PROGRAM USER GUIDE FOR PART

By A.T. Rutledge

INTRODUCTION

This manual describes the use of the computer program PART for analysis of streamflow records using data in a particular format (example: Figure 1). This format was not available at the time the program was developed but is now available from USGS web sites. This manual does not include complete explanation of the computer program; the reader is referred to earlier report (Rutledge, 1998, pages 33-38).

The program uses streamflow partitioning to estimate a daily record of base flow (ground-water discharge) under the streamflow record. The program scans the period of record for days that fit a requirement of antecedent recession, designates ground-water discharge to be equal to streamflow on these days, then linearly interpolates the ground-water discharge on days that do not fit the requirement of antecedent recession. Although calculations are made on the daily time scale, the author recommends that results should be reported at a larger time scale (at least a month but preferably a year or more).

The PART program is intended for analyzing a ground-water-flow system that is characterized by diffuse areal recharge to the water table and ground-water discharge to a stream. The method is appropriate if all or most ground water in the basin discharges to the stream and if a streamflow-gaging station at the downstream end of the basin measures all or most outflow. Regulation and diversion of streamflow should be negligible. More information about application of the method is included in the earlier report (Rutledge, 1998, pages 2-3).

```
#
# U.S. Geological Survey
# National Water Information System
# Retrieved: 2001-08-29 13:12:17 EDT
#
# ---------------------WARNING--------------------
# The data you have obtained from this automated
# U.S. Geological Survey database have not received
# Director's approval and as such are provisional
# and subject to revision.  The data are released
# on the condition that neither the USGS nor the
# United States Government may be held liable for
# any damages resulting from its use.
#
# This file contains published daily mean streamflow data.
#
# This information includes the following fields:
#
#  agency_cd    Agency Code
#  site_no      USGS station number
#  dv_dt        date of daily mean streamflow
#  dv_va        daily mean streamflow value, in cubic-feet per-second
#  dv_cd        daily mean streamflow value qualification code
#
# Sites in this file include:
#  USGS 02038850 HOLIDAY CREEK NEAR ANDERSONVILLE, VA
#
#
agency_cd    site_no      dv_dt dv_va dv_cd
5s      15s    10d    12n    3s
USGS   02038850     1970-01-01  17
USGS   02038850     1970-01-02  8.4
USGS   02038850     1970-01-03  6.8
USGS   02038850     1970-01-04  6.2
USGS   02038850     1970-01-05  7.3
USGS   02038850     1970-01-06  4.9
USGS   02038850     1970-01-07  5.1
USGS   02038850     1970-01-08  6.5
USGS   02038850     1970-01-09  4.0
USGS   02038850     1970-01-10  3.2
USGS   02038850     1970-01-11  3.3
USGS   02038850     1970-01-12  3.7
USGS   02038850     1970-01-13  3.4
USGS   02038850     1970-01-14  3.5
USGS   02038850     1970-01-15  3.7
USGS   02038850     1970-01-16  3.8
USGS   02038850     1970-01-17  4.0
USGS   02038850     1970-01-18  13
USGS   02038850     1970-01-19  18
USGS   02038850     1970-01-20  11
```

**Figure 1. Example streamflow data file obtained from a USGS web site.
(This is truncated from the data file Holiday.txt, which is available
with this manual.)**

PREPARING TO USE THE PROGRAM

This section describes things the program user may need to do before using the program. The first-time user who is experimenting with the data files included with this report can skip this section and proceed to the instructions for running the program. The section about the SCREEN program may be helpful to the first-time user.

OBTAINING STREAMFLOW DATA FILES

A streamflow data file can be obtained from the following USGS web site: http://water.usgs.gov/nwis/discharge. From this site, the user will need to select site selection criteria. For example, if the site of interest is Holiday Creek in Virginia, yet the site identification number is not known, the selection criteria might be *State* and *Site Name*. After proceeding to the option to select a site, the user would then enter *Holiday* under site name, then the state of Virginia. After these options, the user selects the particular station of interest. Under *Choose Output Format* a range of dates is selected and the user should select *Tab-separated data*. Then the user should select to save as a file, designate the directory where the data are to be written on the user's computer, and specify a file name. File names should be in the format *xxxxx.txt*, where *xxxxx* is an abbreviated station name. In this case the file name might be designated as *Holiday.txt*. (Note: the length of the file name, including .*txt,* should be 12 characters or less.) Under *save as file type* the user should specify *plain text*. An example streamflow data file, obtained as described above, is illustrated in figure 1.

THE "SCREEN" PROGRAM

Before analyzing a streamflow data file the user might execute the SCREEN program to display the period of record. To demonstrate, execute the program by clicking on the application in windows or by entering the command "screen" in the MS-DOS command window. Designate the streamflow data file Indian.txt. The output file screenout.txt should look like figure 2. This illustrates data are available from October 1958 to September 1968 and from October 1970 to September 1986.

```
READING FILE NAMED Indian.txt
FIRST YEAR IN RECORD =  1958
 LAST YEAR IN RECORD =  1986
               MONTH
 YEAR   J F M A M J J A S O N D
 1958   X X X X X X X X X . . .
 1959   . . . . . . . . . . . .
 1960   . . . . . . . . . . . .
 1961   . . . . . . . . . . . .
 1962   . . . . . . . . . . . .
 1963   . . . . . . . . . . . .
 1964   . . . . . . . . . . . .
 1965   . . . . . . . . . . . .
 1966   . . . . . . . . . . . .
 1967   . . . . . . . . . . . .
 1968   . . . . . . . . . X X X
 1969   X X X X X X X X X X X X
 1970   X X X X X X X X X . . .
 1971   . . . . . . . . . . . .
 1972   . . . . . . . . . . . .
 1973   . . . . . . . . . . . .
 1974   . . . . . . . . . . . .
 1975   . . . . . . . . . . . .
 1976   . . . . . . . . . . . .
 1977   . . . . . . . . . . . .
 1978   . . . . . . . . . . . .
 1979   . . . . . . . . . . . .
 1980   . . . . . . . . . . . .
 1981   . . . . . . . . . . . .
 1982   . . . . . . . . . . . .
 1983   . . . . . . . . . . . .
 1984   . . . . . . . . . . . .
 1985   . . . . . . . . . . . .
 1986   . . . . . . . . . X X X

 COMPLETE RECORD = .      INCOMPLETE = X
```

Figure 2. Example graphical display of a streamflow record, showing periods of complete record (a number for each day in the month) and periods of incomplete record. (This display is generated onto a file by the program SCREEN, and on the monitor by PART. Streamflow data file is *Indian.txt*.)

DRAINAGE AREA

The PART program allows the user to derive estimates of ground-water discharge that are expressed in units of length (inches) and in units of specific discharge (inches per year). In order to make such calculations the program needs the drainage area of the streamflow station. There should be one line written to the file *station.txt* for each streamflow data file. Each line must include the name of the streamflow data file and the drainage area. This variable may be obtained from USGS databases, web sites, or data books, or the program user may determine it from topographic maps or other sources. The file *station.txt* includes entries for the streamflow data files that are included with this report. These can be used as a guide for the format of additional entries.

Typically, this variable will be the same as the surface drainage area of the streamflow gaging station. In some applications the hydrologist may have information to indicate the ground-water contributing area is significantly different from the surface drainage area. In this case the former might be designated in file *station.txt*. If the value placed in station.txt differs from the surface drainage area the program user should exercise caution because program output files express streamflow in units of length and units of specific discharge.

RUNNING THE PROGRAM

This section gives specific instructions for running PART for the five streamflow data files that are included with this report. The station information file *station.txt* has entries for these stations. The file *partsum.txt* has header information for summary results of the PART program. As provided with this report, the file does not include results, but each time the program is executed a new line will be written to the end of this file.

The program can be executed by clicking on the PART application in Windows Explorer, or by opening the MS-DOS window and entering the command "part". In the first trial run, enter *Indian.txt* as the streamflow data file, then designate the starting year as 1971 and the ending year as 1980. As a test of the program the first-time user should repeat the process for the other four stations *Holiday.txt*, *Sewee.txt*, *LitAndro.txt*, and *BigHill.txt*.

After the program is executed five times as described above, the output file *partsum.txt* should be identical to figure 3. Each time the program was run, a new line was written to the end of this file. The other output files *partqrt.txt*, *partmon.txt*, *partWY.txt*, and *partday.txt* are created the first time the program is executed, then over-written each time the program is executed again. To save results on these files the user will need to copy or rename to a separate file with each program run. As noted in the documentation report (Rutledge, 1998), results at the small time scale (partday.txt) are provided for generating graphics but should not be reported or used quantitatively. The meaningful results of the program are those that correspond to the quarter year, season, year, or greater time scale. Monthly results may be useful in some applications. Seasonal results might be obtained by calculating monthly totals from file *partmon.txt*.

The program generates a graphical display of the completeness of the record (figure 2). Results of the program will be most useful if the time period is one in which the record is complete for all calendar years. In the case of the record illustrated in figure 2, this would be 1959 to 1967 (or a subset of these years) or 1971 to 1985 (or a subset of these years). If there is a gap within the period specified, the program will not make calculations. (For example if the period specified was 1961 to 1980.) The program will make calculations in some cases of missing record if the days missing are only at the beginning or the ending of the period specified. In this case, long-term results will not be written to *partsum.txt*. To demonstrate, the program user can execute PART, specifying *Indian.txt* as the streamflow file, and specifying the time period 1970 to 1980. In this case, a line is written to *partsum.txt* indicating incomplete record, but partial results are written to other files (*partqrt.txt, partmon.txt, partday.txt*, and *partWY.txt*). The number "-99.99" indicates no result.

```
File "partsum.txt"
------------------
Each time the PART program is run, a new line is written to the
end of this file.

          Drainage                                              Base-
           area                 Mean              Mean          flow
File name   (Sq.   Time      streamflow        baseflow        index
          miles)  period    (cfs)  (in/yr)    (cfs)  (in/yr)   (%)
------------------------------------------------------------------
Indian.txt    8.88  1971-1980   16.06   24.56    10.46   16.00   65.2
Holiday.txt   8.53  1971-1980   11.66   18.57     6.96   11.09   59.7
Sewee.txt   117.00  1971-1980  227.35   26.39   129.77   15.07   57.1
LitAndro.txt 73.50  1971-1980  154.52   28.56   105.32   19.46   68.2
BigHill.txt  37.00  1971-1980   32.98   12.11     4.84    1.78   14.7
```

Figure 3. Example results of the PART program (written to file partsum.txt) from test runs described above. (Other results are written to other files described in the report.)

REFERENCE

Rutledge, A.T., 1998, Computer programs for describing the recession of ground-water discharge and for estimating mean ground-water recharge and discharge from streamflow data – update: U.S. Geological Survey Water-Resources Investigations Report 98-4148, 43 p.