

If the scale (or Data Mode) is set to Log Transform Land's formulas are used to compute the Confidence Interval Limits (see Section 12.1 of *Statistical Analysis of Groundwater Monitoring Data: Unified Guidance*). The CI on Mean window for a Parametric Confidence Interval on the Mean for log-normal data is shown in Figure 5-100 and the statistics shown for each confidence interval are described in Table 5-29.

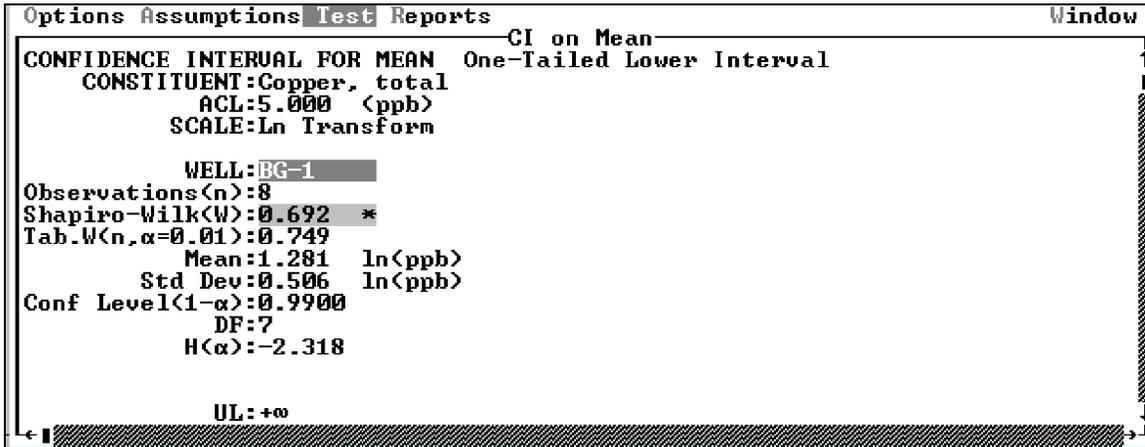


Figure 5-100. CI on Mean window for a Parametric Confidence Interval on the log-normal mean.

Statistic	Description
Observations(n)	Number of observations in the well or group.
Shapiro-Wilk(W) or Shapiro-Francia(W')	For less than 50 past observations the Shapiro-Wilk(W) statistic. If 50 or more past observations are selected the Shapiro-Francia(W') statistic is computed. This value is flagged with an asterisk (*) if the data are not normally distributed at the 1% level of significance.
Tab. W(n, $\alpha=0.01$) or Tab. W'(n, $\alpha=0.01$)	Critical value of W or W' for n observations at the 1% level of significance.
Mean	Mean of the natural logarithms of the observations
Std Dev	Standard Deviation of the natural logarithms of the observations.
Conf Level(1- α)	Confidence Level

DF	Degrees of Freedom
$H(\infty)$ for a one-sided lower interval $H(1-\infty)$ for a one-sided upper interval $H(\frac{\infty}{2}), H(1-\frac{\infty}{2})$ for a two-sided interval	Tabulated values for Land's formulas.
UL	Upper Confidence Limit
LL	Lower Confidence Limit

Table 5-29. Statistics displayed in the CI on Mean window for each Parametric Confidence Interval on the log-normal Mean.

Parametric CI on 95th Percentile

Execute the CI on 95th option of the Test menu to construct a Parametric Confidence Interval on the 95th percentile. The computed Confidence Interval will appear in the CI on 95th percentile window. The CI on 95th percentile window is shown in Figure 5-101 and the statistics shown for each confidence interval are described in Table 5-30.

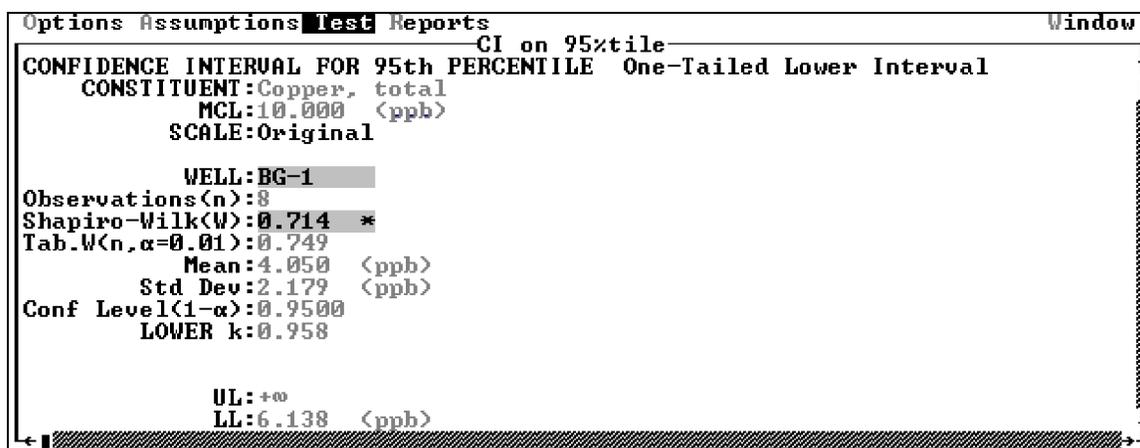


Figure 5-101. CI on 95th percentile Window.

Statistic	Description
Observations(n)	Number of observations in the well or group.
Shapiro-Wilk(W) or Shapiro-Francia(W')	For less than 50 past observations the Shapiro-Wilk(W) statistic. If 50 or more past observations are selected the Shapiro-Francia(W') statistic is computed. This value is flagged with an asterisk (*) if the data are not normally distributed at the 1% level of significance.
Tab. W(n, $\alpha=0.01$) or Tab. W'(n, $\alpha=0.01$)	Critical value of W or W' for n observations at the 1% level of significance.
Mean	Mean
Std Dev	Standard Deviation
Conf Level(1- α)	Confidence Level
LOWER k for a one-sided lower interval UPPER k for a one-sided upper interval LOWER k, UPPER k for a two-sided interval	Tabulated kappa values from Hahn and Meeker (1991).
UL	Upper Confidence Limit
LL	Lower Confidence Limit

Table 5-30. Statistics shown for each Confidence Interval in the CI on 95%tile window.

If the computed Confidence Interval does not contain the concentration limit being tested (i.e., ACL or MCL) the Confidence Interval is flagged with an asterisk (*) and explanatory text as shown in Figure 5-102.

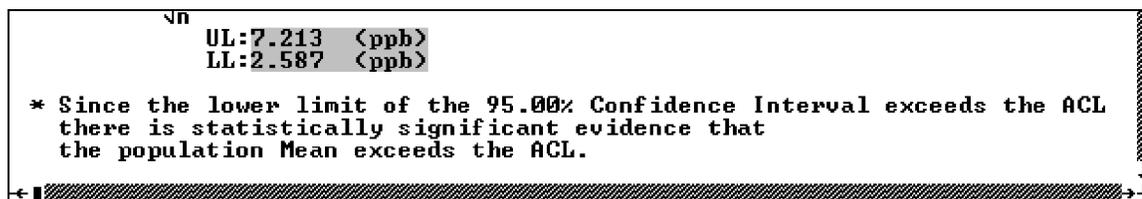


Figure 5-102. Explanatory text displayed for a two-sided Confidence Interval on the mean compared to an ACL of 2 ppb.

1. Use the **R**eports | **P**rint option to print the Parametric Prediction Interval results to a printer or ASCII file (Section 5.7.9).
2. Use the **R**eports | **D**isplay option to view a graphical representation of the Parametric

Confidence Interval results (Figure 5-103). The Confidence Intervals and concentration limit (i.e., ACL or MCL) are superimposed on Box Plots.

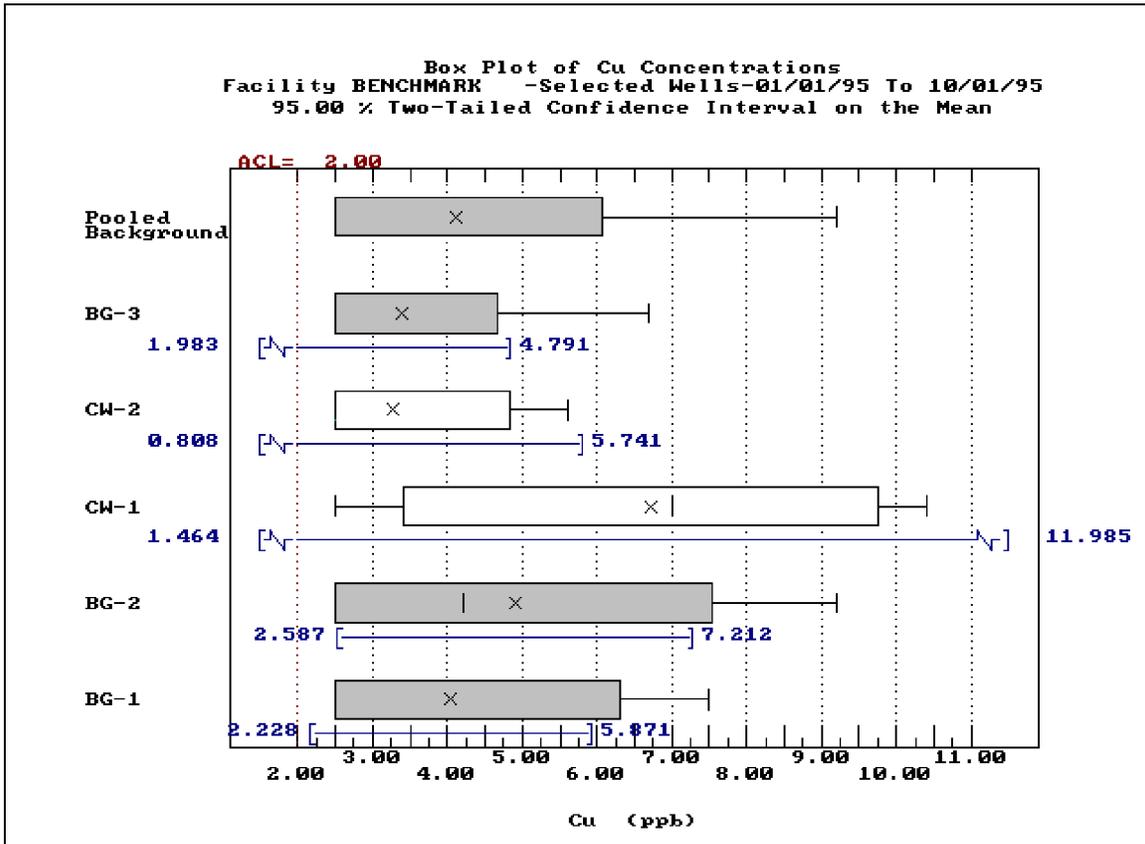


Figure 5-103. Two-sided Confidence Intervals superimposed on Box Plots.

5.7.8 METHODS | INTERVALS | CONFIDENCE | NONPARAMETRIC

The Methods | Intervals | Confidence | NonParametric option allows you to:

- Compute a Non-Parametric Confidence Interval around a user-specified percentile for comparison to an ACL or MCL.

For statistical guidance consult Section 12 of *Statistical Analysis of Groundwater Monitoring Data: Unified Guidance*.

The instructions below assume that a data set is loaded.

1. At the GRITS Statistics menu press </>. This will take you to the top most level of the GRITS Statistics menu (Figure 5-12).

2. Press <M> to descend into the Methods menu.
3. Press <I> to descend into the Intervals menu.
4. Press <C> to descend into the Confidence menu.
5. Press <N> to execute the Nonparametric option of the Confidence menu. The Non-Parametric Confidence Interval Menu appears on your screen as shown in Figure 5-104.

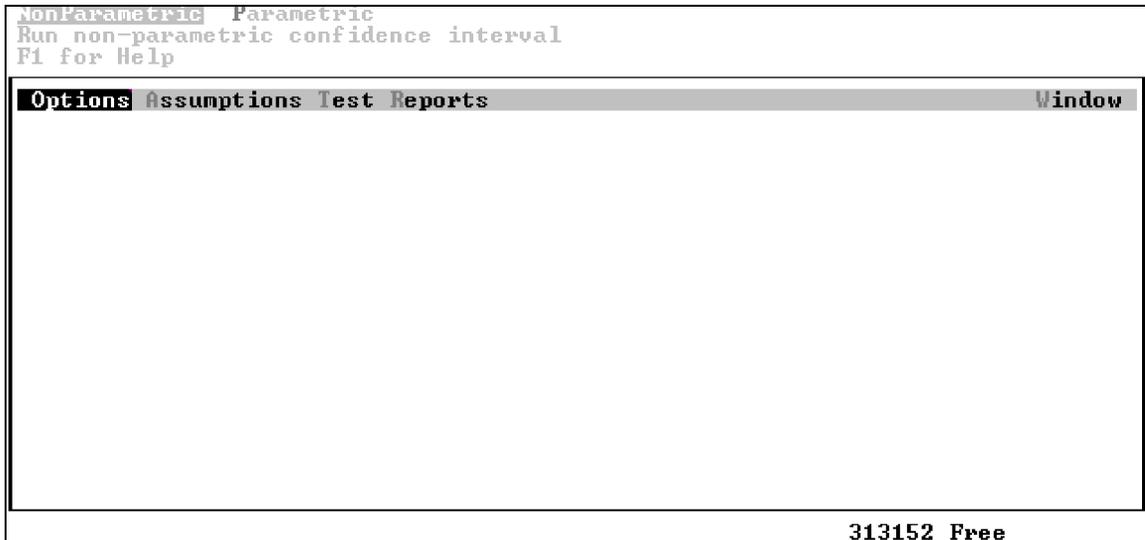


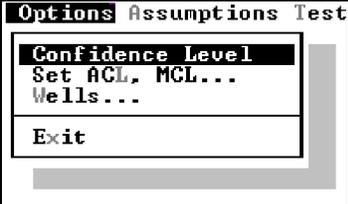
Figure 5-104. The Non-parametric Confidence Interval Menu.

6. The default settings for the Non-Parametric Confidence Interval methods are listed in Table 5-31.

Option	Default Value
Confidence Level	99±10%
ACL, MCL	The ACL and MCL default to the ACL and MCL specified for the parameter being tested.
Pooling	Individual Wells. Confidence Intervals are constructed for each well.
Interval Type	One-Tailed Lower

Table 5-31. Default settings for the Non-parametric Confidence Interval Method.

To change the desired Confidence Level, User Tolerance, ACL or MCL follow the instructions for the Options pull-down menu in Table 5-32.

Pull-Down	Menu Item	Description
	C onfidence Level...	Set the desired Confidence Level and User Tolerance.
<p data-bbox="203 478 511 529"><i>Figure 5-105.</i> The Options pull-down menu.</p>	<p data-bbox="587 352 1286 415">Upon executing the Parameters option the message box shown in Figure 5-106 appears on your screen.</p> <div data-bbox="597 436 1318 604" style="border: 1px solid black; padding: 5px; text-align: center;"> <p data-bbox="678 445 1286 508">Significance Levels for non-parametric intervals are usually only approximate and often cannot be constructed to meet the desired confidence level.</p> <p data-bbox="928 529 993 571">OK</p> </div> <p data-bbox="587 625 1318 676"><i>Figure 5-106.</i> Message Box to inform users about Significance Levels in Non-parametric Intervals.</p> <p data-bbox="587 730 1318 877">Computation of the Non-parametric Confidence Interval is iterative. A list of possible Confidence Intervals is constructed based for each group. The approximate Confidence Level is computed for each interval in the list. The Interval that comes closest to meeting the desired Confidence Level is selected and used for comparisons.</p> <p data-bbox="587 919 1318 970">Press <Enter> to proceed to the Confidence Level dialog (Figure 5-107).</p> <div data-bbox="695 991 1221 1096" style="border: 1px solid black; padding: 5px; text-align: center;"> <p data-bbox="711 1012 1205 1075">Confidence Level(1-α): 99.00% Tolerance: 10.00%</p> </div> <p data-bbox="690 1108 1079 1138"><i>Figure 5-107.</i> Confidence Level dialog.</p> <p data-bbox="587 1222 1263 1285">Enter the desired Confidence Level and User Tolerance press <Enter>.</p> <p data-bbox="587 1327 1295 1411">If a Non-parametric Confidence Interval has already been computed and the Confidence Level is changed the Confidence Interval will be re-computed for the selected Confidence Level.</p>	

	Set ACL, MCL...	<p>The Set ACL, MCL... option allows you to edit the ACL or MCL that the Confidence Interval(s) are compared to.</p> <p>Upon selection you are prompted for the concentration limit you wish to edit as shown in Figure 5-95.</p> <p>Use the up and down arrow keys to select the desired concentration limit.</p> <p>The Adjust Concentration Limit Value dialog appears on your screen as shown in Figure 5-96. Type in the desired value and press <Enter>.</p> <p>If a Confidence Interval has already been computed and the ACL or MCL is changed the comparison(s) are automatically refreshed for the new ACL or MCL.</p>
	<u>W</u> ells...	Allows you to toggle Well Selection Flags. See Section 5.5.3.2.
	E x it	Exits the Non-parametric Prediction Intervals menu.

Table 5-32. The Options pull-down of the Non-parametric Confidence Interval Menu.

To change the Pooling option and Interval Type follow the instructions for the Test pull-down menu in Table 5-33.

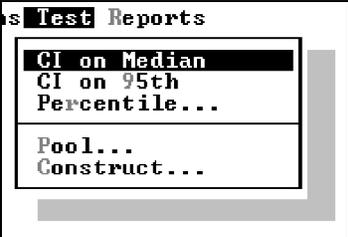
Pull-Down	Menu Item	Description
	CI on <u>M</u> edian	The CI on Mean option computes the Confidence Interval around the mean.
	CI on <u>9</u> 5 th	The CI on 95 th computes the Confidence Interval around the 95 th Percentile.
	Percentile... 	The <u>P</u> ercentile... option computes the Confidence Interval for a user specified percentile. Upon execution of the <u>P</u> ercentile... option the Percentile dialog appears on your screen (Figure 5-109). Enter the desired percentile and press < Enter >.

Figure 5-108. The Test pull-down menu.

Figure 5-109. The Percentile dialog.

	<p><u>P</u>ool...</p>	<p>The Pool... option allows you to specify the group(s) that Confidence Intervals are computed on.</p> <p>Upon selection the Pool dialog appears on your screen as shown in Figure 5-98.</p> <p>Select the Individual Wells option to construct Confidence Intervals for each well.</p> <p>Select the Pooled Background option to construct a single Confidence Interval around all pooled background observations.</p> <p>Select the Pooled Compliance option to construct a single Confidence Interval around pooled compliance well observations.</p> <p>Use the up and down arrow keys to highlight the desired pooling option and press <Enter>.</p> <p>If a Confidence Interval has already been computed and the Pool... option is changed the existing Confidence Interval will be replaced.</p>
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	<u>C</u> onstruct...	<p>Use the <u>C</u>onstruct... option to select the type of Confidence Interval to construct (i.e., one-sided upper, one-sided lower or two-sided).</p> <p>Upon selecting the <u>C</u>onstruct... option the Interval Type dialog appears (Figure 5-55). Use the up and down arrow keys to highlight the desired interval type and press <Enter>.</p>
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Table 5-33. The Test pull-down menu for the Non-parametric Confidence Interval method.

- The first three options of the Test pull-down menu compute Non-parametric Confidence Intervals (Table 5-33). Upon execution the Non-parametric Confidence Intervals are displayed in the Non-Parametric CI window as shown in Figure 5-110. The statistics displayed for each Confidence Interval are described in Table 5-34.

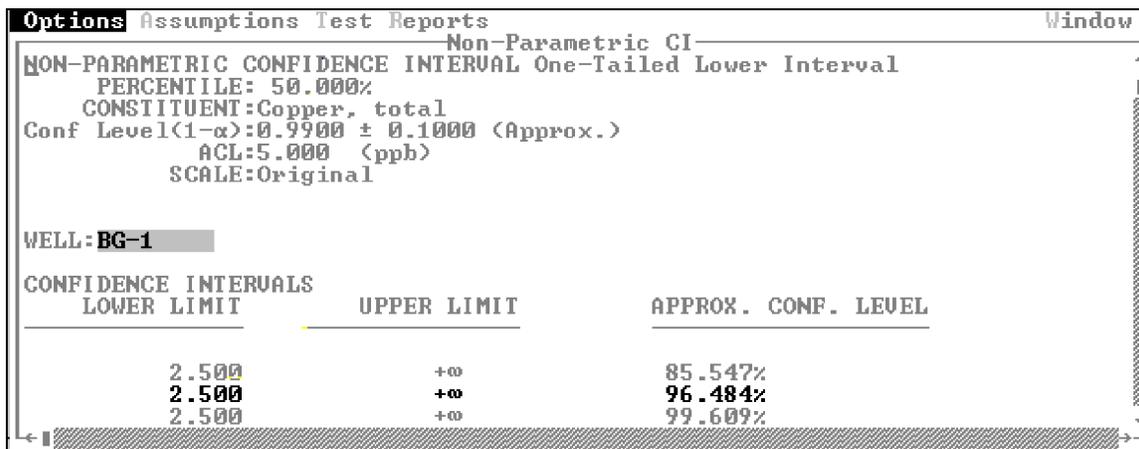


Figure 5-110. The Non-Parametric CI window.

Statistic	Description
Observations(n)	Number of background observations used to compute the Confidence Interval Limits.
Conf Level(1-∞)	Desired Confidence Level ±User Tolerance.

List of possible Confidence Intervals	A list of all possible Confidence Intervals is displayed. The interval selected for comparison to ACL or MCL is shown in bright white. All other intervals are shown in yellow. The Approximate Confidence Level is displayed for each Confidence Interval in the list.
LL	Lower Confidence Limit
UL	Upper Confidence Limit

Table 5-34. Statistics displayed in the Non-Parametric CI window for each Confidence Interval.

If the computed Confidence Interval does not contain the concentration limit being tested (i.e., ACL or MCL) the Confidence Interval is flagged with an asterisk (*) and explanatory text as shown in Figure 5-111.

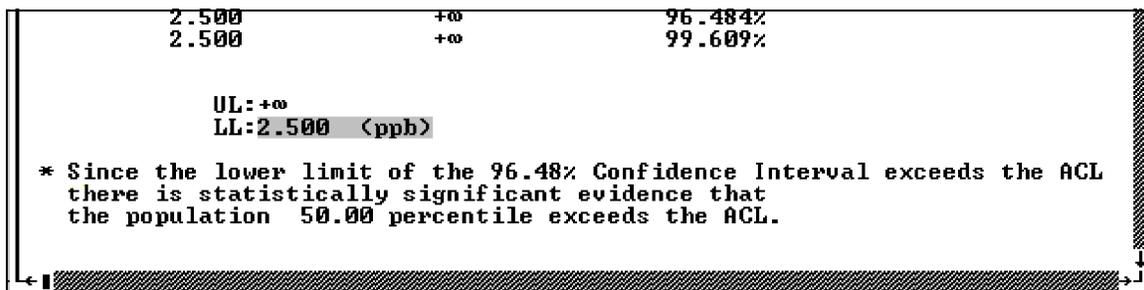


Figure 5-111. Explanatory text for a one-sided lower Non-parametric Confidence Interval around the median compared to an ACL of 2 ppb.

7. Use the **Reports | Print** option to print the Parametric Prediction Interval results to a printer or ASCII file (Section 5.7.9).
8. Use the **Reports | Display** option to view a graphical representation of the Non-parametric Confidence Interval results (Figure 5-112). The Confidence Intervals and concentration limit (i.e., ACL or MCL) are superimposed on Box Plots.

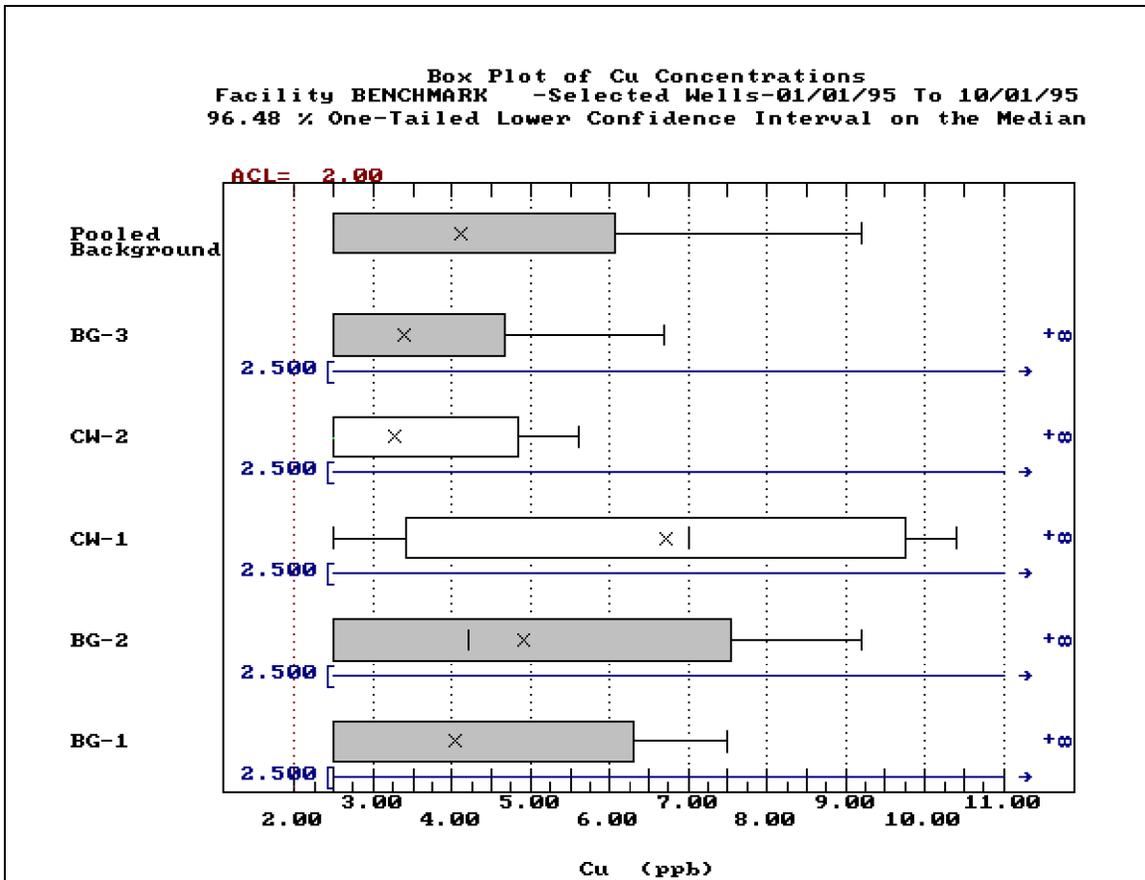


Figure 5-112. One-sided lower Non-Parametric Confidence Intervals superimposed on Box Plots.

See Section 5.5.3.3 for instructions on printing the plot.

5.7.9 PRINTING INTERVAL REPORTS

Upon executing the Print option of the Reports menu the Printing menu shown in Figure 5-113 appears on your screen.

```

Report: Parametric II
Display Printer File
Output report to disk file
  
```

Figure 5-113. The Printing destination menu.

Use the left and right arrow keys to highlight the desired destination and press <Enter>. See Section 7.6.9.1 for instructions on setting up the report printer.

Display

The Display option displays the report to your screen as shown in Figure 5-114. The keystrokes available in the Display option are detailed in Table 5-35.

Parametric Tolerance Interval Report Printed April 21,1997		Page
Facility: Benchmark Datasets Parameter: Chromium, total(CAS Number:7440-47-3)		
ONE-TAILED UPPER PARAMETRIC PREDICTION INTERVAL		
Observations (n):	16	
Shapiro-Wilk (W):	0.6550	* Data are not normally distributed
Critical W, $\alpha=0.01$:	0.8440	at the 1% level of significance.
Mean:	39.063	ppb
Std Dev:	32.466	ppb
DF:	15	
Conf. Level (1- α):	0.950	
Coverage:	0.950	
Kappa:	2.5240	
(L) Line, (S) Screen, (P) Pan, (W) Window, (C) Continuous, (R) Restart, (Q) Quit		

Figure 5-114. The Report | Display option of the Parametric Tolerance Interval Menu..

Keystroke	Description
<L>, < >	Scroll down one line.
< >	Scroll up one line.
<S>, <Page Down>	Scroll down one page.
<Page Up>	Scroll up one page.
<P>	Activate the left and right arrow keys to pan left and right. Press <Esc> when through.
<W>	Window is used to split the report window. This is usually used for wide reports.
<C>	Run report to the end with no stops.
<R>	Restart the report.
<Q>	Quit the report and return to the Interval Menu.

Table 5-35. Report Display commands.

File

The File option writes the report to user specified file. This option may be used to create a printer codes file or an ASCII file. Generally the ASCII file is the most useful option. Upon selection of the File option the File Type selection box appears on your screen as shown in Figure 5-115.

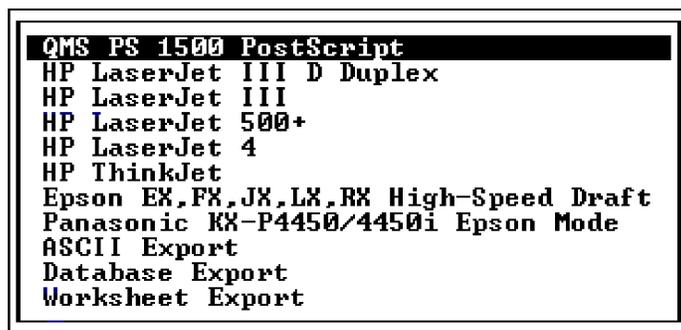


Figure 5-115. The File Type selection dialog

Use the up and down arrow keys to highlight the ASCII Export option and press <Enter>. A prompt for the DOS file name appears on your screen.

The ASCII file may be imported into almost any popular word processor file.(i.e., the Insert | File... option of Corel WordPerfect® and Microsoft Word® will insert an ASCII file into the currently active document).

Print

The Print option is used to print the report to a selected printer. Upon selection of the Print option the Printer Selection dialog appears on your screen as shown in Figure 5-116.

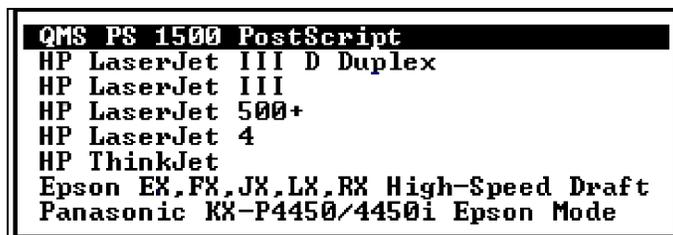


Figure 5-116. The Printer Selection dialog

Use the up and down arrow keys to highlight the desired printer and press <Enter>.

Note: The list of printers may be customized by running the RRSETUP utility in the \GRITS500\MODULE1 directory. See Section 5.7.9.1 for instructions.

5.7.9.1 Configuring Printers for Interval Method Reports

The instructions in this section show you how to customize the printers for the intervals reports (i.e., the printers listed in the Printer Selection dialog shown in Figure 5-116).

1. At the MS-DOS prompt switch to the \GRITS500\MODULE1 directory.
2. Type RRSETUP and press <Enter>. The R&R Report Writer Configuration Program appears on your screen as shown in Figure 5-117.

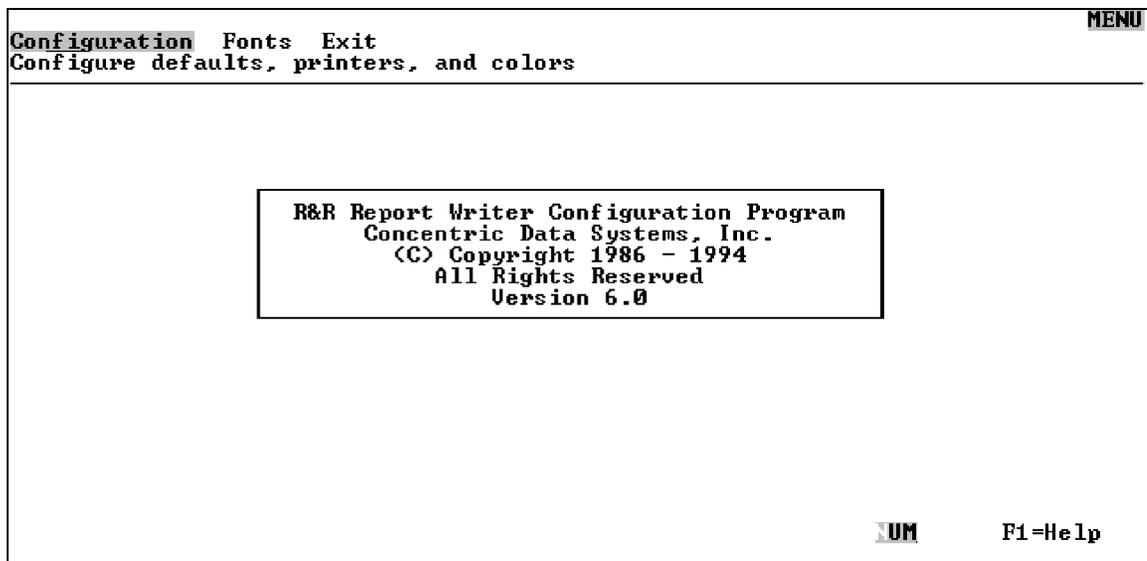


Figure 5-117. The R&R Report Writer Configuration Program.

3. Press <C> to execute the Configure option. A File Name prompt appears. Press <Enter> to accept RR.CNF.
4. Press <P> to execute the Printers option. The Printer Configuration dialog appears on your screen as shown in Figure 5-118.

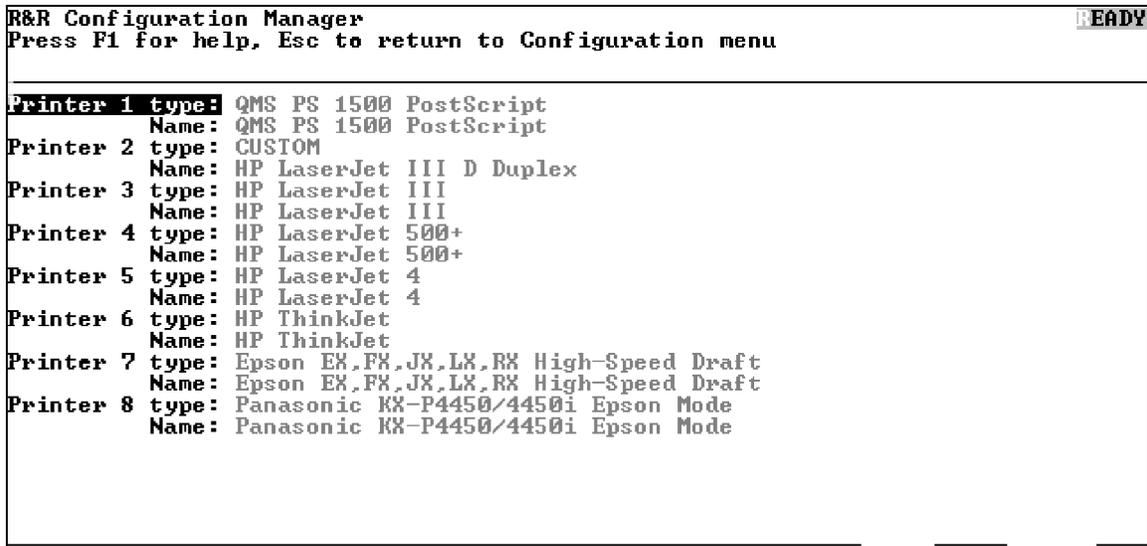


Figure 5-118. The Printer Configuration dialog.

The Printer Configuration dialog allows you to specify the printers which appear in the Printer Selection dialog (Figure 5-116) when printing interval method reports.

5. Use the up and down arrow keys to highlight the printer you wish to change and press **<Enter>**. A pop-up list of printers appears on your screen as shown in Figure 5-119.

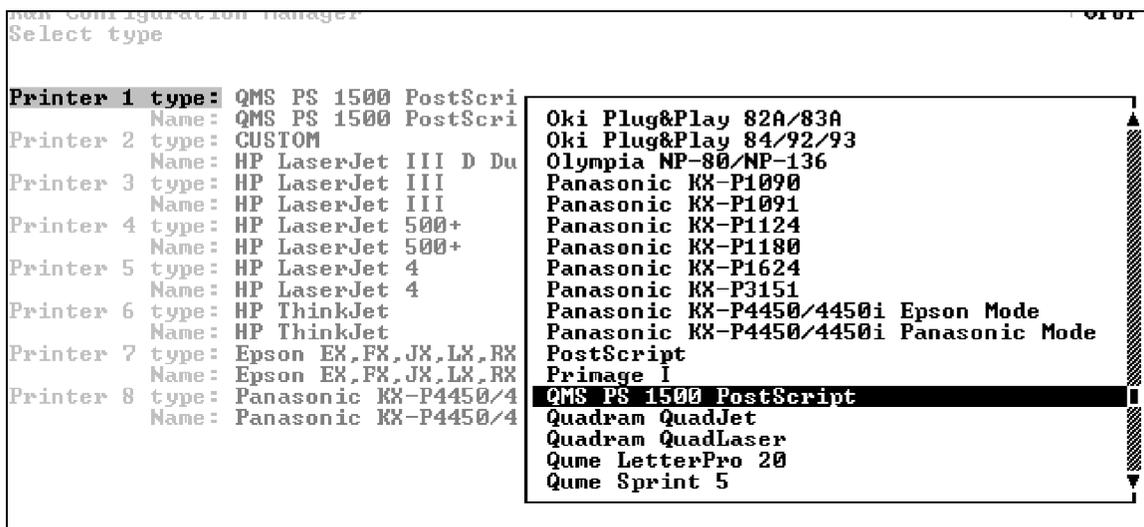


Figure 5-119. Pop-up list of printers.

6. Use the up and down arrow keys or first-letter pointing to highlight the name of your printer or, if the exact name does not appear, the name of a printer that your printer emulates. Select **CUSTOM** if no name on the menu matches your printer. Select **UNASSIGNED** if you want to remove a printer. Press **<Enter>**.
7. Press **<I>** to execute the **Interface** menu. Use the up and down arrow keys to highlight **Port** and press **<Enter>**. Use the left and right arrow keys to highlight the port the printer is attached to and press **<Enter>**.
8. Press **<Esc>** three times and press **<S>** to save your changes.
9. Press **<Q> <E>** to exit **RRSETUP**.

5.8 GRITS STATISTICS ANOVA, Two-Sample, Control Chart Module Methods

The **GRITS STATISTICS ANOVA, Two-Sample, Control Chart Module** contains the following statistical methods:

- Shewhart-CUSUM Control Chart
- Kruskal-Wallis Test (Non-parametric One-Way ANOVA)
- Parametric One-Way ANOVA
- Wilcoxon Rank Sum Test
- Welch's t-Test

The menu tree for the Methods menu of the **GRITS STATISTICS ANOVA, Two-Sample, Control Chart** module is shown in Figure 5-120.

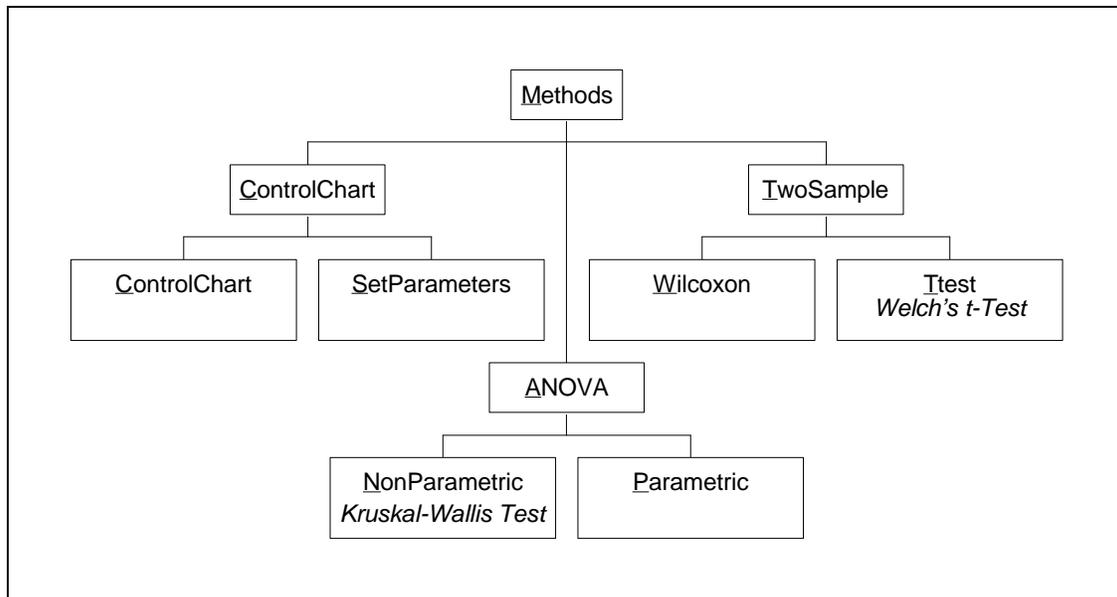


Figure 5-120. The Methods menu options of the **GRITS Statistics ANOVA, Two-Sample, Control Chart Module**. *Note:* This menu tree does not show the Normality and Variance menus.

5.8.1 METHODS | CONTROLCHART | CONTROLCHART

The Methods | ControlChart | ControlChart method allows you to:

- Construct a Shewhart-CUSUM Control Chart on a user-specified well.

For statistical guidance consult Section 10 of *Statistical Analysis of Groundwater Monitoring Data: Unified Guidance*.

The instructions below assume that a data set is loaded.

1. At the GRITS Statistics menu press </>. This will take you to the top most level of the GRITS Statistics menu (Figure 5-12).
2. Press <M> to descend into the Methods menu.
3. Press <C> to descend into the ControlChart menu.
4. Press <C> to execute the ControlChart option of the ControlChart menu. The Choose Well dialog shown in Figure 5-121 appears on the screen.

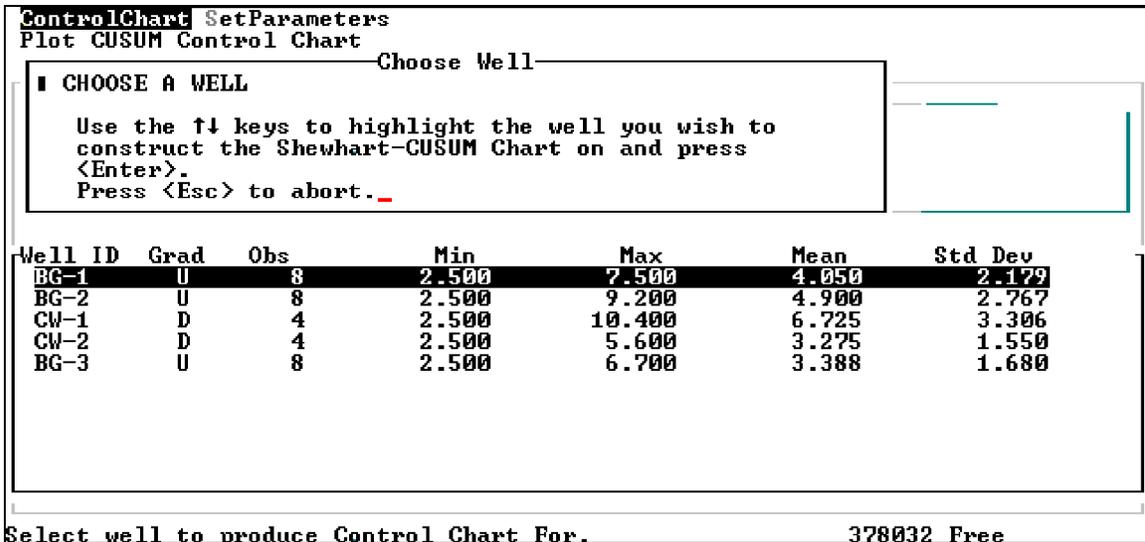


Figure 5-121. The Choose Well dialog.

5. Use the up and down arrow keys to highlight the well to construct the Shewhart-CUSUM Chart on and press **<Enter>**. The Choose Scale dialog shown in Figure 5-122 appears on your screen.

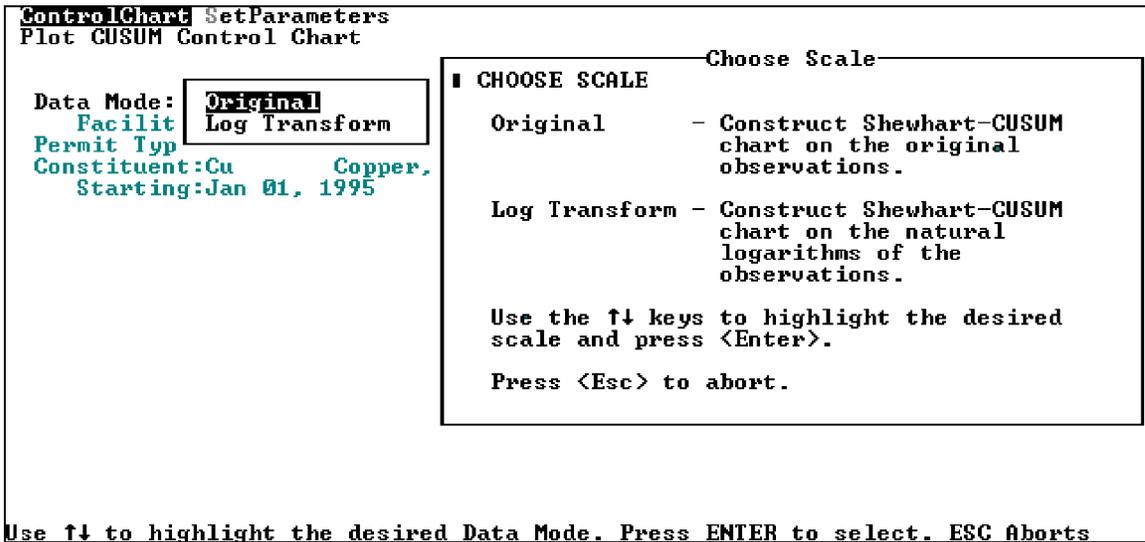


Figure 5-122. The Choose Scale dialog.

6. Use the up and down arrow keys to highlight the desired scale and press **<Enter>**. The Background Data Source dialog appears on your screen as shown in Figure 5-123.

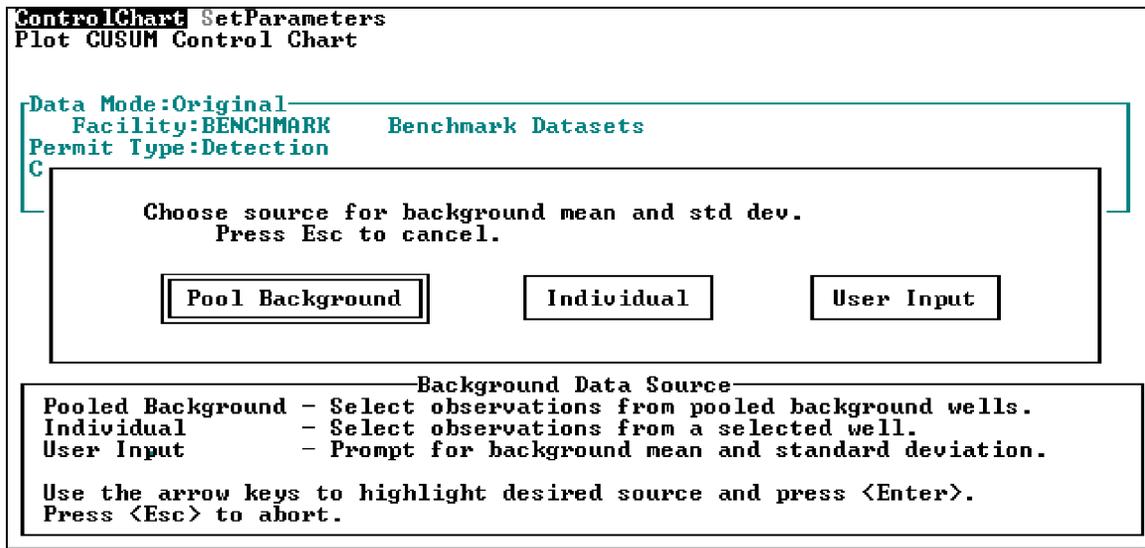


Figure 5-123. The Background Data Source dialog.

7. The Background Data Source dialog offers three choices for selecting the background data that the background mean (i.e., baseline) and standard deviation will be computed from.

Pool Background

Upon selection of the Pool Background option builds a list of observations from all selected background wells. The Data Selection dialog appears on your screen as shown in Figure 5-124.

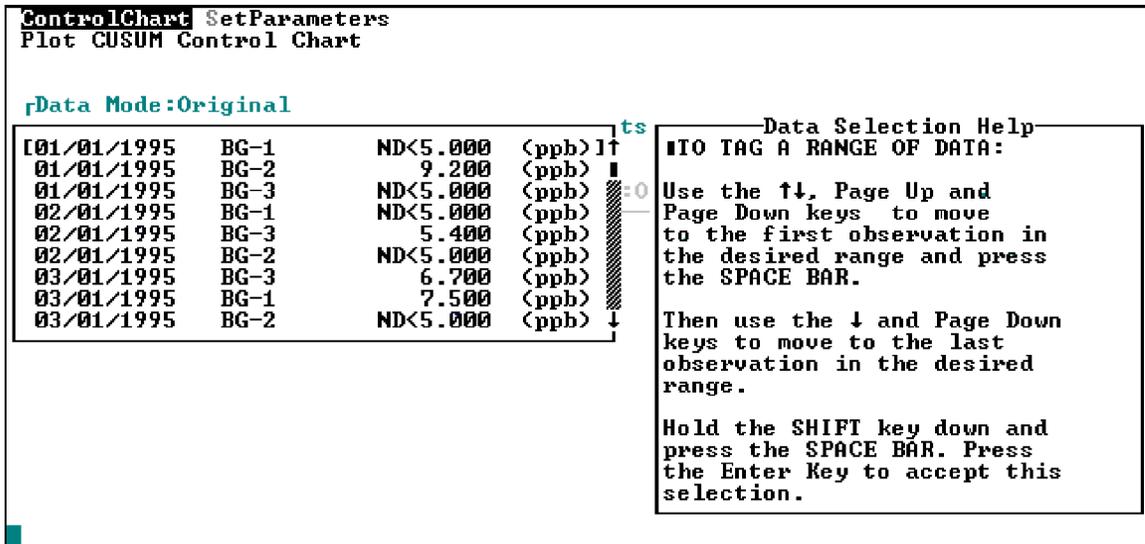


Figure 5-124. The Data Selection dialog used to select the data that the Control Chart limits will be computed on.

To tag a contiguous block of data use the up and down arrow keys to bracket the first observation in the desired block and press the **<Space Bar>**.

Use the up and down arrow keys to bracket the last observation in the desired block. Hold the **<Shift>** key down and press the **<Space Bar>**.

To tag or un-tag an individual observation use the up and down arrow keys to bracket the observation and press the **<Space Bar>** to toggle the observation's toggle state.

Press **<Enter>** accept your selection and proceed to step 8.

Individual

The Individual option allows you to select data from an individual well to compute the background mean and standard deviation. Upon selection of the Individual option the Well Selection dialog appears on your screen (Figure 5-125). Use the up and down arrow keys to highlight the desired well and press **<Enter>**.

Well ID	Grad	Obs	Min	Max	Mean	Std Dev
BG-1	U	8	2.500	7.500	4.050	2.179
BG-2	U	8	2.500	9.200	4.900	2.767
CW-1	D	4	2.500	10.400	6.725	3.306
CW-2	D	4	2.500	5.600	3.275	1.550
BG-3	U	8	2.500	6.700	3.388	1.680

Figure 5-125. Well Selection dialog

The Data Selection dialog consisting of the observations from the selected well appears on your screen (Figure 5-126). To tag a contiguous block of data use the up and down arrow keys to bracket the first observation in the desired block and press the **<Space Bar>**.

Use the up and down arrow keys to bracket the last observation in the desired block. Hold the **<Shift>** key down and press the **<Space Bar>**.

To tag or un-tag an individual observation use the up and down arrow keys to bracket the observation and press the **<Space Bar>** to toggle the observation's toggle state.

Press **<Enter>** accept your selection and proceed to step 8.

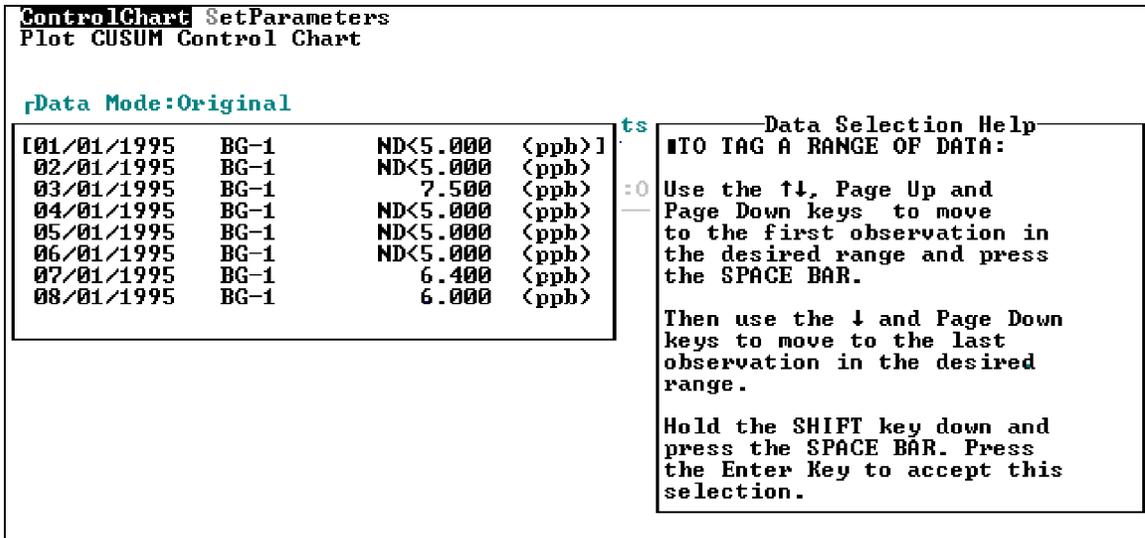


Figure 5-126. Data Selection dialog for observations from an individual well.

User Input

The User Input option allows you to enter a Mean and Standard Deviation to be used to compute control chart limits. Upon execution of the User Input option the BACKGROUND MEAN AND STD DEV dialog appears on your screen as shown in Figure 5-127.

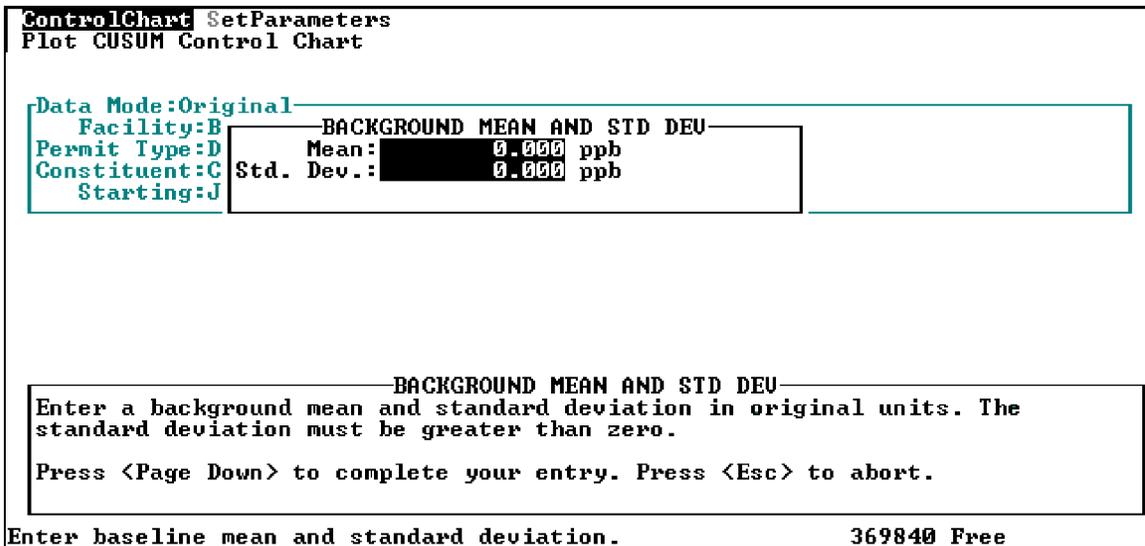


Figure 5-127. The BACKGROUND MEAN AND STD DEV dialog.

Enter the baseline mean and standard deviation and press <Enter>.

8. The Shewhart-CUSUM window appears on your screen as shown in Figure 5-128. Observations from the well that the control chart is constructed on appear in the Period Summary. The statistics displayed in the Shewhart-CUSUM window are described in Table 5-36.

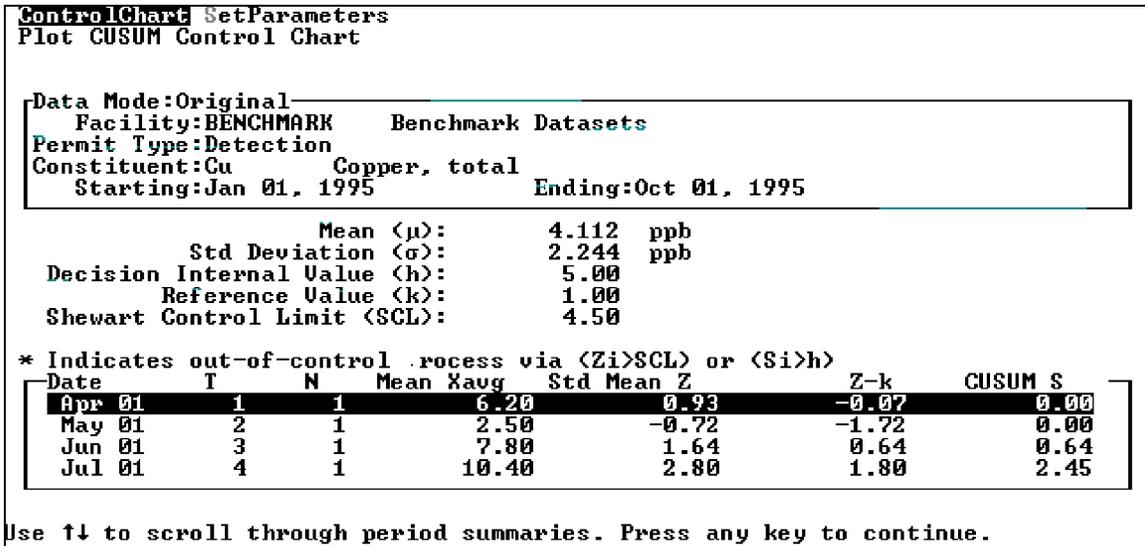


Figure 5-128. The Shewhart-CUSUM window and Period Summary.

Statistic	Description		
Mean ()	Mean of the background data.		
Std Deviation (σ)	Standard Deviation of the background data.		
Decision Internal Value (h)	Value compared to S_i . The default value of h is 5.0. The value of h may be changed in the Statistical Method Parameters dialog under the <u>M</u> ethods <u>C</u> ontrolChart <u>S</u> etParameters option.		
Reference Value (k)	Reference Value. The default value of k is 1. The value of k may be changed in the Statistical Method Parameters dialog under the <u>M</u> ethods <u>C</u> ontrolChart <u>S</u> etParameters option.		
Shewhart Control Limit (SCL)	Value compared to Z_i . The default value of SCL is 4.5. The value of SCL may be changed in the Statistical Method Parameters dialog under the <u>M</u> ethods <u>C</u> ontrolChart <u>S</u> etParameters option.		
Period Summary	<table border="1"> <thead> <tr> <th>Date</th> <th>Sample Date</th> </tr> </thead> </table>	Date	Sample Date
Date	Sample Date		

	T	Ordinal period
	N	Number of observations for this sample date.
	Mean Xavg	Mean of the N observations on this sample date.
	Std Mean Z	Standardized Mean Z_T . This value is plotted on the Shewhart-CUSUM Chart.
	Z-k	Standardize Mean (Z_T) minus Reference Value (k).
	CUSUM S	CUSUM S_T . This value is plotted on the Shewhart-CUSUM Chart.

Table 5-36. Statistics displayed in the Shewhart-CUSUM window and the Period Summary.

Use the up and down arrow keys to scroll through the Period Summary. Press **<Enter>** to proceed.

9. CONTINUE, PRINT and PLOT options become active at the bottom of the screen.

PRINT

The PRINT option prints the statistics described in Table 5-36 to a local printer.

PLOT

Use the left and right arrow keys to highlight the PLOT option and press <Enter> to view the Shewhart-CUSUM Chart (Figure 5-129).

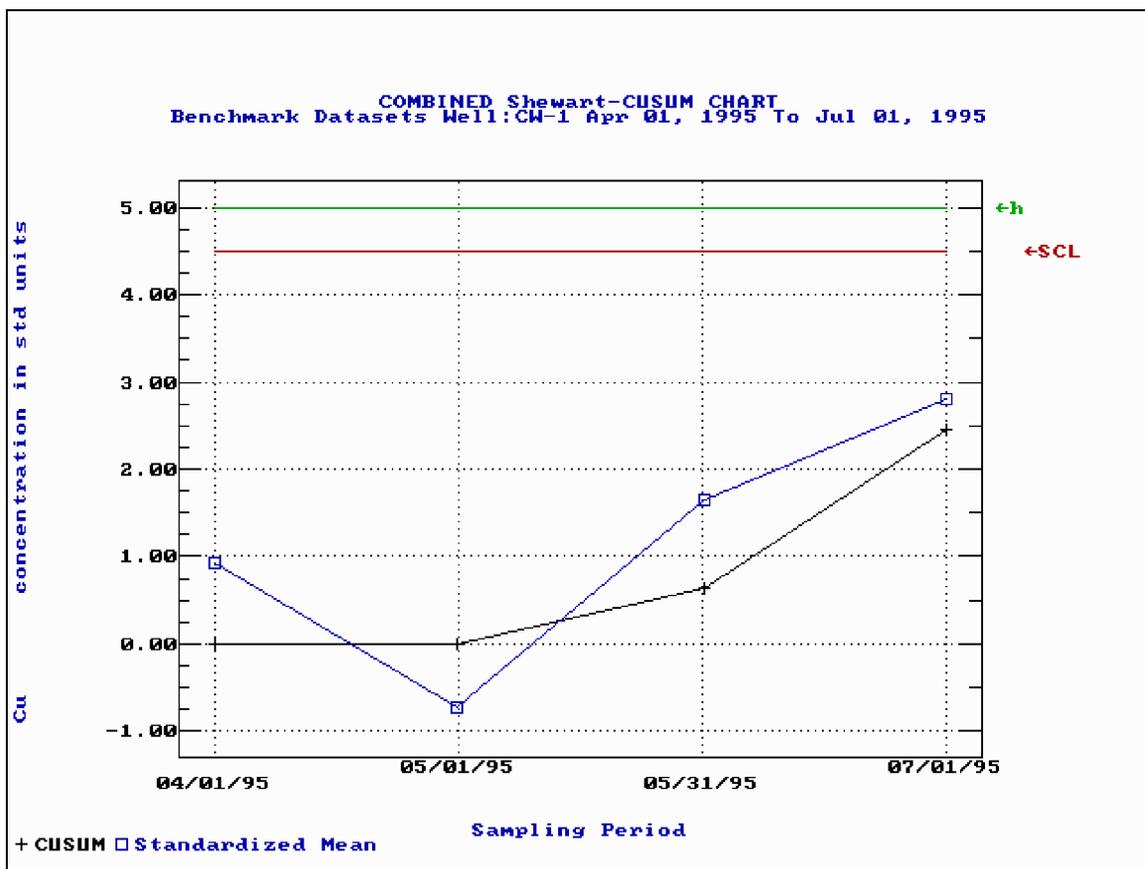


Figure 5-129. The COMBINED Shewhart-CUSUM Control Chart.

See Section 5.5.3.3 for instructions on printing the plot. Press <Enter> to return to the Shewhart-CUSUM window.

CONTINUE

The CONTINUE option closes the Shewhart-CUSUM window and returns to the Methods | ControlChart menu.

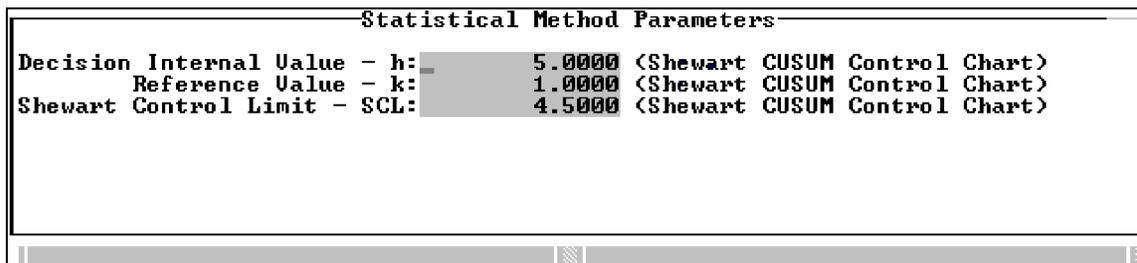
5.8.2 METHODS | CONTROLCHART | SETPARAMETERS

The Methods | ControlChart | SetParameters option allows you to:

- Edit the values of the Decision Internal Value (h), Reference Value (k) and Shewhart Control Limit (SCL) used by the Shewhart-CUSUM Control Chart. (Section 5.8.1).

Follow the instructions below to change the Shewhart-CUSUM Control Chart Parameters.

1. At the GRITS Statistics menu press </>. This will take you to the top most level of the GRITS Statistics menu (Figure 5-12).
2. Press <M> to descend into the Methods menu.
3. Press <C> to descend into the ControlChart menu.
4. Press <S> to execute the SetParameters option of the ControlChart menu. The Statistical Method Parameters dialog shown in Figure 5-130 appears on your screen.



Statistical Method Parameters		
Decision Internal Value - h:	5.0000	<Shewart CUSUM Control Chart>
Reference Value - k:	1.0000	<Shewart CUSUM Control Chart>
Shewart Control Limit - SCL:	4.5000	<Shewart CUSUM Control Chart>

Figure 5-130. The Statistical Method Parameters dialog..

5. Use the up and down arrow keys to navigate between entries. Press <Page Down> to save your changes.

5.8.3 METHODS | ANOVA | NONPARAMETRIC

The Methods | ANOVA | NonParametric method allows you to:

- Run the Kruskal-Wallis Test to compare background well observations to compliance wells.

Note: The Kruskal-Wallis test implemented in GRITS Statistics automatically pools all selected background wells into one group. If you wish to exclude one or more background wells from the Kruskal-Wallis test use the DataSet | View | Plot | Select option to toggle the well selection flags (Section 5.5.3.2).

For statistical guidance consult Section 8.2 of the *Statistical Analysis of Groundwater Monitoring Data: Unified Guidance*.

The instructions below assume that a data set consisting of at least one background well and two compliance wells is loaded.

1. At the GRITS Statistics menu press </>. This will take you to the top most level of the GRITS Statistics menu (Figure 5-12).
2. Press <M> to descend into the Methods menu.
3. Press <A> to descend into the ANOVA menu.
4. Press <N> to execute the NonParametric option of the ANOVA menu. The One-Way Non-parametric Analysis of Variance window and Ranks Summary appears on your screen as shown in Figure 5-131. The statistics shown in the One-Way Non-parametric Analysis of Variance window are described in Table 5-37.

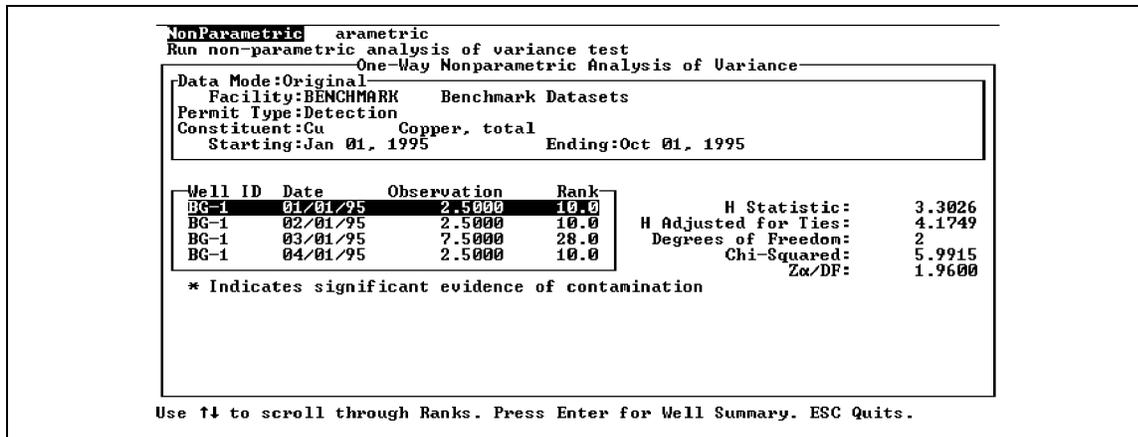


Figure 5-131. The One-Way Non-parametric Analysis of Variance window and Rank Summary.

Statistic	Description																									
H Statistic	Kruskal-Wallis Statistic																									
H Adjusted for Ties	H' adjustment for groups of distinct tied observations.																									
Degrees of Freedom	Degrees of Freedom (K-1) used to obtain chi-squared value. where K is the total number of groups or equivalently the total number of selected compliance wells plus one.																									
Chi-Squared	Chi-squared value for (K-1) degrees of freedom at the 5% significance level.																									
$Z_{\frac{\alpha}{DF}}$	Upper $\frac{\alpha}{DF}$ percentile from the standard normal distribution where: $\alpha = 0.05$ DF = Degrees of Freedom Note if $K > 6$, $Z_{0.01}$ is used.																									
Rank Summary Window	The Rank Summary displays the ranks of all observations by group and sample date. The Rank sum and average for each group is displayed in the Rank Summary window. <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Well ID</th> <th>Date</th> <th>Observation</th> <th>Rank</th> <th>H Ad Deg</th> </tr> </thead> <tbody> <tr> <td>BG-1</td> <td>01/01/95</td> <td>2.5000</td> <td>10.0</td> <td></td> </tr> <tr> <td>BG-1</td> <td>02/01/95</td> <td>2.5000</td> <td>10.0</td> <td></td> </tr> <tr> <td>BG-1</td> <td>03/01/95</td> <td>7.5000</td> <td>28.0</td> <td></td> </tr> <tr> <td>BG-1</td> <td>04/01/95</td> <td>2.5000</td> <td>10.0</td> <td></td> </tr> </tbody> </table>	Well ID	Date	Observation	Rank	H Ad Deg	BG-1	01/01/95	2.5000	10.0		BG-1	02/01/95	2.5000	10.0		BG-1	03/01/95	7.5000	28.0		BG-1	04/01/95	2.5000	10.0	
Well ID	Date	Observation	Rank	H Ad Deg																						
BG-1	01/01/95	2.5000	10.0																							
BG-1	02/01/95	2.5000	10.0																							
BG-1	03/01/95	7.5000	28.0																							
BG-1	04/01/95	2.5000	10.0																							

Figure 5-132. The Rank Summary window.

Table 5-37. Statistics displayed in the One-Way Non-parametric Analysis of Variance.

- Use the up and down arrow keys to scroll through the Rank Summary. Press **<Enter>** to proceed to the Well Summary (Figure 5-133).

* Indicates significant evidence of contamination				
Well ID	Crit. Diff.	Rank Avg.	Background Rank Avg.	Difference
CW-1	9.9296	24.00	15.88	8.13
CW-2	9.9296	12.75	15.88	-3.13

Figure 5-133. The Well Summary window.

The statistics displayed in each column of the Well Summary column are described in Table 5-38.

Column	Description
Well ID	Well ID of each compliance well
Crit. Diff.	Critical Difference (C_i)
Rank Avg.	Average rank of each compliance well: R_i
Background Rank Avg.	Average rank of the pooled background observations: \bar{R}_b
Difference	$\bar{R}_i - \bar{R}_b$ If this difference is greater than or equal to C_i there is significant evidence of contamination and the well is flagged with an asterisk (*),

Table 5-38. Statistics shown in the Well Summary window.

- Use the up and down arrow keys to scroll through the Well Summary. Press **<Enter>** to proceed. **PRINT** and **CONTINUE** options become active at the bottom of the screen.

PRINT

The **PRINT** option prints the results of the Kruskal-Wallis test to the local printer. To print the results use the left and right arrow keys to highlight the **PRINT** option and press **<Enter>**.

CONTINUE

The CONTINUE option closes the One Way Non-parametric ANOVA window and returns to the ANOVA menu. Use the left and right arrow keys and highlight the CONTINUE option and press <Enter>.

5.8.4 METHODS | ANOVA | PARAMETRIC

The Methods | ANOVA | Parametric method allows you to:

- Run a One-Way Parametric ANOVA to compare background well observations to compliance wells.

Note: The One-Way Parametric ANOVA test implemented in GRITS Statistics automatically pools all selected background wells into one group. If you wish to exclude one or more background wells from the One-Way Parametric ANOVA test use the DataSet | View | Plot | Select option to toggle the well selection flags (Section 5.5.3.2).

For statistical guidance consult Section 8.1 of the *Statistical Analysis of Groundwater Monitoring Data: Unified Guidance*.

The instructions below assume that a data set consisting of at least one background well and two compliance wells is loaded.

1. At the GRITS Statistics menu press </>. This will take you to the top most level of the GRITS Statistics menu (Figure 5-12).
2. Press <M> to descend into the Methods menu.
3. Press <A> to descend into the ANOVA menu.
4. Press <P> to execute the Parametric option. The One-Way Parametric ANOVA window appears on your screen as shown in Figure 5-134.

onParametric **Parametric**
 Run parametric analysis of variance test
 One-Way Parametric ANOVA Table

Data Mode: Source of Variation	Original Log Transform	Degrees of freedom	Mean squares	Computed F
Between wells				
Within wells				
Total				

Use ↑ to highlight the desired Data Mode. Press ENTER to select. ESC Aborts

Figure 5-134. The One-Way Parametric ANOVA window.

- Use the up and down arrow keys to highlight the scale you wish to use (i.e., Original or Log Transform) and press <Enter>. The Significance Level dialog appears on your screen (Figure 5-135).



Figure 5-135. The Significance Level dialog.

- Type in the desired Significance Level and press <Enter>. The One-Way Parametric ANOVA Table is computed. The default significance level is 5%.

If the F-test is significant post-hoc comparisons are automatically computed and displayed for each compliance well in a Well Summary window (Figure 5-136). The statistics in the One-Way Parametric ANOVA Table are described in Table 5-38. The statistics shown in the columns of the Well Summary are described in Table 5-39.

Post-hoc comparisons are not performed by the software if the F test is not significant.

NonParametric ~~Parametric~~
 Run parametric analysis of variance test
 One-Way Parametric ANOVA Table

Source of Variation	Sum of squares	Degrees of freedom	Mean squares	Computed F
Between wells	2878.672	3	959.557	p= 0.011083
Within wells	1993.702	12	166.142	
Total	4872.374	15		

Data Mode:Original
 Tabulated F($\alpha= 0.050$): 3.490
 Since the calculated F exceeds the tabulated F, the hypothesis of equal well means must be rejected.
 Avg Background Concentration: 9.800 ppb
 * Indicates statistically significant evidence of contamination.

WELL ID	OBS.S	WELL MEAN	DIF. FROM BACK.	STD. ERROR	CALC.-t	t-CRIT
Well 1	4	19.875	10.075	9.114	1.105	2.403
*Well 3	4	46.275	36.475	9.114	4.002	2.403

Use ↑↓ to scroll through well summary. Press Enter to continue.

Figure 5-136. The One-Way Parametric ANOVA Table and post-hoc comparisons.

One-Way Parametric ANOVA Table				
Source of Variation	Sum of Squares	Degrees of freedom	Mean Squares	Computed F
Between Wells	SS_{wells}	DF_{wells}	MS_{wells}	$\frac{MS_{wells}}{MS_{within}}$
Within Wells	SS_{error}	DF_{error}	MS_{error}	p-Value
Total	SS_{total}	DF_{total}		
Critical F(∞)			(1- ∞) Percentile of the F Distribution with Degrees of Freedom $_{wells}$ numerator and Degrees of Freedom $_{error}$ denominator.	
Avg Background Concentration			Average of pooled background well observations.	

Table 5-38. Statistics shown in the One-Way Parametric ANOVA window.

Column	Description
WELL ID	Well IDs
OBS	Number of observations in each well
WELL MEAN	Mean of the observations in each well
DIF. FROM BACK	WELL MEAN minus Avg Background Concentration
STD. ERROR	Standard Error of each mean difference
CALC.-t	Calculated t-statistic
t-CRIT	Bonferroni t-statistic for selected α and DF_{error} degrees of freedom. If CALC-t exceeds t-CRIT the row is proceeded with an asterisk (*) and there is statistically significant evidence of an increase over background.

Table 5-39. Statistics shown in the Well Summary for post-hoc comparisons.

Compliance wells in the Well Summary are flagged with an asterisk (*) if CALC-t exceeds t-CRIT.

Use the up and down arrow keys to scroll through the Well Summary. Press <Enter> to proceed.

7. PRINT and CONTINUE options become active at the bottom of the screen.

PRINT

The PRINT option prints the results of the Parametric One-Way ANOVA test to the local printer. To print the results use the left and right arrow keys to highlight the PRINT option and press <Enter>.

CONTINUE

The CONTINUE option closes the One Way Parametric ANOVA window and returns to the ANOVA menu. Use the left and right arrow keys and highlight the CONTINUE option and press <Enter>.

5.8.5 METHODS | TWOSAMPLE | WILCOXON

The Methods | TwoSample | Wilcoxon method allows you to:

- Run the Wilcoxon Rank-Sum test to compare background data from one or more background wells to a single compliance well.

Note: The Wilcoxon Rank-Sum test implemented in GRITS Statistics automatically pools all selected background wells into one group. If you wish to exclude one or more background wells from the Wilcoxon Rank-Sum test use the DataSet | View | Plot | Select option to toggle the well selection flags (Section 5.5.3.2).

For statistical guidance consult Section 7.2 of *Statistical Analysis of Groundwater Monitoring Data: Unified Guidance*.

The instructions below assume that a data set consisting of at least one background well and one compliance well is loaded.

1. At the GRITS Statistics menu press **</>**. This will take you to the top most level of the GRITS Statistics menu (Figure 5-12).
2. Press **<M>** to descend into the Methods menu.
3. Press **<T>** to descend into the TwoSample menu.
4. Press **<W>** to execute the Wilcoxon option of the TwoSample menu. The Significance Level dialog appears on your screen as shown in Figure 5-137.

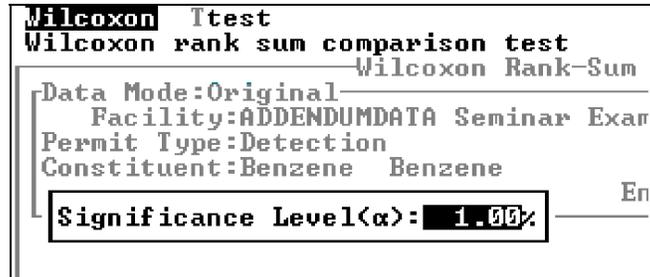


Figure 5-137. The Significance Level dialog.

5. Type in the desired significance level and press **<Enter>**. The default Significance Well is 1%. The Well Selection dialog appears on your screen as shown in Figure 5-138. Use the up and down arrow keys to highlight the compliance well that you wish to compare to background and press **<Enter>**. The Wilcoxon Rank-Sum

Test For Two Groups and Rank Summary windows appear on your screen (Figure 5-139).

Well ID	Grad	Obs	Min	Max	Mean	Std Dev
BW-1	D	8	0.500	186.000	31.138	63.237

Select compliance well to test. 305248 Free

Figure 5-138. The Well Selection dialog.

Table 5-40 describes the statistics displayed in the Wilcoxon Rank-Sum Test For Two Groups window.

Well	Date	Observation	Rank
BW-1	01/01/92	0.5000	3.0
BW-1	02/01/92	0.5000	3.0
BW-1	03/01/92	1.6000	7.5
BW-1	04/01/92	1.8000	9.0
BW-1	05/01/92	1.1000	6.0
BW-1	06/01/92	16.1000	13.0
BW-1	07/01/92	1.6000	7.5
BW-1	08/01/92	0.5000	3.0

Background Data Pts m: 8
 Compliance Data Pts n: 8
 Wilcoxon Statistic W: 48.0000
 Expected Value E(W): 32.0000
 Std Dev SD(W): 9.5219
 Std Dev (Ties) SD'(W): 9.3737
 Approx Z-Score Z: 1.6536
 Significance Level α : 0.01
 Z α : 2.3263

Since the Approx. Z-Score does not exceed Z α there is no significant evidence of contamination at the compliance well.

Use \uparrow to scroll through Observations and Ranks. Press any key to continue

Figure 5-139. The Wilcoxon Rank-Sum Test For Two Groups window.

Statistic	Description
Background Data Pts m	Total number of observations from pooled background wells
Compliance Data Pts n	Number of observations from the compliance well being tested
Wilcoxon Statistic W	Wilcoxon Statistic W
Expected Value E(W)	Expected value of W: E(W).
Std Dev SD(W)	Standard Deviation of W: SD(W).
Std Dev (Ties) SD'(W)	Standard Deviation of W adjusted for tied observations: SD'(W).
Approx Z Score	Approximate Z-score computed from W, E(W) and SD'(W).
Significance Level α	Selected Significance Level α .
Z $_{\alpha}$	Upper α percentile of the standard Normal distribution.
Rank Summary window	The Rank Summary window lists the observations , ranks and Rank-Sums of the pooled background wells and the compliance well being tested.

Table 5-40. Statistics shown in the Wilcoxon Rank-Sum Test For Two Groups window
Use the up and down arrow keys to scroll through the Rank Summary. Press <Enter> to proceed.

- PRINT and CONTINUE options become active at the bottom of the screen.

PRINT

The PRINT option prints the results of the Wilcoxon Rank-Sum test to the local printer. To print the results use the left and right arrow keys to highlight the PRINT option and press <Enter>.

CONTINUE

The CONTINUE option closes the Wilcoxon Rank-Sum Test For Two Groups window and returns to the TwoSample menu. Use the left and right arrow keys and highlight the CONTINUE option and press <Enter>.

5.8.6 METHODS | TWOSAMPLE | TTEST

The Methods | TwoSample | Ttest method allows you to:

- Run the Welch's t-test to compare background data from one or more background wells to a single compliance well.

Note: The Welch's t-test implemented in GRITS Statistics automatically pools all selected background wells into one group. If you wish to exclude one or more background wells from the Welch's t-test use the DataSet | View | Plot | Select option to toggle the well selection flags (Section 5.5.3.2).

For statistical guidance consult Section 7.1 of *Statistical Analysis of Groundwater Monitoring Data: Unified Guidance*.

The instructions below assume that a data set consisting of at least one background well and one compliance wells is loaded.

1. At the GRITS Statistics menu press </>. This will take you to the top most level of the GRITS Statistics menu (Figure 5-12).
2. Press <M> to descend into the Methods menu.
3. Press <T> to descend into the TwoSample menu.
4. Press <T> to execute the Ttest option of the TwoSample menu. The Data Mode prompt appears on your screen as shown in Figure 5-140. Use the up and down arrow keys to highlight the desired scale (i.e., Original or Log Transform) and press <Enter>. The Significance Level dialog appears on your screen (Figure 5-141).



Figure 5-140. The Data Mode prompt.

5. Type in the desired Significance Level and press <Enter>. The default Significance Level is 1%. The Well Selection dialog appears on your screen as shown in Figure 5-142.

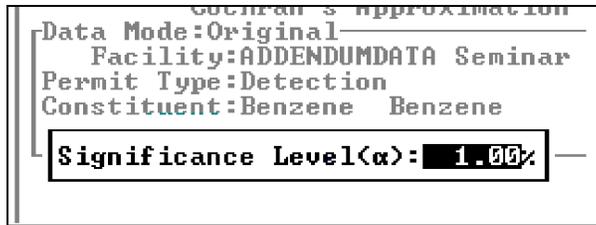


Figure 5-141. The Significance Level dialog.

- Use the up and down arrow keys to highlight the compliance well you wish to compare to background and press <Enter>. The Welch's T-Test window appears on your screen (Figure 5-143). Statistics shown for the Welch's t-test are described in Table 5-41.

Well ID	Grad	Obs	Min	Max	Mean	Std Dev
BW-1	D	8	0.500	186.000	31.138	63.237

Select compliance well to test. 305248 Free

Figure 5-142. The Well Selection dialog.

Wells		Background/Upgradient	Compliance/DownGradient
Observations	Mean		
8	31.1375	8	31.1375
	28.4741		3998.8772
Standard Error	22.4370		
Degrees of Freedom	7.0997		
Significance Level(α)	0.0100		

t-Statistic: 1.2557 Critical Value: 2.9863
 Since the t-statistic does not exceed Critical Value, the hypothesis of equal means is not rejected.

CONTINUE PRINT

305248 Free

Figure 5-143. The Welch's t-test window.

Statistic	Description	
	Background/Upgradient	Compliance/Downgradient
Wells	Well ID(s) of pooled background wells	Well ID of compliance well being tested.
Observations	Total number of pooled background well observations	Number of observations in the compliance well.
Mean	Mean of pooled background well observations ($Mean_{Up}$)	Mean of compliance well observations ($Mean_{Down}$)
Variance	Variance of pooled background well observations	Variance of compliance well observations
Standard Error	SE_{diff} (Standard Error of the Difference in Means)	
Degrees of Freedom	DF	
Significance Level (α)	Selected Significance Level (α).	
t-Statistic	Computed t-statistic $\frac{Mean_{Down} - Mean_{Up}}{SE_{diff}}$	
Critical Value	$t(\alpha, DF)$ Upper $(1-\alpha)$ Percentile of the Student-t Distribution with DF Degrees of Freedom	

Table 5-41. Statistics shown in the Welch's T-Test window

7. PRINT and CONTINUE options are active at the bottom of the screen.

PRINT

The PRINT option prints the results of the Welch's t-test to the local printer. To print the results use the left and right arrow keys to highlight the PRINT option and press **<Enter>**.

CONTINUE

The CONTINUE option closes the Welch's T-Test window and returns to

the TwoSample menu. Use the left and right arrow keys and highlight the CONTINUE option and press **<Enter>**.