:

| Projection Data |
|---|
| NEWYEAR |
| HNUMHOMS |
| HCOMPARM |
| HINDPARM |

At least two, but not more than seven, data points for any parameter will cause that parameter to be projected by extrapolation of the historical data provided.

Projections of specific parameters may be made external to the IWR MAIN System and provided to the system directly by placing the projected values under the proper subgroup heading in the following list:

| Projection Data |
|---|
| NEWYEAR |
| NUMHOMES |
| COMFPARM |
| INDPROJT |
| PUBPARAM |

Certain parameters may be specified indirectly as well. Projections of commercial employment may be available, for example, where no value is available for the related commercial parameter. In this case, an additional

subgroup, COMFEMPL, is provided for the projected values of commercial employment, which are internally converted to a projection of the commercial parameter, overriding other options. Public/unaccounted water requirements may be provided directly for a projection year without use of parameters by placing the data in the subgroups PUBANAVE, PUBMAXDY, and PUBPEKHR.

When several different projection options are employed for a given projection year, the possibility of conflicts or inconsistent assumptions must be considered. The IWR MAIN System resolves internal conflicts by a system of priorities, where one option always takes precedence over another, should both be present. The complete structure is somewhat complex, but priorities are indicated, where applicable, in discussions of individual projection methods which follow.

## B. Projection by Internal Growth Models

### 1. Introduction

During the course of the research which led to the development of the MAIN II System, data were collected for approximately 65 Standard Metropolitan Statistical Areas (SMSA) throughout the conterminous United States, covering up to 25 years of records of selected water use parameters and other factors. These data were used to model the time behavior of the water use parameters, particularly as related to other factors and variables found to be well correlated with the parameters under study. The result was a series of growth models, each of which describes the growth of a single parameter or group of parameters as a function of time and other explanatory variables. These same cities were re-evaluated using 1970 and 1980 data, and the parameters updated, resulting in the IWR MAIN System. The actual growth models used are presented as Appendix B of this manual.

When no other instructions are given, the IWR MAIN System uses these internal growth models to predict the values of the various parameters in future years. Experience with the development and application of IWR MAIN to date indicates that these models produce reliable estimates in the great majority of cases. It will frequently be possible to produce superior estimates of specific parameters by making use of special knowledge of a local trend or situation, but where special knowledge or special studies are not available, it will seldom be possible to improve on the internal models.

This general advice may not apply, however, where the study area is not a complete community. The growth models were developed for complete metropolitan areas and assume the study area includes a reasonably self-sufficient urban system. When a substantial portion of the industrial employment is drawn from outside the study area, when the commercial/institutional sector serves a significant population beyond that residing in the study area, or when any of several other conditions exist which indicate an unbalanced community, the other projection options should be used to the maximum extent

feasible on the parameters most likely to be affected. It is strongly recommended that the judgement of an experienced urban planner familiar with the study area be sought in defining approaches to problems of this type.

## 2. Residential Submodel

The residential submodel of the IWR MAIN System contains internal growth models for the following parameters:

(a) Total number of homes

(b) Fraction of homes in the low value group

(c) Fraction of homes in the medium value group

(d) Fraction of homes in the high value group

Provision is made for the optional supply of the following parameters:

(a) Total residential land acreage

(b) Overall average housing density

The four categories of residential water use are estimated from a total of seven parameters. Three of these, namely, annual price of water, summer price of water, and assessment factor, are held constant. Since the assessment factor is used only as a correction factor for value ranges which are not subsequently redefined, there is no need to consider any changes which might occur in the future.

The price of water is subject to change but no convenient method is available at this stage of development of the IWR MAIN System to incorporate future changes. Water prices used in the water use equations are marginal prices to individual groups of consumers. Data for a future year would consist of an assumption regarding a rate schedule and the marginal price for a group of consumers would require knowledge of the price block at which a group was purchasing their water, as well as assumptions regarding other charges, such as wastewater service charges which might appear as a fraction of the water bill. Furthermore, charges may vary for different districts, such as a municipally owned system charging higher rates to customers outside the city limits. For these reasons, water prices are held constant and, where changes are to be investigated, additional runs must be made with the Municipal Data modified to reflect alternative pricing schedules. The remaining parameters, dwelling unit value ranges, number of homes in each value range, housing density, and population density, are modified by the growth models or optional projections as described in the following.

The Municipal Data includes sets of value ranges for each of the residential categories used. These value ranges are expressed in terms of

current dollars at the base year. The value may be an assessed value or a market value. If an assessed value, it is modified by the assessment factor, and both values are modified by a ratio of two construction cost indices to convert all values to 1980 dollars, market value. The IWR MAIN System uses the same value ranges for each projection year, changing only the number of homes contained within each value range. This is done by utilizing the projection of total number of homes and fraction homes in each of the value groups, applying the appropriate fraction to each value range. Part of the Municipal Data is the number of value ranges in each value group.

Housing density is provided as part of the Municipal Data for each housing value range. If none of the optional projections are made, the housing densities are held constant for each value range. If total residential acreage is provided for a projection year, the total acreage for the base year is computed by summing the number of homes divided by housing density for each value range and all housing densities are adjusted by a correction factor equal to the ratio of the current residential area to the projected area. If overall housing density is projected, the current overall density is calculated and each individual density adjusted by the ratio of the projected density to the current density.

Population density, or persons per household, is provided for each value range in the base year, for all categories except metered-sewered. Overall population density is computed for the base year and projection year by dividing current or projected total number of housing units. The ratio of these overall densities is used to adjust each individual density to the projection year value.

### 3. Commercial/Institutional Submodel

The IWR MAIN System contains water use equations for 28 categories of commercial/institutional establishments. Based on data availability and on similarity of growth patterns, many of these categories were combined for purposes of developing growth models. Nine internal growth models are incorporated in the system:

(a) Hotels, Motels

(b) Barber Shops, Beauty Shops

(c) Restaurants, Drive-In Restaurants, Night Clubs

(d) Hospitals, Nursing Homes, Medical Offices

(e) Laundries, Laundromats

(f) Retail Space

(g) Elementary Schools

(h) High Schools

(i) Total Services Employment

In the case of all categories except schools, the growth model is used to project employment within the category, based on base year employments provided under subgroup COMMEMPL. The ratio of the projected employment to the base year employment is then used to project the value of the water use parameter, such as square feet in the case of Retail Space.

Total services employment is used in two ways within the commercial/institutional submodel. It is used directly as the growth model for all categories not listed for one of the other models. Any new categories added by the user will be included in this growth model unless optional projection methods are selected by the user. The projected value of the various water use parameters is determined in the same way as described above -- projected employment is calculated first and the projected parameter value determined by using an employment ratio. The second use of the projected total services employment is as a constraint on the individual service industries. The total projected employment for all commercial/institutional categories except schools is computed and compared to the projected total services employment. If the total of the individual categories is less than the projection of total services employment, no change is made. If it is greater, however, each category is reduced proportionately until the totals are equal.

It should be noted that an external projection of total services employment can be provided by the user. In this case, the externally generated value will replace the internal projection in both of the functions described. It is also important to note that the total services employment constraint overrides all projection options, that is, regardless of whether an individual category projection was determined by an internal growth model or whether one of the optional projection methods was used, the category may still be reduced to meet the total services employment criteria.

## 4. Industrial Submodel

The IWR MAIN System calculates water requirements individually for each three-digit S.I.C. category from 200 to 399, inclusive, for which water use coefficients have been developed. Among the 200 possible categories, a number have not yet been assigned an industry description by the U.S. Department of Commerce and others have not had sufficient water use data reported to permit calculation of a water use coefficient. The present Library of Water Use Coefficients contains values for 105 categories. Others may be added by the user, if required.

The industrial categories are initially grouped by two-digit S.I.C. numbers for purposes of projection. All categories from 200 to 209, for example, are treated as category 20. These two-digit groupings are further

grouped by similarity of industry type and growth pattern into 11 final groups. Growth models have been developed for each of the 11 groups, which are defined as follows:

| Industry Group | S.I.C. Numbers |
|---|---|
| Food, Tobacco | 20, 21 |
| Textile, Apparel | 22, 23 |
| Furniture, Paper, Lumber | 24, 25, 26, 27 |
| Chemicals, Petroleum, Coal | 28, 29 |
| Rubber, Plastics | 30 |
| Leather | 31 |
| Stone, Clay, Glass | 32 |
| Primary & Fabricated Metal | 33, 34 |
| Machinery, except electrical | 35, 36 |
| Transportation | 37 |
| Instruments, Misc. Manufacture | 38, 39 |

Since the water use parameters for the industrial classifications are, in every case, employment, the operation of the industrial growth models is straightforward. The current total employment within the industry group is projected by use of the growth model and the ratio of the projected total group employment to the base year total group employment is used to modify each of the three-digit S.I.C. employments with the group.

Unlike the Commercial/Institutional Submodel, where an overall constraint on employment is mandatory, constraint of total manufacturing employment is optional. It can be accomplished by providing an externally projected value of total manufacturing employment as variable name EMPM in subgroup INDPROJT, following the NEWYEAR subgroup. In this case, the projected employments for all categories will be totaled and this number compared to the projection of total manufacturing employment provided. Each individual category employment will be modified proportionately such that the totals agree. This optional constraint overrides all other projections, whether by internal growth models or by optional projection methods.

## 5. Public/Unaccounted Submodel

The Public/Unaccounted Submodel of the IWR MAIN System contains three categories of water use; distribution losses, free services, and airports. The water use parameter for airports is passengers per day and the other two categories are based on total population. Since a projection of population is one of the data which must be provided by the system user, calculation of projected values of distribution losses and free services does not require the use of a growth model. In the case of airports, the parameter is projected by multiplying the base year value by the ratio of projected population to base year population.

The Public/Unaccounted Submodel contains provision for up to 27 additional categories of water use which may be defined by the user. No projection is made by the system of any of these additional categories. Should one or more of the categories be defined and used in the water use calculations, it will be necessary to employ one of the projection options for that category. If no option is selected, the value of the parameter will remain unchanged.

Instead of estimating public/unaccounted water use based on the parameters described the user may estimate water requirements directly for this sector of usage, entering the estimates under data subgroups PUBANAVE, PUBMAXDY, and PUBPEKHR. In this case, as with the optional categories, no projection is made by the system, and the only method available for incorporating projected values is to develop them externally and provide the data as described in Section III.D.

## C. Projection by Extrapolation of Local Historical Data

### 1. Introduction

In the course of applying the IWR MAIN System to urban water supply planning problems, many situations will arise where no special knowledge of the future growth of a given parameter is available, yet there are good reasons for believing that the internal growth projections made within the IWR MAIN System will be inappropriate. In a resort city, for example, the growth of hotels and motels cannot be predicted from growth experienced in otherwise similar cities which are commercially or industrially oriented. Problems of this type arise when the study area is not a self-sufficient community, or when a particular industry so dominates a community that fluctuations in its national market affect the growth of other businesses and services. In each of these cases, provided no other information is available, it is usually prudent to base projections on a simple extrapolation of recent trends, rather than rely on the internal growth models.

Where this projection option is required, additional data must be gathered for the study area. Values must be provided for the parameter for at least two, but not more than seven, different years. One of these years may be the base year. It is usually desirable to provide as many data points as possible, particularly if the historical trend of the parameter has not been linear. The span of time covered by the historical data is a matter of judgment, but in general it should be at least 10 years and not more than the span covered by the projection. The IWR MAIN System performs a linear regression on the data provided and uses the slope of the regression line to project a value of the parameter from the base year value. The value thus projected generally preempts projections by internal growth models, except as discussed in the following sections.

## 2. Residential Submodel

The parameters which can be extrapolated from historical trends in each category of the Residential Submodel are limited to the following:

(a) Total number of homes

(b) Number of homes in low value group

(c) Number of homes in medium value group

(d) Number of homes in high value group

The projection option is selected by providing the required historical record under data subgroup HNUMHOMS. This projection option can be used for any or all of these parameters for any or all active residential categories.

Conflicts and inconsistencies which might arise through the use of the optional projections of number of homes are resolved through a system of priorities. In general, the projections made by extrapolation of historical data supersede those made by internal growth models. Where partial options are employed, the system attempts to preserve first its internally generated totals for categories (metered-sewered, metered-septic tank, etc.), then for value groups, and finally the total number of homes (in order of increasing priority). Table III-1 indicates the operation of the Residential Submodel, given various combinations of projection options. When the use of these options is contemplated for anything less than every active category and value group, it is advisable to refer to Table III-1 to ensure that the desired results will be obtained.

## 3. Commercial/Institutional Submodel

Any of the commercial/institutional categories may be projected by extrapolating historical trends in the related parameters. The historical record is provided in data subgroup HCOMPARM for each category selected and the Commercial/Institutional Submodel projects values of those parameters based on a linear regression analysis of the historical record. These projected values replace the values projected by the internal growth models in every case. Where the internal growth model is used for two or more categories, as in the case of hotels and motels, the categories for which projection options are not selected are unaffected. Historical data provided for motels, for example, will not change the internal projection of hotels.

It should be noted that the internal computation of category employment is also unaffected by this projection option. Although employment is not used in the water use computations, this fact is important because of the total services employment constraint imposed on all commercial categories. This constraint overrides internal projections and projections options alike and may alter a projection made by extrapolation of historical data unnecessarily,

The IWR MAIN System generates tentative internal projections of the number of homes in each value range (low, medium, high), in each category (metered-sewered, metered-septic tank, etc.), as well as all totals. These projections can be designated:

| | | Categories A | B | C | D | Totals |
|---|---|---|---|---|---|---|
| Value Groups | 1 | A1 | B1 | C1 | D1 | T1 |
| | 2 | A2 | B2 | C2 | D2 | T2 |
| | 3 | A3 | B3 | C3 | D3 | T3 |
| Total | | AT | BT | CT | DT | TT |

The user may, by optional projection methods, provide values for any or all of the following numbers (designated with a prime (') to indicate final values):

| A | B | C | D |
|---|---|---|---|
| A1' | B1' | C1' | D1' |
| A2' | B2' | C2' | D2' |
| A3' | B3' | C3' | D3' |
| AT' | BT' | CT' | DT' |

The system must calculate the row totals:

| | Totals |
|---|---|
| 1 | T1' |
| 2 | T2' |
| 3 | T3' |
| Totals | TT' |

and generate projections for all above positions not projected by the user thorough an optional method. Since conflicts and inconsistencies are possible, the following procedure is followed, in the sequence given, to complete the projections.

o Adjustments to grand total

If: (T1' + T2" + T3') ½ TT', TT' is raised to equal (T1' + T2' + T3'). If AT', BT', CT', and DT' have been provided by the user for each active category TT' is final. If not, and if TT ½ TT', TT' is set equal to TT. TT' is now final.

Table III-1. Procedure for Resolving Mixed Projections of Housing Units

- Adjustments to value group totals

  If: An', Bn', Cn', and Dn' for any value group (n = 1, 2, o4 3) have been provided for all active categories, Tn' for that group is final. If not, and Tn' ½ Tn for any value group, Tn' for that group is final. Any remaining Tn' are found by adjusting corresponding Tn proportionately so that (T1' + T2' + T3') = TT'.

- Adjustments to category totals

  User-supplied category totals are final. Others are found by adjusting corresponding internal projections (AT, BT, etc.) proportionately until (AT' + BT' + CT' + DT') = TT'. All totals are now final.

- Adjustments to category value groups

  User-supplied values are final. All other values are found by a series of proportional adjustments to internally generated values. These adjustments preserve, in order of priority: the grand total, value group totals, and category totals. All values are not final and the internal projections are destroyed.

Table III-1. Procedure for Resolving Mixed Projections of Housing Units (Continued)

since the constraint is based on employment and that data is unaffected by the optional projection. If this is expected to be a problem, the user may wish to consider the use of external projections, as described in Section III.D, of employments related to commercial categories selected for the extrapolation of historical data option.

4. Industrial Submodel

The Industrial Submodel of the IWR MAIN System operates in a manner similar to the Commercial/Institutional Submodel, although the use of employment as a parameter simplifies the procedure. Employment in any S.I.C. category may be projected by providing a historical record of that employment for the area under study. These data are placed in data subgroup HINDPARM. The resulting projection will override the internal projection for that category in every case. Other employments within the same growth model grouping will be adjusted proportionately to preserve the internally projected total for the group, unless the total of the categories projected by the optional method exceeds that internal total. In that case, any remaining categories will be set equal to zero and the total of the optional projections will replace the internal total. If the optional projection of total manufacturing employment is used, any adjustment on that account will override optional projections of individual categories, or groups of categories.

5. Public/Unaccounted Submodel

The three public/unaccounted water use parameters, as well as any additional parameters for categories that may be added by the user, can be projected by extrapolation of historical data. Since two of the categories use population as the parameter, which is already available for the projection year, the utility of this option may not be immediately obvious. The water usage coefficients, which are contained in the Library of Water Usage Coefficients, can be used, together with a historical record of actual distribution losses, or free service, to determine a record of equivalent population. This record can be placed in data subgroup HPUBPARM and used to project an equivalent population. The projected equivalent population will then be used to calculate the water usage in the projection year, rather than the actual projected population for that year. This method permits the use of projection option and approach for the public/unaccounted sector which is compatible with those described. The airport category, as well as any additional categories provided by the user, can be projected by simply providing the historical data for each category. These optional projections override, in every case, the projections developed internally, as described in Section III.B.

## D. Use of Projections Made External to the IWR MAIN System

### 1. Introduction

Earlier sections of this chapter discussed the use of the internal growth models of the IWR MAIN System and the capability for extrapolating historical data. Both of these techniques were presented as methods of projecting parameter values where no special knowledge of the expected future behavior of the parameter is available. Situations will frequently arise, however, where some degree of knowledge is available on the likely growth of some specific parameter. This may come about because of a detailed study which has been made of some aspect of the community's economy, or because of firm plans on the part of an industry or commercial enterprise to expand, relocate, or phase out an operation. In any of these situations, it will be desirable to bypass alternative methods of projecting parameter values, and provide the projected value of the affected parameters directly from sources external to the IWR MAIN System. This capability is available by simply placing the projections in the proper data fields under subgroups NUMHOMES, COMFEMPL, COMFPARM, INDPROJT, PUBPARAM, PUBANAVE, PUBMAXDY, and PUBPEKHR, all following NEWYEAR.

This option in the IWR MAIN System has a secondary purpose that, in many applications, may overshadow the first in importance. Use of the internal growth models, or projection by extrapolation of historical trends, yields a deterministic set of projections which are used to estimate a deterministic set of water requirements. All urban or water supply planners are familiar with the large uncertainties implicit in all projections. One useful method of exploring those uncertainties is by testing the sensitivity of the final forecast to ranges of values for various critical projections. Tests of this type can be carried out conveniently by using the external projection option of the IWR MAIN System. The recommended procedure is to process the IWR MAIN System in the normal manner and review the output reports, determining which parameters appear the most significant in affecting overall water requirements, and which parameter values appear suspect in the judgement of the system user. A second run is made with each projection year repeated several times. Each iteration of each projection year contains direct external projections of those parameters previously identified as critical or suspect, with a range of values, constructed to represent the range of reasonable parameter estimates, utilized over the various iterations. In this manner, a range of water requirement forecasts will result for each projection year which embraces the probable variation in the parameters studied.

### 2. Residential Submodel

The IWR MAIN System provides for direct external projection of the following residential parameters:

(a) Total number of homes

(b) Number of homes in low value group

(c) Number of homes in medium value group

(d) Number of homes in high value group

Each of these parameters can be supplied for any or all of the active residential categories (metered-sewered, metered-septic tank, etc.). The projection option is selected by placing the required data in the data subgroup NUMHOMES, following NEWYEAR.

In every case, projections supplied in this manner override those developed by the internal growth models or by extrapolation of historical trends. Conflicts and inconsistencies which might arise through the use of mixed projection options are resolved through a system of priorities. In general, the projections made by direct external projection supersede those made by extrapolation of historical trends, which, in turn, supersede those made by internal growth models. When conflicts occur, the system attempts to preserve first its internally generated totals for categories (metered-sewered, metered-septic tank, etc.), then totals for value groups (low, medium, high), and finally the total number of homes (in order of increasing priority). Table III-1 describes, in somewhat simplified form, the operation of the Residential Submodel, given various combinations of projection options. When the use of a particular option is contemplated for anything less than every parameter in every active category, it is advisable to refer to Table III-1 to insure that the desired results will be obtained.

### 3. Commercial/Institutional Submodel

External projections of any commercial-institutional parameter may be used in preference to other projections by providing the projections in the data subgroup COMFPARM. In addition, a direct projection may be made of employment within a given category by placing this information in the data subgroup COMFEMPL. As the IWR MAIN System assumes a constant relationship between employment and parameter value in each category (a constant productivity assumption), it is usually desirable to provide both the employment and parameter value when a study has been made of the expected growth in a particular category. Either data point is sufficient to cause the external projection to be accepted, however, overriding both internal growth model projections and projections made by extrapolating historical data.

As noted in previous sections, a projection of total services employment, either internally generated or provided by the user, is used as an upper limit for the total of all commercial/institutional employment, except schools. This constraint overrides individual projections, regardless of the option chosen. and every category is reduced proportionately, if required. At no time are parameters increased by reason of this constraint. When a direct external projection is made of a commercial/institutional parameter only, the

employment associated with that parameter is that generated by the internal growth model, thus potentially affecting the behavior of the constraint. When commercial/institutional employment only is provided for a parameter, both employment and the parameter value are changed, but the relationship between them assumes the same employee productivity present in the base year.

In most cases, a single growth model is used for several commercial/institutional categories. When a portion of those categories are projected by direct external projections, the value of the remaining parameters are adjusted proportionately such that the total employment in all categories in the group is equal to that projected by the internal growth model. Should the total of categories where the projection option is exercised equal or exceed the internally projected group total, the other categories are set to zero. Again, the total services employment constraint follows and overrides this adjustment.

### 4. Industrial Submodel

Employment in any industrial S.I.C. category may be externally projected and provided to the IWR MAIN System by placing the required information in data subgroup INDPROJT. This optional projection will override any other option except the total manufacturing employment constraint, when selected. When the direct external projection option is selected for fewer than all active categories within a given growth model grouping (see Section III.B.4), the categories projected by internal growth models are reduced proportionately to preserve the internally projected total for the group. Categories projected by extrapolation of historical trends are not reduced, but if the same category is provided with a direct external projection, the latter overrides the former. When the total of categories which have been projected by a method other than the internal growth models equals or exceeds the total for the group projected internally, the internal total is revised and other active categories in the group are reduced to zero. When the total manufacturing employment constraint has been selected, it follows and overrides all adjustments discussed.

### 5. Public-Unaccounted Submodel

Direct external projections can be provided for the values of any of the public-unaccounted parameters, or for the actual public-unaccounted water requirements. This option is selected by placing the data in the proper position in data subgroups PUBPARAM, PUBANAVE, PUBMAXDY, and PUBPEKHR. The discussion of the use of equivalent population to project the values of free service and distribution losses, as presented in Section III.C.5, also applies here. In many cases, however, it will be more convenient to use the water requirement subgroups for this purpose, rather than manipulating the parameters. Direct external projections override projections made by internal growth models or by extrapolation of historical data in every case. No other constraints are applied to this submodel.

# IV. SYSTEM OUTPUT REPORTS

## A. General Description

The printed output generated by the IWR MAIN System computer program is determined by the data provided to the system. The System generates up to nine reports for each year analyzed, plus a single summary of all years. A complete list of all possible systems reports is tabulated below:

(1) Residential Water Requirements - Metered and Sewered Areas

(2) Residential Water Requirements - Flat Rate and Sewered Areas

(3) Residential Water Requirements - Metered and Septic Tank Areas

(4) Residential Water Requirements - Flat Rate and Septic Tank Areas

(5) Residential Water Requirements - Summary of All Areas

(6) Commercial Water Requirements - Categories and Summary

(7) Industrial Water Requirements - Categories and Summary

(8) Public/Unaccounted Water Requirements - Categories and Summary

(9) Municipal Summary Report

(10) Forecast Summary Report

## B. Residential Reports

The IWR MAIN System contains four categories of residential water use:

(1) Metered - sewered residences

(2) Flat rate - sewered residences

(3) Metered - septic tank residences

(4) Flat rate - septic tank residences

A particular urban area may require one or more of these categories. Reports are generated for those categories actually present and for which water requirements are calculated. Table IV-1 includes an example of a report detailing metered and sewered residential areas. In addition, a residential summary report is generated in every case, as shown in the lower part of Table IV-1.

MUNICIPAL WATER REQUIREMENTS FOR THE CITY OF BALTIMORE (CITY),MD. FOR THE YEAR 19[illegible]

ANALYZED BY MAIN SYSTEM

CURRENT RESIDENTIAL WATER REQUIREMENTS BY CATEGORY

METERED AND SEWERED AREAS

ANNUAL AVERAGE

| VALUE RANGE ($) | NO. OF UNITS | DOMESTIC | SPRINKLING | TOTAL | MAX DAY | PEAK HOUR |
|---|---|---|---|---|---|---|
| 3500. - 4999. | 2354. | 417113. | 167659. | 584772. | 716521. | 2231463. |
| 5000. - 5999. | 7943. | 1441919. | 662286. | 2104205. | 2768396. | 8236835. |
| 6000. - 6999. | 19097. | 3533307. | 2648576. | 6181883. | 7113749. | 20726831. |
| 7000. - 7999. | 15167. | 2858574. | 1537601. | 4396175. | 6369600. | 17913262. |
| 8000. - 8999. | 17682. | 3393341. | 1922568. | 5316506. | 8070098. | 22187990. |
| 9000. - 9999. | 25918. | 5064721. | 3355500. | 8420222. | 12651679. | 34175948. |
| 10000. - 10999. | 10239. | 2335[illegible]. | 1443453. | 3479818. | 5355822. | 14222523. |
| 11000. - 11999. | 13937. | 2820197. | 1452350. | 4272547. | 8066061. | 20324203. |
| 12000. - 12999. | 30261. | 6228919. | 3840623. | 10069041. | 18399230. | 47218421. |
| 13000. - 14999. | 9286. | 1959078. | 1150371. | 3109980. | 6228079. | 15663559. |
| 15000. - 19999. | 3959. | 861226. | 438398. | 1299624. | 3182102. | 7707206. |
| 20000. - 30000. | 8509. | 2120443. | 1360923. | 3481365. | 9442336. | 21887197. |
| TOTAL | 164252. | 32735538. | 19979805. | 52715343. | 88363489. | 233049330. |

MUNICIPAL WATER REQUIREMENTS FOR THE CITY OF BALTIMORE (CITY),MD. FOR THE YEAR 19[illegible]

ANALYZED BY MAIN SYSTEM

CURRENT RESIDENTIAL WATER REQUIREMENTS IN GALLONS PER DAY

| ANNUAL AVERAGE | MAXIMUM DAILY | PEAK HOURLY |
|---|---|---|
| 95173[illegible]97. | 17[illegible]563927. | 4[illegible]976160. |

REQUIREMENTS BY TYPE - ANNUAL AVERAGE

| TYPE | NO. OF UNITS | GALLONS PER DAY DOMESTIC | SPRINKLING | TOTAL |
|---|---|---|---|---|
| METERED AND SEWERED AREAS | 164252. | 32735538. | 19979805. | 52715343. |
| FLAT RATE AND SEWERED AREAS | 108114. | 19776836. | 22651718. | 42458554. |
| TOTAL | 272266. | 52512374. | 42631523. | 95173997. |

SUMMER EVAPOTRANSPIRATION (INCHES) = 16.75

SUMMER PRECIPITATION (INCHES) = 6.50

MAX. DAY EVAPOTRANSPIRATION (INCHES) = .79

Table IV-1. Residential Water Requirements Reports

The detailed residential water requirement report for the metered and sewered areas is identical with reports that may be generated for the other three categories. The value ranges indicated are those provided by the user and are in terms of assessed value or market value, whichever was provided. The number of units are the total number of residences in each value group, as provided by the user if current requirements are being reported, or as projected by the system for predicted water requirement reports. The last five columns detail water requirements in terms of gallons per day. Domestic water uses refer to all uses within the home itself, while sprinkling uses include all outside or seasonal uses. The sum of the two is the total annual average requirement, which is followed by estimates of requirements for the maximum day of the year and the peak hour of the year. The last line presents totals for all columns.

The residential summary report lists totals of annual average, maximum daily, and peak hourly requirements, as detailed in the separate reports discussed above. All values are in gallons per day. Below the totals, a recapitulation of the requirements of each category, as given by totals on each category report, is presented, including the number of residential units in each category and their total. The final entries on the report are the climatic data used in computing water requirements, as determined from data contained in the Library of Water Usage Coefficients.

## C. Commercial/Institutional Reports

The commercial water requirements report contains both summary and detailed information on water use for 28 categories of commercial establishments and institutions, as well as any categories added by the user. Table IV-2 shows such a report. Near the top of the report, total commercial/institutional requirements are shown, in gallons per day, for the annual average, the maximum day, and the peak hour. These values are the totals of the detailed categories which appear below.

Each commercial/institutional category is identified by a name under the "TYPE" heading, followed by the designation of the units of the water use parameter. For example, the parameter for hotels and motels is square feet of floor space, while for barber shops it is the number of barber chairs. The third column displays the number of units, or the value of the water use parameter for the year of the report. When current requirements are being estimated, this value is provided by the user, but it is projected by the system for forecasts of future years. The remaining three columns list annual average, maximum day, and peak hourly requirements for each category. Table IV-2 shows some of the 28 standard categories, as well as providing for two additional ones, multi-family housing and fast food restaurants.

MUNICIPAL WATER REQUIREMENTS FOR THE CITY OF BALTIMORE (CITY),MD. FOR THE YEAR 1967

ANALYZED BY MAIN SYSTEM

TOTAL COMMERCIAL REQUIREMENTS IN GALLONS PER DAY

| ANNUAL AVERAGE | MAXIMUM DAILY | PEAK HOURLY |
|---|---|---|
| 14318161. | 24492808. | 57276235. |

WATER REQUIREMENTS BY TYPE OF COMMERCIAL ESTABLISHMENT

| TYPE | UNITS | NUMBER OF UNITS | ANNUAL AVERAGE | MAXIMUM DAILY | PEAK HOURLY |
|---|---|---|---|---|---|
| | | | ( GALLONS PER DAY ) | | |
| HOTELS | SQ. FT. | 1969000. | 504064. | 579886. | 852577. |
| MOTELS | SQ. FT. | 592000. | 132608. | 272912. | 917600. |
| BARBER SHOPS | BARBER CHAIR | 1426. | 77860. | 114508. | 554714. |
| BEAUTY SHOPS | STATION | 1881. | 505989. | 616968. | 2012670. |
| RESTAURANTS | SEAT | 26600. | 643720. | 2218440. | 4442200. |
| DRIVE-IN REST-NT | CAR SPACE | 600. | 65400. | 85400. | 328200. |
| NIGHT CLUBS | PERSON SERVED | 131200. | 174496. | 174496. | 174496. |
| HOSPITALS | BED | 9554. | 3305684. | 5264254. | 8713248. |
| NURSING HOMES | BED | 2711. | 360563. | 395806. | 1149464. |
| MEDICAL OFFICES | SQ. FT. | 300000. | 185400. | 498000. | 1491000. |
| LAUNDRY | SQ. FT. | 384000. | 97152. | 125184. | 602880. |
| LAUNDROMATS | SQ. FT. | 154500. | 335265. | 448050. | 2379300. |
| RETAIL SPACE | SALES SQ. FT. | 19830000. | 2101980. | 3053820. | 5373930. |
| SCHOOL+ELEM. | STUDENT | 119927. | 645207. | 1160893. | 5888416. |
| SCHOOL+ HIGH | STUDENT | 72839. | 442923. | 1427644. | 8813519. |
| BUS-RAIL DEPOTS | SQ. FT. | 64960. | 216317. | 422240. | 1624000. |
| CAR WASHES | INSIDE SQ. FT. | 75000. | 358500. | 772500. | 2362500. |
| CHURCHES | MEMBER | 436000. | 60108. | 375832. | 2049200. |
| GOLF-SWIM CLUBS | MEMBER | 400. | 8880. | 8880. | 8880. |
| BOWLING ALLEYS | ALLEY | 340. | 45220. | 45220. | 45220. |
| COLLEGES RESID. | STUDENT | 6488. | 687728. | 739632. | 1622000. |
| DRIVE-IN MOVIES | CAR STALL | 1000. | 5000. | 5330. | 5330. |
| NEW OFFICE BLDG. | SQ. FT. | 8800000. | 818400. | 1522400. | 4584800. |
| OLD OFFICE BLDG. | SQ. FT. | 11000000. | 1562000. | 2904000. | 8767000. |
| JAIL + PRISONS | PERSON | 2570. | 341810. | 341810. | 341810. |
| THEATERS | SEAT | 39171. | 130439. | 130439. | 130439. |
| YOUTH-YMCA FACIL. | PERSON | 2155. | 71761. | 71761. | 71761. |
| SERVICE STATIONS | INSIDE SQ. FT. | 120000. | 30120. | 70800. | 586800. |
| COLLEGE, NON-RES | STUDENTS | 23915. | 363508. | 645705. | 1382287. |

Table IV-2. Commercial/Institutional Water Requirements Report

## D. Industrial Reports

Similar to the commercial report, the industrial water requirements report contains both summary and detail information on industrial water use. A typical report is shown as Table IV-3. The summary of industrial water requirements appears at the top of the report, giving estimates of annual average, maximum day, and peak hour usage, all in gallons per day. These estimates are totals of the individual category estimates listed below.

The IWR MAIN System Library of Water Usage Coefficients contains coefficients for 105 three-digit S.I.C. categories of manufacturing industry. The report shown contains 30 of these categories. The next column contains the value of the water use parameter for each category, which, in the case of industrial categories, is the number of employees for each three-digit S.I.C. number. These values are either those provided by the user or values projected by the system, for base year or projection year reports, respectively. Finally, the annual average, maximum day, and peak hourly requirements estimates are listed.

## E. Public/Unaccounted Reports

The public/unaccounted sector of the IWR MAIN System consists of three built-in categories: distribution losses, free services, and airports, plus any additional categories which might be added by the user. The public/unaccounted requirements, followed by details by category. A report is shown in Table IV-4. The summary information consists of annual average, maximum day, and peak hour, given in gallons per day. These quantities are the totals of the category estimates, detailed in the following. Table IV-4 shows the distribution losses and free services only, since no airport was located within the study area and no additional public/unaccounted categories were provided. Had these categories been active, they would have appeared directly below the free services category.

## F. Municipal Summary Reports

The reports described in Sections IV.B through IV.E appear only when water requirements in the related sector of the community are actually calculated. This, in turn, is determined by the provision of the required input data for each category. The Municipal Summary Report is printed, however, regardless of which sectors are reported elsewhere. An example of this report is shown as Table IV-5. This report summarizes those shown earlier as Tables IV-1 through IV-4. The first line is the estimate of

ANALYZED BY MAIN SYSTEM

TOTAL INDUSTRIAL WATER REQUIREMENTS IN GALLONS PER DAY

| ANNUAL AVERAGE | MAXIMUM DAILY | PEAK MONTHLY |
|---|---|---|
| 45121352. | 45121352. | 45121352. |

REQUIREMENTS BY TYPE OF INDUSTRY

| CODE | INDUSTRY CATEGORY | NUMBER OF EMPLOYEES | ANNUAL AVERAGE | GALLONS/DAY MAXIMUM DAY | PEAK MONTH |
|---|---|---|---|---|---|
| 201 | MEAT PRODUCTS | 1642. | 3231967. | 3231967. | 3231967. |
| 202 | DAIRIES | 2895. | 2292956. | 2292956. | 2292956. |
| 203 | CAN. FROZEN FOOD | 1054. | 827115. | 827115. | 827115. |
| 204 | GRAIN MILLS | 238. | 1162?3. | 1162?3. | 1162?3. |
| 205 | BAKERY PRODUCTS | 3756. | 823694. | 823694. | 823694. |
| 206 | SUGAR | 750. | 1075?38. | 1075?38. | 1075?38. |
| 207 | CANDY | 476. | 116?7?. | 116?7?. | 116?7?. |
| 208 | BEVERAGES | 3085. | 3531918. | 3531918. | 3531918. |
| 209 | MISCELL. FOODS | 3258. | 1355319. | 1355319. | 1355319. |
| 211 | CIGARETTES | 28. | 5421. | 5421. | 5421. |
| 221 | WEAVING, COTTON | 35. | 6??7. | 6??7. | 6??7. |
| 223 | WEAVING, WOOL | 55. | 25544. | 25544. | 25544. |
| 225 | KNITTING MILLS | 210. | 57422. | 57422. | 57422. |
| 226 | TEXTILE FINISH. | 35. | 28376. | 28376. | 28376. |
| 228 | YARN-THREAD MILL | 461. | 29237. | 29237. | 29237. |
| 229 | MISCELL. TEXTILE | 65. | 22553. | 22553. | 22553. |
| 230 | WHL.APPAREL IND. | 13564. | 2712??. | 2712??. | 2712??. |
| 242 | SAW-PLANING MILL | 99. | 22158. | 22158. | 22158. |
| 243 | MILLWORK | 174. | 55?57. | 55?57. | 55?57. |
| 244 | WOOD CONTAINERS | 352. | 83776. | 83776. | 83776. |
| 249 | MISCELL. WOOD | 132. | 19176. | 19176. | 19176. |
| 251 | HOME FURNITURE | 1581. | 199276. | 199276. | 199276. |
| 259 | FURNITURE-FIXTURE | 1751. | 215155. | 215155. | 215155. |
| 263 | PAPERBOARD MILLS | 175. | 431284. | 431284. | 431284. |
| 264 | PAPER PRODUCTS | 7?9. | 335123. | 335123. | 335123. |
| 265 | PAPERBOARD BOXES | 3354. | 513213. | 513213. | 513213. |
| 270 | WHOL.PRINT IND. | 9187. | 137605. | 137605. | 137605. |
| 281 | BASIC CHEMICALS | 3022. | 8293580. | 8293580. | 8293580. |
| 282 | FIBERS, PLASTICS | 10. | 8649. | 8649. | 8649. |
| 283 | DRUGS | 747. | 341645. | 341645. | 341645. |
| 284 | SOAP-TOILET GOOD | 2590. | 1740591. | 1740591. | 1740591. |
| 285 | PAINT-ALLIED PRD | 1075. | 909154. | 909154. | 909154. |
| 287 | AGRICULTURE CHEM | 895. | 402603. | 402603. | 402603. |
| 289 | MISCELL. CHEMICL | 485. | 477441. | 477441. | 477441. |
| 291 | PETROLEUM REFIN. | 925. | 1334967. | 1334967. | 1334967. |
| 295 | PAVING-ROOFING | 165. | 136883. | 136883. | 136883. |
| 301 | TIRES + TUBES | 315. | 116315. | 116315. | 116315. |
| 306 | RUBBER PRODUCTS | 1303. | 484659. | 484659. | 484659. |
| 307 | PLASTIC PRODUCTS | 860. | 453894. | 453894. | 453894. |
| 322 | PRESS-BLOWN GLAS | 1874. | 621533. | 621533. | 621533. |
| 323 | PROD.PURCH.GLASS | 230. | 203617. | 203617. | 203617. |
| 325 | STRUCTURAL CLAY | 181. | 126374. | 126374. | 126374. |
| 326 | POTTERY PRODUCTS | 750. | 245231. | 245231. | 245231. |
| 327 | CEMENT-PLASTER | 715. | 252958. | 252958. | 252958. |
| 328 | CUT STONE PROD. | 45. | 24066. | 24066. | 24066. |
| 329 | NONMETALLIC MNRL | 1140. | 501100. | 501100. | 501100. |
| 331 | STEEL ROLLING | 2740. | 1354535. | 1354535. | 1354535. |
| 332 | IRON-STEEL FOUND | 571. | 234711. | 234711. | 234711. |
| 333 | PRIME NONFERROUS | 750. | 537469. | 537469. | 537469. |
| 334 | SEC. NONFERROUS | 215. | 218568. | 218568. | 218568. |
| 335 | NONFERROUS ROLLG | 2995. | 2023048. | 2023048. | 2023048. |
| 336 | NONFERROUS FOUND | 140. | 135742. | 135742. | 135742. |
| 339 | PRIME METAL IND. | 40. | 19833. | 19833. | 19833. |
| 341 | METAL CANS | 3179. | 515737. | 515737. | 515737. |
| 342 | CUTLERY+HARDWARE | 80. | 36744. | 36744. | 36744. |
| 343 | PLUMBING+HEATING | 530. | 341638. | 341638. | 341638. |
| 344 | STRUCTURE METAL | 1689. | 540269. | 540269. | 540269. |
| 345 | SCREW MACHINE | 240. | 103966. | 103966. | 103966. |
| 346 | METAL STAMPINGS | 1035. | 479421. | 479421. | 479421. |
| 347 | METAL SERVICES | 596. | 1076740. | 1076740. | 1076740. |
| 349 | FABRICATED WIRE | 600. | 206020. | 206020. | 206020. |
| 349 | FABRICATED METAL | 530. | 143729. | 143729. | 143729. |
| 353 | CONSTRUCT. EQUIP | 247. | 52408. | 52408. | 52408. |
| 354 | METALWORK.MACHRY | 310. | 64?64. | 64?64. | 64?64. |
| 355 | SPECL INDUS.MACH | 1240. | 362213. | 362213. | 362213. |
| 356 | GENRL IND. MACH. | 890. | 213553. | 213553. | 213553. |
| 357 | OFFICE MACHINES | 45. | 6211. | 6211. | 6211. |
| 358 | SERV. IND. MACH. | 20. | 6684. | 6684. | 6684. |
| 359 | MISCELL. MACHINI | 1726. | 412236. | 412236. | 412236. |
| 361 | ELECT.DISTR.PROD | 10. | 2720. | 2720. | 2720. |
| 362 | ELECT.IND.APPART | 415. | 139447. | 139447. | 139447. |
| 363 | HOME APPLIANCES | 45. | 18536. | 18536. | 18535. |
| 364 | LIGHT-WIRING FIX | 135. | 49895. | 49895. | 49885. |
| 365 | RADIO TV RECEIV. | 19. | 2358. | 2358. | 2358. |
| 366 | COMMUNICATION EQ | 1607. | 311176. | 311176. | 311176. |
| 367 | ELECTRONIC COMP. | 67. | 12197. | 12197. | 12197. |
| 369 | ELECT. PRODUCTS | 850. | 314618. | 314618. | 314618. |
| 371 | MOTOR VEHICLES | 4313. | 1378904. | 1378904. | 1378904. |
| 372 | AIRCRAFT + PARTS | 450. | 69646. | 69646. | 69646. |
| 373 | SHIP + BOAT BLDG | 4214. | 699836. | 699836. | 699836. |
| 373 | ** NO COEFF. ** | 253. | 0. | 0. | 0. |
| 381 | SCIENTIFIC INSTR | 117. | 21179. | 21179. | 21179. |
| 382 | MECHAN. MEASURL | 50. | 11851. | 11851. | 11851. |
| 383 | ** NO COEFF. ** | 58. | 0. | 0. | 0. |
| 384 | MEDICAL INSTRUM. | 35. | 48101. | 48101. | 48101. |
| 385 | ** NO COEFF. ** | 35. | 0. | 0. | 0. |
| 33 | PHOTO EQUIPMENT | 10. | 1203. | 1203. | 1203. |
| 391 | JEWELRY, SILVER | 223. | 68347. | 68347. | 68347. |
| 391 | ** NO COEFF. ** | 10. | 0. | 0. | 0. |
| 394 | TOYS+SPORT GOODS | 123. | 25669. | 25669. | 25669. |
| 395 | ** NO COEFF. ** | 60. | 0. | 0. | 0. |
| 396 | COSTUME JEWELRY | 55. | 23272. | 23272. | 23272. |
| 394 | MISCEL. MANUFACT | 440. | 113639. | 113639. | 113639. |
| 393 | MISCEL. MANUFACT | 615. | 158836. | 158836. | 158836. |

Table IV-3. Industrial Water Requirements Report

MUNICIPAL WATER REQUIREMENTS FOR THE CITY OF BALTIMORE (CITY),MD. FOR THE YEAR 1965

ANALYZED BY MAIN SYSTEM

TOTAL PUBLIC-UNACCOUNTED REQUIREMENTS IN GALLONS PER DAY

| ANNUAL AVERAGE | MAXIMUM DAILY | PEAK HOURLY |
|---|---|---|
| 18558330. | 18558330. | 18558330. |

REQUIREMENTS BY TYPE OF PUBLIC-UNACCOUNTED USAGE IN GALLONS PER DAY

| TYPE | ANNUAL AVERAGE | MAXIMUM DAILY | PEAK HOURLY |
|---|---|---|---|
| DISTRIB. LOSSES | 13757170. | 13757170. | 13757170. |
| FREE SERVICES | 4801160. | 4801160. | 4801160. |

Table IV-4. Public/Unaccounted Water Requirements Report

SUMMARY OF MUNICIPAL WATER REQUIREMENTS FOR CITY OF BALTIMORE (CITY),MD.

ESTIMATED WATER REQUIREMENTS FOR YEAR 1963.
(ALL VALUES IN GALLONS PER DAY)

| | ANNUAL AVERAGE | MAXIMUM DAILY | PEAK HOURLY |
|---|---|---|---|
| MUNICIPAL | 173171740. | 248567660. | 512974000. |
| RESIDENTIAL | 95173897. | 170569820. | 474976160. |
| COMMERCIAL | 14318161. | 24492808. | 67276235. |
| INDUSTRIAL | 45121352. | 45121352. | 45121352. |
| PUBLIC AND UNACC. | 18558330. | 18558330. | 18558330. |

Table IV-5. Municipal Summary Report

Municipal, or total, water requirements. The municipal annual average is the total of the annual average for each sector listed below it, which, in turn, are the totals from the individual summary reports. The municipal maximum day is not a simple total, however. It is the sum of the maximum day for a single sector of water use and the annual averages for the remaining sectors which gives the largest value. The same procedure is followed for peak hourly requirements.

## G. Forecast Summary Reports

The Forecast Summary Report appears whenever the IWR MAIN System is used to forecast municipal water requirements. If the system is used to estimate requirements for the current year only, the Municipal Summary Report constitutes the final summary. When more than one year is involved, however, as in forecasting, it is desirable to compare the final results for the various years. Table IV-6 is a Forecast Summary Report showing a base year and five projection years. Each year is listed after the related run number with annual average, maximum daily, and peak hourly requirements indicated. The run numbers specify the order of input. The Forecast Summary Report will list water requirements for up to 25 years, including the base year.

## H. Other Displays and Outputs

In addition to the reports described in Sections IV.B through IV.G, the IWR MAIN System may produce two other types of data. These are:

(1) Input data listing

(2) Library listing

The input data listing is always produced, and precedes the output reports. The format used corresponds to the data themselves, and the listing of the data permits verification. More importantly, this listing constitutes a convenient record of the input data and options upon which a given run was based, assisting in interpretation of the output reports.

MAIN IT SYSTEM

SUMMARY OF PROJECTED MUNICIPAL WATER REQUIREMENTS

FOR CITY OF

BALTIMORE (CITY), MD.

| RUN NO. | YEAR | MEAN ANNUAL | MAX DAY | PEAK HOUR |
|---|---|---|---|---|
| | | GALLONS PER DAY | | |
| 1 | 1963 | 173171740. | 248567660. | 512974000. |
| 2 | 1964 | 163288300. | 273586410. | 570137980. |
| 3 | 1970 | 166480300. | 293574150. | 611948210. |
| 4 | 1975 | 170126090. | 306620720. | 650059120. |
| 5 | 1985 | 176012260. | 339325230. | 727529780. |
| 6 | 1985 | 180137910. | 343150881. | 731655430. |

Table IV-6. Forecast Summary Report

# V. DATA PREPARATION

## A. General Considerations

Chapter II of this manual described the use of the IWR MAIN System, discussing general data requirements and sources. Chapter III discussed the various projection methods available, with general information concerning the data requirements of each. This chapter presents procedures for preparation of the data, with the specific requirements of each data group.

The input data for the IWR MAIN System consists of a series of data subgroups, each subgroup preceded by a subgroup name. Data will be requested by the input interactive mode.

## B. Municipal Data

### 1. Municipal Identification Data

The subgroup for municipal identification data is:

CITYDATA

Some of the data input here are used by the system as identification information on the displays, while other parameters are needed for computations in the system. The first piece of identification information is the name of the study area. Several examples of this type of data are shown.

LOS ANGELES (BURBANK)
CHICAGO, ILL.
POUGHKEEPSIE, NEW YORK
AUSTIN, TEXAS

Data identification names that may be input here are:

CDAT, LATD, LONG, POPU, PDEN, POPP, EMPL
EMTC, ICOM, TSER, CCBN, CCBL, CCAL

Definitions:

CDAT: Calendar year of current parameter values provided at Municipal Data. This value is used as the base year for all forecasts.

LATD: Latitude (in degrees) of urban area being studied. This value is required by the system to extract climatic data from the Library.

LONG: Longitude (in degrees) of urban area being studied. This value is required by the system to extract climatic data from the Library.

POPU: Population of study area in base year (CDAT). This value is required for all forecasts and for computation of public/unaccounted requirements. It may be deleted when no forecast are to be made and no public/unaccounted results are required.

PDEN: Gross population density of study area in base year (CDAT) expressed in persons/square mile. This value is required for all forecasts.

POPP: Fraction of the population which is in the 20 to 39 year age group in the base year. This value is required for all forecasts and is expressed as a fraction, i.e., less than 1.0.

EMPL: Total employment within the study area in the base year. This value is required for all forecasts and includes all reported employment by firms or individuals located within the study area, without respect to location of the residences of those employed.

EMTC: Total employment within the study area in the transportation, communications, and utilities industries (S.I.C. Categories 400 through 499). This value is provided for the base year and is required for all forecasts.

ICOM: Per capita personal income of population residing within study area, expressed in 1980 dollars. The value is obtained for the base year and corrected to 1980 dollars by use of an index such as the Consumer Price Index of the Bureau of Labor Statistics, U.S. Department of Labor. Local indices should be used where available, but the national index may be used, which had a value of 247 in 1980. The value of ICOM is required for all forecasts and is expressed as dollars/person/year.

TSER: Total employment in service industries (S.I.C. categories 700 through 899) within the study area for the base year. This value is required for all forecasts.

CCBN: Department of Commerce National Composite Construction Costs Index for the base year. This value is used to adjust home values to 1980 price levels prior to computation of residential water requirements. If this data is not provided, the data identification name CCAL and CCBL must be used. The 1980 value is 143.3 (1977=100).

CCBL: Department of Commerce local Construction Cost Index or other cost or price index which might be used to deflate home values to 1980 price levels. This value is for the base year and must be provided with a value for data identification name CCAL, as an alternate to the national index, CCBN.

CCAL: Department of Commerce local Construction Cost Index or other cost or price index which might be used to deflate home values to 1980 price levels. This value is for the year 1980 and must be provided together with a value for data identification name CCBL, as an alternate to the national index, CCBN.

2. Residential Data

Current data describing the residential sector of a community may be prepared under any of four subgroups, as required. Each subgroup consists of the subgroup name, followed by a series of value ranges, and summary. Each value range begins with the data identification names required by the subgroup in use. These requirements are indicated in the definitions below. The summary follows the last value range and contains the data identification names, LOWV, MEDV, and HIGH, as required. The four subgroup names for the residential parameters appear as follows:

FLATSEPT
FLATSEWR
METRSEPT
METRSEWR

and have the following respective meanings: Flat rate-septic tank areas, flat rate-sewered areas, metered-septic tank areas, and metered-sewered areas. Data identification names for the residential parameters are:

ANPR, ASMT, DENS, NUMB, PEPL, SMPR, VALN,
VALX, LOWV, MEDV, HIGH

Definitions:

ANPR: Marginal price of water, including any charges billed on the water bill as a percentage of water price, which is paid by consumers in a value group on a year-round basis. This value is expressed as cents per 1000 gallons and can be determined as the total charge on the water bill caused by the last 1000 gallons purchased i.e., the billing rate in the highest block being used, including sewer or other charges when they are a percentage of the water rate. This value may be different for each value range and is required for METRSEPT and METRSEWR only.

ASMT: Assessment factor (ratio of assessed value to current market value). The user should provide this quantity when assessed property values are used instead of market values. If the quantity is not provided, a value of 1. is assumed. A different value may be used for each value range.

DENS: Housing density expressed in dwelling units per residential acre, including streets. This value may be different for each value range.

NUMB: Number of occupied housing units in a value range.

PEPL: Population density expressed in persons per housing unit. A different value may be used for each value range. This value is required for all categories except METRSEWR.

SMPR: Marginal price of water, as defined for ANPR, except for summer use only. This value may be different from ANPR where the rate structure causes the marginal price of water paid by the average consumer in a value group to differ seasonally. In this case, the marginal price paid during the summer, expressed in cents per 1000 gallons is assigned to this variable. Otherwise, the value provided is identical to ANPR. This value may be different for each value range and is required for METRSEWR and METRSEPT only.

VALN: Lower limit of a property value range, expressed in dollars. This may be assessed or market value, provided the ASMT value is correctly set.

VALX: Upper limit of property value range, expressed in dollars, either assessed or market value.

LOWV: Number of value ranges in low value group. This group is defined as all value ranges having a median value below $25,500, 1980 dollars. Current dollar value ranges may be corrected to 1980 by the Department of Commerce Composite Construction Cost Index, which had a value of 143.3 in 1980, or by local or regional indices.

MEDV: Number of value ranges in medium value group. This group is defined as all value ranges having a median value of at least $25,500, but less than $51,000, 1980 dollars, adjustments made as described previously.

HIGH: Number of value ranges in high value group. This group is defined as all value ranges having a median value of at least $51,000, 1980 dollars, adjustments made as described.

Up to 25 value ranges may be defined within each residential subgroup heading. When the IWR MAIN System is used to forecast water requirements, each subgroup must contain a value for LOWV, MEDV, HIGH. The value ranges themselves must be arranged so that all low value group ranges appear first, followed by medium value group ranges, and finally the high value group ranges. Within a value group, the ranges need be in no special order. Due to the sensitivity of the residential water requirements to home value, it is recommended that no individual value range be larger than necessary, preferably less than $3000.00 from VALN to VALX. Values should not be averaged unless absolutely necessary. It is usually desirable to gather data separately for relatively homogeneous areas, reducing the variations in values of DENS and PEPL, as well as home value.

### 3. Commercial/Insititutional Data

The IWR MAIN System uses 28 commercial and institutional categories to estimate water requirements for this sector of a community. Where local water use patterns suggest the need for other categories, they may be added by the user. This modification consists of placing the necessary labels, water use parameter identifications, and usage coefficients in the Library of Water Usage Coefficients, as requested by the Library Subroutine. Whenever estimates of commerical/insititutional requirements are to be included in computations of current or forecasted water requirements, the following subgroup must be utilized:

COMMPARM

The information following the subgroup contain the data identification names for any of the 28 commerical/institutional categories listed on Table II-4. Each data identification name is followed by the value of the water use parameter for that category. These values are computed as of the current, or base year. Data identification names for categories added by the user are C001, C002, C003, etc., up to a maximum of 22 additional categories.

When the IWR MAIN System is used for forecasting municipal water requirements, and the COMMPARM subgroup is used, the COMMEMPL subgroup must also be used. The subgroup name will appears as:

COMMEMPL

The data identification names are the same as those used in the COMMPARM subgroup and the value placed after each name is the employment reported for the category in the current, or base year, This information must be provided for each data identification name used in COMMPARM except SKLL and SKLH.

4. Industrial Data

When industrial water requirements are to be included in calculations of current or forecast municipal water usage, the following subgroup must be provided:

INDPARAM

The subgroup is followed by data identification names and the values of the associated water use parameters. These parameters are the total employment of each three-digit S.I.C. category. Data identification names consist of the letter "I" followed by the three-digit S.I.C. number for the category. The names of these categories, together with their S.I.C. codes, are given as in Table II-5. The proper data identification names are I201, I202, I203, etc. The employment provided for each category is the average employment for the current, or base year. Where categories are required that do not appear on Table II-5, they can be provided by adding the necessary category label, and identification name, and water usage coefficient to the Library of Water Usage Coefficients, when requested by the Library subroutine. These categories are limited to unused data identification names between 1200 and 1399, inclusive.

5. Public/Unaccounted Data

Four data subgroups are provided for specifying public and unaccounted water requirements. They are:

PUBPARAM
PUBANAVE
PUBMAXDY
PUBPEKHR

Within each of these subgroups, three categories of water usage are provided by the system and provision is made for the user to define up to 27 additional categories. The system-provided categories are:

LOSS, FSER, AIRP

Definitions:

LOSS: Distribution losses in the supply system, including leakage and apparent losses caused by meter misregistration.

FSER: Free service; includes water supplied to all non-revenue-producing uses, such as street flushing, fire suppression, public buildings, parks, fountains, etc.

AIRP: Water required by airports to the extent that it is provided from the municipal system.

The water use parameter for airports, AIRP, is the average number of passengers using the facility per day. The parameter for the other two data identification names, LOSS and FSER, is the total population of the study area. Additional categories which may be added by the user when requested by the Library Subroutine, will have data identification names P001, P002, P003, etc., up to category P027. These will have water use parameters as specified by the user.

The PUBPARAM subgroup is used to provide the current, or base year, value of the water use parameter for AIRP category, as well as any user-added categories. The parameters for LOSS and FSER are provided internally and need not be entered by the user. The appearance of public/unaccounted water requirements estimates and reports are contingent on the provision of the category POPU in subgroup CITYDATA. If this value is present and the PUBPARAM, PUBANAVE, PUBMAXDY, and PUBPEKHR subgroups are not used, requirements will be calculated for LOSS and FSER only. If the public/unaccounted subgroups are used, LOSS and FSER will appear with any additional categories that might be specified.

When the user prefers to specify the actual values of the water usage for certain public/unaccounted categories, he may do so by use of the PUBANAVE, PUBMAXDY, and PUBPEKHR subgroups. The subgroups, when used, should all appear. The data identification names for the categories to be processed in this manner are followed by the user-provided estimate of water requirements of that category and subgroup, expressed in gallons per day. The PUBNAVE subgroups contains estimates of annual average requirements, the PUBMAXDY subgroup contains maximum day requirements, and the PUBMAXDY subgroup contains maximum day requirements, and the PBUPEKHR subgroup is used for peak hour requirements. The use of these subgroups does not preclude the use of the PUBPARAM subgroup for other categories. If the same category is entered both ways, the values provided in PUBANAVE, PUBMAXDY, and PUBPEKHR will be used.

## C. Local Historical Data

### 1. General Requirements

When the IWR MAIN System is used to forecast municipal water requirements, data must be provided to establish the historical trends of certain parameters. These trends are among the information used by the internal growth models to project future values of water use parameters. When all sectors or categories built into the IWR MAIN System are not being used for a particular community, it may be possible to reduce the number of subgroups of Local Historical Data required. The discussions of individual subgroups will indicate these relationships, where they exist. When IWR MAIN is begin used to estimate current water requirements only, none of the subgroups described in this section are required.

Each data subgroup within the Local Historical Data group consists of a subgroup name, followed by related data. All data, except those in the INDHISTY subgroup, have the same data identification names, YEAR and DATA.

Local Historical Data may be provided for any specific years for which it may be available, covering any period of time desired. In general, a total span of at least 10 years should be provided, but shorter periods of time may be necessary, or even desirable when older data are believed to be unreliable or unrepresentative of future trends. At least two separate years of data must be provided for each subgroup, and up to five separate years can be accommodated. When the historical trend being represented is noticeably nonlinear, an effort should be made to prepare enough data to adequately describe the actual trend. The years used may be different from subgroup to subgroup and one of them may or may not be the base year. Where the parameter value has been provided for the base year in another part of the input stream, as in the case of population, that value will not be used in the computation of historical trends unless it is repeated in the appropriate Local Historical Data subgroup.

## 2. Data Subgroups

A maximum of 11 subgroups are used in the Local Historical Data group. With the exception of INDHISTY, each subgroup name is listed in the proper format, with a brief definition of the associated data following each. Section V-C-3 describes the INDHISTY subgroup in greater detail.

### POPULATN

The total resident population of the study area, expressed in number of persons. Required for all projections.

### ALLHOMES

The total number of occupied residential units within the study area, expressed in number of units. Required for residential categories and the SKLL and SKLH categories of the commercial/institutional submodel.

### MEDHOMES

The fraction of all single unit, owner-occupied dwelling units which fall in the medium value group. This group is defined as dwelling unit having a market value, expressed in 1980 dollars, of at least $25,500 but less than $51,000.00. For years other than 1980, the market values should be adjusted to 1980 prices by use of the U.S. Department of Commerce Composite Construction Cost Index, or a similar index. This value is expressed as a fraction (less than 1.0). This subgroup is required by residential categories only.

HIGHOMES

The fraction of all single unit, owner-occupied dwelling units which fall in the high value group. This group is defined as dwelling unit having a market value, expressed in 1980 dollars, of at least $51,000.00 For years other than 1980, the market values should be adjusted as described above. This subgroup is required by residential categories only, and values are expressed as fractions (less than 1.0).

SKOLYEAR

The median number of years of school completed by adults 25 years old and older within the study area. This value is required by the residential categories only and values are expressed in years.

ELEMSKOL

The number of students attending elementary schools (kindergarten through grade 8) located within the study area. This value is required for commercial institutional categories SKLL and SKLH only and is expressed in number of students.

HIGHSKOL

The number of students attending high schools (grades 9 - 12) located within the study area. This value is required for commercial/institutional category SKLH only and is expressed in number of students.

SERVICE

Total employment of service industries and occupations within the study area. These occupations can be further identified as those classified under S.I.C. categories 700 through 899, inclusive. This employment is included in the total determined for the TSERVICE subgroup. The value is required for commercial/institutional categories HOSP, MEDL, and NURS, and is expressed in number of persons employed.

3. Industrial History

All required historical data for the industrial submodel is contained in one subgroup, INDHISTY. The subgroup is prepared as before:

INDHISTY

Data identification names used in this subgroup are:

YEAR, POPU, ICOM, EMPL, I200, I210, I220, I230,
I240, I250, I260, I270, I300, I330, I340, I370, I400

In every case, the data identification name YEAR and its value precede all data associated with that year. At least two, but not more than five, groups of data may be provided, each beginning with the name YEAR.

Definitions:

YEAR: The calendar year for which the following data applies.

POPU: The total population of the study area, or optionally, of the employment area of the study area industry, where that is significantly different. Expressed in number of persons.

ICOM: Per capita personal income of the study area, or the employment area of the study area industry. Expressed in 1980 dollars per person per year. When the year is other than 1980, the Bureau of Labor Statistics Consumer Price Index or some similar index must be used to adjust values to 1980 dollars.

EMPL: Total employment of the study area, or of the employment area of of the study area industry. This includes all reported nonfarm employment and is expressed in number of persons employed.

I200: Total employment within the study area only in S.I.C. categories 200 through 209, inclusive. Required whenever study area includes current employment in S.I.C. categories 200 through 219. Expressed in persons employed.

I210: Total employment within the study area only in S.I.C. categories 210 through 219, inclusive. Required whenever study area includes current employment in S.I.C. categories 200 through 219. Expressed in persons employed.

I220: Total employment within study area only in S.I.C. categories 220 through 229, inclusive. Required whenever study area includes current employment in S.I.C. categories 220 through 239. Expressed in persons employed.

I230: Total employment within study area only in S.I.C. categories 230 through 239, inclusive. Required whenever study area includes current employment in S.I.C. categories 220 through 239. Expressed in persons employed.

I240: Total employment within study area only in S.I.C. categories 240 through 249, inclusive. Required whenever study area includes current employment in S.I.C. categories 240 through 279. Expressed in persons employed.

I250: Total employment within study area only in S.I.C. categories 250 through 259, inclusive. Required whenever study area includes current employment in S.I.C. categories 240 through 279. Expressed in persons employed.

I260: Total employment within study area only in S.I.C. categories 260 through 269, inclusive. Required whenever study area includes current employment in S.I.C. categories 240 through 279. Expressed in persons employed.

I270: Total employment within study area only in S.I.C. categories 270 through 279, inclusive. Required whenever study area includes current employment in S.I.C. categories 240 through 279. Expressed in persons employed.

I300: Total employment within study area only in S.I.C. categories 300 through 309, inclusive. Required whenever study area includes current employment in S.I.C. categories 300 through 309. Expressed in persons employed.

I330: Total employment within study area only in S.I.C. categories 330 through 339, inclusive. Required whenever study area includes current employment in S.I.C. categories 330 through 339. Expressed in persons employed.

I340: Total employment within study area only in S.I.C. categories 340 through 349, inclusive. Required whenever study area includes current employment in S.I.C. categories 340 through 349. Expressed in persons employed.

I370: Total employment within study area only in S.I.C. categories 370 through 379, inclusive. Required whenever study area includes current employment in S.I.C. categories 340 through 379. Expressed in persons employed.

I400: Total employment within study area only in S.I.C. categories 400 through 499, inclusive (transportation, communications, utilities). Required whenever study area includes current employment in S.I.C. categories 350 through 369. Expressed in persons employed.

It will be noted that several of the data descriptions refer to the study area, or the employment area of study area industry, where that is substantially different. There may be cases where an urban area is being studied which contains manufacturing industries drawing a large part of their employment from outside the area under study. A typical example of this situation is the core city of a metropolitan area, where many employees of industry live in the surrounding suburbs, outside the study area. In these cases, it is possible to force the industrial submodel to draw its trends from the entire area, rather than just the one under study, by providing values of the POPU, ICOM, and EMPL for the employment area instead of the study area. It is important that the same area definition be used for all three variables, however.

## D. Projection Data

### 1. General Requirements

A set of Projection Data must be provided for each year forecast by the IWR MAIN System. These data include several projections, which are required in every case, and a variety of optional information. The data subgroups used and the information provided determine which of the three alternative methods of projection are to be used for the various parameters. The three methods, described in detail in Chapter III, are:

(a) Projection by internal growth models

(b) Projection by extrapolation of local historical data

(c) Use of projections made external to the IWR MAIN System

In addition, the user may specify a number of constraints or limits on projections or groups of projections by providing the appropriate data. Each year forecast is independent of all other years, and wholely different projection options and assumptions may be selected.

Each forecast year is specified by the appearance of data subgroup NEWYEAR. This subgroup is required in all cases, but no all of its data

identification names must be used, as described in the next section. Local historical data subgroups and external projection subgroups may follow the NEWYEAR subgroup, if required. In every case, the data to be used in a single forecast begins with a NEWYEAR subgroup. As many as 24 NEWYEAR subgroups may be used at one time, each followed by related data.

2. Key Projection Data

Each forecast year is specified by the appearance of the subgroup name:

NEWYEAR

This group contains the required key projections and may contain several optional constraints on the residential and commercial/institutionl submodels. The data identification names for this subgroup are:

YEAR, POPU, ICOM, ACRE, DENS, TSER

Definitions:

YEAR: The calendar year for which the forecast is desired. This may be any year subsequent to the base year named in the CITYDATA subgroup.

POPU: The population projection for the study area in the forecast year (YEAR). This projection is required and must be prepared externally. It is expressed in terms of 1980 dollars per person per year. Existing projections in terms of other dollar bases may be deflated by use of the Bureau of Labor Statistics' Consumer Price Index or by a similar method.

ACRE: Projected area of residential land, including streets, for the study area in the forecast year (YEAR). This is an optional projection and will cause all housing densities to be adjusted proportionately such that the total projected residential area equals the value provided. Expressed in acres of residential land use.

DENS: Projected density of residential land for the study area in the forecast year. This is an optional projection which may be used alternatively with ACRE. When provided, it will cause all housing densities to be adjusted proportionately until their weighted average equals the value given. Expressed in units per gross residential acre, including streets.

TSER: Projected total employment in service industries for the study area in the projection year. This is an optional projection which, when used, replaces the internal projection of this in the projection of various commercial/insitutional parameters and in the constrain to total projected services employment. Expressed in persons employed within the study area in S.I.C. categories 700 through 899, inclusive.

3. Local Historical Data

Certain water use parameters may be projected by extrapolating local historical data, replacing projections generated by internal growth models. This option is described in detail in Chapter III. Selection of projection by extrapolation of local historical data occurs whenever at least two, but not more than seven, data points are provided for the parameter in one of the subgroups described below. Chapter III details the effects of mixed options and should be reviewed prior to data preparation.

Projection by extrapolation of historical trends may be selected for residential parameters by providing the data subgroup:

HNUMHOMS

The data identification names for this subgroup are:

YEAR, MWLO, MWMD, MWHI, MWTL, FWLO, FWMD,
FWHI, FWTL, MPLO, MPMD, MPHI, MPTL, FPLO,
FPMD, FPHI, FPTL

Definitions:

YEAR: The year to which the data points immediately following apply. In every case, the first data identification name in the subgroup must be YEAR, and all data following it and prior to the appearance of another YEAR will be interpreted as associated with the first YEAR. The data value is expressed as a calendar year and may be any year, including the base year.

MWLO, FWLO, MPLO, FPLO: The total number of housing units in the low value group that are in the metered-sewered, flat rate-sewered, metered-septic tank, or flat rate-septic tank categories, respectively. The low value group is defined, as before, as those homes whose market value is less than $25,500.00, 1980 dollars. Deflation to 1980 price levels may be carried out using the U.S. Department of Commerce Composite construction Cost Index or a similar index. Expressed in number of housing units.

MWMD, FWMD, MPMD, FPMD: The total number of housing units in the medium value group, categories as defined above. The medium value group includes homes whose market value is at least $25,500.00 but less than $51,000.00, 1980 dollars.

MWHI, FWHI, MPHI, FPHI: The total number of housing units in the high value group, categories as defined above. The high value group includes homes whose market value is at least $51,000.00, 1980 dollars.

MWTL, FWTL, MPTL, FPTL: The total number of housing units in the study area, categories as defined above. Expressed in number of housing units per category.

Any of the commercial/institutional category parameters may be projected by extrapolation of local historical trends through the use of data subgroup:

HCOMPARM

The data identification names for this subgroup are:

YEAR, HOTL, MOTL, etc., C001, C002, etc.

Definitions:

YEAR: The year to which all data points immediately following apply. In every case, the first data identification name in the subgroup must be YEAR, and all data following it and prior to the appearance of another YEAR will be interpreted as associated with the first YEAR. The data value is expressed as calendar year, which may be any year, including the base year.

HOTL, MOTL, etc.: The data identification names of the 28 built-in commercial/institutional parameters, as listed in Table II-4. The data value immediately following each is the value of the parameter for the YEAR specified. The units are also listed on Table II-4.

C001, C002, The data identification names of up to 22 additional commercial/institutional parameters which may be added by the user. When one or more of these has been added, the historical data may be placed after the proper data identification name, in the units previously defined by the user.

The industrial parameters, or S.I.C. three-digit category employments, may be projected by extrapolation of historical records of employment by providing the proper data in

HINDPARM

The data identification names for this subgroup are:

YEAR, I201, I202, I203, etc.

Definitions:

YEAR: The year to which all data points immediately following apply. In every case, the first data identification name in the subgroup must be YEAR, and all data following it and prior to the appearance of another YEAR will be interpreted as associated with the first YEAR. The data value is expressed as a calendar year and may be any year, including the base year.

I201, I202, I203, etc.: The data identification names of the industrial categories, as listed in Table II-5. The data value immediately following each is the employment in the industry category for the year named in YEAR. The data values are expressed in persons employed within the study area.

Public/unaccounted parameters may be projected by extrapolation of local historical data when the proper data is placed in data subgroup:

HPUBPARM

The data identification names for this subgroup are:

YEAR, LOSS, FSER, AIRP, P001, P002, etc.

Definitions:

YEAR: The year to which all data points immediately following apply. In every case, the first data identification name in the subgrouup must be YEAR, and all data following it and prior to the appearance of another YEAR will be interpreted as associated with the first YEAR. The data value is expressed as a calendar year and may be any year, including the base year.

LOSS: Distribution losses in the system, including leaks and apparent loss through meter misregistration. The parameter for this category is population, and historical data may be either actual historical population or an equivalent

population found by dividing actual losses by the water use coefficient for the category. The data value is expressed in number of persons.

FSER: Free services, including street flushing, fire suppression, public buildings, parks, etc. The water use parameter for this category is population, and historical data may be either actual historical population or any equivalent population found by dividing actual free services by the water use coefficient for the category. The data value is expressed in number of persons.

AIRP: Use of water by airports, to the extent that it is supplied by the municipal system. The water use parameter is the number of airline passengers per day and the data value is expressed in number of persons.

P001, P002, etc.: These data identification names refer to any public/unaccounted categories that may have been added by the user. The data values are expressed in the units defined by the user for that category.

4. Direct External Projections

Projections made external to the IWR MAIN System may be provided for certain water use parameters, replacing other projections, through the use of up to eight data subgroups, as required. These subgroups are placed in any arrangement after the NEWYEAR subgroup to which they apply and the values provided for the various parameters are the values that will be used in the water requirements forecasts, subject to conditions described in Chapter III. Although these and other projection options may be mixed in any desired manner, a careful review of Chapter III is recommended prior to selection of mixed options.

Direct projections of residential data are made using subgroup:

NUMHOMES

The data identification names are:

MWLO, MWMD, MWHI, MWTL, MPLO, MPMD, MPHI,
MPTL, FWLO, FWMD, FWHI, FWTL, FPLO, FPMD,
FPHI, FPTL

Definitions:

MWLO, MPLO, FWLO, FPLO: Projected number of housing units in the low value group of metered-sewered, metered-septic tank, flat rate-sewered, or flat rate-septic tank categories, respectively. The low value range is defined, as before, as those homes having a

market value of less than $25,500, 1980 dollars. Deflation to 1980 price levels may be carried out using the U.S. Department of Commerce Composite Construction Cost Index, or a similar index. Expressed in number of housing units.

MWMD, MPMD, FWMD, FPHI: Projected number of housing units in the medium value group, categories as defined above. The medium value group includes homes whose market value is at least $25,500 but less than $51,000, 1980 dollars.

MWTL, MPTL, FWTL, FPTL: Projected total number of housing units in the study area, categories as defined above. Expressed in number of housing units per category.

In the case of commercial/institutional categories, either the parameter value or the category employment may be projected externally and provided to the system. This is done by preparing either or both of the following subgroups:

COMFPARM

COMFEMPL

These subgroups contain projections of parameter values or employment, respectively. The data identification names are those listed on Table II-4 (HOTL, MOTL, etc.) as well as C001, C002, etc. for any categories that may have been added by the user. The data values are expressed in the units shown on Table II-4 for parameter values, and in number of persons employed for employment values.

The industrial submodel of the IWR MAIN System uses S.I.C. three-digit industrial classifications as categories, providing a maximum of 200 categories ranging from S.I.C. 200 to 399, inclusive. The employment within the study area for each of these classifications serves as the water use parameter for each category. These employments may be projected externally and provided to the system through the use of the data subgroup:

INDPROJT

The data identification names are those listed in Table II-5, namely, I201, I202, etc. The data value for each data identification name is the projected number of persons employed within the study area by the associated industry classification. One additional data identification name is provided for this subgroup:

EMPM: Projected total employment within the study area in manufacturing (S.I.C. 200-399, inclusive). Providing this value will cause all projected category totals to be

adjusted proportionately such that their total equals the value of EMPM. The data value is expressed in number of persons employed.

When EMPM is not provided, each industry category is projected separately with no constraint on the total.

Public/unaccounted water requirements are subject to external projection through the use of four data subgroups:

PUBPARAM
PUBANAVE
PUBMAXDY
PUBPEKHR

The data subgroup PUBPARAM permits the use of external projections of water use parameters, while the subgroups PUBANAVE, PUBMAXDY, and PUBPEKHR accommodate external projections of water requirements directly in terms of annual average, maximum day, and peak hour requirements, respectively. These last three subgroups should normally be used together. The data identification names are the same for all four data subgroups:

LOSS, FSER, AIRP, P001, P002, etc.

Definitions:

LOSS: Distribution losses in the system, including leaks and apparent losses though meter misregistration. The water use parameter for this category is population. When no projection options are selected, the system uses the population projection for the forecast year as the parameter value. Water requirements can be calculated from an equivalent population provided in subgroup PUBPARAM, but the other three subgroups are normally more convenient to use.

FSER: Free services, including street flushing, fire suppression, public building, parks, etc. The water use parameter for this category is population, and the value used by the system, if none other is provided, will be the actual projected population. This category is normally not used in the PUBPARAM subgroup for this reason. In the other subgroups, actual expected requirements can be provided, expressed in gallons per day.

AIRP: Use of water by airports, to the extent that it is supplied by the municipal system. The water use parameter is number of passengers per day, and the projected value of that parameter is used in the PUBPARAM subgroup. When the other

three subgroups are used, the projected water requirements are used directly, expressed in gallons per day.

P001, P002, etc.: These data identification names refer to any public unaccounted categories that may have been added by the user. When they are used in the PUBPARAM subgroup, the data value is expressed in terms of the parameter defined by the user for that category. In the other three subgroups, projections of water requirements are used directly, expressed in gallons per day.

### E. End of Input Data

After all data have been prepared, including Municipal Data, Local Historical Data, and Projection Data as required, the end of the data stream will be signaled to the user.

# VI. LIBRARY OF WATER USAGE COEFFICIENTS

## A. General Description of Library

The Library of Water Usage Coefficients is one of the products of the IWR MAIN System. It consists of all the invariant data needed by the System, such as residential equation constants; climatic data for the entire United States, category labels and usage coefficients for the commercial, industrial, and public/unaccounted submodels. It may be easily modified from a general purpose nationwide collection of data into a very specialized local Library. A listing of the contents of the Library is given in Appendix C.

## B. Use of the Library

The Library of Water Usage Coefficients provides data inputs to the IWR MAIN System. These data include residential equation constants, coefficients of usage for many different types of establishments and industries, and climatic information. This Library allows the user to make water usage computations without having to re-research the data values. It represents then, a synthesis of current state-of-the-art knowledge in a single, central place.

For this reason, it may prove to be useful to water resource analysts and planners as a stand-alone product. As the technology allows refinement and upgrading of this preliminary compilation of data values, prospective users may come to rely upon it as a handbook containing a host of design-type values. Designers of commercial and industrial establishments may find it to be an adequate base of usage coefficients for purposes of estimating proposed facility water requirements.

The residential and industrial data represent the results of evaluation of national figures. The commercial data are largely oriented towards study of establishments in Baltimore, Maryland and need to be refined and compared with data values from other cities as they become available.

## C. Library Data

This section of the report will explain to the user how the Library data were prepared. The data for each of the submodels, except the residential submodel, are composed of several data subgroups, such as category labels and usage coefficients. The details of the data preparation are discussed below:

Table VI-1. Residential Equation Constants
for the Library of Water Usage Coefficients

| Data Identification Name | *Equation Number | Constant Number | Constant Value |
|---|---|---|---|
| E011 | 1 | 1 | 206.000 |
| E012 | 1 | 2 | 3.470 |
| E013 | 1 | 3 | -1.300 |
| E021 | 2 | 1 | 28.900 |
| E022 | 2 | 2 | 4.390 |
| E023 | 2 | 3 | 33.600 |
| E031 | 3 | 1 | 30.200 |
| E032 | 3 | 2 | 39.500 |
| E041 | 4 | 1 | 30.200 |
| E042 | 4 | 2 | 39.500 |
| E051 | 5 | 1 | 0.480 |
| E052 | 5 | 2 | 1130.000 |
| E053 | 5 | 3 | -0.703 |
| E054 | 5 | 4 | 0.429 |
| E061 | 6 | 1 | 0.390 |
| E062 | 6 | 2 | 0.164 |
| E063 | 6 | 3 | -0.793 |
| E064 | 6 | 4 | 2.930 |
| E065 | 6 | 5 | -1.570 |
| E066 | 6 | 6 | 1.450 |
| E071 | 7 | 1 | 0.410 |
| E072 | 7 | 2 | 100.000 |
| E073 | 7 | 3 | 0.783 |
| E081 | 8 | 1 | 0.340 |
| E082 | 8 | 2 | 0.164 |
| E083 | 8 | 3 | -0.793 |
| E084 | 8 | 4 | 2.930 |
| E085 | 8 | 5 | -1.570 |
| E086 | 8 | 6 | 1.450 |
| E091 | 9 | 1 | 0.410 |
| E092 | 9 | 2 | 100.000 |
| E093 | 9 | 3 | -0.783 |
| E094 | 9 | 4 | 2.930 |
| E095 | 9 | 5 | -1.570 |
| E096 | 9 | 6 | 1.450 |
| E101 | 10 | 1 | 0.830 |
| E102 | 10 | 2 | -1.260 |
| E111 | 11 | 1 | 3400.000 |
| E112 | 11 | 2 | 2.060 |
| E113 | 11 | 3 | 0.413 |
| E121 | 12 | 1 | 0.0106 |
| E122 | 12 | 2 | 0.118 |

* See Appendix C for corresponding equations

Table VI-1. Residential Equation Constants for the Library of Water Usage Coefficients (Continued)

| Data Identification Name | *Equation Number | Constnat Number | Constant Value |
|---|---|---|---|
| E123 | 12 | 3 | -10.400 |
| E124 | 12 | 4 | -1.250 |
| E125 | 12 | 5 | 0.931 |
| E131 | 13 | 1 | 2750.000 |
| E132 | 13 | 2 | 0.943 |
| E133 | 13 | 3 | 0.523 |
| E141 | 14 | 1 | 0.0106 |
| E142 | 14 | 2 | 0.118 |
| E143 | 14 | 3 | -10.400 |
| E144 | 14 | 4 | -1.250 |
| E145 | 14 | 5 | 0.931 |
| E151 | 15 | 1 | 2750.000 |
| E152 | 15 | 2 | 0.943 |
| E153 | 15 | 3 | 0.523 |
| E154 | 15 | 4 | 1.250 |
| E155 | 15 | 5 | 0.931 |
| E161 | 16 | 1 | 334.000 |
| E162 | 16 | 2 | 2.017 |

* See Appendix C for corresponding equations

1. Residential Data

The system equations for the residential submodel are shown in Appendix A, Equation Numbers 1 through 16, inclusive. A tabulation of the existing data identification names and constants is shown in Table VI-1. (See Appendix C, page C-2, for the constants as they actually appear in the Library.)

2. Commercial Data

There are five data subgroups on the Library to describe the commercial submodel.

They are commercial category labels, annual average usage coefficients, maximum day usage coefficients, peak hour usage coefficients, and parameter unit labels. There are 28 general purpose commercial and institutional categories built into the Library. Table VI-2 contains a list of these categories with data identification names, category names, parameter units, and six sets of usage coefficients. Three of the sets are the expected values incorporated in the Library. The other three shown are design values. They represent the upper 95 percent confidence limit of the data measured in the original study of commercial/institutional water usage. Since the variance in water usage among individual establishments in the same category can be considerable, caution should be exercised in applying the expected values of the coefficients to categories containing only one or several establishments. There may be instances where the user may wish to replace the coefficient in the Library with the design value, thus gaining a measure of conservatism when the number of establishments is very small. Appendix C contains listing of the commercial category labels, parameters unit labels, and usage coefficients of pages C-22 and C-23.

3. Industrial Data

The Library contains four data subgroups to describe the industrial submodel.

They are industrial annual average usage coefficients, industrial category labels, maximum day usage coefficients, peak hour usage coefficients. Data identification names for the industrial categories are shown as the letter I followed by the three digit S.I.C. code. A complete list of those industrial categories in the Library with usage coefficients is given in Table VI-3. The actual industrial data subgroups in the Library are given in Appendix C. Page C-24 contains the category labled, and pages C-25, C-26, and C-27 contain mean annual usage coefficients, maximum day usage coefficients, and peak hour usage coefficients, respectively.

| Data Identification Name | Commercial Category | Parameters | Coefficients (gallons/day/unit of parameter) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Design Usage Coefficients | | | Library Data Expected Usage Coefficients | | |
| | | | Mean Annual | Max. Day | Peak Hour | Mean Annual | Max. Day | Peak Hour |
| BARB | Barber Shops | Barber Chairs | 97.5 | 123.0 | 432.0 | 54.6 | 80.3 | 389.0 |
| BEUT | Beauty Shops | Station | 532.0 | 591.0 | 1330.0 | 269.0 | 328.0 | 1070.0 |
| DPOT | Bus-Rail Depots | Sq. Ft. | 5.0 | 9.8 | 37.6 | 3.33 | 6.5 | 25.0 |
| CARW | Car Washes | Inside Sq. Ft. | 4.78 | 10.3 | 31.5 | 4.78 | 10.3 | 31.5 |
| CHUR | Churches | Member | 0.138 | 0.862 | 4.7 | 0.138 | 0.862 | 4.7 |
| CLUB | Golf-Swim Clubs | Member | 33.3 | 33.3 | 33.3 | 22.2 | 22.2 | 22.2 |
| BOWL | Bowling Alleys | Alley | 200.0 | 200.0 | 200.0 | 133.0 | 133.0 | 133.0 |
| COLG | Colleges Resid. | Student | 179.0 | 187.0 | 232.0 | 106.0 | 114.0 | 250.0 |
| HOSP | Hospitals | Bed | 559.0 | 764.0 | 1120.0 | 346.0 | 551.0 | 912.0 |
| HOTL | Hotels | Sq. Ft. | 0.256 | 0.294 | 0.433 | 0.256 | 0.294 | 0.433 |
| LNDM | Laundromats | Sq. Ft. | 6.39 | 7.12 | 19.6 | 2.17 | 2.90 | 15.4 |
| LNDY | Laundry | Sq. Ft. | 0.639 | 0.712 | 1.96 | 0.253 | 0.461 | 1.57 |
| MEDL | Medical Offices | Sq. Ft. | 0.618 | 1.66 | 4.97 | 0.618 | 1.66 | 4.97 |
| MOTL | Motels | Sq. Ft. | 0.326 | 0.563 | 1.65 | 0.224 | 0.461 | 1.55 |
| MOVI | Drive-In Movies | Car Stall | 8.0 | 8.0 | 8.0 | 5.33 | 5.33 | 5.33 |
| NURS | Nursing Homes | Bed | 209.0 | 222.0 | 500.0 | 133.0 | 146.0 | 424.0 |

Table VI-2. Commercial Categories and Usage Coefficient Values for the Library of Water Usage Coefficients

| Data Identification Name | Commercial Category | Parameters | Coefficients (gallons/day/unit of parameter) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Design Usage Coefficients | | | Library Data Expected Usage Coefficients | | |
| | | | Mean Annual | Max. Day | Peak Hour | Mean Annual | Max. Day | Peak Hour |
| OFFN | New Office Bldg. | Sq. Ft. | 0.164 | 0.224 | 0.592 | 0.193 | 0.173 | 0.521 |
| OFFO | Old Office Bldg. | Sq. Ft. | 0.273 | 0.345 | 0.928 | 0.142 | 0.264 | 0.797 |
| JAIL | Jail and Prison | Person | 200.0 | 200.0 | 200.0 | 133.0 | 133.0 | 133.0 |
| EATN | Rstaurants | Seat | 55.2 | 114.0 | 198.0 | 24.2 | 83.4 | 167.0 |
| EATO | Drive-In Rest. | Car Stalls | 109.0 | 21.0 | 820.0 | 109.0 | 144.0 | 547.0 |
| NITE | Night Clubs | Person Served | 2.0 | 2.0 | 2.0 | 1.33 | 1.33 | 1.33 |
| SALE | Retail Space | Sale Sq. Ft. | 0.16 | 0.232 | 0.412 | 0.106 | 0.154 | 0.271 |
| SKLL | School, Elem. | Student | 7.38 | 9.96 | 45.9 | 3.83 | 6.39 | 37.4 |
| SKLH | School, High | Student | 14.81 | 21.46 | 122.57 | 8.02 | 17.7 | 79.9 |
| YMCA | YMCA-YWCA | Person | 50.0 | 50.0 | 50.0 | 33.3 | 33.3 | 33.3 |
| GASS | Service Station | Inside Sq. Ft. | 0.485 | 0.824 | 5.12 | 0.251 | 0.590 | 4.89 |
| THTR | Theaters | Seat | 5.0 | 5.0 | 5.0 | 3.33 | 3.33 | 3.33 |



Table VI-2. Commercial Categories and Usage Coefficient Values for the Library of Water Usage Coefficients (Continued)

| S.I.C. Number | Industrial Category | Mean Annual Usage Coefficient* (gal/day/employee) |
|---|---|---|
| 201 | MEAT PRODUCTS | 903.890 |
| 202 | DAIRIES | 791.350 |
| 203 | CANNED, FROZEN FOODS | 784.739 |
| 204 | GRAIN MILLS | 488.249 |
| 205 | BAKERY PRODUCTS | 220.608 |
| 206 | SUGAR | 1,433.611 |
| 207 | CANDY | 244.306 |
| 208 | BEVERAGES | 1,144.868 |
| 209 | MISCELLANEOUS FOODS | 1,077.360 |
| 211 | CIGARETTES | 193.613 |
| 221 | WEAVING, COTTON | 171.434 |
| 222 | WEAVING, SYNTHETICS | 344.259 |
| 223 | WEAVING, WOOL | 464.439 |
| 225 | KNNITTING MILLS | 273.439 |
| 226 | TEXTILE FINISHING | 810.741 |
| 227 | FLOOR COVERING | 297.392 |
| 228 | YARN, THREAD MILLS | 63.558 |
| 229 | MISCELLANEOUS TEXTILES | 346.976 |
| 230 | WHOLE APPAREL INDUSTRY | 20.000 |
| 242 | SAW - PLANING MILLS | 223.822 |
| 243 | MILLWORK | 316.420 |
| 244 | WOOD CONTAINERS | 238.000 |
| 249 | MISCELLANEOUS WOOD | 144.745 |
| 251 | HOME FURNITURE | 122.178 |
| 259 | FURNITURE FIXTURE | 122.178 |
| 261 | PULP MILLS | 13,494.110 |
| 262 | PAPER MILLS | 2,433.856 |
| 263 | PAPERBOARD MILLS | 2,464.478 |
| 264 | PAPER PRODUCTS | 435.790 |
| 265 | PAPERBOARD BOXES | 154.804 |
| 266 | BUILDING PAPER MILLS | 583.355 |
| 270 | WHOLE PRINT INDUSTRY | 15.000 |
| 281 | BASIC CHEMICALS | 2,744.401 |
| 282 | FIBERS, PLASTICS | 864.892 |
| 283 | DRUGS | 457.356 |
| 284 | SOAP, TOILT GOODS | 672.043 |
| 285 | PAINT, ALLIED PRODUCTS | 845.725 |
| 286 | GUM - WOOD CHEMICALS | 332.895 |
| 287 | AGRICULTURE CHEMICALS | 449.836 |
| 289 | MISCELLANEOUS CHEMICALS | 984.415 |
| 291 | PETROLEUM REFINING | 3,141.100 |
| 295 | PAVING, ROOFING | 829.592 |
| 301 | TIRES, TUBES | 375.211 |
| 302 | RUBBER FOOTWEAR | 82.592 |

Table VI-3. Industrial Categories and Usage Coefficient Values

| S.I.C. Number | Industrial Category | Mean Annual Usage Coefficient* (gal/day/employee) |
|---|---|---|
| 303 | RECLAIMED RUBBER | 1,031.523 |
| 306 | RUBBER PRODUCTS | 371.956 |
| 307 | PLASTIC PRODUCTS | 527.784 |
| 311 | LEATHER TANNING | 899.500 |
| 321 | FLAT GLASS | 590.140 |
| 322 | PRESSED, BLOWN GLASSWARE | 340.753 |
| 323 | PRODUCTS OF PURCHASED GLASS | 872.246 |
| 324 | CEMENT, HYDRAULIC | 279.469 |
| 325 | STRUCTURAL CLAY | 698.197 |
| 326 | POTTERY PRODUCTS | 326.975 |
| 327 | CEMENT, PLASTER | 353.787 |
| 328 | CUT STONE PRODUCTS | 534.789 |
| 329 | NON-METALLIC MINERAL | 439.561 |
| 331 | STEEL-ROLLING | 494.356 |
| 332 | IRON, STELL FOUNDRIES | 411.052 |
| 333 | PRIME NON-FERROUS | 716.626 |
| 334 | SECONDARY NON-FERROUS | 1,016.596 |
| 335 | NON-FERROUS ROLLING | 675.475 |
| 336 | NON-FERROUS FOUNDRIES | 969.586 |
| 339 | PRIME METAL INDUSTRIES | 498.331 |
| 341 | METAL CANS | 162.547 |
| 342 | CUTLERY, HARDWARE | 459.300 |
| 343 | PLUMBING, HEATING | 411.576 |
| 344 | STRUCTURE, METAL | 319.875 |
| 345 | SCREW MACHINE | 433.193 |
| 346 | METAL STAMPING | 463.209 |
| 347 | METAL SERVICE | 1,806.611 |
| 348 | FABRICATED WIRE | 343.367 |
| 349 | FABRICATED METAL | 271.186 |
| 351 | ENGINES, TURBINES | 197.418 |
| 352 | FARM MACHINERY | 320.704 |
| 353 | CONSTRUCTION EQUIPMENT | 218.365 |
| 354 | METALWORK, MACHINERY | 196.255 |
| 355 | SPECIAL INDUSTRY MACHINERY | 290.494 |
| 356 | GENERAL INDUSTRIAL MACHINERY | 246.689 |
| 357 | OFFICE MACHINES | 138.025 |
| 358 | SERVICE INDUSTRIAL MACHINE | 334.203 |
| 359 | MISCELLANEOUS MACHINES | 238.839 |
| 361 | ELECTRIC DISTRIBUTION PRODUCTS | 272.001 |

Table VI-3. Industrial Categories and Usage Coefficient Values (Continued)

| S.I.C. Number | Industrial Category | Mean Annual Usage Coefficient* (gal/day/employee) |
|---|---|---|
| 362 | ELECTRIC INDUSTRIAL APPARATUS | 336.016 |
| 363 | HOME APPLIANCES | 411.914 |
| 364 | LIGHT-WIRING FIXTURES | 369.592 |
| 365 | RADIO-TV RECEIVING | 235.763 |
| 366 | COMMUNICATION EQUIPMENT | 86.270 |
| 367 | ELECTRONIC COMPONENTS | 203.289 |
| 369 | ELECTRIC PRODUCTS | 393.272 |
| 371 | MOTOR VEHICLES | 318.233 |
| 372 | AIRCRAFT AND PARTS | 154.769 |
| 373 | SHIP AND BOAT BUILDING | 166.074 |
| 374 | RAILROAD EQUIPMENT | 238.798 |
| 375 | MOTORCYCLE, BIKE | 414.859 |
| 381 | SCIENTIFIC INSTRUMENTS | 181.007 |
| 382 | MECHANICAL MEASURE | 237.021 |
| 384 | MEDICAL INSTRUMENTS | 506.325 |
| 386 | PHOTOGRAPHIC EQUIPMENT | 120.253 |
| 387 | WATCHES, CLOCKS | 164.815 |
| 391 | JEWELRY, SILVER | 306.491 |
| 394 | TOYS, SPORT GOODS | 213.907 |
| 396 | COSTUME JEWELRY | 423.124 |
| 398 | MISCELLANEOUS MANUFACTURING | 258.270 |
| 399 | MISCELLANEOUS MANUFACTURING | 258.270 |

* Maximum day and peak hour usage coefficients have not been determined at this time. Therefore, the Library contains identical tables of the values as tabulated here for the mean annual usage coefficients.

Table VI-3. Industrial Categories and Usage Coefficient Values (Continued)

4. Public/Unaccounted Data

Public/unaccounted data in the Library are made up of four data subgroups. They are annual average usage coefficients, maximum day usage coefficients, maximum day usage coefficients, peak hour usage coefficients, and category labels. There are only three data identification names of categories built into the public/unaccounted submodel. These are:

AIRP, FSER, LOSS

The definitions of these names are the follows:

AIRP: Airport category

FSER: Free service category, which could include such detail items as: firefighting, street cleaning, zoos, parks, fountains, museums, and public offices and buildings

LOSS: Unaccounted water usage due to distribution losses, etc.

Table VI-4 is a summary of the usage coefficients for each of the public/unaccounted categories. The listing of all four data subgroups in the Library is shown in Appendix C, page C-28.

5. Climatic Data

The residential sprinkling equations require climatic data values to compute water usage. Since the IWR MAIN System is intended for use by Anycity, U.S.A., the Library of Water Usage Coefficients was designed to contain the required climatic data for the entire United States. Maps of the United Sates were developed to show lines of constant summer evapotranspiration and constant summer precipitation. Figures VI-1 and VI-2 are illustrations of these maps with latitude and longitude grid lines drawn at one degree increments. The grid points recorded were for the entire United States, including those grid points one degree outside the borders of the country.

A listing of the climatic data, as contained in the Library, are shown on pages C-3 through C-21 inclusive. The data identification names shown have the following meanings:

EVAP: Value of summer potential evapotranspiration (inches)

LATD: Latitude of grid point (degrees)

LONG: Longitude of grid point (degrees)

RAIN: Value of summer precipitation (inches) at the grid point

| Data Identification Name | Category | Mean Annual Usage Coefficient* |
|---|---|---|
| LOSS | Distribution Losses | 14.9 |
| FSER | Free Service | 5.2 |
| AIRP | Airports | 5.0 |

*Values for maximum day and peak hour are the same as the values for mean annual usage coefficients.

Table VI-4. Public/Unaccounted Categories and Usage Coefficient Values for the Library of Water Usage Coefficients

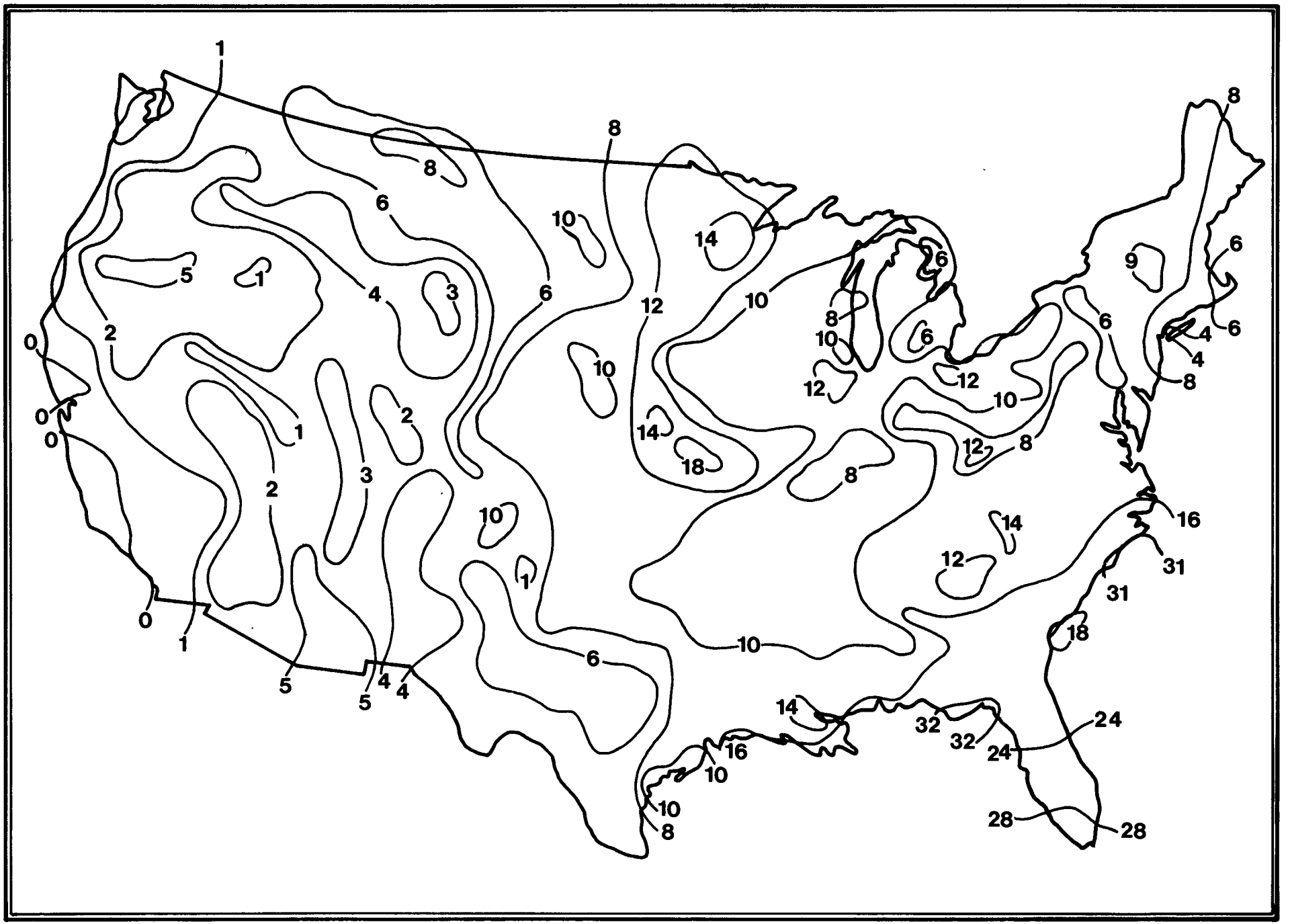


Figure VI-1. Lines of Constant Summer Precipitation

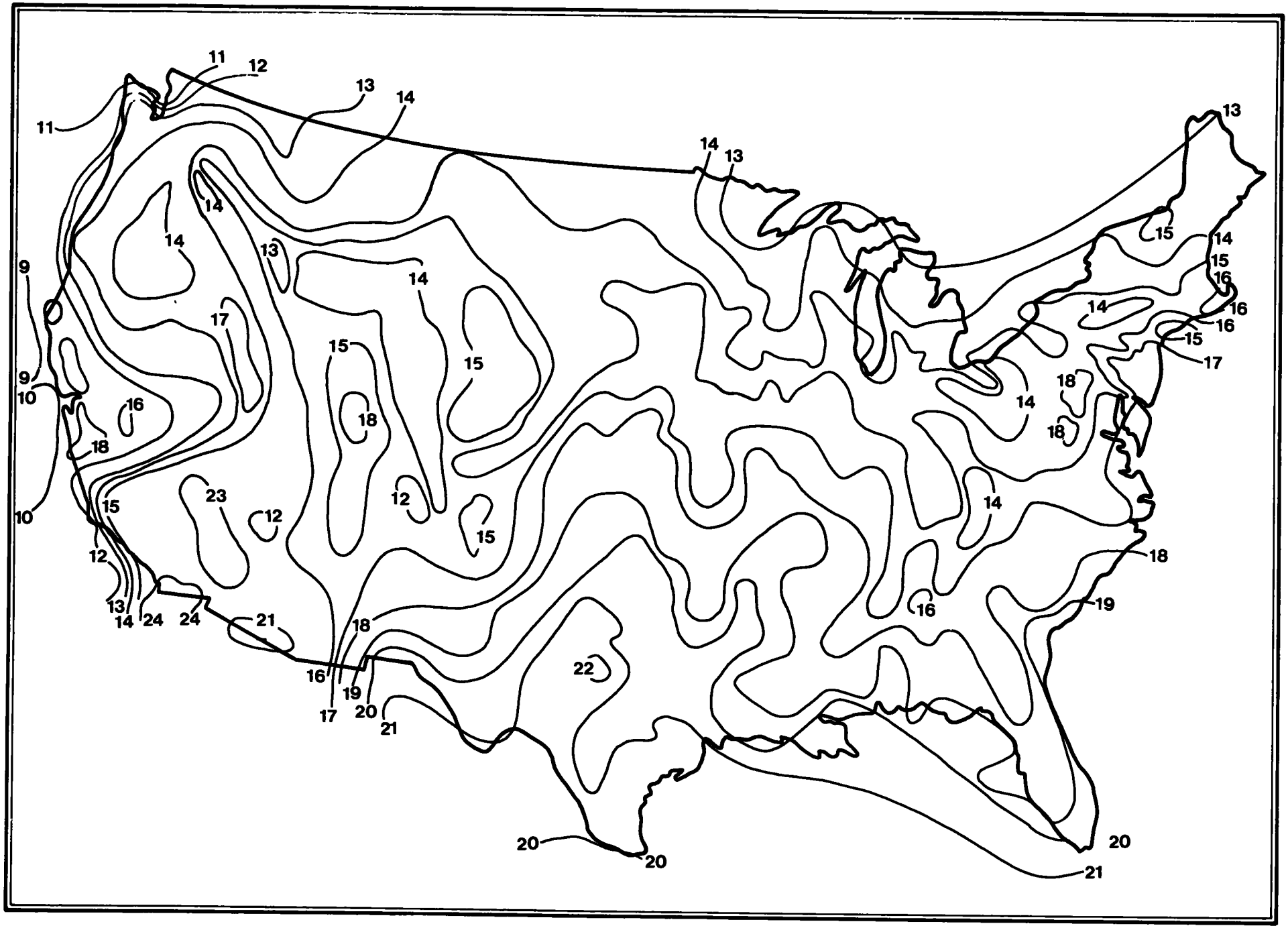


Figure VI-2. Lines of Constant Summer Potential Evapotranspiration

## D. Updating and Modifying the Library

It was anticipated that some users of the IWR MAIN System may find that the Library does not contain up-to-date usage coefficient values nor adequate category definitions that satisfy specific requirements. These users may make changes to the Library.

It is expected that users will be making Library modifications to only the commercial, industrial, and public/unaccounted submodels. Changes to the residential equation constants and the climatic data are possible but not likely to occur. These changes, if necessary, should be done with the help of an ADP specialist. Changes to existing category labels on usage coefficients may be incorporated. It is also possible to modify the Library by creating additional new data subgroups containing only the new sets of data.

### 1. Commercial Modifications

Assume a user wishes to change the usage coefficients for the commercial category retail space and to open the two new categories, nonresident college and shopping center. The following tabulation refers to data that will be requested by the Library Submodel.

| Example | Illustration of |
|---|---|
| C001, College Non-Res | New commercial category labels |
| Students | Parameter unit labels for the new commercial categories |
| 15.2 | New and corrected mean annual usage coefficients |
| 27.0 | New and corrected maximum day usage coefficients |
| 57.8 | New and corrected peak hour usage coefficients |

### 2. Industrial Modification

To illustrate modification to the industrial submodel, assume water usage coefficients have been determined for the cigar industry, whose three digit S.I.C. code might be 212. These data could be incorporated in the Library with the examples of new data subgroups as tabulated below:

| Example | Illustration of |
|---|---|
| I212, CIGARS | New industrial category label |
| 172.4 | New mean annual usage coefficient |

| | |
|---|---|
| 172.4 | New maximum day usage coefficient |
| 172.4 | New peak hour usage coefficient |

3. Public/Unaccounted Modifications

For this illustration, assume the user wants to change the usage coefficients for the distribution losses category and to open the new categories of street cleaning and firefighting. A tabulation of the examples of the new public-unaccounted data subgroups is as follows:

| Example | Illustration of |
|---|---|
| P001, Street Cleaning | New public/unaccounted category labels |
| 3.7 | New and corrected mean annual usage coefficients |
| 3.7 | New and corrected maximum day usage coefficients |
| 3.7 | New and corrected peak hour usage coefficients |

# APPENDIX A

# COMPUTATIONAL EQUATIONS

## Definition of Symbols and Subscripts

| Symbol | Meaning of Symbol | Units |
|---|---|---|
| q | water usage for a particular cateogry | gpd |
| V | average home value in a range of values = $\frac{Vmin + Vmax}{2 \times 1000}$ | thousands of dollars |
| Vmin | lower limit of home value range | dollars |
| Vmax | upper limit of home value range | dollars |
| $N_r$ | the number of residences of value range r | residences |
| $F_a$ | assessment factor | none |
| L | gross residential land area, including streets | acres |
| $H_d$ | housing density, $N_r//L$ | units/acres |
| B | irrigable land per dwelling | acres/unit |
| $D_p$ | population density in residences | persons/unit |
| p | mean annual price of water | cents/thousand gallons |
| $p_s$ | summer price of water | cents/thousand gallons |
| E | total summer evapotranspiration | inches |
| R | total summer precipitation | inches |
| $E_m$ | maximum day evapotranspiration = = 0.25 for west = 0.29 for east | inches |
| $P_c$ | commercial usage parameter | parameter units |
| C | commercial usage coefficient | gpd/parameter |
| U | industrial water usage per employee in an industry | gpd/employee |
| $P_n$ | industrial population in industry | employees |
| M | public-unaccounted usage coefficient | gpcd |
| $P_{pu}$ | public-unaccounted parameter | persons |

| Subscript | Quantity Indicated |
|---|---|
| pkhr | peak-hour quantities |
| mxdy | maximum-day quantities |
| D | domestic water usage |
| s | sprinkling water usage |
| ms | meter-sewered residences |
| fs | flat-rate sewered residences |
| mt | metered septic tank residences |
| ft | flat-rate septic tank residences |
| mxs | maximum day sprinkling |
| pks | peak hour sprinkling |
| n | industrial usage category |
| pu | public-unaccounted usage category |
| w | west of the 100th meridian |
| e | east of the 100th meridian |
| c | category of commercial |

## Residential Equations

1. Mean annual domestic usage

$$(q_D)_{ms} = (206 + 3.47\ V/F_a - 1.3\ p\ )N_r \quad (1)$$

$$(q_D)_{fs} = (28.9 + V/F_a + 33.6\ D_p)N_r \quad (2)$$

$$(q_D)_{mt} = (30.2 + 39.5\ D_p)N_r \quad (3)$$

$$(q_D)_{ft} = (30.2 + 39.5\ D_p)N_r \quad (4)$$

2. Mean annual sprinkling usage

$$(q_s)_{ms,w} = (0.48 \times 1130\ p_s^{-0.703}\ (V/F_a)^{0.429})N_r \quad (5)$$

$$(q_s)_{ms,e} = (0.39 \times 0.164B^{-0.793}\ (E-0.6R)^{2.93} p_s^{-1.57} (V/F_a)^{1.45})N_r \quad (6)$$

$$(q_s)_{fs} = (0.41 \times 100\ (V/F_a)^{0.789})N_r \quad (7)$$

$$(q_s)_{mt} = (0.39 \times 0.164B^{-0.793} (E-0.6R)^{2.93}\ p_s^{-1.57} (V/F_a)^{1.45})N_r \quad (8)$$

$$(q_s)_{ft} = (0.41 \times 100 (V/F_a)^{0.789})N_r \quad (9)$$

where

$$B = 0.803\ H_d^{-1.26} \quad (10)$$

3. Maximum day sprinkling usage

$$(q_{mxs})_{ms,w} = (3400\ E_m^{2.06} (V/F_a)^{0.413})N_r \quad (11)$$

$$(q_{mxs})_{ms,e} = (0.0106B^{0.118} E_m^{-10.4}\ p_s^{-1.25} (V/F_a)^{0.931})N_r \quad (12)$$

$$(q_{mxs})_{fs} = (2750B^{0.943} (V/F_a)^{0.523})N_r \quad (13)$$

$$(q_{mxs})_{mt} = (0.0106B^{0.118} E_m^{-10.4}\ p_s^{-1.25} (V/F_a)^{0.931})N_r \quad (14)$$

$$(q_{mxs})_{ft} = (2750B^{0.943} (V/F_a)^{0.523})N_r \quad (15)$$

4. Peak hour usage (single equation for all four categories)

$$q_{pkhr} = 334\ N_r + 2.017\ (q_D + q_{mxs}) \quad (16)$$

Commercial Equations

$$\bar{q}_c = \bar{C}\ P_c \quad (17)$$

$$(q_c)_{mxdy} = C_{mxdy} P_c \quad (18)$$

$$(q_c)_{pkhr} = C_{pkhr} P_c \quad (19)$$

Industrial Equations

$$\bar{q}_n = \bar{U}_n P_n \quad (20)$$

$$(q_n)_{mxdy} = (U_n)_{mxdy} P_n \quad (21)$$

$$(q_n)_{pkhr} = (U_n)_{pkhr} P_n \quad (22)$$

Public-Unaccounted Equations

$$\bar{q}_{pu} = \bar{M}_{pu} P_{pu} \quad (23)$$

$$(q_{pu})_{mxdy} = (M_{pu})_{mxdy} P_{pu} \quad (24)$$

$$(q_{pu})_{pkhr} = (M_{pu})_{pkhr} P_{pu} \quad (25)$$

# APPENDIX B

# PROJECTION MODELS

## Definition of Symbols and Subscripts

| Symbol | Meaning of Symbol | Units |
|---|---|---|
| $t$ | calendar year | years |
| $P$ | study area resident population | number of persons |
| $N_t$ | Total number of occupied housing units | number of units |
| $N_1$ | Total number of occupied housing units having 1980 market value less than $25,500 | number of units |
| $N_2$ | Total number of occupied housing units having 1980 market value of at least $25,000 but not more than $51,000 | number of units |
| $N_3$ | Total number of occupied housing units having 1980 market value of at least $51,000 | number of units |
| NW | fraction of resident population that is non-white | fraction |
| PD | gross population density | person/square mile |
| AGE | fraction of resident population 20-39 years of age | fraction |
| $Y_m$ | median years school completed by adults | years |
| $I_f$ | median family income | 1980 dollars/family/ year |
| $I_p$ | per capita personal income | 1980 dollars/family/ year |
| $PAR_m$ | parameter value for commercial/institutional category m, except elementary and high schools | as indicated on Table II-4 |
| $PAR_7$ | parameter value for elementary schools | number of pupils enrolled |
| $PAR_8$ | parameter value for high schools | number of pupils enrolled |
| $EMP_1$ | employment in hotel, motel categories | number employed |

Definition of Symbols and Subscripts (Continued)

| Symbol | Meaning of Symbol | Units |
|---|---|---|
| $EMP_2$ | employment in barber shop, beauty shop categories | number employed |
| $EMP_3$ | employment in restaurant, drive-in restaurant, night club categories | number employed |
| $EMP_4$ | employment in hospital, nursing home, and medical office cagegories | number employed |
| $EMP_5$ | employment in laundry, laundromat categories | number employed |
| $EMP_6$ | employment in retail sales category | number employed |
| $EMP_9$ | employment in bus-rail depot, car wash, church, golf-swim club, bowling alley, resident college, drive-in movies, new office building, old office building, jail and prison, theatre, YMCA-YWCA facility, and service station categories | number employed |
| $EMP_{10}$ | employment in any user-added categories | number employed |
| $EMP_s$ | total employment in service industries (S.I.C. categories 700 through 899, except schools) | number employed |
| $EMP_t$ | total employment by all commercial, institutionall, and industrial activity within study area | number employed |
| $EMP_{40}$ | employment in transportation, communications, and utilities industries (S.I.C. categories 400 through 499) | number employed |
| $IND_1$ | employment in S.I.C. categories 200-219 | number employed |
| $IND_2$ | employment in S.I.C. categories 220-239 | number employed |
| $IND_3$ | employment in S.I.C. categories 240-279 | number employed |
| $IND_4$ | employment in S.I.C. categories 280-299 | number employed |
| $IND_5$ | employment in S.I.C. categories 300-309 | number employed |
| $IND_6$ | employment in S.I.C. categories 310-319 | number employed |

## Definition of Symbols and Subscripts (Continued)

| Symbol | Meaning of Symbol | Units |
|---|---|---|
| $IND_7$ | employment in S.I.C. categories 320-329 | number employed |
| $IND_8$ | employment in S.I.C. categories 330-349 | number employed |
| $IND_9$ | employment in S.I.C. categories 350-369 | number employed |
| $IND_{10}$ | employment in S.I.C. categories 370-379 | number employed |
| $IND_{11}$ | employment in S.I.C. categories 380-399 | number employed |
| AIRP | parameter value for airports | number of passengers per day |

| Subscript | Quantity Indicated |
|---|---|
| ' | prime mark indicating value in projection year. No mark indicates current data. |
| h | historical trend: $\left[\frac{\Delta Q}{\Delta t}\right]_h$ is interpreted as $-- (Q - Q_1)/(t - t_1)$, or the change in the value of Q between the base year and some past year divided by the number of years between the base year and the past year. |
| p | projected trend: $\left[\frac{\Delta Q}{\Delta t}\right]_p$ is interpeted as $-- (Q' - Q)/(t' - t)$, or the change in the value of Q between a projected year and the base year divided by the number of years between the projected year and the base year. |

## Residential Models

a. Median family income

$$\left[\frac{\Delta I_f}{\Delta t}\right]_p = \frac{I_f' - I_f}{t[I_f]} \tag{1}$$

$$I_f = -156812.67 + 2.53698\, I_p + 79.6025\, t \tag{2}$$

b. Total number of homes

$$\frac{\Delta N_t}{\Delta t} = -10.391 + 0.1501 \left[\frac{\Delta P}{\Delta t}\right]_h + 0.1017 \left[\frac{\Delta P}{\Delta t}\right]_p +$$

$$0.38751 \left[\frac{\Delta N_t}{\Delta t}\right]_h - 97540.0 \left[\frac{\Delta NW}{\Delta t}\right]_h + 0.29338\, PD \tag{3}$$

$$N_t' = N_t + \Delta t \left[\frac{\Delta N_t}{\Delta t}\right] \tag{4}$$

c. Number of homes in low value range

$$\frac{\Delta\left[\frac{N_1}{N_t}\right]}{\Delta t} = -0.0378505 + 0.000000097 \left[\frac{\Delta N_t}{\Delta t}\right]_h + 0.10643\, AGE$$

$$+ 0.424 \left[\frac{\Delta NW}{\Delta t}\right]_h - 0.036121 \left[\frac{\Delta Y_m}{\Delta t}\right]_h -$$

$$0.0008956 \left[\frac{\Delta I_f}{\Delta t}\right]_p \tag{5}$$

$$\frac{N_1'}{N_t'} = \frac{N_1}{N_t} + \Delta t \left[ \frac{\Delta \left[ \frac{N_1}{N_t} \right]}{\Delta t} \right] \tag{6}$$

$$N_1' = N_t' \left[ \frac{N_1'}{N_t'} \right] \tag{7}$$

d. Number of homes in medium value range

$$\frac{\Delta \left[ \frac{N_2}{N_t} \right]}{\Delta t} = 0.0110124 - 0.000000067 \left[ \frac{\Delta N_t}{\Delta t} \right]_h +$$

$$0.31158 \left[ \frac{\Delta \left[ \frac{N_2}{N_t} \right]}{\Delta t} \right]_h - 0.377 \left[ \frac{\Delta NW}{\Delta t} \right]_h \tag{8}$$

$$\frac{N_2'}{N_t'} = \frac{N_2}{N_t} + \Delta t \left[ \frac{\Delta \left[ \frac{N_2}{N_t} \right]}{\Delta t} \right] \tag{9}$$

$$N_2' = N_t' \left[ \frac{N_2'}{N_t'} \right] \tag{10}$$

e. Number of homes in high value range

$$\frac{\Delta \left[ \frac{N_3}{N_t} \right]}{\Delta t} = 0.2025125 - 0.10704 \text{ AGE} - 0.27168 \left[ \frac{\Delta \left[ \frac{N_3}{N_t} \right]}{\Delta t} \right]_h +$$

$$0.0819373 \left[ \frac{\Delta Y_m}{\Delta t} \right]_h + 0.01475 \left[ \frac{\Delta I_f}{\Delta t} \right]_p \tag{11}$$

$$\frac{N_3'}{N_t'} = \frac{N_3}{N_t} + \Delta t \left[ \frac{\Delta \left[ \frac{N_3}{N_t} \right]}{\Delta t} \right] \quad (12)$$

$$N_3' = N_t' \left[ \frac{N_3'}{N_t'} \right] \quad (13)$$

## Commercial/Institutional Models

a. Total services employment (Used when not provided by user)

$$\left[ \frac{\Delta EMP_s}{\Delta t} \right]_p = -100.784 + 0.045532 \left[ \frac{\Delta P}{\Delta t} \right]_p + 0.6449 \left[ \frac{\Delta EMP_s}{\Delta t} \right]_h \quad (14)$$

b. Values of all commercial/institutional parameters except elementary and high school enrollment

$$PAR_m' = PAR_m \left[ \frac{EMP_n'}{EMP_n} \right] \quad (15)$$

Where: n = 1, 2, 3, 4, 5, 6, 9, 10
m = related commercial categories

c. Employment in hotels, motels

$$\frac{\Delta EMP_1}{\Delta t} = 18.01103 + 0.00163803 \left[ \frac{\Delta P}{\Delta t} \right]_h + 0.1771566 \left[ \frac{\Delta EMP_s}{\Delta t} \right]_p - 0.1422007 \left[ \frac{\Delta EMP_s}{\Delta t} \right]_h \quad (16)$$

$$EMP_1' = \Delta t \left[ \frac{EMP_1}{\Delta t} \right] + EMP_1 \quad (17)$$

d. Employment in barber shops, beauty shops

$$\frac{\Delta EMP_2}{\Delta t} = 11.27909 + 0.00147525 \left[\frac{\Delta P}{\Delta t}\right]_h + 0.038257 \left[\frac{\Delta EMP_s}{\Delta t}\right]_p -$$

$$0.021728 \left[\frac{\Delta EMP_s}{\Delta t}\right]_h \quad (18)$$

$$EMP_2' = \Delta t\left[\frac{\Delta EMP_2}{\Delta t}\right] + EMP_2 \quad (19)$$

e. Employment in restaurants, drive-in restaurants, night clubs

$$\frac{\Delta EMP_3}{\Delta t} = 95.8166 + 0.218327 \left[\frac{\Delta EMP_s}{\Delta t}\right]_p -$$

$$0.101819 \left[\frac{\Delta EMP_s}{\Delta t}\right]_h \quad (20)$$

$$EMP_3' = \Delta t\left[\frac{\Delta EMP_3}{\Delta t}\right] + EMP_3 \quad (21)$$

f. Employment in hospitals, nursing homes, medical offices

$$\frac{\Delta EMP_4}{\Delta t} = 21.2427 + 0.0107481 \left[\frac{\Delta P}{\Delta t}\right]_h + 0.004156 \left[\frac{\Delta EMP_s}{\Delta t}\right]_p +$$

$$0.32774 \left[\frac{\Delta EMP_4}{\Delta t}\right]_h \quad (22)$$

$$EMP_4' = \Delta t\left[\frac{\Delta EMP_4}{\Delta t}\right] + EMP_4 \quad (23)$$

g. Employment in laundries, laundromats

$$\frac{\Delta EMP_5}{\Delta t} = -9.78924 + 0.002336 \left[\frac{\Delta P}{\Delta t}\right]_p -$$

$$0.0056347 \left[\frac{\Delta EMP_s}{\Delta t}\right]_p \quad (24)$$

$$EMP_5' = \Delta t\left[\frac{\Delta EMP_5}{\Delta t}\right] + EMP_5 \quad (25)$$

h. Employment in retail sales

$$\frac{\Delta EMP_6}{\Delta t} = 89.6963 + 0.0332268 \left[\frac{\Delta P}{\Delta t}\right]_h + 0.718593 \left[\frac{\Delta EMP_s}{\Delta t}\right]_p -$$

$$0.410774 \left[\frac{\Delta EMP_s}{\Delta t}\right]_h \quad (26)$$

$$EMP_6' = \Delta t\left[\frac{\Delta EMP_6}{\Delta t}\right] + EMP_6 \quad (27)$$

i. Enrollment in elementary schools

$$\frac{\Delta PAR_7}{\Delta t} = 501.5301 + 0.32602 \left[\frac{\Delta P}{\Delta t}\right]_h + 0.7743 \left[\frac{\Delta P}{\Delta t}\right]_p +$$

$$0.165203 \left[\frac{\Delta N_t}{\Delta t}\right]_h - 1.19209 \left[\frac{\Delta PAR_7}{\Delta t}\right]_h + 0.311873\ PD \quad (28)$$

$$PAR_7' = \Delta t \left[\frac{\Delta PAR_7}{\Delta t}\right] + PAR_7 \quad (29)$$

j. Enrollment in high schools

$$\frac{\Delta PAR_8}{\Delta t} = 20.4796 + 0.07764 \left[\frac{\Delta P}{\Delta t}\right]_h + 0.0185 \left[\frac{\Delta P}{\Delta t}\right]_p +$$

$$0.036191 \left[\frac{\Delta N_t}{\Delta t}\right]_h - 0.0703 \left[\frac{\Delta PAR_7}{\Delta t}\right]_h - 21598.0 \left[\frac{\Delta NW}{\Delta t}\right]_h -$$

$$0.28595 \left[\frac{\Delta PAR_8}{\Delta t}\right]_h + 0.047556\ PD \qquad (30)$$

$$PAR_8' = \Delta t \left[\frac{\Delta PAR_8}{\Delta t}\right] + PAR_8 \qquad (31)$$

k. Employment in bus-rail depots, car washes, churches, golf-swim clubs, bowling alleys, resident colleges, drive-in movies, new office buildings, old office buildings, jails and prisons, theatres, YMCA-YWCA facilities, and service stations

$$EMP_9' = EMP_9 \left[\frac{EMP_s + \Delta t \left[\frac{\Delta EMP_s}{\Delta t}\right]_p}{EMP_s}\right] \qquad (32)$$

l. Employment in all user-added commercial/institutional categories

$$EMP_{10}' = EMP_{10} \left[\frac{EMP_s + \Delta t \left[\frac{\Delta EMP_s}{\Delta t}\right]_p}{EMP_s}\right] \qquad (33)$$

## Industrial Models

a. Method of projecting employment in all S.I.C. categories

$$\frac{IND'_m}{P'} = \frac{IND_m}{P} + \Delta t \left[\frac{\Delta\left[\frac{IND_m}{P}\right]}{\Delta P}\right] \qquad (34)$$

$$IND'_m = P' \left[\frac{IND_m}{P'}\right] \qquad (35)$$

where:

$m = 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11$

b. Employment ratio in S.I.C. categories 200 through 219

$$\frac{\Delta\left[\frac{IND_1}{P}\right]}{\Delta t} = 0.001356065 + 0.23359 \left[\frac{\Delta\left[\frac{IND_1}{P}\right]}{\Delta t}\right]_h - 0.0035744 \left[\frac{EMP_t}{P}\right] +$$

$$0.03493 \left[\frac{\Delta\left[\frac{EMP_t}{P}\right]}{\Delta t}\right]_h - 0.0030098 \left[\frac{EMP_{40}}{EMP_t}\right] \quad (36)$$

c. Employment ratio in S.I.C. categories 220 through 239

$$\frac{\Delta\left[\frac{IND_2}{P}\right]}{\Delta t} = 0.000015904 + 0.41563 \left[\frac{\Delta\left[\frac{IND_2}{P}\right]}{\Delta t}\right]_h \quad (37)$$

d. Employment ratio in S.I.C. categories 240 through 279

$$\frac{\Delta\left[\frac{IND_3}{P}\right]}{\Delta t} = 0.000258613 + 0.3152 \left[\frac{\Delta\left[\frac{IND_3}{P}\right]}{\Delta t}\right]_h \quad (38)$$

e. Employment ratio in S.I.C. categories 280 through 299

$$\frac{\Delta\left[\frac{IND_4}{P}\right]}{\Delta t} = 0.000387689 - 0.00000000001382\ P - 0.0051765 \left[\frac{EMP_{40}}{EMP_t}\right] \quad (39)$$

f. Employment ratio in S.I.C. categories 300 through 309

$$\frac{\Delta\left[\frac{IND_5}{P}\right]}{\Delta t} = 0.000036492 + 0.16464 \left[\frac{\Delta\left[\frac{IND_5}{P}\right]}{\Delta t}\right]_h \quad (40)$$

g. Employment ratio in S.I.C. categories 310 through 319

$$\frac{\Delta\left[\frac{IND_6}{P}\right]}{\Delta t} = 0.000521444 - 0.00000021704\ I_p - 0.002139\left[\frac{\sum_{i=1}^{11} IND_i}{EMP_t}\right] \quad (41)$$

h. Employment ration in S.I.C. categories 320 through 329

$$\frac{\Delta\left[\frac{IND_7}{P}\right]}{\Delta t} = 0.000320341 + 0.0009603\left[\frac{EMP_t}{P}\right] - 0.02062\left[\frac{\Delta\left[\frac{EMP_t}{P}\right]}{\Delta t}\right]_h +$$

$$0.000001437\left[\frac{\Delta I_p}{\Delta t}\right]_h - 0.0006646\left[\frac{\sum_{i=11} IND_i}{EMP_t}\right] \quad (42)$$

i. Employment ratio in S.I.C. categories 330 through 349

$$\frac{\Delta\left[\frac{IND_8}{P}\right]}{\Delta t} = 0.000219727 + 0.35843\left[\frac{\Delta\left[\frac{IND_8}{P}\right]}{\Delta t}\right]_h \quad (43)$$

j. Employment ratio in S.I.C. categories 350 through 369

$$\frac{\Delta\left[\frac{IND_9}{P}\right]}{\Delta t} = 0.002321291 - 0.0056829\left[\frac{EMP_t}{P}\right] +$$

$$0.0769\left[\frac{\Delta\left[\frac{EMP_t}{P}\right]}{\Delta t}\right]_h + 0.000013332\left[\frac{\Delta I_p}{\Delta t}\right]_h + 0.1955\left[\frac{\Delta\left[\frac{EMP_{40}}{EMP_t}\right]}{\Delta t}\right]_h \quad (44)$$

k. Employment ratio in S.I.C. categories 370 through 379

$$\frac{\Delta\left[\frac{IND_{10}}{P}\right]}{\Delta t} = -0.000870205 + 0.40891 \left[\frac{\Delta\left[\frac{IND_{10}}{P}\right]}{\Delta t}\right]_h - 0.370286 \left[\frac{\Delta\left[\frac{\sum_{i=11}^{11} IND_i}{EMP_t}\right]}{\Delta t}\right]_h \quad (45)$$

l. Employment ratio in S.I.C. categories 380 through 399

$$\frac{\Delta\left[\frac{IND_{11}}{P}\right]}{\Delta t} = 0.001558391 - 0.00000075074\, I_p - 0.00000445 \left[\frac{\Delta I_p}{\Delta t}\right]_h - 0.062943 \left[\frac{\Delta\left[\frac{\sum_{i=11}^{11} IND_i}{EMP_t}\right]}{\Delta t}\right]_h \quad (46)$$

## Public/Unaccounted Models

a. Projection of airport parameter

$$AIRP' = AIRP \frac{P'}{P} \quad (47)$$

# APPENDIX C

## LISTING OF CONTENTS

## LIBRARY OF WATER USAGE COEFFICIENTS

```
1CONSTANT
 E011 206.6          E012 1.246          E013 -0.467
 E021 28.9           E022 1.576          E023 33.6
 E031 30.2           E032 39.5           E041 30.2
 E042 39.5           E051 0.48           E052 1496.95
 E053 -0.703         E054 0.429          E061 0.441
 E062 0.164          E063 -0.783         E064 2.93
 E065 -1.57          E066 1.45           E071 0.41
 E072 44.573         E073 0.783          E081 0.441
 E082 0.164          E083 -0.783         E084 2.93
 E085 -1.57          E086 1.45           E091 0.41
 E092 100.           E093 -0.783         E094 2.93
 E095 -1.57          E096 1.45           E101 0.803
 E102 -1.26          E111 2227.34        E112 2.06
 E113 0.413          E121 0.0147         E122 0.118
 E123 -10.4          E124 -1.25          E125 0.931
 E131 1609.59        E132 0.943          E133 0.523
 E141 0.0147         E142 0.118          E143 -10.4
 E144 -1.25          E145 0.931          E151 1609.59
 E152 0.943          E153 0.523          E154 1.25
 E155 0.931          E161 334.0          E162 2.017
 ENDD
```

Figure C-1. Residential Equation Constants

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1EVAPTRAN
 LATD 48.    LONG 67.    RAIN 9.     EVAP 12.
 LATD 47.    LONG 67.    RAIN 8.     EVAP 13.
 LATD 46.    LONG 67.    RAIN 7.     EVAP 13.
 LATD 45.    LONG 67.    RAIN 7.     EVAP 13.
 LATD 44.    LONG 67.    RAIN 7.     EVAP 13.
 LATD 48.    LONG 68.    RAIN 9.     EVAP 12.
 LATD 47.    LONG 68.    RAIN 9.     EVAP 12.
 LATD 46.    LONG 68.    RAIN 7.     EVAP 13.
 LATD 45.    LONG 68.    RAIN 7.     EVAP 13.
 LATD 44.    LONG 68.    RAIN 7.     EVAP 13.
 LATD 48.    LONG 69.    RAIN 9.     EVAP 12.
 LATD 47.    LONG 69.    RAIN 8.     EVAP 12.
 LATD 46.    LONG 69.    RAIN 8.     EVAP 13.
 LATD 45.    LONG 69.    RAIN 8.     EVAP 13.
 LATD 44.    LONG 69.    RAIN 7.     EVAP 13.
 LATD 43.    LONG 69.    RAIN 7.     EVAP 14.
 LATD 42.    LONG 69.    RAIN 6.     EVAP 14.
 LATD 41.    LONG 69.    RAIN 5.     EVAP 13.
 LATD 48.    LONG 70.    RAIN 9.     EVAP 12.
 LATD 47.    LONG 70.    RAIN 9.     EVAP 12.
 LATD 46.    LONG 70.    RAIN 8.     EVAP 13.
 LATD 45.    LONG 70.    RAIN 8.     EVAP 13.
 LATD 44.    LONG 70.    RAIN 7.     EVAP 13.
 LATD 43.    LONG 70.    RAIN 7.     EVAP 14.
 LATD 42.    LONG 70.    RAIN 6.     EVAP 14.
 LATD 41.    LONG 70.    RAIN 5.     EVAP 13.
 LATD 47.    LONG 71.    RAIN 10.    EVAP 12.
 LATD 46.    LONG 71.    RAIN 10.    EVAP 12.
 LATD 45.    LONG 71.    RAIN 9.     EVAP 13.
 LATD 44.    LONG 71.    RAIN 20.    EVAP 11.
 LATD 43.    LONG 71.    RAIN 7.     EVAP 14.
 LATD 42.    LONG 71.    RAIN 7.     EVAP 15.
 LATD 41.    LONG 71.    RAIN 6.     EVAP 15.
 LATD 46.    LONG 72.    RAIN 10.    EVAP 12.
 LATD 45.    LONG 72.    RAIN 17.    EVAP 13.
 LATD 44.    LONG 72.    RAIN 10.    EVAP 13.
 LATD 43.    LONG 72.    RAIN 8.     EVAP 14.
 LATD 42.    LONG 72.    RAIN 7.     EVAP 15.
 LATD 41.    LONG 72.    RAIN 6.     EVAP 15.
 LATD 40.    LONG 72.    RAIN 5.     EVAP 17.
 LATD 46.    LONG 73.    RAIN 11.    EVAP 12.
 LATD 45.    LONG 73.    RAIN 11.    EVAP 13.
 LATD 44.    LONG 73.    RAIN 10.    EVAP 14.
 LATD 43.    LONG 73.    RAIN 9.     EVAP 14.
 LATD 42.    LONG 73.    RAIN 9.     EVAP 15.
 LATD 41.    LONG 73.    RAIN 5.     EVAP 15.
 LATD 40.    LONG 73.    RAIN 6.     EVAP 17.
 LATD 46.    LONG 74.    RAIN 10.    EVAP 12.
 LATD 45.    LONG 74.    RAIN 10.    EVAP 13.
 LATD 44.    LONG 74.    RAIN 9.     EVAP 14.
 LATD 43.    LONG 74.    RAIN 9.     EVAP 15.
 LATD  42.   LONG  74.   RAIN  8.    EVAP  15.
 LATD 41.    LONG 74.    RAIN 5.     EVAP 17.
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Figure C-2. Climatic Data

| | | | |
|---|---|---|---|
| LATD 40. | LONG 74. | RAIN 9. | EVAP 17. |
| LATD 39. | LONG 74. | RAIN 11. | EVAP 17. |
| LATD 38. | LONG 74. | RAIN 10. | EVAP 17. |
| LATD 46. | LONG 75. | RAIN 10. | EVAP 12. |
| LATD 45. | LONG 75. | RAIN 10. | EVAP 13. |
| LATD 44. | LONG 75. | RAIN 9. | EVAP 14. |
| LATD 43. | LONG 75. | RAIN 8. | EVAP 15. |
| LATD 42. | LONG 75. | RAIN 8. | EVAP 15. |
| LATD 41. | LONG 75. | RAIN 6. | EVAP 16. |
| LATD 40. | LONG 75. | RAIN 8. | EVAP 16. |
| LATD 39. | LONG 75. | RAIN 10. | EVAP 16. |
| LATD 38. | LONG 75. | RAIN 10. | EVAP 17. |
| LATD 37. | LONG 75. | RAIN 11. | EVAP 17. |
| LATD 36. | LONG 75. | RAIN 13. | EVAP 17. |
| LATD 35. | LONG 75. | RAIN 16. | EVAP 17. |
| LATD 45. | LONG 76. | RAIN 8. | EVAP 13. |
| LATD 44. | LONG 76. | RAIN 7. | EVAP 14. |
| LATD 43. | LONG 76. | RAIN 6. | EVAP 15. |
| LATD 42. | LONG 76. | RAIN 7. | EVAP 14. |
| LATD 41. | LONG 76. | RAIN 6. | EVAP 15. |
| LATD 40. | LONG 76. | RAIN 6. | EVAP 17. |
| LATD 39. | LONG 76. | RAIN 7. | EVAP 16. |
| LATD 38. | LONG 76. | RAIN 8. | EVAP 16. |
| LATD 37. | LONG 76. | RAIN 11. | EVAP 17. |
| LATD 36. | LONG 76. | RAIN 14. | EVAP 16. |
| LATD 35. | LONG 76. | RAIN 16. | EVAP 17. |
| LATD 34. | LONG 76. | RAIN 20. | EVAP 18. |
| LATD 45. | LONG 77. | RAIN 7. | EVAP 13. |
| LATD 44. | LONG 77. | RAIN 7. | EVAP 14. |
| LATD 43. | LONG 77. | RAIN 6. | EVAP 15. |
| LATD 42. | LONG 77. | RAIN 7. | EVAP 15. |
| LATD 41. | LONG 77. | RAIN 8. | EVAP 14. |
| LATD 40. | LONG 77. | RAIN 6. | EVAP 17. |
| LATD 39. | LONG 77. | RAIN 7. | EVAP 17. |
| LATD 38. | LONG 77. | RAIN 8. | EVAP 16. |
| LATD 37. | LONG 77. | RAIN 10. | EVAP 16. |
| LATD 36. | LONG 77. | RAIN 15. | EVAP 16. |
| LATD 35. | LONG 77. | RAIN 20. | EVAP 17. |
| LATD 34. | LONG 77. | RAIN 25. | EVAP 18. |
| LATD 44. | LONG 78. | RAIN 7. | EVAP 14. |
| LATD 43. | LONG 78. | RAIN 7. | EVAP 15. |
| LATD 42. | LONG 78. | RAIN 9. | EVAP 15. |
| LATD 41. | LONG 78. | RAIN 8. | EVAP 14. |
| LATD 40. | LONG 78. | RAIN 7. | EVAP 15. |
| LATD 39. | LONG 78. | RAIN 7. | EVAP 15. |
| LATD 38. | LONG 78. | RAIN 8. | EVAP 15. |
| LATD 37. | LONG 78. | RAIN 8. | EVAP 16. |
| LATD 36. | LONG 78. | RAIN 16. | EVAP 16. |
| LATD 35. | LONG 78. | RAIN 16. | EVAP 17. |
| LATD 34. | LONG 78. | RAIN 31. | EVAP 18. |
| LATD 33. | LONG 78. | RAIN 23. | EVAP 19. |
| LATD 44. | LONG 79. | RAIN 8. | EVAP 13. |
| LATD 43. | LONG 79. | RAIN 10. | EVAP 14. |

Figure C-2. Climatic Data (Continued)

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LATD 42.   LONG 79.   RAIN 10.   EVAP 15.
LATD 41.   LONG 79.   RAIN 9.    EVAP 14.
LATD 40.   LONG 79.   RAIN 8.    EVAP 14.
LATD 39.   LONG 79.   RAIN 8.    EVAP 14.
LATD 38.   LONG 79.   RAIN 7.    EVAP 15.
LATD 37.   LONG 79.   RAIN 7.    EVAP 16.
LATD 36.   LONG 79.   RAIN 15.   EVAP 17.
LATD 35.   LONG 79.   RAIN 15.   EVAP 17.
LATD 34.   LONG 79.   RAIN 22.   EVAP 17.
LATD 33.   LONG 79.   RAIN 19.   EVAP 18.
LATD 32.   LONG 79.   RAIN 19.   EVAP 19.
LATD 43.   LONG 80.   RAIN 10.   EVAP 14.
LATD 42.   LONG 80.   RAIN 10.   EVAP 15.
LATD 41.   LONG 80.   RAIN 9.    EVAP 14.
LATD 40.   LONG 80.   RAIN 10.   EVAP 14.
LATD 39.   LONG 80.   RAIN 8.    EVAP 14.
LATD 38.   LONG 80.   RAIN 9.    EVAP 15.
LATD 37.   LONG 80.   RAIN 8.    EVAP 16.
LATD 36.   LONG 80.   RAIN 15.   EVAP 17.
LATD 35.   LONG 80.   RAIN 13.   EVAP 17.
LATD 34.   LONG 80.   RAIN 16.   EVAP 17.
LATD 33.   LONG 80.   RAIN 21.   EVAP 18.
LATD 32.   LONG 80.   RAIN 18.   EVAP 19.
LATD 31.   LONG 80.   RAIN 20.   EVAP 19.
LATD 30.   LONG 80.   RAIN 21.   EVAP 19.
LATD 29.   LONG 80.   RAIN 23.   EVAP 18.
LATD 28.   LONG 80.   RAIN 22.   EVAP 18.
LATD 27.   LONG 80.   RAIN 28.   EVAP 19.
LATD 26.   LONG 80.   RAIN 28.   EVAP 19.
LATD 25.   LONG 80.   RAIN 28.   EVAP 20.
LATD 24.   LONG 80.   RAIN 28.   EVAP 21.
LATD 43.   LONG 81.   RAIN 10.   EVAP 14.
LATD 42.   LONG 81.   RAIN 10.   EVAP 14.
LATD 41.   LONG 81.   RAIN 9.    EVAP 15.
LATD 40.   LONG 81.   RAIN 9.    EVAP 14.
LATD 39.   LONG 81.   RAIN 8.    EVAP 15.
LATD 38.   LONG 81.   RAIN 9.    EVAP 15.
LATD 37.   LONG 81.   RAIN 10.   EVAP 14.
LATD 36.   LONG 81.   RAIN 13.   EVAP 16.
LATD 35.   LONG 81.   RAIN 12.   EVAP 17.
LATD 34.   LONG 81.   RAIN 16.   EVAP 17.
LATD 33.   LONG 81.   RAIN 16.   EVAP 18.
LATD 32.   LONG 81.   RAIN 18.   EVAP 18.
LATD 31.   LONG 81.   RAIN 19.   EVAP 17.
LATD 30.   LONG 81.   RAIN 21.   EVAP 17.
LATD 29.   LONG 81.   RAIN 23.   EVAP 18.
LATD 28.   LONG 81.   RAIN 23.   EVAP 18.
LATD 27.   LONG 81.   RAIN 26.   EVAP 18.
LATD 26.   LONG 81.   RAIN 28.   EVAP 19.
LATD 25.   LONG 81.   RAIN 20.   EVAP 20.
LATD 24.   LONG 81.   RAIN 20.   EVAP 21.
LATD 46.   LONG 82.   RAIN 10.   EVAP 12.
LATD 45.   LONG 82.   RAIN 10.   EVAP 12.
LATD 44.   LONG 82.   RAIN 9.    EVAP 13.
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Figure C-2. Climatic Data (Continued)

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LATD 43.    LONG 82.    RAIN 8.     EVAP 13.
LATD 42.    LONG 82.    RAIN 10.    EVAP 14.
LATD 41.    LONG 82.    RAIN 8.     EVAP 15.
LATD 40.    LONG 82.    RAIN 10.    EVAP 15.
LATD 39.    LONG 82.    RAIN 8.     EVAP 16.
LATD 38.    LONG 82.    RAIN 9.     EVAP 16.
LATD 37.    LONG 82.    RAIN 12.    EVAP 15.
LATD 36.    LONG 82.    RAIN 14.    EVAP 14.
LATD 35.    LONG 82.    RAIN 14.    EVAP 16.
LATD 34.    LONG 82.    RAIN 15.    EVAP 17.
LATD 33.    LONG 82.    RAIN 13.    EVAP 17.
LATD 32.    LONG 82.    RAIN 16.    EVAP 17.
LATD 31.    LONG 82.    RAIN 20.    EVAP 17.
LATD 30.    LONG 82.    RAIN 20.    EVAP 18.
LATD 29.    LONG 82.    RAIN 23.    EVAP 19.
LATD 28.    LONG 82.    RAIN 22.    EVAP 19.
LATD 27.    LONG 82.    RAIN 26.    EVAP 19.
LATD 26.    LONG 82.    RAIN 28.    EVAP 20.
LATD 25.    LONG 82.    RAIN 15.    EVAP 20.
LATD 24.    LONG 82.    RAIN 15.    EVAP 21.
LATD 47.    LONG 83.    RAIN 10.    EVAP 12.
LATD 46.    LONG 83.    RAIN 10.    EVAP 12.
LATD 45.    LONG 83.    RAIN 7.     EVAP 12.
LATD 44.    LONG 83.    RAIN 10.    EVAP 13.
LATD 43.    LONG 83.    RAIN 7.     EVAP 13.
LATD 42.    LONG 83.    RAIN 13.    EVAP 14.
LATD 41.    LONG 83.    RAIN 10.    EVAP 15.
LATD 40.    LONG 83.    RAIN 11.    EVAP 16.
LATD 39.    LONG 83.    RAIN 8.     EVAP 16.
LATD 38.    LONG 83.    RAIN 10.    EVAP 16.
LATD 37.    LONG 83.    RAIN 13.    EVAP 16.
LATD 36.    LONG 83.    RAIN 12.    EVAP 15.
LATD 35.    LONG 83.    RAIN 12.    EVAP 16.
LATD 34.    LONG 83.    RAIN 12.    EVAP 17.
LATD 33.    LONG 83.    RAIN 14.    EVAP 17.
LATD 32.    LONG 83.    RAIN 16.    EVAP 18.
LATD 31.    LONG 83.    RAIN 20.    EVAP 18.
LATD 30.    LONG 83.    RAIN 26.    EVAP 19.
LATD 29.    LONG 83.    RAIN 24.    EVAP 19.
LATD 28.    LONG 83.    RAIN 21.    EVAP 19.
LATD 27.    LONG 83.    RAIN 27.    EVAP 20.
LATD 26.    LONG 83.    RAIN 28.    EVAP 20.
LATD 47.    LONG 84.    RAIN 10.    EVAP 12.
LATD 46.    LONG 84.    RAIN 10.    EVAP 13.
LATD 45.    LONG 84.    RAIN 7.     EVAP 14.
LATD 44.    LONG 84.    RAIN 8.     EVAP 14.
LATD 43.    LONG 84.    RAIN 7.     EVAP 14.
LATD 42.    LONG 84.    RAIN 10.    EVAP 15.
LATD 41.    LONG 84.    RAIN 11.    EVAP 15.
LATD 40.    LONG 84.    RAIN 8.     EVAP 16.
LATD 39.    LONG 84.    RAIN 8.     EVAP 16.
LATD 38.    LONG 84.    RAIN 8.     EVAP 16.
LATD 37.    LONG 84.    RAIN 12.    EVAP 16.
LATD 36.    LONG 84.    RAIN 12.    EVAP 17.
LATD 35.    LONG 84.    RAIN 12.    EVAP 17.
LATD 34.    LONG 84.    RAIN 12.    EVAP 17.
LATD 33.    LONG 84.    RAIN 15.    EVAP 17.
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Figure C-2. Climatic Data (Continued)

```
LATD 32.    LONG 84.    RAIN 16.    EVAP 18.
LATD 31.    LONG 84.    RAIN 20.    EVAP 18.
LATD 30.    LONG 84.    RAIN 28.    EVAP 19.
LATD 29.    LONG 84.    RAIN 32.    EVAP 19.
LATD 47.    LONG 85.    RAIN 9.     EVAP 13.
LATD 46.    LONG 85.    RAIN 9.     EVAP 13.
LATD 45.    LONG 85.    RAIN 8.     EVAP 13.
LATD 44.    LONG 85.    RAIN 7.     EVAP 14.
LATD 43.    LONG 85.    RAIN 7.     EVAP 14.
LATD 42.    LONG 85.    RAIN 9.     EVAP 14.
LATD 41.    LONG 85.    RAIN 9.     EVAP 15.
LATD 40.    LONG 85.    RAIN 8.     EVAP 15.
LATD 39.    LONG 85.    RAIN 9.     EVAP 16.
LATD 38.    LONG 85.    RAIN 10.    EVAP 16.
LATD 37.    LONG 85.    RAIN 11.    EVAP 16.
LATD 36.    LONG 85.    RAIN 12.    EVAP 16.
LATD 35.    LONG 85.    RAIN 11.    EVAP 17.
LATD 34.    LONG 85.    RAIN 12.    EVAP 16.
LATD 33.    LONG 85.    RAIN 14.    EVAP 17.
LATD 32.    LONG 85.    RAIN 15.    EVAP 18.
LATD 31.    LONG 85.    RAIN 21.    EVAP 18.
LATD 30.    LONG 85.    RAIN 32.    EVAP 18.
LATD 29.    LONG 85.    RAIN 32.    EVAP 19.
LATD 47.    LONG 86.    RAIN 8.     EVAP 13.
LATD 46.    LONG 86.    RAIN 9.     EVAP 13.
LATD 45.    LONG 86.    RAIN 7.     EVAP 14.
LATD 44.    LONG 86.    RAIN 7.     EVAP 14.
LATD 43.    LONG 86.    RAIN 8.     EVAP 14.
LATD 42.    LONG 86.    RAIN 10.    EVAP 14.
LATD 41.    LONG 86.    RAIN 10.    EVAP 15.
LATD 40.    LONG 86.    RAIN 8.     EVAP 15.
LATD 39.    LONG 86.    RAIN 10.    EVAP 16.
LATD 38.    LONG 86.    RAIN 10.    EVAP 17.
LATD 37.    LONG 86.    RAIN 11.    EVAP 17.
LATD 36.    LONG 86.    RAIN 12.    EVAP 17.
LATD 35.    LONG 86.    RAIN 11.    EVAP 16.
LATD 34.    LONG 86.    RAIN 12.    EVAP 16.
LATD 33.    LONG 86.    RAIN 13.    EVAP 17.
LATD 32.    LONG 86.    RAIN 16.    EVAP 19.
LATD 31.    LONG 86.    RAIN 21.    EVAP 19.
LATD 30.    LONG 86.    RAIN 32.    EVAP 19.
LATD 29.    LONG 86.    RAIN 32.    EVAP 20.
LATD 48.    LONG 87.    RAIN 7.     EVAP 12.
LATD 47.    LONG 87.    RAIN 7.     EVAP 13.
LATD 46.    LONG 87.    RAIN 9.     EVAP 14.
LATD 45.    LONG 87.    RAIN 9.     EVAP 14.
LATD 44.    LONG 87.    RAIN 8.     EVAP 15.
LATD 43.    LONG 87.    RAIN 8.     EVAP 15.
LATD 42.    LONG 87.    RAIN 11.    EVAP 15.
LATD 41.    LONG 87.    RAIN 11.    EVAP 16.
LATD 40.    LONG 87.    RAIN 10.    EVAP 16.
LATD 39.    LONG 87.    RAIN 8.     EVAP 16.
LATD 38.    LONG 87.    RAIN 9.     EVAP 17.
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Figure C-2. Climatic Data (Continued)

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LATD 37.    LONG 87.    RAIN 9.     EVAP 17.
LATD 36.    LONG 87.    RAIN 9.     EVAP 18.
LATD 35.    LONG 87.    RAIN 12.    EVAP 18.
LATD 34.    LONG 87.    RAIN 15.    EVAP 17.
LATD 33.    LONG 87.    RAIN 14.    EVAP 17.
LATD 32.    LONG 87.    RAIN 10.    EVAP 18.
LATD 31.    LONG 87.    RAIN 16.    EVAP 18.
LATD 30.    LONG 87.    RAIN 18.    EVAP 20.
LATD 48.    LONG 88.    RAIN 10.    EVAP 12.
LATD 47.    LONG 88.    RAIN 8.     EVAP 13.
LATD 46.    LONG 88.    RAIN 8.     EVAP 14.
LATD 45.    LONG 88.    RAIN 9.     EVAP 14.
LATD 44.    LONG 88.    RAIN 8.     EVAP 15.
LATD 43.    LONG 88.    RAIN 9.     EVAP 14.
LATD 42.    LONG 88.    RAIN 10.    EVAP 15.
LATD 41.    LONG 88.    RAIN 12.    EVAP 16.
LATD 40.    LONG 88.    RAIN 9.     EVAP 16.
LATD 39.    LONG 88.    RAIN 8.     EVAP 16.
LATD 38.    LONG 88.    RAIN 9.     EVAP 17.
LATD 37.    LONG 88.    RAIN 10.    EVAP 18.
LATD 36.    LONG 88.    RAIN 10.    EVAP 19.
LATD 35.    LONG 88.    RAIN 11.    EVAP 19.
LATD 34.    LONG 88.    RAIN 10.    EVAP 18.
LATD 33.    LONG 88.    RAIN 10.    EVAP 18.
LATD 32.    LONG 88.    RAIN 11.    EVAP 18.
LATD 31.    LONG 88.    RAIN 16.    EVAP 19.
LATD 30.    LONG 88.    RAIN 15.    EVAP 20.
LATD 49.    LONG 89.    RAIN 11.    EVAP 12.
LATD 48.    LONG 89.    RAIN 11.    EVAP 12.
LATD 47.    LONG 89.    RAIN 10.    EVAP 12.
LATD 46.    LONG 89.    RAIN 10.    EVAP 13.
LATD 45.    LONG 89.    RAIN 9.     EVAP 13.
LATD 44.    LONG 89.    RAIN 9.     EVAP 13.
LATD 43.    LONG 89.    RAIN 10.    EVAP 14.
LATD 42.    LONG 89.    RAIN 12.    EVAP 15.
LATD 41.    LONG 89.    RAIN 12.    EVAP 16.
LATD 40.    LONG 89.    RAIN 10.    EVAP 16.
LATD 39.    LONG 89.    RAIN 8.     EVAP 17.
LATD 38.    LONG 89.    RAIN 8.     EVAP 17.
LATD 37.    LONG 89.    RAIN 11.    EVAP 18.
LATD 36.    LONG 89.    RAIN 9.     EVAP 19.
LATD 35.    LONG 89.    RAIN 8.     EVAP 19.
LATD 34.    LONG 89.    RAIN 9.     EVAP 19.
LATD 33.    LONG 89.    RAIN 10.    EVAP 18.
LATD 32.    LONG 89.    RAIN 12.    EVAP 18.
LATD 31.    LONG 89.    RAIN 13.    EVAP 18.
LATD 30.    LONG 89.    RAIN 16.    EVAP 20.
LATD 49.    LONG 90.    RAIN 11.    EVAP 12.
LATD 48.    LONG 90.    RAIN 11.    EVAP 12.
LATD 47.    LONG 90.    RAIN 11.    EVAP 12.
LATD 46.    LONG 90.    RAIN 11.    EVAP 13.
LATD 45.    LONG 90.    RAIN 10.    EVAP 13.
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Figure C-2. Climatic Data (Continued)

```
LATD 44.    LONG 90.    RAIN 11.    EVAP 13.
LATD 43.    LONG 90.    RAIN 12.    EVAP 14.
LATD 42.    LONG 90.    RAIN 14.    EVAP 15.
LATD 41.    LONG 90.    RAIN 13.    EVAP 16.
LATD 40.    LONG 90.    RAIN 10.    EVAP 16.
LATD 39.    LONG 90.    RAIN 9.     EVAP 17.
LATD 38.    LONG 90.    RAIN 8.     EVAP 18.
LATD 37.    LONG 90.    RAIN 9.     EVAP 18.
LATD 36.    LONG 90.    RAIN 9.     EVAP 19.
LATD 35.    LONG 90.    RAIN 7.     EVAP 19.
LATD 34.    LONG 90.    RAIN 9.     EVAP 19.
LATD 33.    LONG 90.    RAIN 10.    EVAP 19.
LATD 32.    LONG 90.    RAIN 9.     EVAP 19.
LATD 31.    LONG 90.    RAIN 14.    EVAP 19.
LATD 30.    LONG 90.    RAIN 14.    EVAP 19.
LATD 29.    LONG 90.    RAIN 16.    EVAP 20.
LATD 49.    LONG 91.    RAIN 12.    EVAP 12.
LATD 48.    LONG 91.    RAIN 12.    EVAP 12.
LATD 47.    LONG 91.    RAIN 12.    EVAP 12.
LATD 46.    LONG 91.    RAIN 12.    EVAP 13.
LATD 45.    LONG 91.    RAIN 10.    EVAP 13.
LATD 44.    LONG 91.    RAIN 11.    EVAP 14.
LATD 43.    LONG 91.    RAIN 13.    EVAP 14.
LATD 42.    LONG 91.    RAIN 15.    EVAP 14.
LATD 41.    LONG 91.    RAIN 13.    EVAP 15.
LATD 40.    LONG 91.    RAIN 10.    EVAP 17.
LATD 39.    LONG 91.    RAIN 11.    EVAP 18.
LATD 38.    LONG 91.    RAIN 9.     EVAP 18.
LATD 37.    LONG 91.    RAIN 12.    EVAP 18.
LATD 36.    LONG 91.    RAIN 10.    EVAP 19.
LATD 35.    LONG 91.    RAIN 10.    EVAP 19.
LATD 34.    LONG 91.    RAIN 10.    EVAP 19.
LATD 33.    LONG 91.    RAIN 10.    EVAP 20.
LATD 32.    LONG 91.    RAIN 6.     EVAP 19.
LATD 31.    LONG 91.    RAIN 14.    EVAP 19.
LATD 30.    LONG 91.    RAIN 14.    EVAP 19.
LATD 29.    LONG 91.    RAIN 16.    EVAP 19.
LATD 49.    LONG 92.    RAIN 12.    EVAP 12.
LATD 48.    LONG 92.    RAIN 12.    EVAP 12.
LATD 47.    LONG 92.    RAIN 13.    EVAP 12.
LATD 46.    LONG 92.    RAIN 14.    EVAP 13.
LATD 45.    LONG 92.    RAIN 11.    EVAP 14.
LATD 44.    LONG 92.    RAIN 10.    EVAP 14.
LATD 43.    LONG 92.    RAIN 17.    EVAP 15.
LATD 42.    LONG 92.    RAIN 17.    EVAP 15.
LATD 41.    LONG 92.    RAIN 10.    EVAP 16.
LATD 40.    LONG 92.    RAIN 10.    EVAP 16.
LATD 39.    LONG 92.    RAIN 11.    EVAP 17.
LATD 38.    LONG 92.    RAIN 9.     EVAP 17.
LATD 37.    LONG 92.    RAIN 12.    EVAP 18.
LATD 36.    LONG 92.    RAIN 10.    EVAP 18.
LATD 35.    LONG 92.    RAIN 12.    EVAP 19.
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Figure C-2. Climatic Data (Continued)

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LATD 34.   LONG 92.   RAIN 12.   EVAP 20.
LATD 33.   LONG 92.   RAIN 10.   EVAP 20.
LATD 32.   LONG 92.   RAIN 10.   EVAP 19.
LATD 31.   LONG 92.   RAIN 12.   EVAP 19.
LATD 30.   LONG 92.   RAIN 15.   EVAP 19.
LATD 29.   LONG 92.   RAIN 16.   EVAP 20.
LATD 49.   LONG 93.   RAIN 12.   EVAP 13.
LATD 48.   LONG 93.   RAIN 12.   EVAP 13.
LATD 47.   LONG 93.   RAIN 14.   EVAP 13.
LATD 46.   LONG 93.   RAIN 14.   EVAP 14.
LATD 45.   LONG 93.   RAIN 12.   EVAP 14.
LATD 44.   LONG 93.   RAIN 11.   EVAP 15.
LATD 43.   LONG 93.   RAIN 15.   EVAP 15.
LATD 42.   LONG 93.   RAIN 15.   EVAP 15.
LATD 41.   LONG 93.   RAIN 10.   EVAP 16.
LATD 40.   LONG 93.   RAIN 10.   EVAP 16.
LATD 39.   LONG 93.   RAIN 13.   EVAP 16.
LATD 38.   LONG 93.   RAIN 10.   EVAP 16.
LATD 37.   LONG 93.   RAIN 12.   EVAP 17.
LATD 36.   LONG 93.   RAIN 10.   EVAP 18.
LATD 35.   LONG 93.   RAIN 11.   EVAP 18.
LATD 34.   LONG 93.   RAIN 12.   EVAP 18.
LATD 33.   LONG 93.   RAIN 11.   EVAP 19.
LATD 32.   LONG 93.   RAIN 8.    EVAP 20.
LATD 31.   LONG 93.   RAIN 12.   EVAP 20.
LATD 30.   LONG 93.   RAIN 14.   EVAP 20.
LATD 29.   LONG 93.   RAIN 16.   EVAP 21.
LATD 50.   LONG 94.   RAIN 12.   EVAP 14.
LATD 49.   LONG 94.   RAIN 12.   EVAP 14.
LATD 48.   LONG 94.   RAIN 12.   EVAP 14.
LATD 47.   LONG 94.   RAIN 14.   EVAP 14.
LATD 46.   LONG 94.   RAIN 14.   EVAP 15.
LATD 45.   LONG 94.   RAIN 13.   EVAP 16.
LATD 44.   LONG 94.   RAIN 12.   EVAP 16.
LATD 43.   LONG 94.   RAIN 10.   EVAP 16.
LATD 42.   LONG 94.   RAIN 9.    EVAP 16.
LATD 41.   LONG 94.   RAIN 10.   EVAP 16.
LATD 40.   LONG 94.   RAIN 11.   EVAP 17.
LATD 39.   LONG 94.   RAIN 17.   EVAP 17.
LATD 38.   LONG 94.   RAIN 12.   EVAP 17.
LATD 37.   LONG 94.   RAIN 12.   EVAP 17.
LATD 36.   LONG 94.   RAIN 8.    EVAP 18.
LATD 35.   LONG 94.   RAIN 8.    EVAP 19.
LATD 34.   LONG 94.   RAIN 12.   EVAP 19.
LATD 33.   LONG 94.   RAIN 11.   EVAP 19.
LATD 32.   LONG 94.   RAIN 6.    EVAP 20.
LATD 31.   LONG 94.   RAIN 12.   EVAP 20.
LATD 30.   LONG 94.   RAIN 16.   EVAP 21.
LATD 29.   LONG 94.   RAIN 13.   EVAP 21.
LATD 50.   LONG 95.   RAIN 12.   EVAP 14.
LATD 49.   LONG 95.   RAIN 12.   EVAP 14.
LATD 48.   LONG 95.   RAIN 12.   EVAP 14.
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Figure C-2. Climatic Data (Continued)

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LATD 47.    LONG 95.    RAIN 13.    EVAP 14.
LATD 46.    LONG 95.    RAIN 13.    EVAP 15.
LATD 45.    LONG 95.    RAIN 13.    EVAP 15.
LATD 44.    LONG 95.    RAIN 12.    EVAP 16.
LATD 43.    LONG 95.    RAIN 10.    EVAP 16.
LATD 42.    LONG 95.    RAIN 10.    EVAP 16.
LATD 41.    LONG 95.    RAIN 11.    EVAP 17.
LATD 40.    LONG 95.    RAIN 17.    EVAP 17.
LATD 39.    LONG 95.    RAIN 19.    EVAP 18.
LATD 38.    LONG 95.    RAIN 12.    EVAP 18.
LATD 37.    LONG 95.    RAIN 11.    EVAP 18.
LATD 36.    LONG 95.    RAIN 9.     EVAP 18.
LATD 35.    LONG 95.    RAIN 8.     EVAP 20.
LATD 34.    LONG 95.    RAIN 11.    EVAP 20.
LATD 33.    LONG 95.    RAIN 10.    EVAP 20.
LATD 32.    LONG 95.    RAIN 7.     EVAP 20.
LATD 31.    LONG 95.    RAIN 11.    EVAP 20.
LATD 30.    LONG 95.    RAIN 12.    EVAP 21.
LATD 29.    LONG 95.    RAIN 10.    EVAP 21.
LATD 28.    LONG 95.    RAIN 10.    EVAP 21.
LATD 50.    LONG 96.    RAIN 11.    EVAP 14.
LATD 49.    LONG 96.    RAIN 12.    EVAP 14.
LATD 48.    LONG 96.    RAIN 12.    EVAP 14.
LATD 47.    LONG 96.    RAIN 11.    EVAP 14.
LATD 46.    LONG 96.    RAIN 12.    EVAP 15.
LATD 45.    LONG 96.    RAIN 12.    EVAP 15.
LATD 44.    LONG 96.    RAIN 9.     EVAP 16.
LATD 43.    LONG 96.    RAIN 11.    EVAP 16.
LATD 42.    LONG 96.    RAIN 10.    EVAP 16.
LATD 41.    LONG 96.    RAIN 12.    EVAP 17.
LATD 40.    LONG 96.    RAIN 13.    EVAP 18.
LATD 39.    LONG 96.    RAIN 17.    EVAP 18.
LATD 38.    LONG 96.    RAIN 12.    EVAP 18.
LATD 37.    LONG 96.    RAIN 10.    EVAP 19.
LATD 36.    LONG 96.    RAIN 10.    EVAP 20.
LATD 35.    LONG 96.    RAIN 9.     EVAP 20.
LATD 34.    LONG 96.    RAIN 10.    EVAP 20.
LATD 33.    LONG 96.    RAIN 9.     EVAP 20.
LATD 32.    LONG 96.    RAIN 8.     EVAP 20.
LATD 31.    LONG 96.    RAIN 8.     EVAP 20.
LATD 29.    LONG 96.    RAIN 10.    EVAP 21.
LATD 28.    LONG 96.    RAIN 10.    EVAP 21.
LATD 50.    LONG 97.    RAIN 10.    EVAP 14.
LATD 49.    LONG 97.    RAIN 11.    EVAP 14.
LATD 48.    LONG 97.    RAIN 12.    EVAP 14.
LATD 47.    LONG 97.    RAIN 12.    EVAP 14.
LATD 46.    LONG 97.    RAIN 12.    EVAP 15.
LATD 45.    LONG 97.    RAIN 10.    EVAP 15.
LATD 44.    LONG 97.    RAIN 12.    EVAP 16.
LATD 43.    LONG 97.    RAIN 10.    EVAP 16.
LATD 42.    LONG 97.    RAIN 10.    EVAP 16.
LATD 41.    LONG 97.    RAIN 13.    EVAP 17.
```

Figure C-2. Climatic Data (Continued)

```
LATD 40.   LONG 97.   RAIN 13.   EVAP 18.
LATD 39.   LONG 97.   RAIN 13.   EVAP 18.
LATD 38.   LONG 97.   RAIN 12.   EVAP 18.
LATD 37.   LONG 97.   RAIN 11.   EVAP 19.
LATD 36.   LONG 97.   RAIN 10.   EVAP 20.
LATD 35.   LONG 97.   RAIN 10.   EVAP 20.
LATD 34.   LONG 97.   RAIN 10.   EVAP 20.
LATD 33.   LONG 97.   RAIN 8.    EVAP 20.
LATD 32.   LONG 97.   RAIN 5.    EVAP 21.
LATD 31.   LONG 97.   RAIN 6.    EVAP 21.
LATD 30.   LONG 97.   RAIN 7.    EVAP 20.
LATD 29.   LONG 97.   RAIN 10.   EVAP 20.
LATD 28.   LONG 97.   RAIN 10.   EVAP 21.
LATD 27.   LONG 97.   RAIN 9.    EVAP 21.
LATD 26.   LONG 97.   RAIN 6.    EVAP 21.
LATD 25.   LONG 97.   RAIN 5.    EVAP 20.
LATD 50.   LONG 98.   RAIN 9.    EVAP 14.
LATD 49.   LONG 98.   RAIN 10.   EVAP 14.
LATD 48.   LONG 98.   RAIN 10.   EVAP 14.
LATD 47.   LONG 98.   RAIN 10.   EVAP 14.
LATD 46.   LONG 98.   RAIN 9.    EVAP 15.
LATD 45.   LONG 98.   RAIN 8.    EVAP 15.
LATD 44.   LONG 98.   RAIN 9.    EVAP 16.
LATD 43.   LONG 98.   RAIN 11.   EVAP 15.
LATD 42.   LONG 98.   RAIN 11.   EVAP 15.
LATD 41.   LONG 98.   RAIN 11.   EVAP 17.
LATD 40.   LONG 98.   RAIN 13.   EVAP 17.
LATD 39.   LONG 98.   RAIN 13.   EVAP 18.
LATD 38.   LONG 98.   RAIN 10.   EVAP 18.
LATD 37.   LONG 98.   RAIN 10.   EVAP 19.
LATD 36.   LONG 98.   RAIN 10.   EVAP 19.
LATD 35.   LONG 98.   RAIN 10.   EVAP 20.
LATD 34.   LONG 98.   RAIN 11.   EVAP 21.
LATD 33.   LONG 98.   RAIN 8.    EVAP 21.
LATD 32.   LONG 98.   RAIN 6.    EVAP 22.
LATD 31.   LONG 98.   RAIN 5.    EVAP 21.
LATD 30.   LONG 98.   RAIN 5.    EVAP 21.
LATD 29.   LONG 98.   RAIN 7.    EVAP 20.
LATD 28.   LONG 98.   RAIN 7.    EVAP 20.
LATD 27.   LONG 98.   RAIN 6.    EVAP 21.
LATD 26.   LONG 98.   RAIN 5.    EVAP 20.
LATD 25.   LONG 98.   RAIN 5.    EVAP 20.
LATD 50.   LONG 99.   RAIN 8.    EVAP 14.
LATD 49.   LONG 99.   RAIN 8.    EVAP 14.
LATD 48.   LONG 99.   RAIN 8.    EVAP 14.
LATD 47.   LONG 99.   RAIN 8.    EVAP 14.
LATD 46.   LONG 99.   RAIN 8.    EVAP 15.
LATD 45.   LONG 99.   RAIN 7.    EVAP 15.
LATD 44.   LONG 99.   RAIN 8.    EVAP 15.
LATD 43.   LONG 99.   RAIN 9.    EVAP 15.
LATD 42.   LONG 99.   RAIN 10    EVAP 15.
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Figure C-2. Climatic Data (Continued)

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LATD 41.    LONG 99.    RAIN 10.    EVAP 16.
LATD 40.    LONG 99.    RAIN 14.    EVAP 11.
LATD 40.    LONG 99.    RAIN 14.    EVAP 17.
LATD 39.    LONG 99.    RAIN 12.    EVAP 18.
LATD 38.    LONG 99.    RAIN 10.    EVAP 18.
LATD 37.    LONG 99.    RAIN 10.    EVAP 18.
LATD 36.    LONG 99.    RAIN 10.    EVAP 19.
LATD 35.    LONG 99.    RAIN 11.    EVAP 19.
LATD 34.    LONG 99.    RAIN 11.    EVAP 20.
LATD 33.    LONG 99.    RAIN 11.    EVAP 21.
LATD 32.    LONG 99.    RAIN 12.    EVAP 21.
LATD 31.    LONG 99.    RAIN 7.     EVAP 21.
LATD 30.    LONG 99.    RAIN 6.     EVAP 21.
LATD 29.    LONG 99.    RAIN 5.     EVAP 21.
LATD 28.    LONG 99.    RAIN 5.     EVAP 21.
LATD 27.    LONG 99.    RAIN 6.     EVAP 21.
LATD 26.    LONG 99.    RAIN 7.     EVAP 20.
LATD 50.    LONG 100.   RAIN 8.     EVAP 14.
LATD 49.    LONG 100.   RAIN 8.     EVAP 14.
LATD 48.    LONG 100.   RAIN 9.     EVAP 14.
LATD 47.    LONG 100.   RAIN 9.     EVAP 14.
LATD 46.    LONG 100.   RAIN 9.     EVAP 15.
LATD 45.    LONG 100.   RAIN 7.     EVAP 15.
LATD 44.    LONG 100.   RAIN 8.     EVAP 15.
LATD 43.    LONG 100.   RAIN 10.    EVAP 15.
LATD 42.    LONG 100.   RAIN 10.    EVAP 16.
LATD 41.    LONG 100.   RAIN 10.    EVAP 16.
LATD 40.    LONG 100.   RAIN 14.    EVAP 16.
LATD 39.    LONG 100.   RAIN 9.     EVAP 17.
LATD 38.    LONG 100.   RAIN 9.     EVAP 18.
LATD 37.    LONG 100.   RAIN 9.     EVAP 18.
LATD 36.    LONG 100.   RAIN 8.     EVAP 18.
LATD 35.    LONG 100.   RAIN 8.     EVAP 18.
LATD 34.    LONG 100.   RAIN 10.    EVAP 19.
LATD 33.    LONG 100.   RAIN 7.     EVAP 20.
LATD 32.    LONG 100.   RAIN 6.     EVAP 21.
LATD 31.    LONG 100.   RAIN 5.     EVAP 21.
LATD 30.    LONG 100.   RAIN 6.     EVAP 21.
LATD 29.    LONG 100.   RAIN 5.     EVAP 21.
LATD 28.    LONG 100.   RAIN 5.     EVAP 21.
LATD 27.    LONG 100.   RAIN 5.     EVAP 21.
LATD 26.    LONG 100.   RAIN 5.     EVAP 21.
LATD 50.    LONG 101.   RAIN 7.     EVAP 14.
LATD 49.    LONG 101.   RAIN 7.     EVAP 14.
LATD 48.    LONG 101.   RAIN 9.     EVAP 14.
LATD 47.    LONG 101.   RAIN 10.    EVAP 14.
LATD 46.    LONG 101.   RAIN 7.     EVAP 15.
LATD 45.    LONG 101.   RAIN 7.     EVAP 15.
LATD 44.    LONG 101.   RAIN 8.     EVAP 15.
LATD 43.    LONG 101.   RAIN 10.    EVAP 16.
LATD 42.    LONG 101.   RAIN 12.    EVAP 15.
LATD 41.    LONG 101.   RAIN 13.    EVAP 15.
LATD 40.    LONG 101.   RAIN 9.     EVAP 16.
```

Figure C-2. Climatic Data (Continued)

```
LATD 39.    LONG 101.    RAIN 7.     EVAP 16.
LATD 38.    LONG 101.    RAIN 8.     EVAP 17.
LATD 37.    LONG 101.    RAIN 9.     EVAP 17.
LATD 36.    LONG 101.    RAIN 10.    EVAP 17.
LATD 35.    LONG 101.    RAIN 7.     EVAP 17.
LATD 34.    LONG 101.    RAIN 6.     EVAP 19.
LATD 33.    LONG 101.    RAIN 6.     EVAP 19.
LATD 32.    LONG 101.    RAIN 5.     EVAP 19.
LATD 31.    LONG 101.    RAIN 6.     EVAP 20.
LATD 30.    LONG 101.    RAIN 5.     EVAP 20.
LATD 29.    LONG 101.    RAIN 5.     EVAP 21.
LATD 50.    LONG 102.    RAIN 7.     EVAP 14.
LATD 49.    LONG 102.    RAIN 7.     EVAP 14.
LATD 48.    LONG 102.    RAIN 7.     EVAP 14.
LATD 47.    LONG 102.    RAIN 7.     EVAP 15.
LATD 46.    LONG 102.    RAIN 7.     EVAP 15.
LATD 45.    LONG 102.    RAIN 6.     EVAP 15.
LATD 44.    LONG 102.    RAIN 6.     EVAP 16.
LATD 43.    LONG 102.    RAIN 8.     EVAP 15.
LATD 42.    LONG 102.    RAIN 9.     EVAP 15.
LATD 41.    LONG 102.    RAIN 10.    EVAP 15.
LATD 40.    LONG 102.    RAIN 9.     EVAP 15.
LATD 39.    LONG 102.    RAIN 7.     EVAP 16.
LATD 38.    LONG 102.    RAIN 8.     EVAP 16.
LATD 37.    LONG 102.    RAIN 9.     EVAP 16.
LATD 36.    LONG 102.    RAIN 10.    EVAP 16.
LATD 35.    LONG 102.    RAIN 12.    EVAP 16.
LATD 34.    LONG 102.    RAIN 7.     EVAP 17.
LATD 33.    LONG 102.    RAIN 6.     EVAP 18.
LATD 32.    LONG 102.    RAIN 5.     EVAP 19.
LATD 31.    LONG 102.    RAIN 6.     EVAP 20.
LATD 30.    LONG 102.    RAIN 5.     EVAP 20.
LATD 29.    LONG 102.    RAIN 5.     EVAP 21.
LATD 50.    LONG 103.    RAIN 6.     EVAP 14.
LATD 49.    LONG 103.    RAIN 6.     EVAP 14.
LATD 48.    LONG 103.    RAIN 6.     EVAP 15.
LATD 47.    LONG 103.    RAIN 5.     EVAP 15.
LATD 46.    LONG 103.    RAIN 6.     EVAP 15.
LATD 45.    LONG 103.    RAIN 6.     EVAP 16.
LATD 44.    LONG 103.    RAIN 6.     EVAP 15.
LATD 43.    LONG 103.    RAIN 7.     EVAP 15.
LATD 42.    LONG 103.    RAIN 8.     EVAP 15.
LATD 41.    LONG 103.    RAIN 8.     EVAP 15.
LATD 40.    LONG 103.    RAIN 8.     EVAP 15.
LATD 39.    LONG 103.    RAIN 8.     EVAP 15.
LATD 38.    LONG 103.    RAIN 7.     EVAP 16.
LATD 37.    LONG 103.    RAIN 10.    EVAP 15.
LATD 36.    LONG 103.    RAIN 10.    EVAP 15.
LATD 35.    LONG 103.    RAIN 7.     EVAP 16.
LATD 34.    LONG 103.    RAIN 6.     EVAP 17.
LATD 33.    LONG 103.    RAIN 6.     EVAP 18.
LATD 32.    LONG 103.    RAIN 5.     EVAP 18.
LATD 31.    LONG 103.    RAIN 6.     EVAP 20.
LATD 30.    LONG 103.    RAIN 5.     EVAP 20.
LATD 29.    LONG 103.    RAIN 5.     EVAP 21.
```

Figure C-2. Climatic Data (Continued)

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LATD 50.  LONG 104.  RAIN 5.  EVAP 14.
LATD 49.  LONG 104.  RAIN 5.  EVAP 14.
LATD 48.  LONG 104.  RAIN 5.  EVAP 15.
LATD 47.  LONG 104.  RAIN 6.  EVAP 15.
LATD 46.  LONG 104.  RAIN 6.  EVAP 15.
LATD 45.  LONG 104.  RAIN 6.  EVAP 16.
LATD 44.  LONG 104.  RAIN 7.  EVAP 15.
LATD 43.  LONG 104.  RAIN 6.  EVAP 15.
LATD 42.  LONG 104.  RAIN 6.  EVAP 15.
LATD 41.  LONG 104.  RAIN 7.  EVAP 15.
LATD 40.  LONG 104.  RAIN 8.  EVAP 15.
LATD 39.  LONG 104.  RAIN 10.  EVAP 15.
LATD 38.  LONG 104.  RAIN 7.  EVAP 16.
LATD 37.  LONG 104.  RAIN 11.  EVAP 14.
LATD 36.  LONG 104.  RAIN 10.  EVAP 15.
LATD 35.  LONG 104.  RAIN 6.  EVAP 15.
LATD 34.  LONG 104.  RAIN 6.  EVAP 17.
LATD 33.  LONG 104.  RAIN 5.  EVAP 18.
LATD 32.  LONG 104.  RAIN 6.  EVAP 19.
LATD 31.  LONG 104.  RAIN 5.  EVAP 20.
LATD 30.  LONG 104.  RAIN 5.  EVAP 21.
LATD 29.  LONG 104.  RAIN 5.  EVAP 21.
LATD 50.  LONG 105.  RAIN 6.  EVAP 14.
LATD 49.  LONG 105.  RAIN 6.  EVAP 14.
LATD 48.  LONG 105.  RAIN 6.  EVAP 15.
LATD 47.  LONG 105.  RAIN 6.  EVAP 15.
LATD 46.  LONG 105.  RAIN 6.  EVAP 15.
LATD 45.  LONG 105.  RAIN 6.  EVAP 16.
LATD 44.  LONG 105.  RAIN 4.  EVAP 16.
LATD 43.  LONG 105.  RAIN 4.  EVAP 16.
LATD 42.  LONG 105.  RAIN 5.  EVAP 14.
LATD 41.  LONG 105.  RAIN 7.  EVAP 14.
LATD 40.  LONG 105.  RAIN 7.  EVAP 14.
LATD 39.  LONG 105.  RAIN 10.  EVAP 14.
LATD 38.  LONG 105.  RAIN 5.  EVAP 14.
LATD 37.  LONG 105.  RAIN 8.  EVAP 14.
LATD 36.  LONG 105.  RAIN 8.  EVAP 13.
LATD 35.  LONG 105.  RAIN 5.  EVAP 17.
LATD 34.  LONG 105.  RAIN 4.  EVAP 17.
LATD 33.  LONG 105.  RAIN 4.  EVAP 18.
LATD 32.  LONG 105.  RAIN 4.  EVAP 19.
LATD 31.  LONG 105.  RAIN 4.  EVAP 20.
LATD 30.  LONG 105.  RAIN 4.  EVAP 21.
LATD 29.  LONG 105.  RAIN 4.  EVAP 21.
LATD 50.  LONG 106.  RAIN 6.  EVAP 14.
LATD 49.  LONG 106.  RAIN 6.  EVAP 14.
LATD 48.  LONG 106.  RAIN 7.  EVAP 15.
LATD 47.  LONG 106.  RAIN 7.  EVAP 15.
LATD 46.  LONG 106.  RAIN 6.  EVAP 16.
LATD 45.  LONG 106.  RAIN 4.  EVAP 16.
LATD 44.  LONG 106.  RAIN 3.  EVAP 16.
LATD 42.  LONG 106.  RAIN 4.  EVAP 16.
LATD 41.  LONG 106.  RAIN 5.  EVAP 14.
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Figure C-2. Climatic Data (Continued)

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LATD 40.  LONG 106.  RAIN 6.  EVAP 14.
LATD 39.  LONG 106.  RAIN 5.  EVAP 14.
LATD 38.  LONG 106.  RAIN 4.  EVAP 13.
LATD 37.  LONG 106.  RAIN 4.  EVAP 12.
LATD 36.  LONG 106.  RAIN 4.  EVAP 16.
LATD 35.  LONG 106.  RAIN 4.  EVAP 17.
LATD 34.  LONG 106.  RAIN 4.  EVAP 17.
LATD 33.  LONG 106.  RAIN 4.  EVAP 18.
LATD 32.  LONG 106.  RAIN 4.  EVAP 19.
LATD 31.  LONG 106.  RAIN 4.  EVAP 20.
LATD 50.  LONG 107.  RAIN 6.  EVAP 14.
LATD 49.  LONG 107.  RAIN 7.  EVAP 14.
LATD 48.  LONG 107.  RAIN 8.  EVAP 14.
LATD 47.  LONG 107.  RAIN 7.  EVAP 14.
LATD 46.  LONG 107.  RAIN 6.  EVAP 15.
LATD 45.  LONG 107.  RAIN 4.  EVAP 16.
LATD 44.  LONG 107.  RAIN 3.  EVAP 14.
LATD 43.  LONG 107.  RAIN 3.  EVAP 14.
LATD 42.  LONG 107.  RAIN 4.  EVAP 14.
LATD 41.  LONG 107.  RAIN 4.  EVAP 14.
LATD 40.  LONG 107.  RAIN 3.  EVAP 14.
LATD 39.  LONG 107.  RAIN 2.  EVAP 15.
LATD 38.  LONG 107.  RAIN 3.  EVAP 15.
LATD 37.  LONG 107.  RAIN 4.  EVAP 15.
LATD 36.  LONG 107.  RAIN 4.  EVAP 16.
LATD 35.  LONG 107.  RAIN 4.  EVAP 16.
LATD 34.  LONG 107.  RAIN 4.  EVAP 17.
LATD 33.  LONG 107.  RAIN 4.  EVAP 17.
LATD 32.  LONG 107.  RAIN 4.  EVAP 18.
LATD 31.  LONG 107.  RAIN 4.  EVAP 19.
LATD 50.  LONG 108.  RAIN 6.  EVAP 14.
LATD 49.  LONG 108.  RAIN 7.  EVAP 14.
LATD 48.  LONG 108.  RAIN 8.  EVAP 14.
LATD 47.  LONG 108.  RAIN 7.  EVAP 14.
LATD 46.  LONG 108.  RAIN 6.  EVAP 15.
LATD 45.  LONG 108.  RAIN 4.  EVAP 16.
LATD 44.  LONG 108.  RAIN 4.  EVAP 14.
LATD 43.  LONG 108.  RAIN 4.  EVAP 14.
LATD 42.  LONG 108.  RAIN 4.  EVAP 14.
LATD 41.  LONG 108.  RAIN 3.  EVAP 14.
LATD 40.  LONG 108.  RAIN 2.  EVAP 15.
LATD 39.  LONG 108.  RAIN 2.  EVAP 18.
LATD 38.  LONG 108.  RAIN 3.  EVAP 15.
LATD 37.  LONG 108.  RAIN 4.  EVAP 15.
LATD 30.  LONG 108.  RAIN 4.  EVAP 15.
LATD 35.  LONG 108.  RAIN 4.  EVAP 15.
LATD 34.  LONG 108.  RAIN 4.  EVAP 15.
LATD 33.  LONG 108.  RAIN 5.  EVAP 16.
LATD 32.  LONG 108.  RAIN 5.  EVAP 16.
LATD 31.  LONG 108.  RAIN 5.  EVAP 16.
LATD 50.  LONG 109.  RAIN 6.  EVAP 14.
LATD 49.  LONG 109.  RAIN 8.  EVAP 14.
LATD 48.  LONG 109.  RAIN 7.  EVAP 14.
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Figure C-2. Climatic Data (Continued)

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LATD 47.    LONG 109.    RAIN 6.    EVAP 14.
LATD 46.    LONG 109.    RAIN 6.    EVAP 14.
LATD 45.    LONG 109.    RAIN 4.    EVAP 16.
LATD 44.    LONG 109.    RAIN 4.    EVAP 14.
LATD 43.    LONG 109.    RAIN 4.    EVAP 14.
LATD 42.    LONG 109.    RAIN 4.    EVAP 14.
LATD 41.    LONG 109.    RAIN 2.    EVAP 15.
LATD 40.    LONG 109.    RAIN 2.    EVAP 15.
LATD 39.    LONG 109.    RAIN 2.    EVAP 18.
LATD 38.    LONG 109.    RAIN 3.    EVAP 15.
LATD 37.    LONG 109.    RAIN 3.    EVAP 15.
LATD 36.    LONG 109.    RAIN 3.    EVAP 15.
LATD 35.    LONG 109.    RAIN 4.    EVAP 15.
LATD 34.    LONG 109.    RAIN 4.    EVAP 15.
LATD 33.    LONG 109.    RAIN 5.    EVAP 16.
LATD 32.    LONG 109.    RAIN 5.    EVAP 16.
LATD 31.    LONG 109.    RAIN 5.    EVAP 16.
LATD 50.    LONG 110.    RAIN 6.    EVAP 13.
LATD 49.    LONG 110.    RAIN 8.    EVAP 13.
LATD 48.    LONG 110.    RAIN 7.    EVAP 14.
LATD 47.    LONG 110.    RAIN 6.    EVAP 14.
LATD 46.    LONG 110.    RAIN 5.    EVAP 14.
LATD 45.    LONG 110.    RAIN 5.    EVAP 16.
LATD 44.    LONG 110.    RAIN 4.    EVAP 14.
LATD 43.    LONG 110.    RAIN 3.    EVAP 14.
LATD 42.    LONG 110.    RAIN 3.    EVAP 14.
LATD 41.    LONG 110.    RAIN 3.    EVAP 15.
LATD 40.    LONG 110.    RAIN 3.    EVAP 15.
LATD 39.    LONG 110.    RAIN 3.    EVAP 15.
LATD 38.    LONG 110.    RAIN 3.    EVAP 15.
LATD 37.    LONG 110.    RAIN 3.    EVAP 16.
LATD 35.    LONG 110.    RAIN 3.    EVAP 15.
LATD 34.    LONG 110.    RAIN 4.    EVAP 16.
LATD 33.    LONG 110.    RAIN 5.    EVAP 16.
LATD 32.    LONG 110.    RAIN 5.    EVAP 16.
LATD 31.    LONG 110.    RAIN 5.    EVAP 21.
LATD 50.    LONG 111.    RAIN 6.    EVAP 12.
LATD 49.    LONG 111.    RAIN 8.    EVAP 13.
LATD 48.    LONG 111.    RAIN 7.    EVAP 13.
LATD 47.    LONG 111.    RAIN 5.    EVAP 14.
LATD 46.    LONG 111.    RAIN 5.    EVAP 14.
LATD 45.    LONG 111.    RAIN 4.    EVAP 15.
LATD 44.    LONG 111.    RAIN 4.    EVAP 14.
LATD 43.    LONG 111.    RAIN 3.    EVAP 14.
LATD 42.    LONG 111.    RAIN 3.    EVAP 15.
LATD 41.    LONG 111.    RAIN 3.    EVAP 15.
LATD 40.    LONG 111.    RAIN 3.    EVAP 15.
LATD 39.    LONG 111.    RAIN 3.    EVAP 16.
LATD 38.    LONG 111.    RAIN 2.    EVAP 16.
LATD 37.    LONG 111.    RAIN 3.    EVAP 16.
LATD 36.    LONG 111.    RAIN 4.    EVAP 16.
LATD 35.    LONG 111.    RAIN 5.    EVAP 14.
LATD 34.    LONG 111.    RAIN 5.    EVAP 16.
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Figure C-2. Climatic Data (Continued)

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LATD 33.   LONG 111.   RAIN 5.   EVAP 16.
LATD 32.   LONG 111.   RAIN 5.   EVAP 21.
LATD 31.   LONG 111.   RAIN 5.   EVAP 21.
LATD 50.   LONG 112.   RAIN 6.   EVAP 12.
LATD 49.   LONG 112.   RAIN 7.   EVAP 13.
LATD 48.   LONG 112.   RAIN 7.   EVAP 13.
LATD 47.   LONG 112.   RAIN 5.   EVAP 13.
LATD 46.   LONG 112.   RAIN 4.   EVAP 14.
LATD 45.   LONG 112.   RAIN 4.   EVAP 15.
LATD 44.   LONG 112.   RAIN 3.   EVAP 14.
LATD 43.   LONG 112.   RAIN 2.   EVAP 14.
LATD 42.   LONG 112.   RAIN 3.   EVAP 15.
LATD 41.   LONG 112.   RAIN 3.   EVAP 16.
LATD 40.   LONG 112.   RAIN 3.   EVAP 16.
LATD 39.   LONG 112.   RAIN 2.   EVAP 16.
LATD 38.   LONG 112.   RAIN 2.   EVAP 16.
LATD 37.   LONG 112.   RAIN 2.   EVAP 16.
LATD 36.   LONG 112.   RAIN 3.   EVAP 16.
LATD 35.   LONG 112.   RAIN 3.   EVAP 12.
LATD 34.   LONG 112.   RAIN 2.   EVAP 23.
LATD 33.   LONG 112.   RAIN 2.   EVAP 22.
LATD 32.   LONG 112.   RAIN 3.   EVAP 21.
LATD 31.   LONG 112.   RAIN 4.   EVAP 21.
LATD 50.   LONG 113.   RAIN 6.   EVAP 12.
LATD 49.   LONG 113.   RAIN 7.   EVAP 12.
LATD 48.   LONG 113.   RAIN 7.   EVAP 12.
LATD 47.   LONG 113.   RAIN 5.   EVAP 12.
LATD 46.   LONG 113.   RAIN 4.   EVAP 12.
LATD 45.   LONG 113.   RAIN 4.   EVAP 15.
LATD 44.   LONG 113.   RAIN 2.   EVAP 16.
LATD 43.   LONG 113.   RAIN 2.   EVAP 13.
LATD 42.   LONG 113.   RAIN 2.   EVAP 15.
LATD 41.   LONG 113.   RAIN 2.   EVAP 16.
LATD 40.   LONG 113.   RAIN 1.   EVAP 15.
LATD 39.   LONG 113.   RAIN 1.   EVAP 17.
LATD 38.   LONG 113.   RAIN 2.   EVAP 15.
LATD 37.   LONG 113.   RAIN 2.   EVAP 15.
LATD 36.   LONG 113.   RAIN 2.   EVAP 15.
LATD 35.   LONG 113.   RAIN 2.   EVAP 23.
LATD 34.   LONG 113.   RAIN 2.   EVAP 23.
LATD 33.   LONG 113.   RAIN 2.   EVAP 23.
LATD 32.   LONG 113.   RAIN 3.   EVAP 23.
LATD 31.   LONG 113.   RAIN 3.   EVAP 23.
LATD 50.   LONG 114.   RAIN 6.   EVAP 12.
LATD 49.   LONG 114.   RAIN 7.   EVAP 12.
LATD 48.   LONG 114.   RAIN 7.   EVAP 13.
LATD 47.   LONG 114.   RAIN 5.   EVAP 13.
LATD 46.   LONG 114.   RAIN 4.   EVAP 14.
LATD 45.   LONG 114.   RAIN 3.   EVAP 15.
LATD 44.   LONG 114.   RAIN 2.   EVAP 13.
LATD 43.   LONG 114.   RAIN 2.   EVAP 16.
LATD 42.   LONG 114.   RAIN 2.   EVAP 16.
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Figure C-2. Climatic Data (Continued)

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LATD 41.  LONG 114.  RAIN 2.  EVAP 15.
LATD 40.  LONG 114.  RAIN 1.  EVAP 17.
LATD 39.  LONG 114.  RAIN 2.  EVAP 15.
LATD 38.  LONG 114.  RAIN 2.  EVAP 15.
LATD 37.  LONG 114.  RAIN 2.  EVAP 15.
LATD 36.  LONG 114.  RAIN 2.  EVAP 15.
LATD 35.  LONG 114.  RAIN 2.  EVAP 23.
LATD 34.  LONG 114.  RAIN 2.  EVAP 23.
LATD 33.  LONG 114.  RAIN 2.  EVAP 23.
LATD 32.  LONG 114.  RAIN 3.  EVAP 24.
LATD 31.  LONG 114.  RAIN 3.  EVAP 24.
LATD 50.  LONG 115.  RAIN 6.  EVAP 12.
LATD 49.  LONG 115.  RAIN 7.  EVAP 12.
LATD 48.  LONG 115.  RAIN 6.  EVAP 12.
LATD 47.  LONG 115.  RAIN 5.  EVAP 13.
LATD 46.  LONG 115.  RAIN 4.  EVAP 14.
LATD 45.  LONG 115.  RAIN 3.  EVAP 16.
LATD 44.  LONG 115.  RAIN 1.  EVAP 16.
LATD 43.  LONG 115.  RAIN 2.  EVAP 14.
LATD 42.  LONG 115.  RAIN 2.  EVAP 15.
LATD 41.  LONG 115.  RAIN 2.  EVAP 17.
LATD 40.  LONG 115.  RAIN 1.  EVAP 14.
LATD 39.  LONG 115.  RAIN 2.  EVAP 13.
LATD 38.  LONG 115.  RAIN 2.  EVAP 13.
LATD 37.  LONG 115.  RAIN 2.  EVAP 15.
LATD 36.  LONG 115.  RAIN 1.  EVAP 23.
LATD 35.  LONG 115.  RAIN 1.  EVAP 23.
LATD 34.  LONG 115.  RAIN 2.  EVAP 23.
LATD 33.  LONG 115.  RAIN 2.  EVAP 23.
LATD 32.  LONG 115.  RAIN 2.  EVAP 24.
LATD 50.  LONG 116.  RAIN 6.  EVAP 12.
LATD 49.  LONG 116.  RAIN 6.  EVAP 12.
LATD 48.  LONG 116.  RAIN 6.  EVAP 12.
LATD 47.  LONG 116.  RAIN 4.  EVAP 14.
LATD 46.  LONG 116.  RAIN 4.  EVAP 14.
LATD 45.  LONG 116.  RAIN 3.  EVAP 16.
LATD 44.  LONG 116.  RAIN 1.  EVAP 14.
LATD 43.  LONG 116.  RAIN 1.  EVAP 15.
LATD 42.  LONG 116.  RAIN 2.  EVAP 15.
LATD 41.  LONG 116.  RAIN 2.  EVAP 13.
LATD 40.  LONG 116.  RAIN 2.  EVAP 14.
LATD 39.  LONG 116.  RAIN 2.  EVAP 13.
LATD 38.  LONG 116.  RAIN 2.  EVAP 13.
LATD 37.  LONG 116.  RAIN 1.  EVAP 14.
LATD 36.  LONG 116.  RAIN 1.  EVAP 15.
LATD 35.  LONG 116.  RAIN 1.  EVAP 15.
LATD 34.  LONG 116.  RAIN 1.  EVAP 15.
LATD 33.  LONG 116.  RAIN 1.  EVAP 15.
LATD 32.  LONG 116.  RAIN 1.  EVAP 24.
LATD 50.  LONG 117.  RAIN 5.  EVAP 12.
LATD 49.  LONG 117.  RAIN 5.  EVAP 14.
LATD 48.  LONG 117.  RAIN 3.  EVAP 13.
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Figure C-2. Climatic Data (Continued)

```
LATD 47.    LONG 117.    RAIN 2.    EVAP 14.
LATD 46.    LONG 117.    RAIN 4.    EVAP 15.
LATD 45.    LONG 117.    RAIN 3.    EVAP 16.
LATD 44.    LONG 117.    RAIN 2.    EVAP 15.
LATD 43.    LONG 117.    RAIN 1.    EVAP 14.
LATD 42.    LONG 117.    RAIN 2.    EVAP 13.
LATD 41.    LONG 117.    RAIN 2.    EVAP 13.
LATD 40.    LONG 117.    RAIN 1.    EVAP 14.
LATD 39.    LONG 117.    RAIN 2.    EVAP 13.
LATD 38.    LONG 117.    RAIN 2.    EVAP 13.
LATD 37.    LONG 117.    RAIN 1.    EVAP 13.
LATD 36.    LONG 117.    RAIN 1.    EVAP 14.
LATD 35.    LONG 117.    RAIN 1.    EVAP 15.
LATD 34.    LONG 117.    RAIN 0.    EVAP 15.
LATD 33.    LONG 117.    RAIN 0.    EVAP 14.
LATD 32.    LONG 117.    RAIN 0.    EVAP 12.
LATD 50.    LONG 118.    RAIN 4.    EVAP 12.
LATD 49.    LONG 118.    RAIN 4.    EVAP 12.
LATD 48.    LONG 118.    RAIN 3.    EVAP 13.
LATD 47.    LONG 118.    RAIN 2.    EVAP 14.
LATD 46.    LONG 118.    RAIN 4.    EVAP 16.
LATD 45.    LONG 118.    RAIN 5.    EVAP 12.
LATD 44.    LONG 118.    RAIN 2.    EVAP 15.
LATD 43.    LONG 118.    RAIN 3.    EVAP 13.
LATD 42.    LONG 118.    RAIN 2.    EVAP 13.
LATD 41.    LONG 118.    RAIN 1.    EVAP 13.
LATD 40.    LONG 118.    RAIN 2.    EVAP 14.
LATD 39.    LONG 118.    RAIN 2.    EVAP 13.
LATD 38.    LONG 118.    RAIN 1.    EVAP 13.
LATD 37.    LONG 118.    RAIN 1.    EVAP 16.
LATD 36.    LONG 118.    RAIN 0.    EVAP 13.
LATD 35.    LONG 118.    RAIN 0.    EVAP 15.
LATD 34.    LONG 118.    RAIN 0.    EVAP 15.
LATD 33.    LONG 118.    RAIN 0.    EVAP 12.
LATD 32.    LONG 118.    RAIN 0.    EVAP 12.
LATD 50.    LONG 119.    RAIN 2.    EVAP 10.
LATD 49.    LONG 119.    RAIN 2.    EVAP 12.
LATD 48.    LONG 119.    RAIN 2.    EVAP 12.
LATD 47.    LONG 119.    RAIN 2.    EVAP 14.
LATD 46.    LONG 119.    RAIN 2.    EVAP 14.
LATD 45.    LONG 119.    RAIN 2.    EVAP 14.
LATD 44.    LONG 119.    RAIN 3.    EVAP 13.
LATD 43.    LONG 119.    RAIN 3.    EVAP 13.
LATD 42.    LONG 119.    RAIN 2.    EVAP 13.
LATD 41.    LONG 119.    RAIN 2.    EVAP 13.
LATD 40.    LONG 119.    RAIN 2.    EVAP 14.
LATD 39.    LONG 119.    RAIN 2.    EVAP 13.
LATD 38.    LONG 119.    RAIN 1.    EVAP 13.
LATD 37.    LONG 119.    RAIN 0.    EVAP 12.
LATD 36.    LONG 119.    RAIN 0.    EVAP 12.
LATD 35.    LONG 119.    RAIN 0.    EVAP 13.
LATD 34.    LONG 119.    RAIN 0.    EVAP 12.
LATD 33.    LONG 119.    RAIN 0.    EVAP 12.
```

Figure C-2. Climatic Data (Continued)

```
LATD 32.    LONG 119.    RAIN 0.    EVAP 12.
LATD 50.    LONG 120.    RAIN 1.    EVAP 10.
LATD 49.    LONG 120.    RAIN 1.    EVAP 10.
LATD 48.    LONG 120.    RAIN 1.    EVAP 10.
LATD 47.    LONG 120.    RAIN 2.    EVAP 13.
LATD 46.    LONG 120.    RAIN 2.    EVAP 14.
LATD 45.    LONG 120.    RAIN 2.    EVAP 14.
LATD 44.    LONG 120.    RAIN 2.    EVAP 13.
LATD 43.    LONG 120.    RAIN 3.    EVAP 13.
LATD 42.    LONG 120.    RAIN 3.    EVAP 13.
LATD 41.    LONG 120.    RAIN 2.    EVAP 14.
LATD 40.    LONG 120.    RAIN 2.    EVAP 13.
LATD 39.    LONG 120.    RAIN 1.    EVAP 12.
LATD 38.    LONG 120.    RAIN 1.    EVAP 18.
LATD 37.    LONG 120.    RAIN 0.    EVAP 18.
LATD 36.    LONG 120.    RAIN 0.    EVAP 18.
LATD 35.    LONG 120.    RAIN 0.    EVAP 11.
LATD 34.    LONG 120.    RAIN 0.    EVAP 11.
LATD 33.    LONG 120.    RAIN 0.    EVAP 11.
LATD 32.    LONG 120.    RAIN 0.    EVAP 11.
LATD 50.    LONG 121.    RAIN 2.    EVAP 10.
LATD 49.    LONG 121.    RAIN 2.    EVAP 10.
LATD 48.    LONG 121.    RAIN 2.    EVAP 10.
LATD 47.    LONG 121.    RAIN 2.    EVAP 13.
LATD 46.    LONG 121.    RAIN 2.    EVAP 14.
LATD 45.    LONG 121.    RAIN 2.    EVAP 14.
LATD 44.    LONG 121.    RAIN 2.    EVAP 14.
LATD 43.    LONG 121.    RAIN 3.    EVAP 13.
LATD 42.    LONG 121.    RAIN 3.    EVAP 13.
LATD 41.    LONG 121.    RAIN 2.    EVAP 14.
LATD 40.    LONG 121.    RAIN 2.    EVAP 13.
LATD 39.    LONG 121.    RAIN 1.    EVAP 12.
LATD 38.    LONG 121.    RAIN 1.    EVAP 15.
LATD 37.    LONG 121.    RAIN 0.    EVAP 10.
LATD 36.    LONG 121.    RAIN 0.    EVAP 10.
LATD 35.    LONG 121.    RAIN 0.    EVAP 10.
LATD 34.    LONG 121.    RAIN 0.    EVAP 10.
LATD 33.    LONG 121.    RAIN 0.    EVAP 10.
LATD 32.    LONG 121.    RAIN 0.    EVAP 10.
LATD 50.    LONG 122.    RAIN 2.    EVAP 10.
LATD 49.    LONG 122.    RAIN 2.    EVAP 10.
LATD 48.    LONG 122.    RAIN 3.    EVAP 10.
LATD 47.    LONG 122.    RAIN 2.    EVAP 13.
LATD 46.    LONG 122.    RAIN 1.    EVAP 13.
LATD 45.    LONG 122.    RAIN 2.    EVAP 13.
LATD 44.    LONG 122.    RAIN 2.    EVAP 14.
LATD 43.    LONG 122.    RAIN 3.    EVAP 14.
LATD 42.    LONG 122.    RAIN 3.    EVAP 14.
LATD 41.    LONG 122.    RAIN 2.    EVAP 13.
LATD 40.    LONG 122.    RAIN 1.    EVAP 19.
LATD 39.    LONG 122.    RAIN 0.    EVAP 16.
LATD 38.    LONG 122.    RAIN 0.    EVAP 13.
LATD 37.    LONG 122.    RAIN 0.    EVAP 10.
LATD 36.    LONG 122.    RAIN 0.    EVAP 10.
```

Figure C-2. Climatic Data (Continued)

```
LATD 35.    LONG 122.   RAIN 0.   EVAP 10.
LATD 50.    LONG 123.   RAIN 2.   EVAP 10.
LATD 49.    LONG 123.   RAIN 2.   EVAP 10.
LATD 48.    LONG 123.   RAIN 3.   EVAP 10.
LATD 47.    LONG 123.   RAIN 3.   EVAP 11.
LATD 46.    LONG 123.   RAIN 1.   EVAP 12.
LATD 45.    LONG 123.   RAIN 2.   EVAP 13.
LATD 44.    LONG 123.   RAIN 1.   EVAP 13.
LATD 43.    LONG 123.   RAIN 2.   EVAP 13.
LATD 42.    LONG 123.   RAIN 2.   EVAP 13.
LATD 41.    LONG 123.   RAIN 1.   EVAP 12.
LATD 40.    LONG 123.   RAIN 1.   EVAP 19.
LATD 39.    LONG 123.   RAIN 0.   EVAP 9.
LATD 38.    LONG 123.   RAIN 0.   EVAP 9.
LATD 37.    LONG 123.   RAIN 0.   EVAP 9.
LATD 36.    LONG 123.   RAIN 0.   EVAP 10.
LATD 49.    LONG 124.   RAIN 2.   EVAP 10.
LATD 48.    LONG 124.   RAIN 2.   EVAP 10.
LATD 47.    LONG 124.   RAIN 3.   EVAP 10.
LATD 46.    LONG 124.   RAIN 3.   EVAP 11.
LATD 45.    LONG 124.   RAIN 1.   EVAP 11.
LATD 44.    LONG 124.   RAIN 1.   EVAP 11.
LATD 43.    LONG 124.   RAIN 1.   EVAP 11.
LATD 42.    LONG 124.   RAIN 1.   EVAP 11.
LATD 41.    LONG 124.   RAIN 1.   EVAP 11.
LATD 40.    LONG 124.   RAIN 1.   EVAP 9.
LATD 39.    LONG 124.   RAIN 0.   EVAP 9.
LATD 38.    LONG 124.   RAIN 0.   EVAP 9.
LATD 37.    LONG 124.   RAIN 0.   EVAP 9.
LATD 49.    LONG 125.   RAIN 2.   EVAP 10.
LATD 48.    LONG 125.   RAIN 2.   EVAP 10.
LATD 47.    LONG 125.   RAIN 3.   EVAP 10.
LATD 46.    LONG 125.   RAIN 3.   EVAP 10.
LATD 45.    LONG 125.   RAIN 1.   EVAP 11.
LATD 44.    LONG 125.   RAIN 1.   EVAP 11.
LATD 43.    LONG 125.   RAIN 1.   EVAP 11.
LATD 42.    LONG 125.   RAIN 1.   EVAP 11.
LATD 41.    LONG 125.   RAIN 1.   EVAP 9.
LATD 40.    LONG 125.   RAIN 1.   EVAP 9.
ENDD
```

Figure C-2. Climatic Data (Continued)

```
1COMLABEL
 BARB BARBER SHOPS        BEUT BEAUTY SHOPS        DPOT BUS-RAIL DEPOTS
 CARW CAR WASHES          CHUR CHURCHES            CLUB GOLF-SWIM CLUBS
 BOWL BOWLING ALLEYS      COLG COLLEGES RESID.     HOSP HOSPITALS
 HOTL HOTELS              LNDM LAUNDROMATS         LNDY LAUNDRY
 MEDL MEDICAL OFFICES     MOTL MOTELS              MOVI DRIVE-IN MOVIES
 NURS NURSING HOMES       OFFN NEW OFFICE BLDG.    OFFO OLD OFFICE BLDG.
 JAIL JAIL & PRISONS      EATN RESTAURANTS         EATO DRIVE-IN REST-NT
 NITE NIGHT CLUBS         SALE RETAIL SPACE        SKLL SCHOOL,ELEM.
 SKLH SCHOOL, HIGH        THTR THEATERS            YMCA YMCA-YWCA FACIL.
 GASS SERVICE STATIONS
 ENDD
```

Figure C-3. Commercial Category Labels

```
1COMMUNIT
 BARB BARBER CHAIR        BEUT STATION             DPOT SQ. FT.
 CARW INSIDE SQ. FT.      CHUR MEMBER              CLUB MEMBER
 BOWL ALLEY               COLG STUDENT             HOSP BED
 HOTL SQ. FT.             LNDM SQ. FT.             LNDY SQ. FT.
 MEDL SQ. FT.             MOTL SQ. FT.             MOVI CAR STALL
 NURS BED                 OFFN SQ. FT.             OFFO SQ. FT.
 JAIL PERSON              EATN SEAT                EATO CAR SPACE
 NITE PERSON SERVED       SALE SALES SQ. FT.       SKLL STUDENT
 SKLH STUDENT             THTR SEAT                YMCA PERSON
 GASS INSIDE SQ. FT.
 ENDD
```

Figure C-4. Commercial Parameter Unit Labels

```
1COMMAVEG       EXPECTED USAGE VALUES
 BARB     54.6          BEUT     269.          CARW     4.78
 CHUR     .138          CLUB     31.0          COLG     106.
 HOSP     346.          HOTL     .256          LNDY     .253
 BOWL     133.          MOTL     .224          MOVI     5.0
 NURS     133.          OFFO     .142          JAIL     133.
 EATN     24.2          NITE     1.33          SALE     .106
 SKLL     5.38          SKLH     6.63          THTR     3.33
 YMCA     33.3          GASS     .291          LNDM     2.17
 EATO     109.          DPOT     3.33
 OFFN     .093          MEDL     .618
 ENDD
```

Figure C-5. Commercial Mean Annual Usage Coefficients

```
1COMMAXDY       EXPECTED USAGE VALUES
 BARB     80.3          BEUT     328.          CARW     10.3
 CHUR     .862          CLUB     22.2          COLG     114.
 HOSP     551.          HOTL     .294          LNDY     .326
 BOWL     133.          MOTL     .461          MOVI     5.33
 NURS     146.          OFFO     .081          JAIL     133.
 EATN     83.4          NITE     1.33          SALE     .154
 SKLL     9.68          SKLH     19.6          THTR     3.33
 YMCA     33.3          GASS     .590          LNDM     4.74
 EATO     144.          DPOT     6.5
 OFFN     .173          MEDL     1.66
 ENDD
```

Figure C-6. Commercial Maximum Day Usage Coefficients

```
1COMMPEAK       EXPECTED USAGE VALUES
 BARB     389.          BEUT     1070.         CARW     31.5
 CHUR     4.70          CLUB     22.2          COLG     250.
 HOSP     912.          HOTL     .433          LNDY     1.57
 BOWL     133.          MOTL     1.55          MOVI     5.33
 NURS     424.          OFFO     .354          JAIL     133.
 EATN     167.          NITE     1.33          SALE     .271
 SKLL     49.1          SKLH     121.          THTR     3.33
 YMCA     33.3          GASS     31.5          LNDM     1.57
 EATO     547.          DPOT     25.0
 OFFN     .521          MEDL     4.97
 ENDD
```

Figure C-7. Commercial Peak Hour Usage Coefficients

```
1INDLABEL
 I201 MEAT PRODUCTS     I202 DAIRIES           I203 CAN, FROZEN FOOD
 I204 GRAIN MILLS       I205 BAKERY PRUDUCTS   I206 SUGAR
 I207 CANDY             I208 BEVERAGES         I209 MISCELL. FOODS
 I211 CIGARETTES        I221 WEAVING, COTTON   I222 WEAVING, SYNTH.
 I223 WEAVING, WOOL     I225 KNITTING MILLS    I226 TEXTILE FINISH.
 I227 FLOUR COVERING    I228 YARN-THREAD MILL  I229 MISCELL. TEXTILE
 I242 SAW-PLANING MILL  I243 MILLWORK          I244 WOOD CONTAINERS
 I249 MISCELL. WOOD     I251 HOME FURNITURE    I259 FURITURE-FIXTURE
 I261 PULP MILLS        I262 PAPER MILLS       I263 PAPERBOARD MILLS
 I264 PAPER PRODUCTS    I265 PAPERBOARD BOXES  I266 BLDG PAPER MILLS
 I281 BASIC CHEMICALS   I282 FIBERS, PLASTICS  I283 DRUGS
 I284 SOAP-TOILET GOOD  I285 PAINT-ALLIED PRD  I286 GUM-WOOD CHEM.
 I287 AGRICULTURE CHEM  I289 MISCELL. CHEMICL  I291 PETROLEUM REFIN.
 I295 PAVING-ROOFING    I301 TIRES & TUBES     I302 RUBBER FOOTWEAR
 I303 RECLAIMED RUBBER  I306 RUBBER PRUDUCTS   I307 PLASTIC PRODUCTS
 I311 LEATHER TANNING   I321 FLAT GLASS        I322 PRESS-BLOWN GLAS
 I323 PROD.PURCH.GLASS  I324 CEMENT,HYDRAULIC  I325 STRUCTURAL CLAY
 I326 POTTERY PRODUCTS  I327 CEMENT-PLASTER    I328 CUT STONE PROD.
 I329 NONMETALLIC MNRL  I331 STEEL ROLLING     I332 IRON-STEEL FOUND
 I333 PRIME NONFERROUS  I334 SEC. NONFERROUS   I335 NONFERROUS ROLLG
 I336 NONFERROUS FOUND  I339 PRIME METAL IND.  I341 METAL CANS
 I342 CUTLERY,HARDWARE  I343 PLUMBING,HEATING  I344 STRUCTURE METAL
 I345 SCREW MACHINE     I346 METAL STAMPINGS   I347 METAL SERVICES
 I348 FABRICATED WIRE   I349 FABRICATED METAL  I351 ENGINES,TURBINES
 I352 FARM MACHINERY    I353 CONSTRUCT. EQUIP  I354 METALWORK.MACHRY
 I355 SPECL INDUS.MACH  I356 GENRL IND. MACH.  I357 OFFICE MACHINES
 I358 SERV. IND. MACH.  I359 MISCELL. MACHINE  I361 ELECT.DISTR.PROD
 I362 ELECT.IND.APPART  I363 HOME APPLIANCES   I364 LIGHT-WIRING FIX
 I365 RADIO TV RECEIV.  I366 COMMUNICATION EQ  I367 ELECTRONIC COMP.
 I369 ELECT. PRODUCTS   I371 MOTOR VEHICLES    I372 AIRCRAFT & PARTS
 I373 SHIP & BOAT BLDG  I374 RAILROAD EQUIP.   I375 MOTORCYCLE, BIKE
 I381 SCIENTIFIC INSTR  I382 MECHAN. MEASURE   I384 MEDICAL INSTRUM.
 I386 PHOTO EQUIPMENT   I387 WATCHES, CLOCKS   I391 JEWELRY, SILVER
 I394 TOYS,SPORT GOODS  I396 COSTUME JEWELRY   I398 MISCEL. MANUFACT
 I230 WHL.APPAREL IND.  I270 WHOL.PRINT IND.
 I399 MISCEL. MANUFACT
 ENDD
```

Figure C-8. Industrial Category Labels

```
1INDANAVE
 I201          903.890 I202          791.350 I203          784.739
 I204          488.249 I205          220.608 I206         1433.611
 I207          244.306 I208         1144.868 I209         1077.360
 I211          193.613 I221          171.434 I222          344.259
 I223          464.439 I225          273.439 I226          810.741
 I227          297.392 I228           63.558 I229          346.976
 I242          223.822 I243          316.420 I249          144.745
 I251          122.178 I261        13494.110 I262         2433.856
 I263         2464.478 I264          435.790 I265          154.804
 I266          583.355 I281         2744.401 I282          864.892
 I283          457.356 I284          672.043 I285          845.725
 I286          332.895 I287          449.836 I289          984.415
 I291         3141.100 I295          829.592 I301          375.211
 I302           82.592 I303         1031.523 I306          371.956
 I307          527.784 I311          899.500 I321          590.140
 I322          340.753 I323          872.246 I324          279.469
 I325          698.197 I326          326.975 I327          353.787
 I328          534.789 I329          439.561 I331          494.356
 I332          411.052 I333          716.626 I334         1016.596
 I335          675.475 I336          969.586 I339          498.331
 I341          162.547 I342          459.300 I343          411.576
 I344          319.875 I345          433.193 I346          463.209
 I347         1806.611 I348          343.367 I349          271.186
 I351          197.418 I352          320.704 I353          218.365
 I354          196.255 I355          290.494 I356          246.689
 I357          138.025 I358          334.203 I359          238.839
 I361          272.001 I362          336.016 I363          411.914
 I364          369.592 I365          235.763 I366           86.270
 I367          203.289 I369          393.272 I371          318.233
 I372          154.769 I373          166.074 I374          238.798
 I375          414.859 I381          181.007 I382          237.021
 I384          506.325 I386          120.253 I387          164.815
 I391          306.491 I394          213.907 I396          423.124
 I399          258.270
 I230              20. I270              15.
 I244          238.000 I259          122.178 I398          258.270
 ENDD
```

Figure C-9. Industrial Mean Annual Usage Coefficients

```
1INDMXDAY
 I201          903.890 I202          791.350 I203          784.739
 I204          488.249 I205          220.608 I206         1433.611
 I207          244.306 I208         1144.868 I209         1077.360
 I211          193.613 I221          171.434 I222          344.259
 I223          464.439 I225          273.439 I226          810.741
 I227          297.392 I228           63.558 I229          346.976
 I242          223.822 I243          316.420 I249          144.745
 I251          122.178 I261        13494.110 I262         2433.856
 I263         2464.478 I264          435.790 I265          154.804
 I266          583.355 I281         2744.401 I282          864.892
 I283          457.356 I284          672.043 I285          845.725
 I286          332.895 I287          449.836 I289          984.415
 I291         3141.100 I295          829.592 I301          375.211
 I302           82.592 I303         1031.523 I306          371.956
 I307          527.784 I311          899.500 I321          590.140
 I322          340.753 I323          872.246 I324          279.469
 I325          698.197 I326          326.975 I327          353.787
 I328          534.789 I329          439.561 I331          494.356
 I332          411.052 I333          716.626 I334         1016.596
 I335          675.475 I336          969.586 I339          498.331
 I341          162.547 I342          459.300 I343          411.576
 I344          319.875 I345          433.193 I346          463.209
 I347         1806.611 I348          343.367 I349          271.186
 I351          197.418 I352          320.704 I353          218.365
 I354          196.255 I355          290.494 I356          246.689
 I357          138.025 I358          334.203 I359          238.839
 I361          272.001 I362          336.016 I363          411.914
 I364          369.592 I365          235.763 I366           86.270
 I367          203.289 I369          393.272 I371          318.233
 I372          154.769 I373          166.074 I374          238.798
 I375          414.859 I381          181.007 I382          237.021
 I384          506.325 I386          120.253 I387          164.815
 I391          306.491 I394          213.907 I396          423.124
 I399          258.270
 I230              20. I270              15.
 I244          238.000 I259          122.178 I398          258.270
 ENDD
```

Figure C-10. Industrial Maximum Day Usage Coefficients

```
1INDPEKHR
 I201          903.890 I202          791.350 I203          784.739
 I204          488.249 I205          220.608 I206         1433.611
 I207          244.306 I208         1144.868 I209         1077.360
 I211          193.613 I221          171.434 I222          344.259
 I223          464.439 I225          273.439 I226          810.741
 I227          297.392 I228           63.558 I229          346.976
 I242          223.822 I243          316.420 I249          144.745
 I251          122.178 I261        13494.110 I262         2433.856
 I263         2464.478 I264          435.790 I265          154.804
 I266          583.355 I281         2744.401 I282          864.892
 I283          457.356 I284          672.043 I285          845.725
 I286          332.895 I287          449.836 I289          984.415
 I291         3141.100 I295          829.592 I301          375.211
 I302           82.592 I303         1031.523 I306          371.956
 I307          527.784 I311          899.500 I321          590.140
 I322          340.753 I323          872.246 I324          279.469
 I325          698.197 I326          326.975 I327          353.787
 I328          534.789 I329          439.561 I331          494.356
 I332          411.052 I333          716.626 I334         1016.596
 I335          675.475 I336          969.586 I339          498.331
 I341          162.547 I342          459.300 I343          411.576
 I344          319.875 I345          433.193 I346          463.209
 I347         1806.611 I348          343.367 I349          271.186
 I351          197.418 I352          320.704 I353          218.365
 I354          196.255 I355          290.494 I356          246.689
 I357          138.025 I358          334.203 I359          238.839
 I361          272.001 I362          336.016 I363          411.914
 I364          369.592 I365          235.763 I366           86.270
 I367          203.289 I369          393.272 I371          318.233
 I372          154.769 I373          166.074 I374          238.798
 I375          414.859 I381          181.007 I382          237.021
 I384          500.325 I386          120.253 I387          164.815
 I391          306.491 I394          213.907 I396          423.124
 I399          258.270
 I230             20.  I270             15.
 I244          238.000 I259          122.178 I398          258.270
ENDD
```

Figure C-11. Industrial Peak Hour Usage Coefficients

```
1PUBCOFAA
 LOSS 14.9                FSER 5.2                 AIRP 5.0
 P001 5.0
 ENDD
```

Figure C-12. Public-Unaccounted Mean Annual Usage Coefficients

```
1PUBCOFMD
 LOSS 14.9                FSER 5.2                 AIRP 5.0
 P001 5.0
 ENDD
```

Figure C-13. Public-Unaccounted Maximum Day Usage Coefficients

```
1PUBCOFPH
 LOSS 14.9                FSER 5.2                 AIRP 5.0
 P001 5.0
 ENDD
```

Figure C-14. Public-Unaccounted Peak Hour Usage Coefficients

```
1PUBLABEL
 LOSS DISTRIB. LOSSES  FSER FREE SERVICES     AIRP AIRPORTS
 P001 P001 USER
 ENDD
 ENDI
```

Figure C-15. Public-Unaccounted Category Labels



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