3.5   Option 5 -- Graphs

--System Command qwgraph

The programs in the **QWGRAPH** menu may be invoked either by entering the command:

qwgraph

or by using Option 5 Graphs, from the main QWDATA menu. The following graph routines are displayed:

```
        QWDATA GRAPHIC ROUTINES   REV NWIS -4_0+20010615
        YOU ARE USING WATER-QUALITY DATA BASE NUMBER 01


                     -Graphs

  1 --  X,Y Plot
  2 --  Boxplots
  3 --  Stiff Diagrams
  4 --  Piper Diagrams
  5 --  Regression Plots
  6 --  Summary Statistics Table
  7 --  Detection Limits Table


 98 -- -Exit Menu

 99 -- - Exit System

 Please enter a number from the above list or a Unix command:
```

Graphic Programs Menu

When in the QWGRAPH menu, UNIX commands such as "ls" or "more" can be used to list a directory or examine the contents of a file. When the selected program has completed, the user will be returned to the QWGRAPH menu shown above. Use option 99 -- -Exit System to exit the software and option 98 -- Exit Menu to return to the previous menu.

Options 1 and 5, qwplot and qwregress, require that a UNIX environment variable called DISPLAY be set to allow the program to plot in a separate window on your screen. The variable must be set from outside of QWGRAPH. The first message after invoking either of these programs is a message asking you to confirm that the variable DISPLAY has been set correctly.

INPUT and OUTPUT FILES for QWGRAPH

All programs in the QWGRAPH menu require an input file of either record numbers or data to operate and an output file. Options 1-5 require a file containing record numbers

from the QWDATA database. This file has the format of one record number per line in columns 1-8 and can be generated through QWDATA (*see Section 3.3.1*) or created with an editor.

Examples of this input file is shown in *Appendix G*.

GRAPHICS OUTPUT

Options 1-5 generate graphics that require the user to specify the output format. Options 1 and 5 use TKG2 to produce the plots, and the other options use S_PLUS.

From the TKG2 window, the plot can be printed, saved as a TKG2 or G2 file, or exported into a FrameMaker Interchange Format (*mif), portable document format (pdf), bitmap (bmp), portable network graphics (png), or postscript file. If a plot is saved as a FrameMaker Interchange Format (*mif), the user will need to complete some editing of the graph, so that the entire plot can be seen on the page. To do this, open the *mif file in FrameMaker; use 'Select All on Page' from the Edit pull-down menu; then choose 'Group' from the Graphics pull-down menu; finally choose 'Scale' from the Graphics menu and make the scale factor 80%. The entire plot can be moved to center it on the page after it has been scaled down in size. When a plot is saved in TKG2 format, it can be edited using TKG2. Open the plot in TKG2 and double click on the axis you would like to edit or double click on the explanation to edit the data points in the plot. Use the editing windows that are displayed to change the appearance. For more information about TKG2, go to *http://tx.cr.usgs.gov/tkg2/*. To continue with the plotting program, exit from the TKG2 window.

When the programs that invoke S_PLUS are used, a directory named NWIS_Swork is created in the user's home directory. This directory will contain any files that are made while using the S_PLUS graphics programs. When the graphics that invoke S_PLUS are selected, the following list of device types is displayed:

> **Enter the number of the device wanted**
> **1 motif (X-window) graphics**
> **2 pdf file**
> **4 HP Laser Jet file**
> **5 PostScript file**
> **7 Tektronix 4010 window (from X-term or TerraPro)**
> **9 EPS file**

If option *(1)* is selected, a separate S-Plus window appears that includes the plot. To exit cleanly from this window, the user should include all responses in the UNIX window, not in the S-Plus window. If option *(2)* is selected, a pdf file is generated after a file name is entered. Known bugs exist for diagrams generated in a pdf format from the S_PLUS window. For boxplots (option 2 from the main QWGRAPH menu), the y-axis label is missing. If option *(4)* is selected, a plot file in HP Laser-Jet format is produced that can

be plotted to printers that accept HP formatted graphics. If option *(5)* is selected, a postscript file is produced that can be plotted to printers that accept postscript format. If option *(7)* is selected, the plot will appear on a Tektronix 4010 window. To use a Tektronix 4010 window, you must be using an xterm window. When option *(7)* is selected a message appears in the UNIX window: "Enable Tek window output now." Activate the Tektronix window by selecting "Switch to Tek mode" after pressing the CTRL and middle mouse button combination while in the UNIX window. To view each plot, hit enter in the Tektronix window after each plot. To return to the UNIX window, deselect "Switch to Tek mode" and deselect "Show Tek window" after pressing the CTRL and middle mouse button combination. If option *(9)* is selected, you can choose the size of the plot you want and plot the file to printers that accept encapsulated postscript format. Five different sizes of output graphics can be chosen; the list of options is displayed when option 9 is selected:

```
Enter the number of the plotsize wanted
      full page     1/2 page
3-column formats
2 wide   21          22
3 wide   31          32
full page landscape: 10
```

The different options in the menu above are shown in example layouts below:

EPS option (10)   EPS option (21)   EPS option (22)   EPS option (31)   EPS option (32)
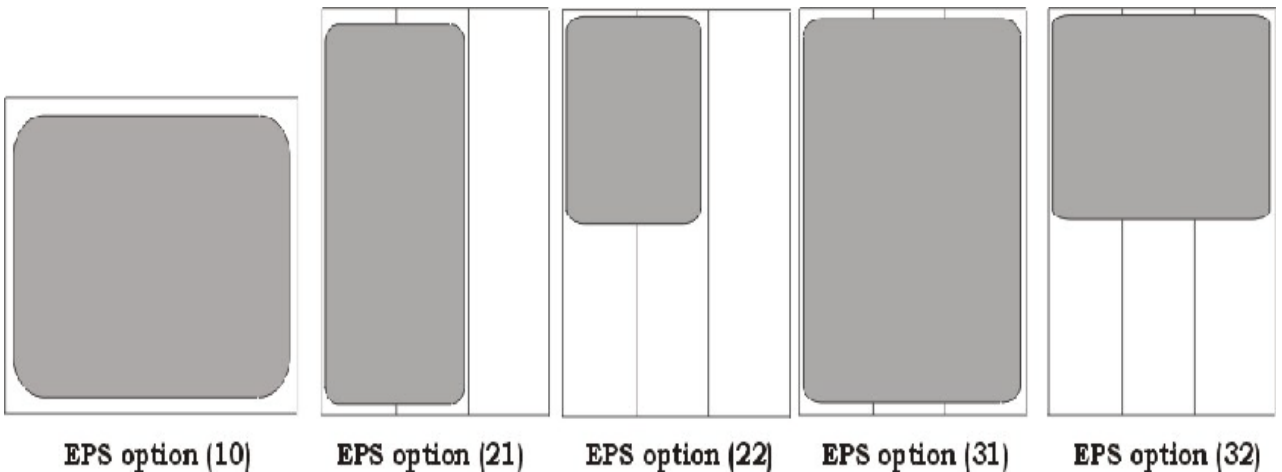
3.5.1 Option 1 -- X,Y Plot
(/usr/opt/nwis/bin/qwplot)

The qwplot program (option 1) creates an X,Y plot in three stages: *(1)* by retrieving data from the QWDATA database that are written to an ASCII file, *(2)* by using data in the ASCII file to create the plot in a separate graphics (TKG2) window, and **(3)** from the TKG2 window, the plot can be printed or saved to a file. All data are used in the plot,

including remarked (i.e., less or greater than) results. Plots created with QWPLOT are limited to 5,000 data points.

The three stages used to complete the plot are described, and the software requests the name of the file containing the record numbers. The next prompt asks for the name of the output file name.

Three options exist for plotting the data: **(1)** 1-7 parameters by one parameter, **(2)** 1-7 parameters by sample date, and **(3)** Multiple stations by sample date for one parameter. All three options will handle data from multiple stations; however, only option **(3)** will identify the individual stations on the plot.

If option **(1)** is chosen, a 5-digit parameter code for the x-axis must be entered followed by as many as seven parameters that will be plotted on the y-axis. If option **(2)** is chosen, the x-axis parameter is sample data and as many as seven parameters can be entered to be plotted on the y-axis. If option **(3)** is chosen, the program reminds you that the file containing the record numbers must be sorted by station-id, date, and time. The x-axis parameter is sample data, and one y-axis parameter can be entered.

After the plot type is chosen, the data are retrieved, some basic statistics (e.g., n, minimum, and maximum) are displayed on the screen, and you are asked if the data are to be listed to the screen. These data are the same data included in the ASCII output file and in the plot. A title then can be entered for the plot, and the x-axis and y-axis labels can be edited if the default choices are not acceptable. Although there is no limit on the length of the plot title or axis labels that can be entered, there is a practical limit because all text entered may not be visible on the plot. Editing of the font size in another application may be needed to see the entire title or label. You then can choose whether the plot points will be connected with lines. Several seconds after this response, a separate TKG2 window will appear that contains the plot you requested.

3.5.2 Option 2 – Boxplots
(/usr/opt/nwis/bin/qwboxplot)

The qwboxplot program (option 2) creates boxplots in two stages: **(1)** by retrieving data from the QWDATA database that are written to an ASCII file and **(2)** by using data in the ASCII file to create the plot in a separate graphics (S-Plus) window and write the output to a file. A boxplot (fig. 10) is a simple graphic means of displaying statistics for the distribution of reported concentrations for a constituent. This program can generate several types of boxplots. The ends of the box (hinges) define the range of the middle 50 percent of the data which is that part of the data between the 25th and 75th percentiles (the interquartile range). The median value of the data, the 50th percentile, is defined by a line across the box. The lines beyond each end of the box are called whiskers, and, in a schematic boxplot, extend to the last value within 1.5 times the interquartile range beyond the ends of the box. Data points beyond the whiskers are called outliers because their values differ greatly from the rest of the data. Outliers that extend from 1.5 to 3 times the range of the 25th and 75th percentiles are plotted as an "x," and outliers that

extend more than 3 times are plotted as an "o." In a truncated boxplot, the whiskers extend to the 10th and 90th percentiles.

This program requires the standard input file of record numbers and an output file. The output file documents the retrieved data and is used as input to the plotting routine. The program then asks if you want to make a boxplot with one station with one or more parameters, multiple stations with one parameter, or multiple stations treated as one station.

```
-----------------------------------------------------------
Data-retrieval options                       Code
-----------------------------------------------------------
One station with one or more parameters   1
Multiple stations with one parameter       2
Multiple stations treated as one           3
-----------------------------------------------------------
   Enter code for option                      >
```

For any of the three options, the next request is for parameter codes that will be included in the boxplot. If option 1 or 3 is selected, you can enter as many as 15 different parameter codes. The data values for each parameter code will be used to complete a boxplot for that parameter. If option 1 is selected and the record number file includes data for more than one station, only the first station listed in the record number file will be used. If option 2 is selected, one parameter code is entered, and the data values for each station will be used to complete a boxplot. If more than 15 stations are included in the record number file for option (2), 16 stations will be shown on the x axis, but only 15 boxplots will be drawn. Boxplots drawn for groups with less than 10 data values may not be complete. For example, if only one data value is available, only the median line is displayed. If plots for less than 10 data values are used for other than exploratory data analysis, groups with less than 5 data values should be displayed using the individual points. The data are retrieved, and summary statistics are displayed on the screen like those displayed below:

```
RETRIEVAL OPTION 3:  2 PARAMETERS FOR A GROUP OF STATIONS
------------------------------------------------------------
GROUPS RETRIEVED  2    MIN VALUE  -10.000
GROUPS WITH DATA  2    MAX VALUE  758.000
------------------------------------------------------------

SUMMARY OF VALUES BY GROUP:
--------------------------------------------------------------------------------------------
GROUP          NUM OF                   25TH              75TH
IDENTIFIER   VALUES   MINIMUM   PCTILE   MEDIAN   PCTILE   MAXIMUM
--------------------------------------------------------------------------------------------
00010          165     -10.000    2.500    6.500    12.000    20.500
00095          154      36.000  132.000  178.000   213.000   758.000
--------------------------------------------------------------------------------------------
```

If any censored values are found in the retrieved data, the software asks the user if they should be estimated and what method should be used:

RETRIEVING DATA ... RETRIEVAL COMPLETED

 Censored values found in the data set.

 Estimate censored values? Ans: y / n, <cr> = n >

Censored values can be estimated by either of two methods

 Select the method you want:

 1 - LOG-PROBABILITY REGRESSION

 2 - ADJUSTED LOGNORMAL MAXIMUM LIKELIHOOD (default)

For more information on these two methods see *Statistical Methods in Water Resources* by D.R. Helsel and R.M. Hirsch.

The next queries are for whether you want the data listed to the screen and whether you want to plot the data. If the data are to be plotted, then the options for the type of boxplots are displayed (schematic or truncated). After you select the type of boxplot, you can supply the title of the plot, the y-axis label (if you want it changed), and the x-axis label (if you want it changed). The S_PLUS list of devices is displayed and you must select an output option as described above.

The data for the most recent boxplot are saved in the NWIS_Swork directory as an S-plus data set called spgu.boxplt. These data can be used in any S-plus analysis.
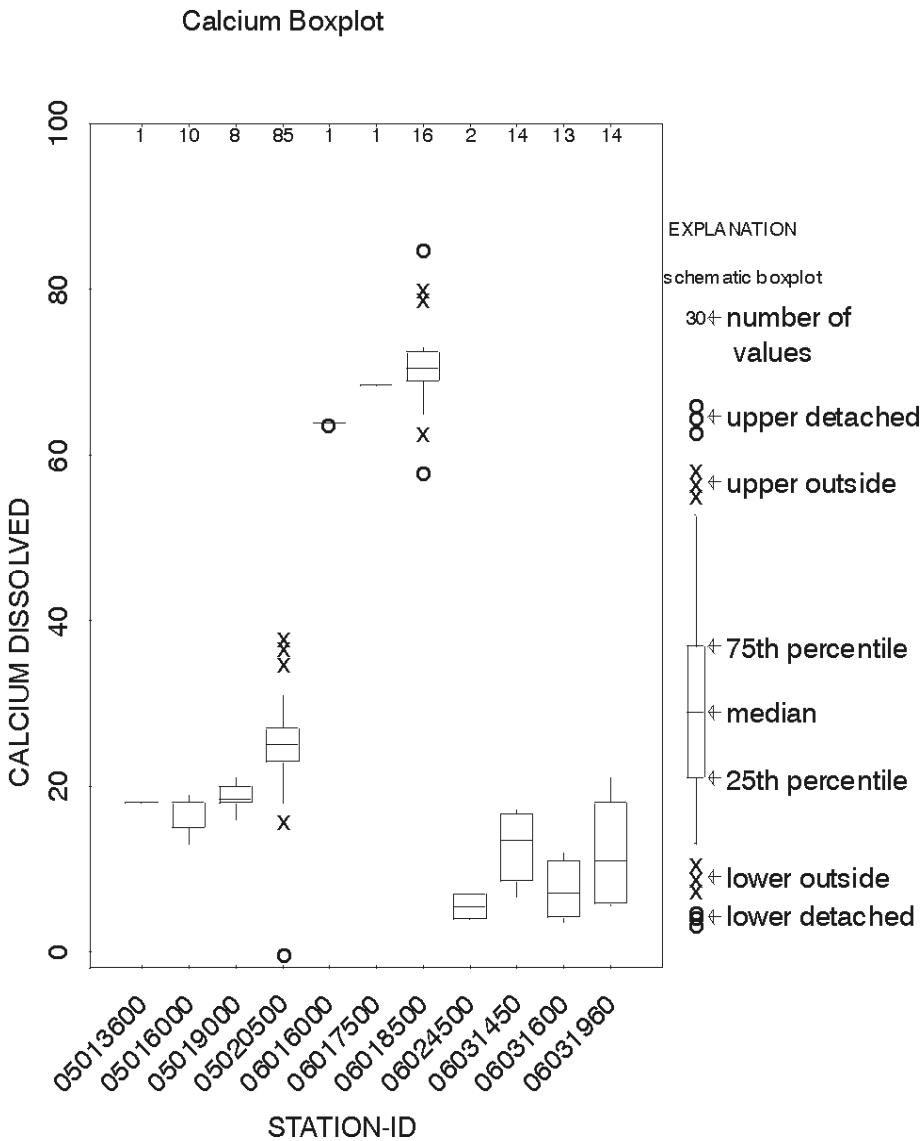
Calcium Boxplot

Figure 11. Boxplot

3.5.3   Option 3 -- Stiff Diagrams
          (/usr/opt/nwis/bin/qwstiff)

The qwstiff program (option 3) creates Stiff diagrams (Stiff, 1951) in two stages: *(1)* by retrieving data from the QW database that are written to an ASCII file and *(2)* by using data in the ASCII file to create the plot in a separate graphics (S-Plus) window and write the output to a file. Using S-Plus, Stiff diagrams are plotted in a separate window by using an input file of record numbers.

The Stiff diagram is a graphical representation of the cations and anions of an analysis in milliequivalents per liter. The Stiff plotting technique uses parallel horizontal axes

extending on each side of a vertical zero axis (Hem, 1985, p. 175). Concentrations of the cations are plotted to the left of the vertical axis and anions to the right. The points are then connected, and an irregular pattern results. Thus, the patterns can be compared among analyses as well as among sites to illustrate similarities and differences.

The NWIS software plots the cations calcium and magnesium alone, and combines the cations sodium and potassium. The anions, bicarbonate and carbonate are combined, chloride and fluoride are combined, and sulfate is plotted alone. Each plot represents one analysis. All data are used in the plot including remarked (i.e., less or greater than) results. The software will not plot a Stiff diagram if any of the parameters are missing. Below is an example of a Stiff diagram produced from the software.
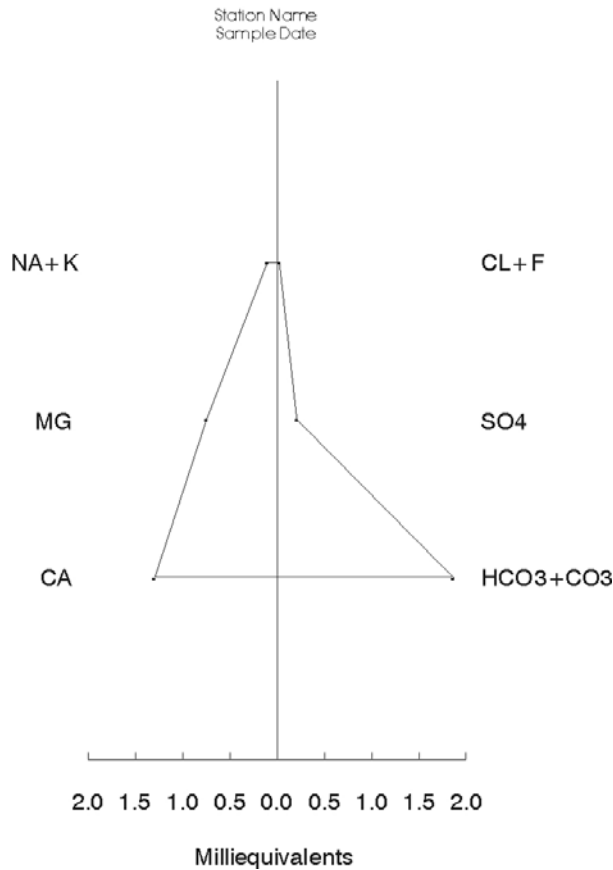
When the program is invoked, a query appears and asks if you want to plot station name (local well number) instead of the station number. The program then requests the input file name of record numbers and the output file name (the output file is referred to as the 'Sample Printout File').   The S_PLUS list of devices is displayed, and you must select an output option as described above.

The output file (ASCII) contains the station number, date, and time for each record and a list of cations and anions. A missing value is represented by "-1". An asterisk (*) indicates that the bicarbonate value was computed from alkalinity, and a message is included at the end of the cation and anion list.

3.5.4 Option 4 -- Piper Diagrams
   (/usr/opt/nwis/bin/qwpiper)

The qwpiper program (option 4) creates Piper diagrams (Piper, 1983). Piper diagrams can be used to show the chemical character of water. In a Piper diagram, selected cations (positively charged ions--calcium, magnesium, and sodium plus potassium) and anions (negatively charged ions--bicarbonate plus carbonate, sulfate, and chloride) for each analysis are shown as a percentage of the total cations and anions, in milliequivalents per liter. The cations are plotted as single points in the triangle on the left side and anions in the triangle on the right side. Cation and anion plots for each sample then are projected into the central diamond field. A water type can be described depending on the location of the projected point in the central diamond. The Piper diagram can be used to determine whether a particular water is *(1)* chemically similar to some other water or *(2)* a simple mixture of two chemically different water types (Hem, 1985, p. 177-179).

A water type in which one cation and one anion dominate (each amounts to 50 percent or more of the cations or anions, respectively) is designated by the names of the dominant cation and anion. A water type in which no cation or anion dominates is designated a mixed-cation or mixed-anion type (Piper and others, 1953, p. 26).

When the qwpiper program is invoked, the program asks for the file containing the record numbers (same format as option 1), and then for the output file name. This output file is the ASCII file created for use with the plotting routine. If the file name exists in the working directory, the program asks if you want to overwrite the current file. Up to 2,000 points can be plotted using qwpiper. The program then displays the following options:

```
 YOU HAVE THE FOLLOWING SYMBOL OPTIONS
   FOR STATIONS:
  ***********************************************
     1.  USE ONE SYMBOL, ONE COLOR
     2.  USE A DIFFERENT SYMBOL, ONE COLOR
     3.  USE ONE SYMBOL, DIFFERENT COLORS
     4.  USE DIFFERENT SYMBOL, DIFFERENT COLORS
  ***********************************************
     ENTER YOUR CHOICE:
```

Note: Too many symbols may clutter a piper diagram so that you cannot adequately view differences between symbols. Consider selecting a different option from the menu above to reduce the number of different symbols on your plot.

If option 1 or 3 is selected, you are prompted for a symbol (marker) number from 0-18 that corresponds to symbols listed in table 10. If a carriage return is entered, the default is 0, a square symbol. If option 4 is selected, the program displays the following two options that allow the user to choose when the symbols change:

```
CHANGE SYMBOLS ON:
 ******************************************
  1. EACH SITE (STATION)
  2. EACH SAMPLE, REGARDLESS OF SITE
    (COLOR CHANGES ON EACH SITE ONLY)
 ******************************************
```

```
0   Square                      10  Circle with + inside
1   Circle                      11  Four small triangles joined
2   Triangle                    12  Square with + inside
3   Plus symbol                 13  Circle with X inside
4   X symbol                    14  Square with a triangle inside
5   Diamond                     15  Filled-in square
6   Upside-down triangle        16  Filled-in circle
7   Square with X inside        17  Filled-in triangle
8   Asterisk                    18  Filled-in diamond
9   Diamond with + inside
```

Table 10. Symbols used for data values in Piper diagrams

When symbol options 2 or 4 are selected, symbols can be changed for each site or each sample. A choice of two symbol sets is available with options 2 and 4. One set of symbols is the S-Plus symbol set, shown in table 10; the second set of symbols contains small and capitalized letters of the alphabet (52 different symbols). When symbol options 3 or 4 are chosen, different colors are used to show a change of station (or possibly samples when option 4 is used). The colors in the order they will be displayed are black, red, green, blue, yellow, cyan, and magenta. For option 3, the user picks a symbol and a different color is used for each station in the plot. If more than 7 stations are plotted, the colors start over, so that the first and eighth stations will be black. The following table shows the colors that will be shown given the number of stations plotted (the station order is the same as in the record number file):

Station order number	Color used
1, 8, 15…	Black
2, 9, 16…	Red
3, 10, 17…	Green
4, 11, 18…	Blue
5, 12, 19…	Yellow
6, 13, 20…	Cyan
7, 14, 21…	Magenta

For option 4, the colors are used in the same order and symbols are used in the order shown in *Table 10*. The colors and symbols are repeated when all have been used. The following example shows the colors and symbols that would be plotted if option *(1)* –

CHANGE SYMBOLS ON: Each site is chosen and 10 stations are plotted (the station order is the same as in the record number file):

Station order number	Color/Symbol used
1	Black/Square
2	Red/Circle
3	Green/Triangle
4	Blue/Plus symbol
5	Yellow/X
6	Cyan/Diamond
7	Magenta/Upside down triangle
8	Black/Square with X inside
9	Red/Asterisk
10	Green/Diamond with + inside

The final option is the size of the symbol to be plotted.

After the options for the plot have been entered, the S_PLUS list of devices is displayed, and the user must choose an output option as described above.

After these options are entered, an output file and plot are produced. The output file contains a list of cations and anions, the station number, date, and time for each record. A missing value is represented by "-1". An asterisk (*) signifies that the bicarbonate value was computed from alkalinity.

The data for the most recent plot are saved in the NWIS_Swork directory as an S-plus data set called spgu.piper. These data can be used in any S-plus analysis.

The figure below is an example of a Piper diagram produced from this program:
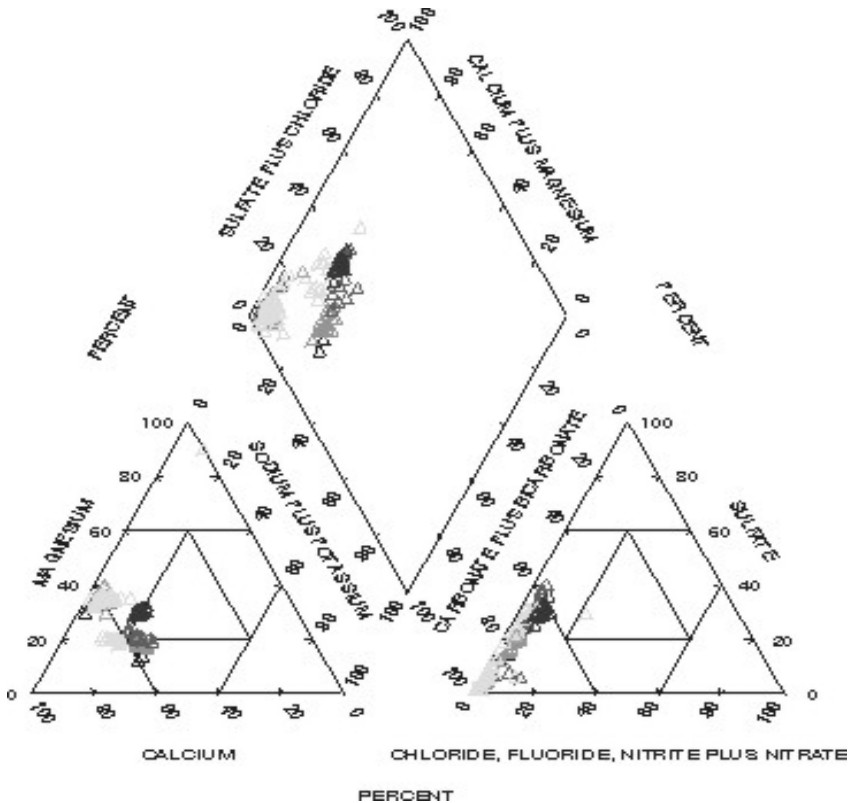
3.5.5 Option 5 -- Regression Plots
(/usr/opt/nwis/bin/qwregress)

The qwregress program (option 6) creates an X,Y plot that can include a line calculated from a linear regression computation to fit a line through a set of results. The linear regression is performed by the IMSL subroutine RLONE and is described in the IMSL Reference Manual, v.4 (IMSL, Inc., 1982). The confidence interval for the coefficient and for the intercept is 95 percent. In the output file, the results of the regression computation are included with the data used in the computation.

The regression plot and output file are created in three stages: *(1)* by retrieving data from the QWDATA database that are written to an ASCII file and the linear regression is computed, *(2)* by using data in the ASCII file to create the plot in a separate graphics (TKG2) window, and *(3)* from the TKG2 window, the plot can be printed or saved to a file. All data are used in the plot, including remarked (i.e., less or greater than) results. Plots created with qwregress are limited to 9,999 data points. You must have at least three values for the program to work. After describing the three stages used to complete the plot, the software requests the name of the input file of record numbers. The next prompt asks for the name of the output data file, which is an ASCII file that contains the data and results from the regression computation.

A code must be entered that describes whether one plot should be made for all stations or if one plot should be made for each station in the record number file. After the code is entered, you have the option to include the regression line on the plot. One parameter code is entered for the x axis and one is entered for the y axis. After each parameter code is entered, a multiplier can be entered that will be used on the values for that parameter. The next prompt asks whether log transformations should be performed on the values for the x and y axes. A summary of the variables to be used in the regression computation and plot is shown on the screen. You can use this summary to determine if the choices are correct. If the choices are not correct, you can re-enter the information.

Several seconds after answering yes to whether the regression variables are correct, a separate TKG2 window appears that contains the plot you requested. To continue with the plotting program, exit the TKG2 window. After the TKG2 window is closed, you are asked if you would like another set of parameters processed. If **YES**, the program asks for the x-axis parameter code and follows the steps described above; if **NO**, the program ends.

3.5.6 Option 6 -- Summary Statistics Table
(/usr/opt/nwis/bin/qwprcntl)

This option runs a program that reads data and parameter-name files created by using option 5 from the data output menu. To create these files, select a fixed-column flat file from the output format selection (*see Section 3.4.5.1 Selecting the Output Format*). These output files are used to produce a table of summary statistics. The heading on the summary table requires information from the Sitefile that is obtained by using the following alpha codes as the first three codes in the parameter list used to make a flat file by sample:

<div align="center">

AGNCY, STAID, DATES

</div>

The above three codes must be present in the parameter list. The following code also may be present:

> **81024 (DRAINAGE AREA)** may be included and will be used as the drainage area in place of the contributing drainage area.

The program asks for the name of the fixed column, space-delimited file. The program then asks for the parameter-list file name. This file is created by a run of qwflatout, or you may create your own file by using the format described in *Section 3.4.5.1*. The names need to be in the same order as the input data. The program then prompts for the output file name and asks if you wish to report estimated percentiles for censored parameters.

At this point, the interactive portion of the qwprcntl program is finished. This program may run for a long time, depending on the number of parameters that are to be processed and the number of records.

A log-probability regression procedure is used to estimate the mean (and the percentiles, if requested) of censored parameters. This procedure handles multiple-detection limits. The methods used are as follows:

Uncensored parameters:

1. The data are ranked in ascending order, and positions for the percentiles are found using the following formula:

   $K = Pct * (N + 1)/100$
   where K is the expected position, Pct is the integer percentile (e.g., for the 5th percentile, Pct = 5; for the 25th percentile, Pct = 25) and N is the number of observations. If the position K is a whole number, then the value in that position in the rank-ordered data is the value used for the percentile. If K is not a whole number, then the following interpolation is used:
   $P(Pct) = X(trunc(K)) + (K\text{-}trunc(K)) * (X(trunc(K)+1) - X(trunc(K)))$
   where P(Pct) is the desired percentile, X() is the rank order data set, trunc(K) is the truncated value of K and Pct is as above.

2. If the number of observations is greater than 1 and less than or equal to 5, only the maximum, minimum, and mean are reported.
3. If the number of observations is equal to 1, only the maximum is reported.
4. If the maximum is equal to 0.0, only the maximum is reported, regardless of the number of observations.
5. All values in uncensored parameters are treated the same regardless of any codes associated with those values.

Censored parameters:

1. If the percent of values flagged with "<" or "U" is greater than 5 percent of the total number of data values for a parameter, the parameter is considered censored.
2. The mean of censored parameters is estimated with a log-probability regression procedure. The method estimates the values below a detection limit and uses these values and the detected values of a parameter to estimate the mean. The FORTRAN implementation of this method was done by the Systems Analysis Group, WRD, USGS. This method was chosen as the best way to handle the problems presented by multiple-detection limits in water-quality data. The estimated mean is flagged with an "*" and explained in a footnote on the statistical summary table.
3. If estimated percentiles are requested, the same procedure that is used to estimate data below the detection limit for the calculation of the mean is used to estimate the data below the detection limit and to calculate the percentiles. The percentile values are calculated using the same method as described in Part 1 of the previously mentioned uncensored methods. These values also are flagged with "*" to indicate that they are based on an estimated data set, and the "*" is explained in a footnote.

4. If non-estimated percentiles are requested, only actual values are used for the percentile values in the statistical table. The percentiles retain a "<" flag if one is associated with the value originally and no interpolation between values is used. To establish the set of sorted data that the percentiles are selected from, all values flagged with "<" or "U" are assumed to be less than any value without a flag. For example, the following values are shown in the ascending order that would be used:

<0.1 <1 <20 .01 17 500

a) Only "<" and "U" remark codes are used to distinguish censored from uncensored parameters and subsequently are established as less-than values in the statistical procedures. Other remark codes are processed as follows:

K - treated as a detected value
E - treated as a detected value
> - values dropped from statistical procedures
M - values dropped from statistical procedures
N - values dropped from statistical procedures

b) If the average of two values must be taken to obtain the value for a percentile, the remark code of the greater value is associated with the percentile.
c) Any values equal to 0 in a censored parameter are replaced with the value of the nearest less-than value (in time-order) and the remark code is set to "<."
d) If the number of observations above the detection limit is less than 5, the estimated values are considered unreliable and are not reported.
e) If the total number of observations (above and below the detection limit) is greater than 1 and less than or equal to 5, only the maximum and minimum are reported.
f) If the total number of observations is equal to 1, only the maximum is reported.

Effective limits of the program:

1. The maximum number of parameters (header and water quality) cannot exceed 1,000.
2. The maximum number of values per parameter per station is set to 5,000.

3.5.7 Option 7 -- Detection-Limits Table
(/usr/opt/nwis/bin/qwdetlims)

The qwdetlims program (option 7) reads the data and parameter-name files created by a run of qwflatout (*Section 3.4.5.1*) and produces a table of detection limits. The heading on the table requires information from the QW database that is obtained by using DATES in the parameter list passed to qwflatout.

The qwdetlims program produces a table of detection limits encountered in the input data file for each parameter in the parameter list file, excluding the alpha parameter codes and the numeric codes for mean discharge, instantaneous discharge, and drainage area (00060, 00061, and 81024, respectively). A maximum of 350 valid numeric parameter codes can be handled by the program, and a maximum of 19 years can be processed for each run.

The program asks for the input data file name created by qwflatout. The program then asks for the parameter list file name. This file is created by qwflatout, or you may create your own file by using the format described in *Section 3.4.5.1*. The names need to be in the same order as the input data.

The program then asks for the output file name and asks if you want to specify the period of record to be used (19 years, maximum) or to use the dates from the input data file (only the last 19 years will be counted). If specifying the period of record, you are then asked for the beginning year and the ending year.

At this point, the interactive portion of the qwdetlims program is finished. This program may run for a long time depending on the number of parameters that are to be processed and the number of records.

The output table is headed by the name of the parameter from the parameter-list file, the corresponding parameter code, and the total of the nonmissing values encountered for that parameter. The table consists of a column of detection limits encountered (a data value with a remark code of "<" or "U"), columns of counts of detection limits encountered for each selected year (up to a maximum of 19 years), a summary column (the total of the counts for that detection limit), and a final column giving the percent of the total, nonmissing values represented by that detection limit. The rows are in the order of detection limits as they are encountered in the input data.

The input data file is considered as a whole. By selecting appropriate record numbers to be used by qwflatout, qwdetlims can be used to show detection limits encountered for a single station, a single county, a specific project, a single year, or any period of years up to 19. If the output from qwflatout had 50 years of data, it could be processed by qwdetlims in three runs.

One use of the detection limits table is for locating probable order-of-magnitude data errors. For example, if a parameter has a detection limit of <0.5 for a period of years and a single (or few) detection limit(s) of <50, the single-data value probably should be reviewed. Another use is for evaluating the data before or as they are used in statistical analyses.