Overview

SeriesSEE is an Excel Add-In for viewing, cleaning, manipulating, and analyzing time series or geophysical logs that is compatible with Excel 2010+ and greater. Data reduction, point-by-point inspection, and independent time or depth scales greatly facilitate analysis of long series with SeriesSEE. Bad data in multiple series can be selected by exceeding user-specified thresholds in series to be cleaned or as conditions are met in other series. Bad data in a single series also can be eliminated graphically. Non-numeric entries are automatically purged from any series that are cleaned. Data gaps can be filled by linear interpolation, loaded with dummy values, or eliminated. Series can be normalized to common scales. Temporary hyperlinks can be created between visible series and source data for rapid inspection. Series can be added, subtracted, multiplied, or divided even where measurement frequencies are irregular, different, and asynchronous. Data can be reduced by averaging within bins, approximating with a polyline, or moving averages.

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Introduction

SeriesSEE is an Excel 2010+ Add-In for graphing time series or geophysical logs with a magnifying window. Two charts are plotted automatically. One shows all of the data, while the second shows a magnified subset of the first chart (Figure 1). As many as 12 series can be viewed simultaneously, and 16,383 is the maximum number of series that can be selected.

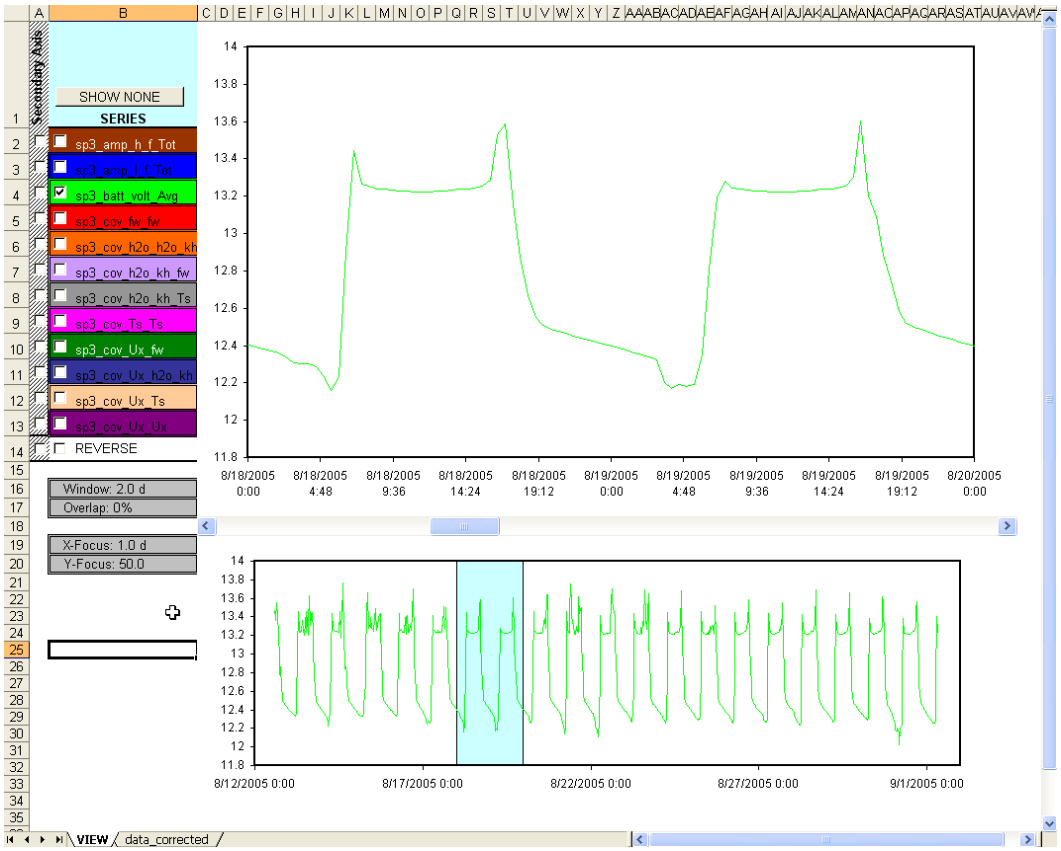

Figure 1.—Example workbook that was created with SeriesSEE.

The magnified region is controlled by the slider and entries in cells B16 and B17. Cell B16 specifies the width of the magnified region for time series and specifies the height of the magnified region for geophysical logs. Slider advancement also is controlled by user-specified overlap in cell B17. Overlap is the percentage of previous magnified region shown in the current magnified region. For example, a 4-d wide window with a 75 percent overlap will advance 1 day with each increment of the slider.

Copies of the original time-series or geophysical log data are plotted and manipulated with SeriesSEE. Specified data are copied to a page in a new workbook. Charts and controls are created on another page in the new workbook. Filtering erroneous data points and creating series comparisons modifies the copied data. Original data are not altered by the SeriesSEE add-in.

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Installation of Add-In

SeriesSEE works correctly in Excel 2010+ or greater. *SeriesSEE* is used through a tab on the ribbon that is created after the right-most tab (Figure 2). The *SeriesSEE* tab appears after the Add-In has been installed (table 1). The *SeriesSEE* add-in, *SeriesSee.v2.xlam*, functions like an installed program,

because it is always available in Excel and the user can forget where the Add-In is installed.

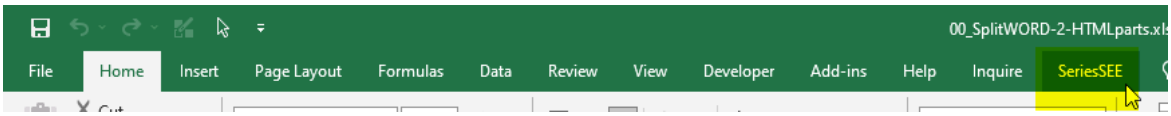
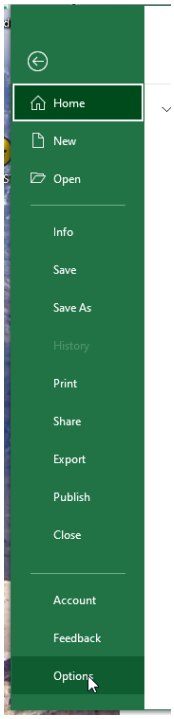
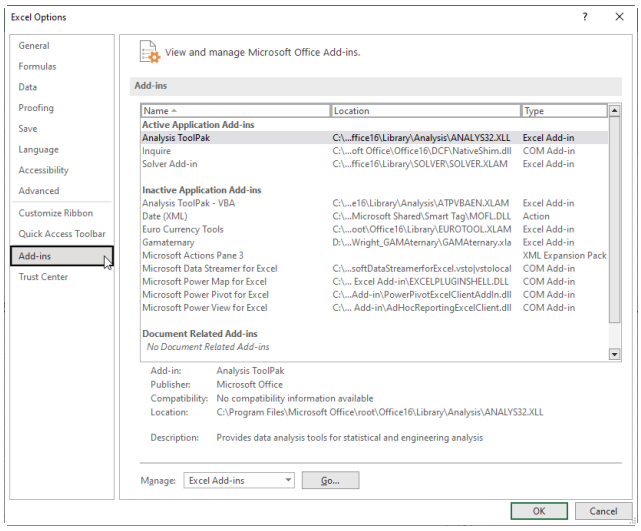
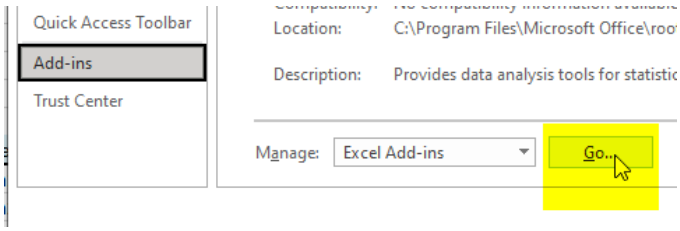
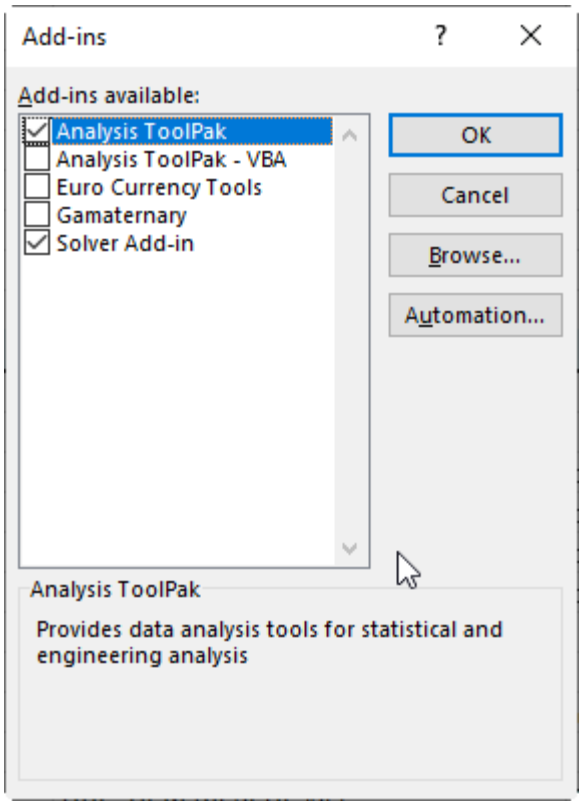


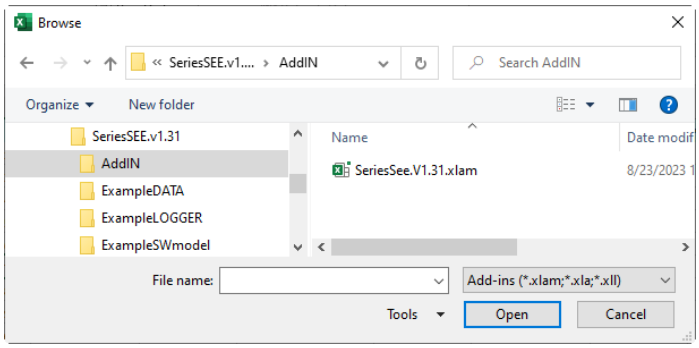
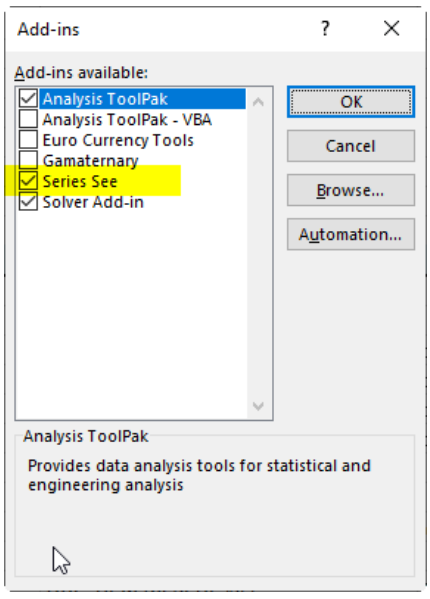
Figure 2.—SeriesSEE tab that appears in the ribbon after successful installation in Excel 2010+.

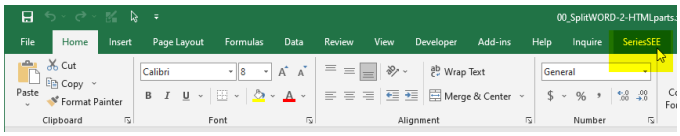
The distribution folder, **AppendixA_SeriesSEE.v2**, should be unzipped and on a local drive before following the "***Install the SeriesSEE add-in***" instructions. Close this file and move the directory if need be before proceeding.

Install the SeriesSEE add-in.

Click Options on side menu after selecting File menu of Excel 2019+.	

Select Add-Ins on the Excel 2019+ Options form	
Click on Go… right of the “Manage: Excel Add-Ins”	
The Add-Ins dialog window will appear. A SeriesSEE checkbox will not appear the first time the Add-In is used. Click on the Browse… button and find the file *SeriesSee.v2.xlam* in whatever directory you tossed it. SeriesSEE generally is not dependent on other add-ins in menu. The Solver Add-In is the only exception and is called by the Align and PolyFit utilities.	

The Browse… for Add-In will start in the standard Excel add-in folder, C:\Users\ USERNAME\AppData\Roaming\Microsoft\AddIns Browse to the folder of your choosing.	
Open the SeriesSee.v2.xlam file.	
SeriesSEE will appear in the Add-Ins dialog window. SeriesSEE can be installed and uninstalled on this machine by checking and unchecking the SeriesSEE option without browsing after the first installation. SeriesSEE is not dependent on other add-ins in menu The Solver Add-In is the only exception and is called by the Align and PolyFit utilities.	

The SeriesSEE menu appears after the Add-In has been installed	

Selecting SeriesSEE reveals a menu with utilities for creating a viewer, manipulating data, water-level modeling, and specifying user preferences (Figure 3). Select help,  , to explain all utilities in SeriesSEE.

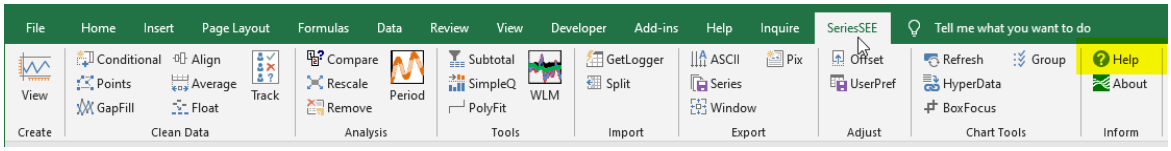


Figure 3.—Commands on the SeriesSEE tab.

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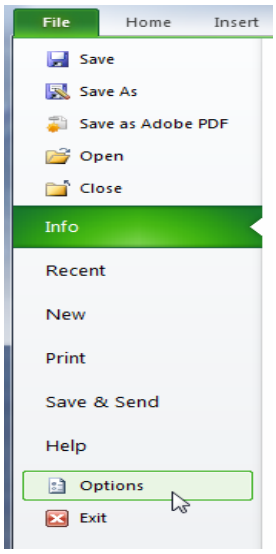
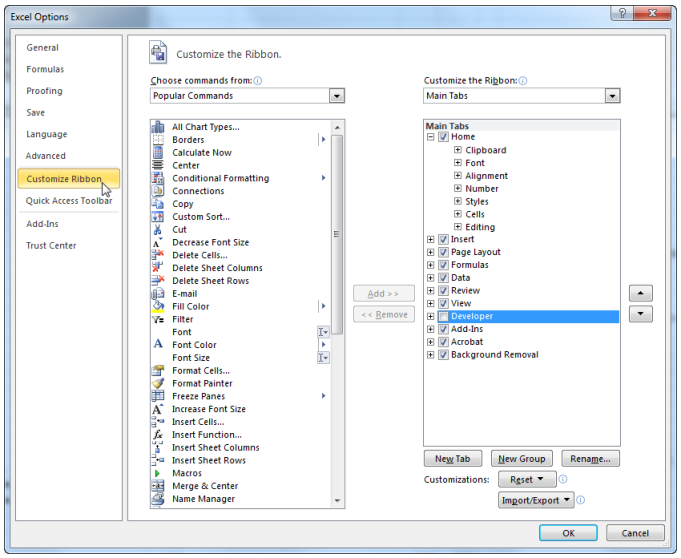
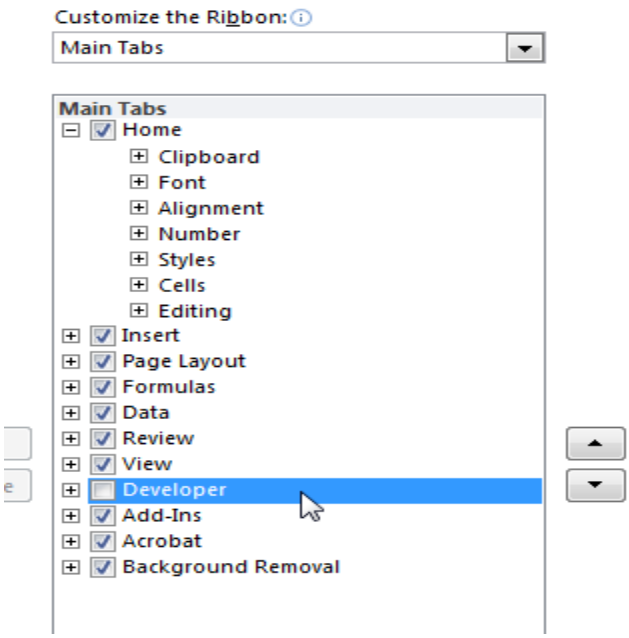
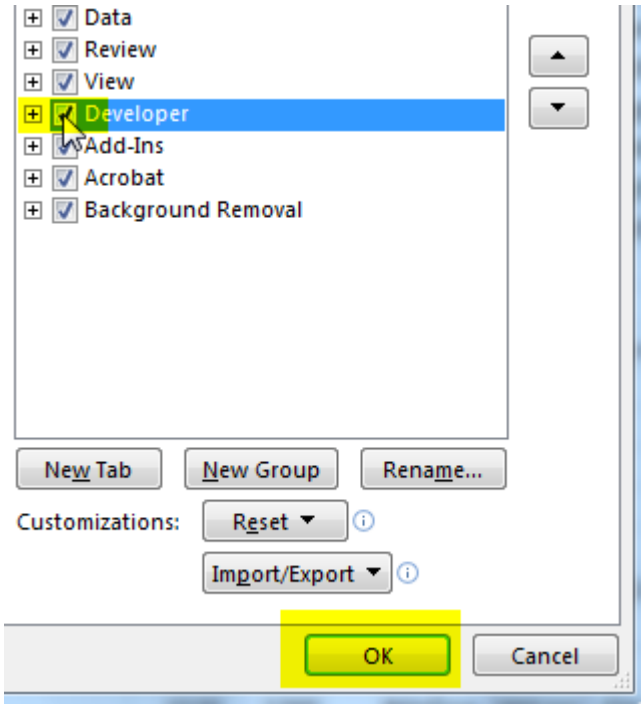
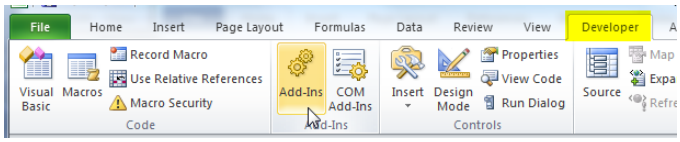
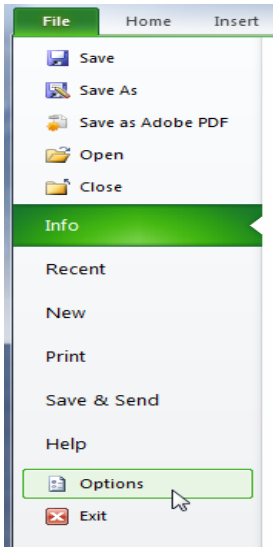
Make Life Easier

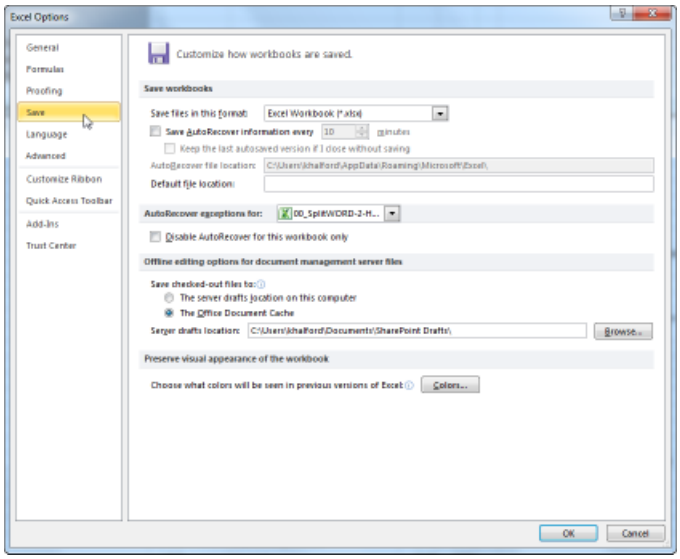
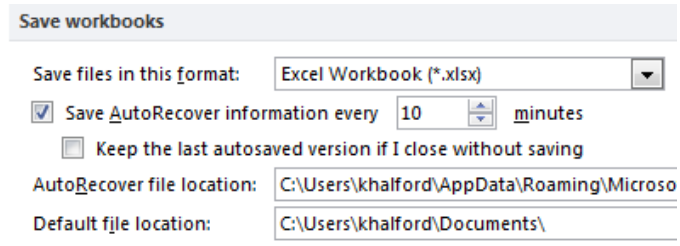
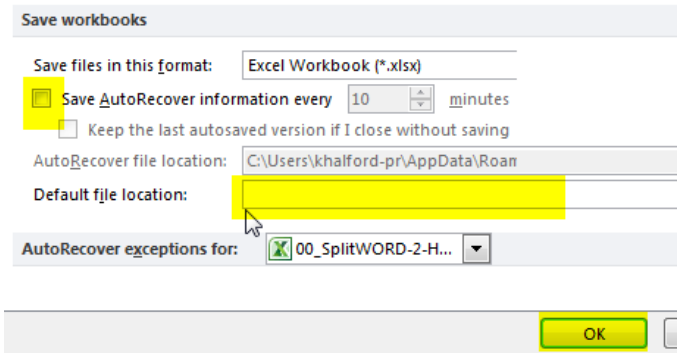
Usage of SeriesSEE and Excel can be expedited by modifying default options in Excel for file ribbon settings, directories, and backup. SeriesSEE and other add-ins can be accessed more directly if the Developer tab is visible. The default file directory is a username directory under some “My Documents” folder, which usually goes unused if you navigate through files with Windows Explorer. The automatic backup guarantees that your work will be interrupted every 10 minutes, but likely will not create a recoverable workbook if any complexity exists.

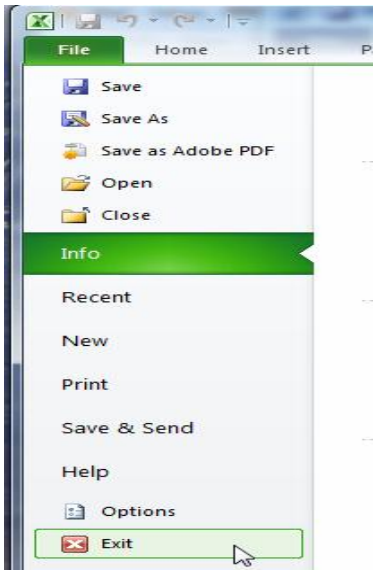
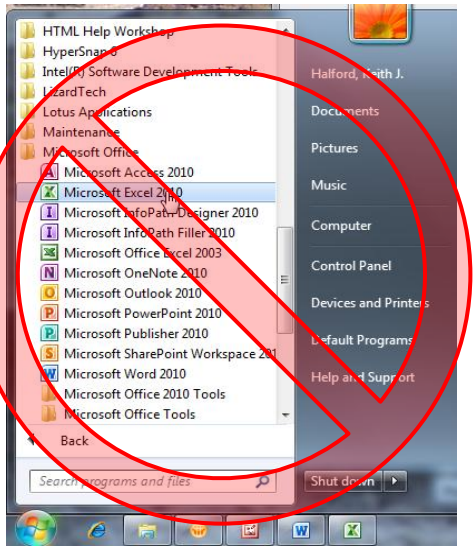
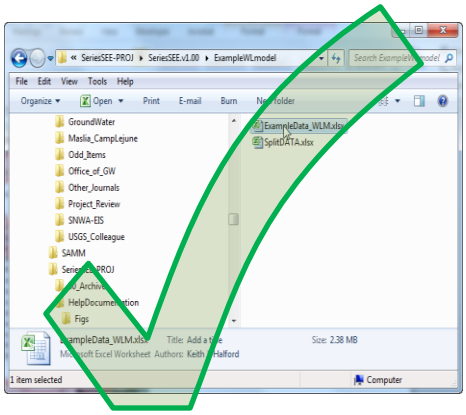
Modify options in Excel

Click on Options under the File menu.	

Select Customize Ribbon on the Excel Options form	
The Developer tab is unchecked by default.	

Check the Developer tab and Select OK.	
The Developer tab will appear in the ribbon, which gives direct access to the Add-Ins control.	
Click on Options under the File menu.	

Select Save on the Excel Options form	
Default options in “Save workbooks” Save AutoRecover… is checked A default file location is specified.	
Change options in “Save workbooks” Uncheck Save AutoRecover… Delete default file location and leave BLANK. Check OK in lower, right corner of form.	

Exit Excel completely. Changes in effect next time Excel is opened.	
Default file location will be where Excel is installed if Excel is started from the Windows Start menu.	
Navigate to the files of interest with Windows Explorer and double-click or right-click to “open with” on the workbook of interest. The default directory will be where Excel was started.	

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Create

Data must be arranged as a continuous series of headers and values. All headers are in the first row (Figure 4). Multiple time or depth columns can be specified, which allows for series with different or irregular sampling intervals. All series are independent, so the range of times or depths do not need to be synchronous. For example, well OR621 was logged between 163 and 1,393-ft below land surface while well OR640 was logged between 182 and 1,729-ft below land surface (Figure 4).

	A	B	C	D	E	F	G	
	DEPTH.FT	OR621-Caliper.in	OR621-StaticD	OR621-PumpDOWN	OR621-StaticQ	OR621-PumpQ	DEPTH.FT	OR640
2	163	29.29	53.59	242.45	-44.36436577	3734.477995	182	
3	163.5	29.3	53.59	242.45	-44.39466413	3737.028432	183	

Figure 4.—Headers and values from the geophysical log example in the file ExampleLOGS_Orlando.xlsx.

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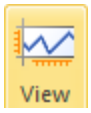
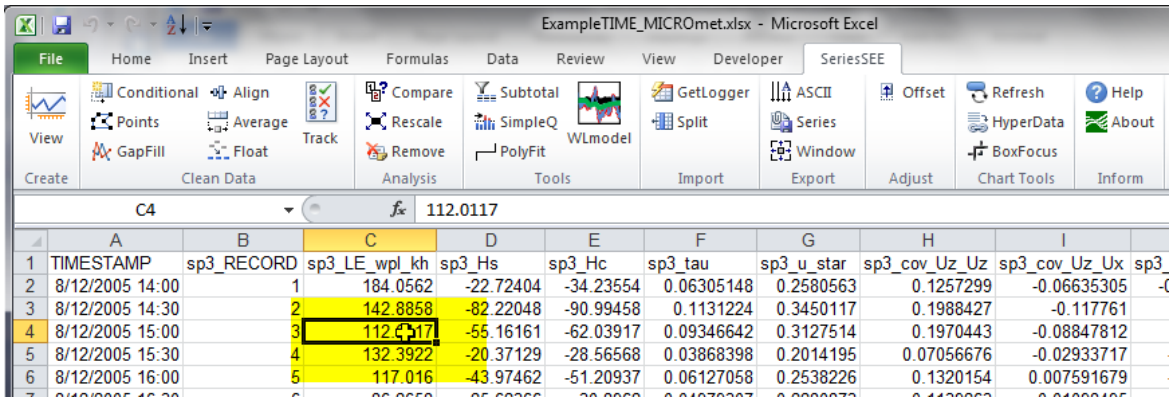
View Utility

A Viewer file is created by selecting a cell in the block of data to be analyzed and pressing the 

button (Figure 5). The entire data block is copied into the viewer file by default. All equations are converted to values in the Viewer file which breaks all linkages to the source book.



	A	B	C	D	E	F	G	H	I
1	TIMESTAMP	sp3_RECORD	sp3_LE_wpl_kh	sp3_Hs	sp3_Hc	sp3_tau	sp3_u_star	sp3_cov_Uz_Uz	sp3_cov_Uz_Ux
2	8/12/2005 14:00	1	184.0562	-22.72404	-34.23554	0.06305148	0.2580563	0.1257299	-0.06635305
3	8/12/2005 14:30	2	142.8858	-82.22048	-90.99458	0.1131224	0.3450117	0.1988427	-0.117761
4	8/12/2005 15:00	3	112.0117	-55.16161	-62.03917	0.09346642	0.3127514	0.1970443	-0.08847812
5	8/12/2005 15:30	4	132.3922	-20.37129	-28.56568	0.03868398	0.2014195	0.07056676	-0.02933717
6	8/12/2005 16:00	5	117.016	-43.97462	-51.20937	0.06127058	0.2538226	0.1320154	0.007591679

Figure 5.—Selecting a cell in a data block and clicking View Series to create a new viewer file.

Analysis of time series or geophysical logs is specified in the Define View form (Figure 6). The magnified region of a series will appear in the chart that reads “MAGNIFY.” Clicking “OK” will create the viewer file, which must be saved before being used. The viewer file is deleted if the user does not save the new file.

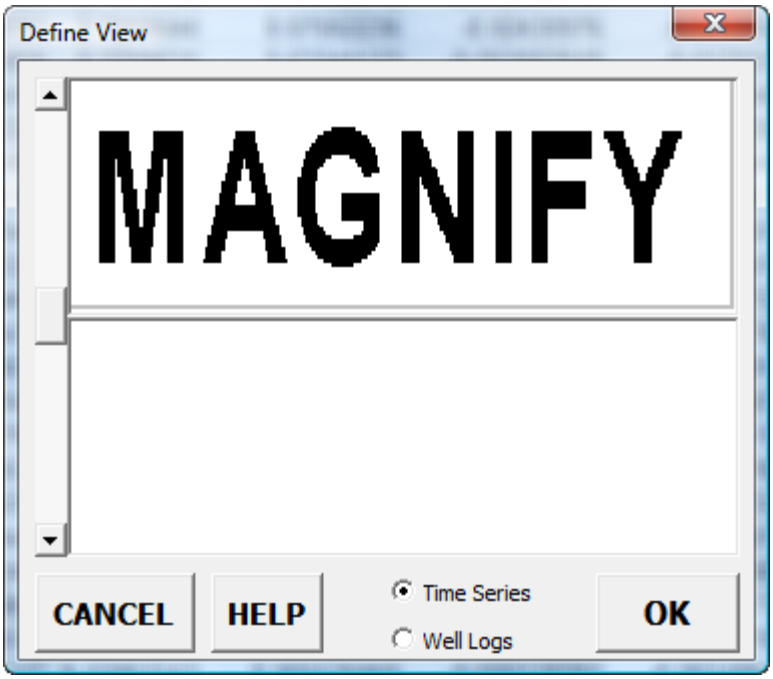


Figure 6.—Define View form that is launched by clicking View in the Create group.

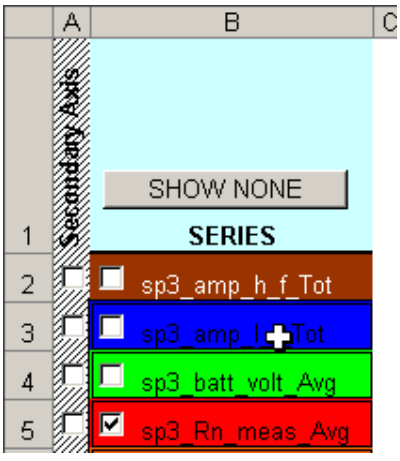
Series and axes on both charts are controlled by the checkboxes in columns A and B. Dependent axes, Y-axes for time series and X-axes for logs, can still be manipulated directly. A user-specified minimum, maximum, or log scale will not be overridden as the magnifier is scrolled.

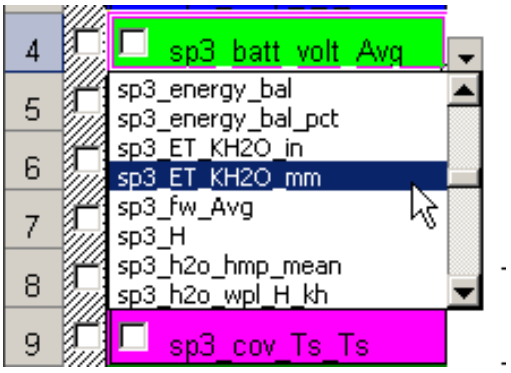
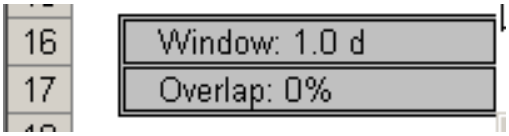
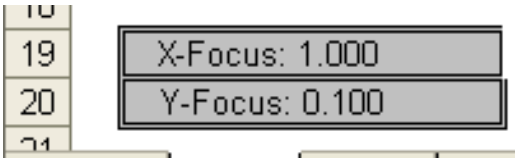
Instructions for Controlling Viewer

Add series to charts by checking the right box, and remove series from charts by unchecking the right box.

Checking the left box places a series on a secondary axis. Series will remain on the primary axis if only 1 series is plotted.

The “SHOW NONE” button removes all series from the charts.



Additional series are selected with drop-down menus where more than 12 series exist. Cell color defines a series color. Change the background color of the cell before adding a series. Series are plotted with a heavy line if the label text is bold.	
Checking the right box in row 14 reverses the primary axis. Checking the left box in row 14 reverses the secondary axis.	
Cell B16 specifies the width of the magnified region for time series and specifies the height of the magnified region for geophysical logs. Overlap, B17, is the percentage of previous magnified region shown in the current magnified region.	
X-Focus, B19, is the default size of the Box Focus utility as a fraction of the X-axis length. Y-Focus, B20, is the default size of the Box Focus utility as a fraction of the Y-axis height.	

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Clean Data

Bad data can be marked and eliminated with the data cleaning utilities (Figure 7). Cells with bad data initially are marked with a shaded background regardless of cleaning utility. Values in shaded cells are deleted, and an empty cell remains. Bad data can be selected by exceeding or equaling a user-specified threshold. All series can be cleaned simultaneously or cleaning can be limited to visible series. Non-numeric entries are automatically purged from any series that are cleaned. A copy of the original data is being cleaned by the SeriesSEE add-in, not the original data. Changes to data with SeriesSEE tools cannot be undone because macro usage clears the log of previously used commands in Excel.

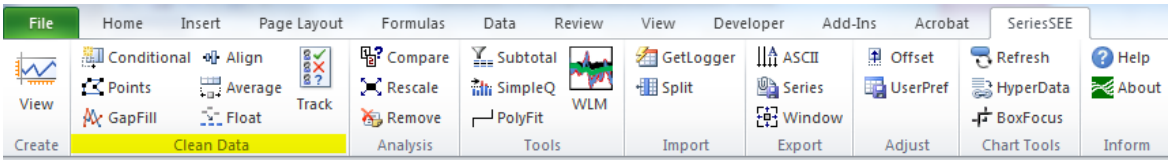

Figure 7.—Clean Data group for eliminating bad data, filling gaps, and offsetting segments of series.

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Conditional Utility

Bad data conditionally can be marked or eliminated with the Conditional utility (Figure 8). Bad data are identified by exceeding or equaling a user-specified threshold in the series to be cleaned or as conditions are met in other series. Bad data can be marked or eliminated from visible series or all series. Non-numeric entries are automatically purged from any series that are cleaned.

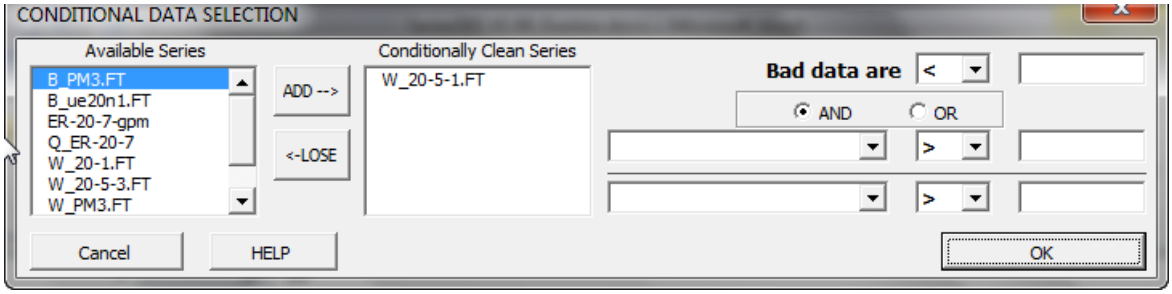
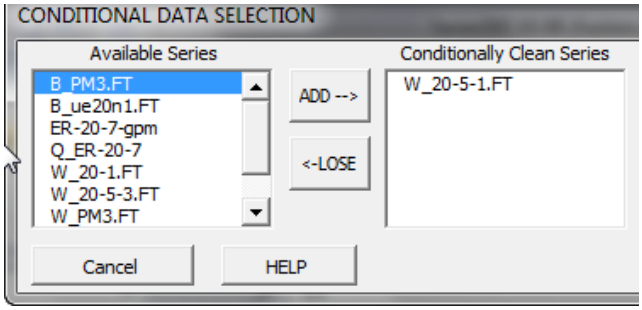
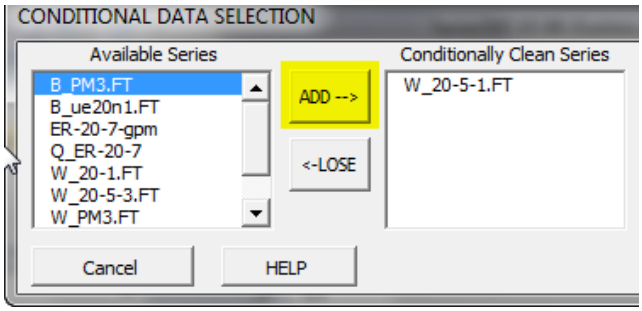
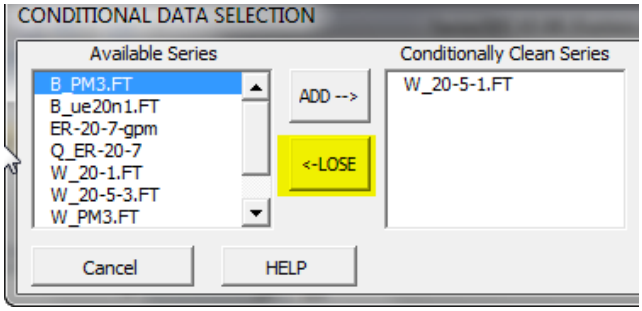
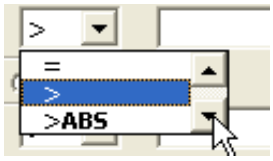
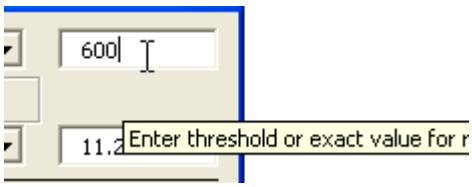
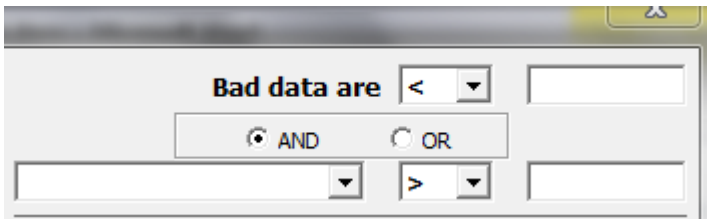
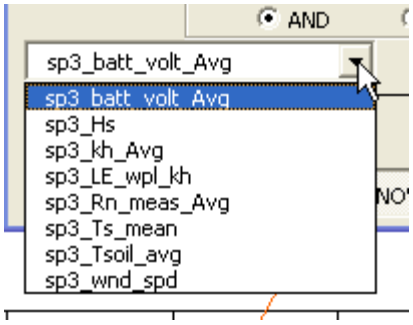
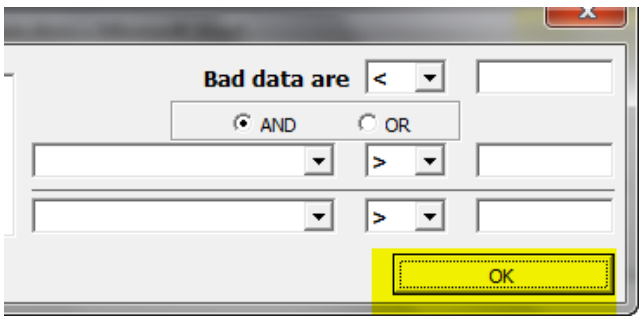
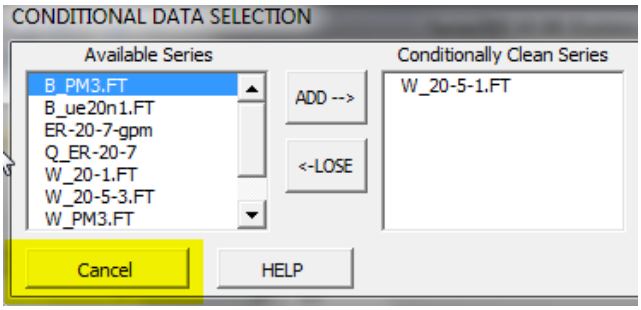


Figure 8.—Form for eliminating bad data from series.

Instructions for Conditionally Selecting Data

The “CONDITIONAL DATA SELECTION” form appears with all visible series selected by default. A tracked series is specified and cannot be changed.	
Under the “Available Series” list, either double-click a series or select a series and press “ADD” to add a series to the “Conditionally Clean Series” list. Function is disabled if a series is being tracked.	

Under the “Conditionally Clean Series” either double-click a series or select a series and press “REMOVE” to move a series back to the “Available Series” list. Function is disabled if a series is being tracked.	
Bad data are selected by the less than (<), equals (=), greater than (>), or absolute value is greater than (>ABS) conditions.	
Threshold values are typed into the rightmost fields.	
Bad data also can be conditionally selected with additional series. The AND/OR conditions apply to all series if three conditions are applied.	
Select additional series from the leftmost pull-down menus. Additional conditions are not used if left blank.	
Press OK to eliminate bad data.	

Press Cancel when finished cleaning series.	

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Points Utility

Bad data in a single series can be marked or eliminated graphically with the Points utility. Selecting a datum point in the magnify window marks a value while the point-by-point utility is active. Selecting another datum point and holding the SHIFT key will mark all points between the previous and current selection. The first visible series is selected by default (Figure 9). Marked values are depicted with a second series that has the prefix “BAD.”

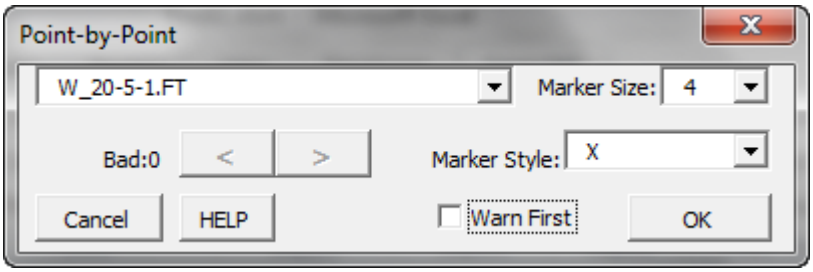
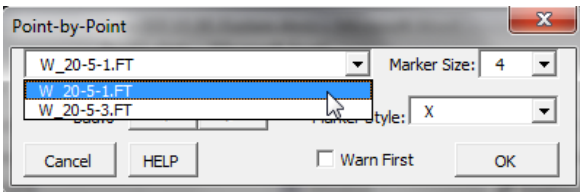
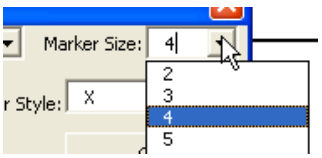
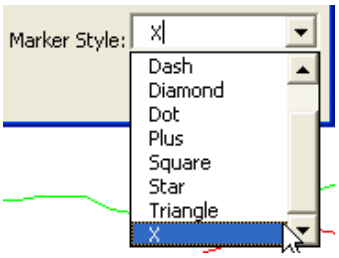
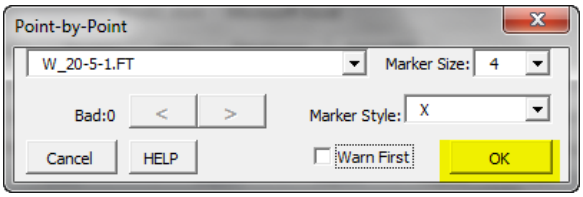
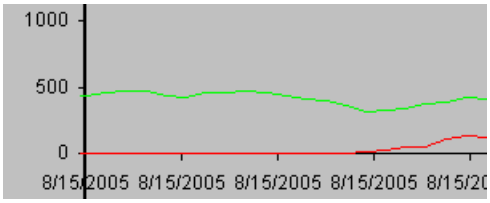
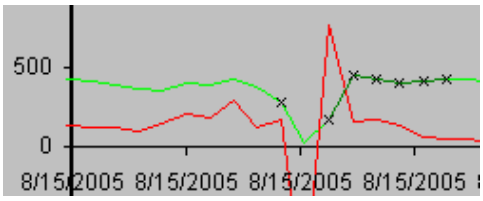
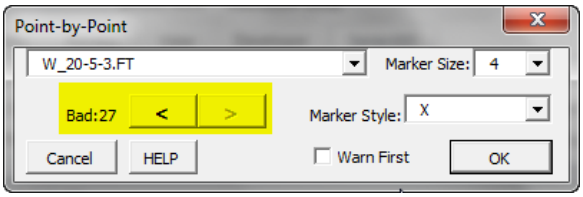
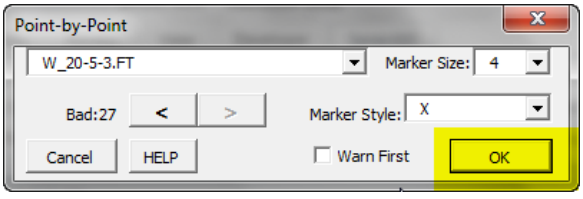


Figure 9.—Form for eliminating discrete datum points from a single series.

Instructions for Selecting Data Point-By-Point

Select one of the visible series to clean point-by-point. A tracked series is specified and cannot be changed.	
Specify a marker size. Values of 3 and 4 work well.	

Select a symbol for denoting bad data.	
Select OK to create a “BAD” series and begin point-by-point data selection.	
The background color of the magnify window will change color.	
Select a datum point to mark. Select another datum point, and hold the SHIFT key to mark all points between previous and current selection.	
The number of marked cells is counted in the “Point-by-Point” window. Selections can be undone and redone with arrow buttons right of the bad counter.	
Select OK to mark the selected cells, delete the selected entries, and remove the BAD values series.	

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Gap Fill Utility

Data gaps from the cleaning process can be filled by linear interpolation, loaded with a dummy value (e.g., 6999), estimated with water-level models, eliminated

altogether, or gaps can be introduced with the GapFill utility (Figure 10). Data gaps will not be filled if the range exceeds a user-defined period. All visible series are added to the “Fill Gaps in Series” list by default.

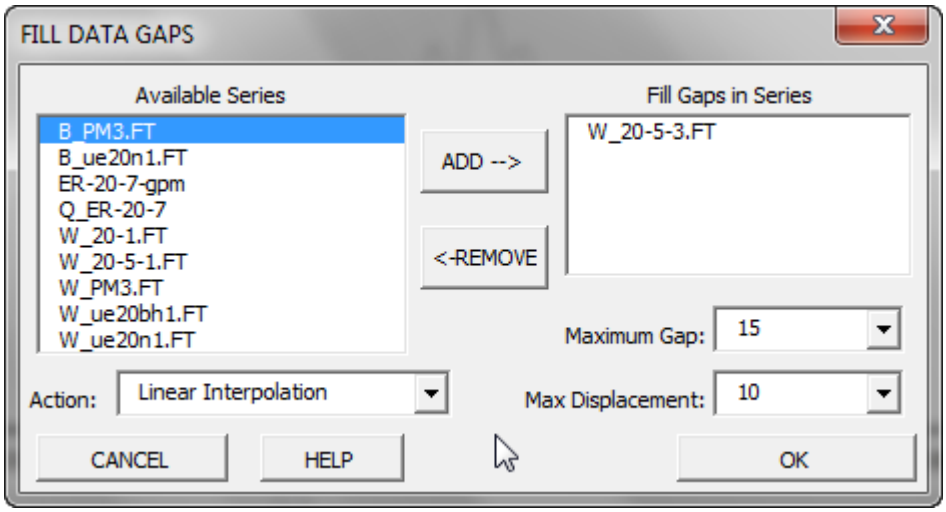
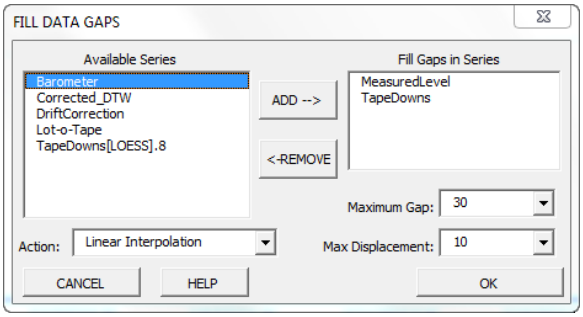
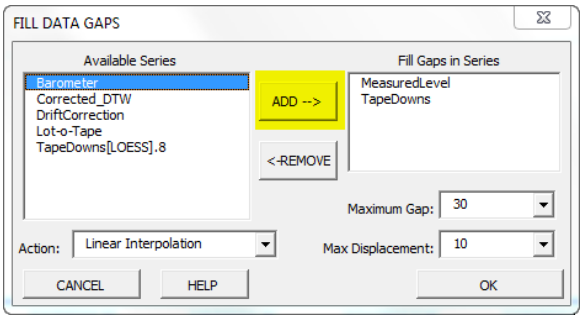
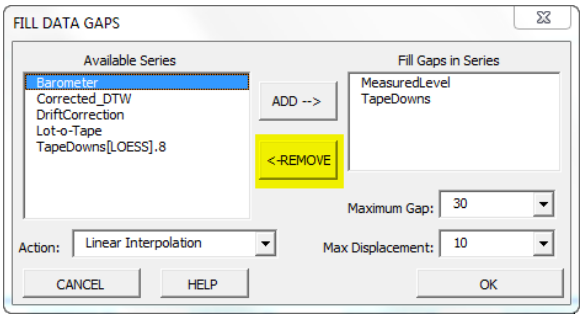
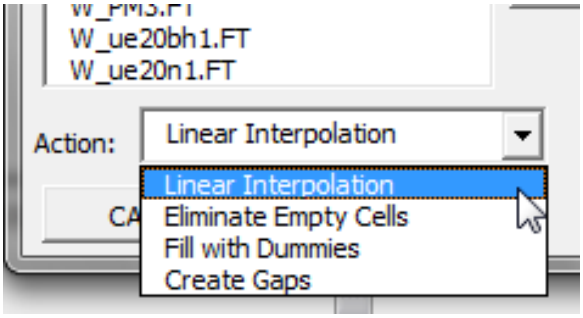
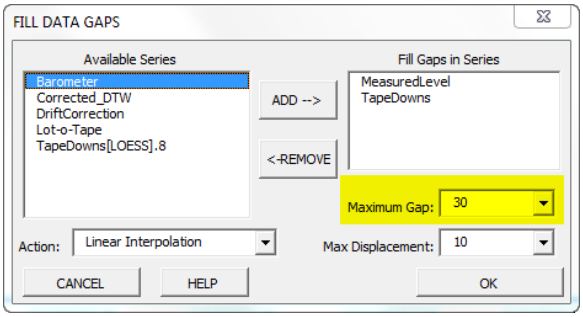
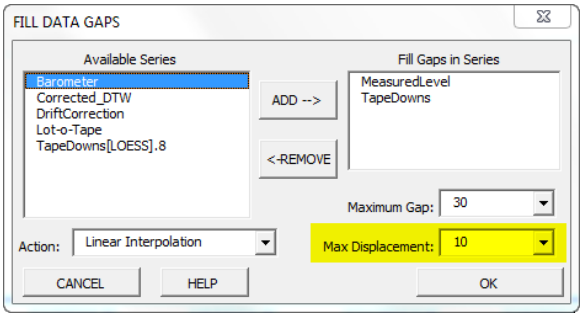
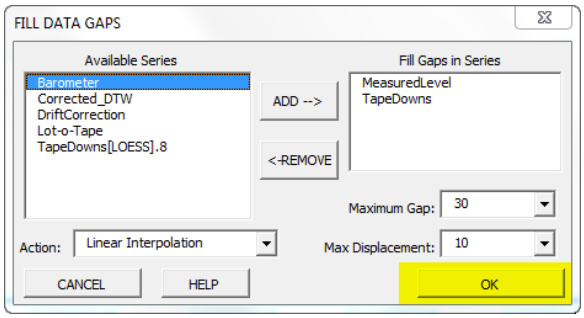


Figure 10.—Form for filling or eliminating gaps in multiple series.

Instructions for Filling Data Gaps

The “FILL DATA GAPS” form appears with all visible series selected by default. A tracked series is specified and cannot be changed.	
Under the “Available Series” list, either double-click a series or select a series and press “ADD” to add a series to the “Fill Gaps in Series” list. Function is disabled if a series is being tracked.	

Under the “Fill Gaps in Series” either double-click a series or select a series and press “REMOVE” to move a series back to the “Available Series” list. Function is disabled if a series is being tracked.	
Select method of filling gaps or eliminating times without data. A new, independent time axis is created for data that share a common time axis if empty cells are eliminated. Create gaps is used with the Align utility where segments of series can be offset between gaps.	
Maximum Gap defines greatest period to be filled and defaults to the “Window:” period in cell B16. Maximum Gap limits range of depths for geophysical logs.	
Max Displacement defines maximum expected change between consecutive values. Changes greater than Max Displacement are treated as breaks in the record where gaps will be introduced. Max Displacement is used exclusively to create gaps.	

Press OK after specifying series to be filled and methods of filling gaps.	

Water-level models (WLM) in combination with SeriesSEE time-series analyses can be used to fill data gaps using an approach similar to neural networks (Papale and Valentini, 2003), where the complex relation between variables driving the series of interest can be simulated and used for series approximation. Time series are approximated by summing multiple component series during a period prior and(or) subsequent to the data gap, minimizing the difference between measured and approximated series (here after referred to as simulated series) and projecting this fit across the data gap. This gap-filling technique has been applied to eddy-covariance evapotranspiration data, where micrometeorological fluctuations were used to simulate turbulent fluxes of latent and sensible heat.

Micrometeorological components were created from measured time series such as net radiation, soil-heat flux, sensible-heat flux, air temperature, latent- or sensible-heat fluxes from an alternate site, and precipitation. See “WLM section” for instructions on modeling time-series data.

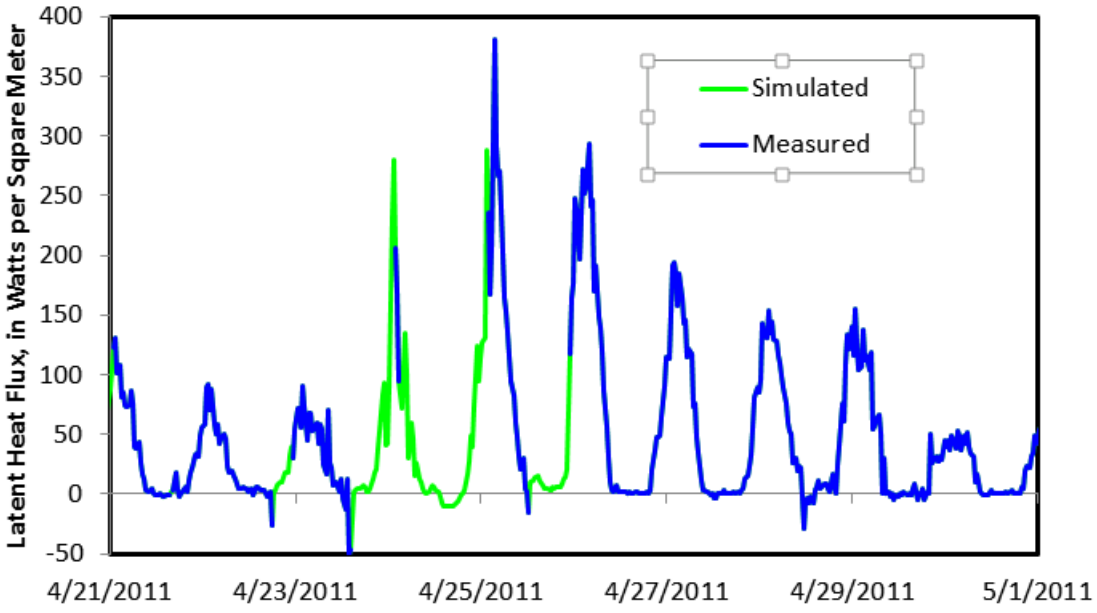
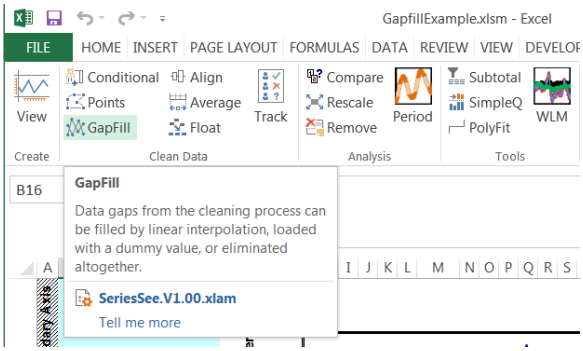
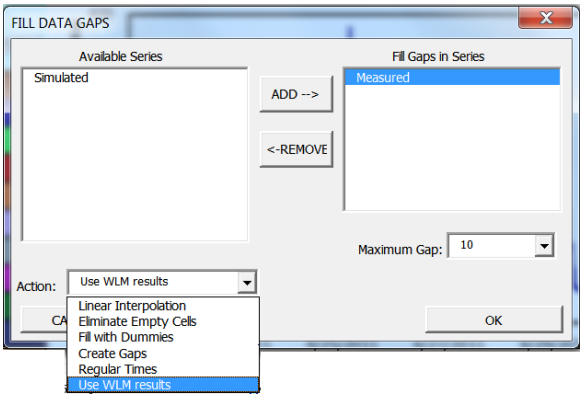
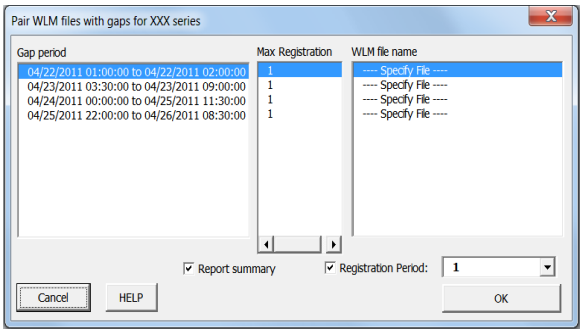
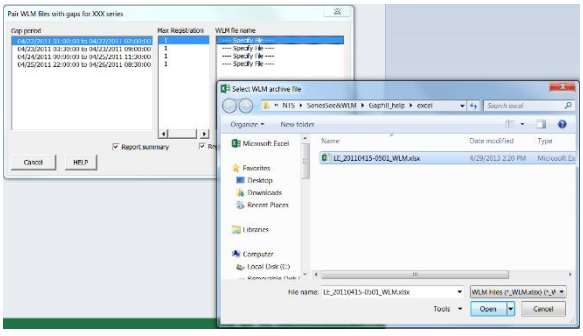
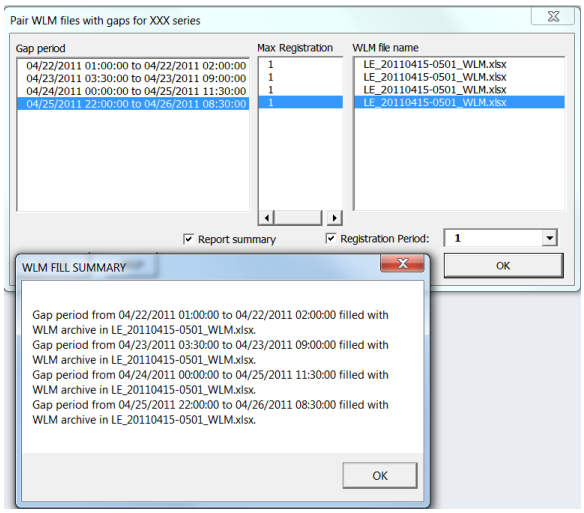


Figure 11.—Example of complex gap-filling with simulated results from a water-level model (WLM).

Instructions for Filling Data Gaps with Water-Level Models (WLM)

Select the Gapfill button in the SeriesSEE menu.	
Data gaps are filled with Water-Level Model (WLM) results by selecting the “Use WLM results” option on the “FILL DATA GAPS” form. Be sure to specify the series to fill gaps in.	
The “Pair WLM files with data gaps for XXX series” form allows you to specify the WLM file to pair with each individual “Gap period.” This form automatically lists all data gaps in the series of interest.	
To pair a WLM with a gap period, in the “WLM file name” box, double click on “----Specify file----“ and navigate to the WLM file of interest.	

After specifying WLM files to be used for each gap period, select “OK” and a “WLM FILL SUMMARY” form will appear. Only gaps where “WLM file names” are specified will be filled.	

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Align Utility

Artificial shifts are minimized by estimating offsets during each break in record and subtracting the offset from the series after the break with the Align utility. Shifts and discontinuities in the record typically are introduced by moving or replacing a transducer. An offset can be estimated with little ambiguity where the break in record is less than a few hours, but not when breaks span days.

Offsets can be estimated in the Align utility with a simplified water-level model that sums barometric changes, earth tides, background water levels, and an offset during a break (Figure 12). The simple water-level model is fit to measured water levels before the gap and after the gap in a series.

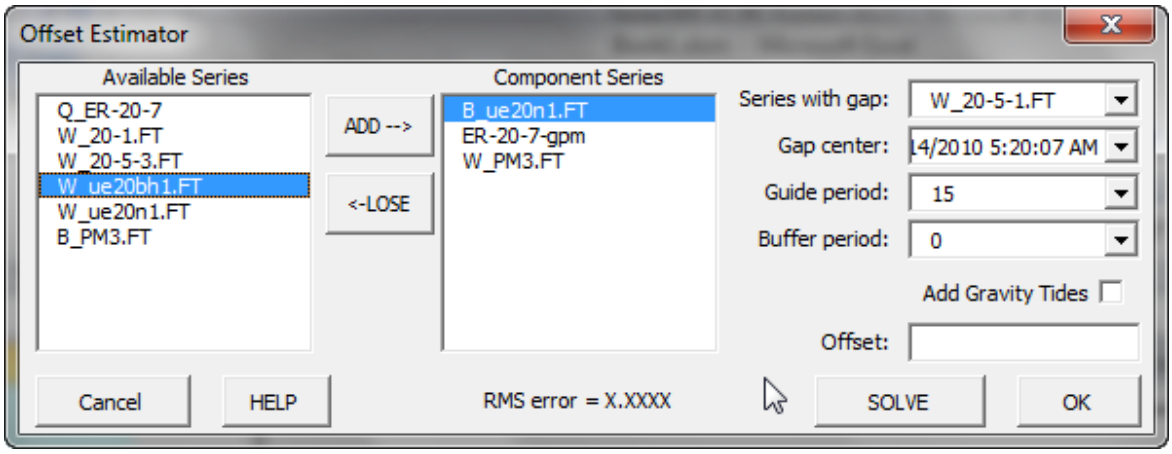
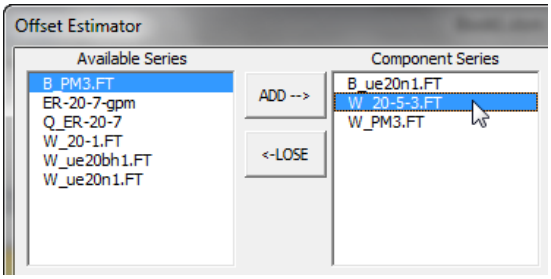
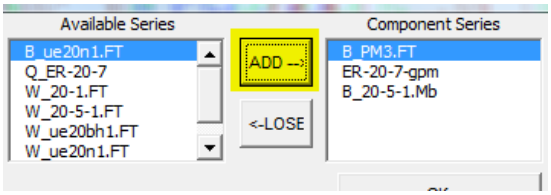
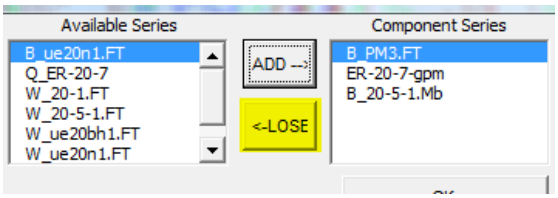
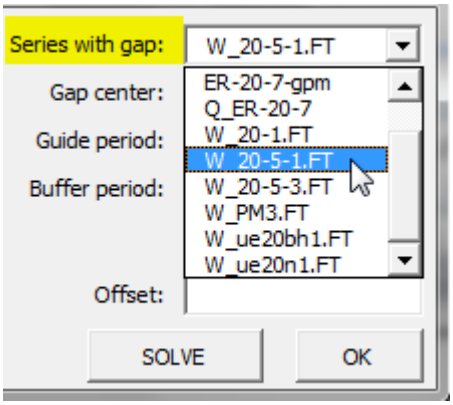
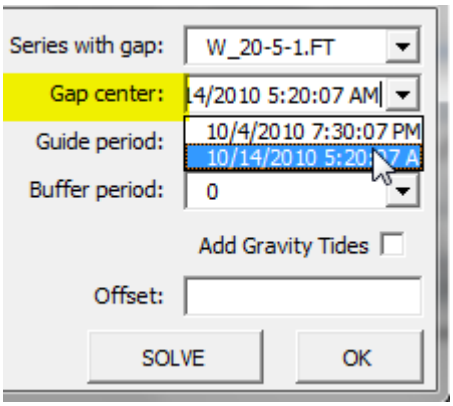
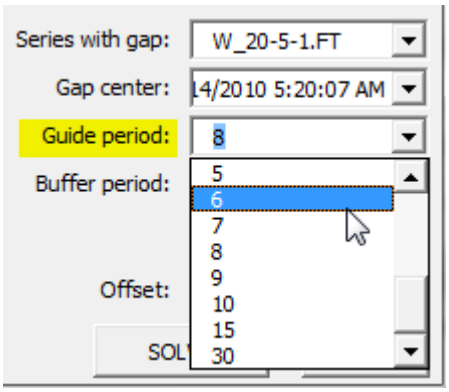
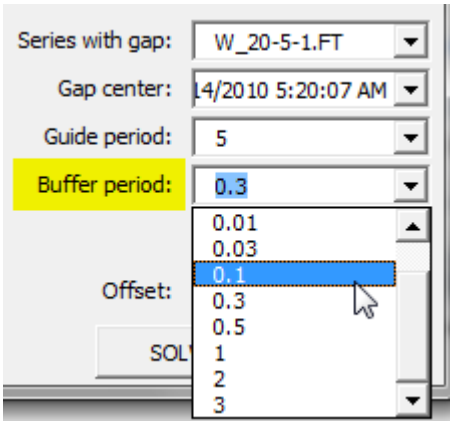
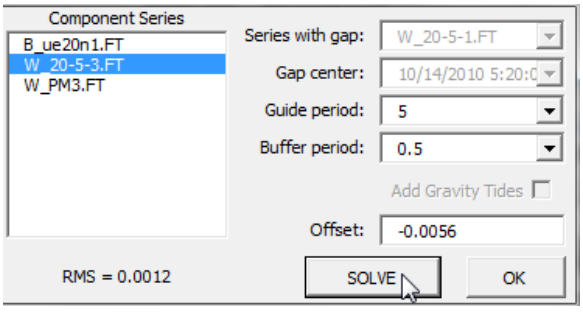


Figure 12.—Form for estimating offset with a simple water-level model and shifting series after each gap.

Instructions for Aligning segments

All visible series are added to the "Component Series" list by default. A tracked series is specified and cannot be changed.	
Under the "Available Series" list, either double-click a series or select a series and press "ADD" to add a series to the "Component Series" list. Function is disabled if a series is being tracked.	
Under the "Component Series list, either double-click a series or select a series and press "REMOVE" to move a series back to the "Available Series" list. Function is disabled if a series is being tracked.	
The first visible series is assumed to be series with gaps. This can be changed on the form if gaps are to be aligned in another series.	

The first gap in the magnifier window is assumed to be the period when water levels will be aligned. Change the gap on the form if an offset is to be applied to another gap in the series.	
The guide period is centered on a gap, and the duration includes the gap and fitting data. Period is defined in days. For example, an 8-day guide period for a 2-day gap could fit a water-level model to 3 days of data prior to the gap and 3 days of data after the gap.	
The water-level model is not fit to measurements in the buffer periods, which are data just prior to the gap and just after the gap. Period is defined in days. The buffer period allows anomalous data near a recently disturbed transducer to be ignored while fitting a water-level model.	
Click SOLVE to create a simple water-level model and estimate an offset.	

Guide period, buffer periods, and simple water-level model are displayed in the magnifier window of the SeriesSEE viewer file after initial solving for an offset (Figure 13). Sensitivity of offset estimates to guide and buffer periods can be tested by changing period durations and solving for an offset again. Small differences between measured water levels with a gap and the synthetic water level can be examined with the BoxFocus utility.

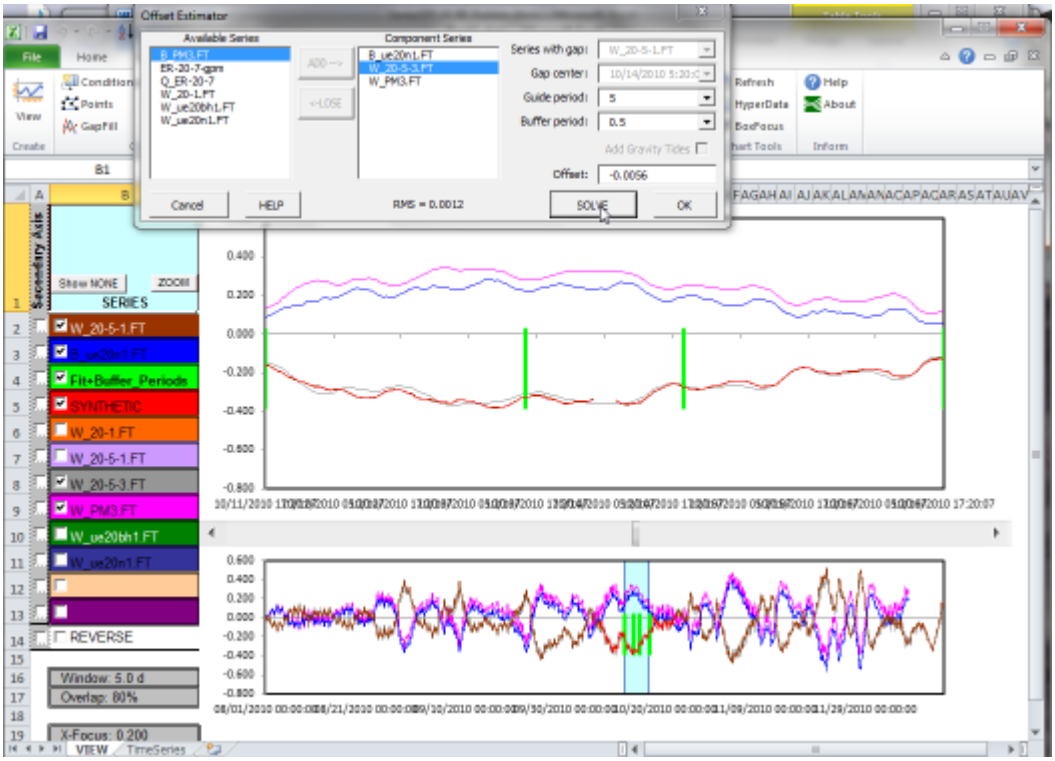
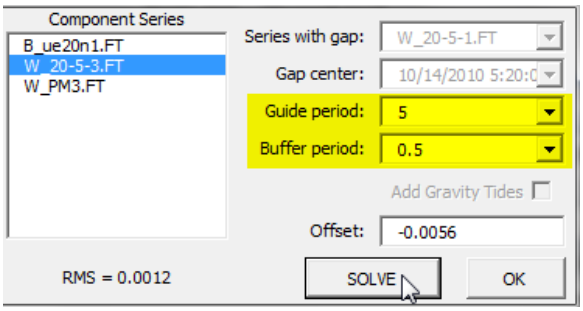
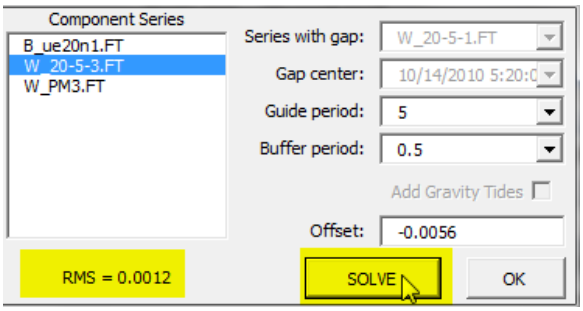
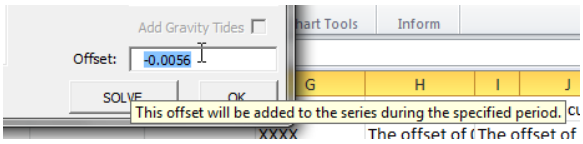
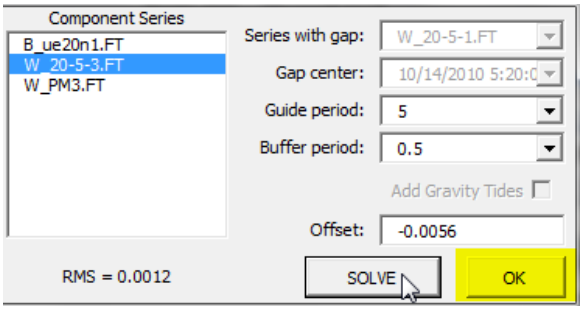


Figure 13.—Form for aligning water levels across gaps where offsets are estimated with simple water-level models.

Instructions for Experimenting with alignment model

Guide period can reduced and buffer period can be adjusted after creating the simple water-level model. All other selections are disabled after the first click of the “SOLVE” button.	

RMS error and estimated offset are displayed in the Offset Estimator form after solving.	
An offset also can be assigned directly without creating a water-level model.	
Select OK after a reasonable offset has been estimated or assigned. The estimated offset is added to all water levels after the gap. This starts with beginning of the gap and is applied till the next gap or the end of the series.	

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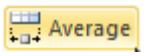
Average Utility

Measurements in a series can be reduced by averaging in bins of uniform duration with the  utility (Figure 14). For example, water levels were measured at frequencies of 5 seconds, 30 seconds, 5 minutes, 15 minutes, and hourly in a single time series. An averaging period of 15 minutes is specified by the analyst. Water levels that were measured at frequencies of 5 seconds, 30 seconds, and 5 minutes will be reduced to 15-minute averages. Water levels that were measured at frequencies of 15 minutes and hourly will be unaffected.

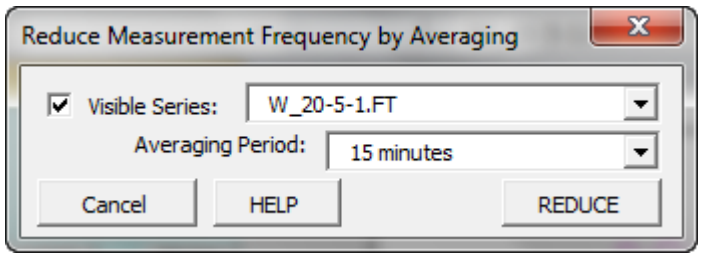
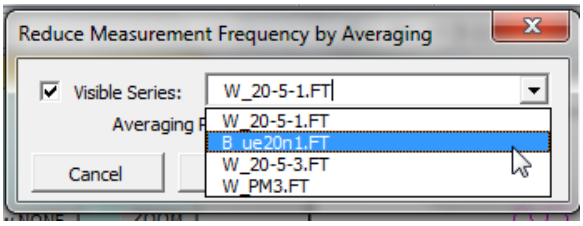
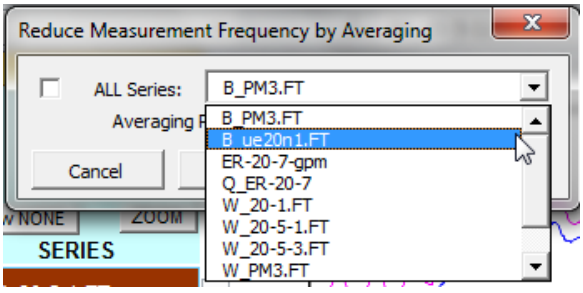
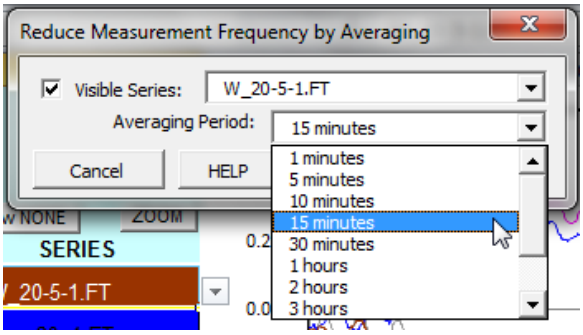
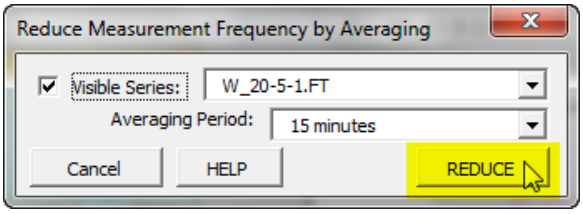
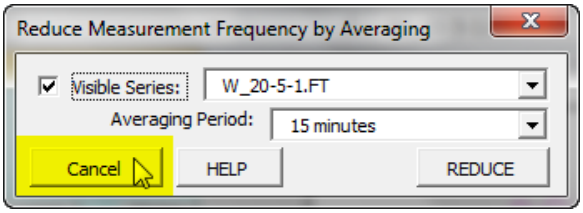


Figure 14.—Form for reducing the measurement frequency of a series by averaging measurements in bins of uniform duration.

Instructions for Reducing Measurement Frequency by Averaging

The first visible series is assumed to be series to be reduced. Another visible series can be selected on the form. A tracked series is specified and cannot be changed.	
Unchecking the check box expands the selection to all series in the SeriesSEE viewer workbook.	
Select a period for averaging from the “Averaging Period” pull down.	
Click the REDUCE button to reduce measurement frequency by averaging. The reduced series will REPLACE the original series.	
Select Cancel to exit the Average utility without changing the series.	

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Float Utility

Continuous water-level records are reconciled with periodic measurements (tape-downs) with the Float utility. Relative water-level changes are assumed to be correct in the continuous record, and all shifts have been removed from the record (Align Utility). Continuous and periodic measurements are reconciled by shifting the continuous record to the average difference between continuous and periodic measurements (Figure 15). Erroneous tape downs can be identified by the analyst and ignored by the Float utility while computing the average difference. Continuous water levels can be recorded as height above a transducer or depth to water because the user can reverse the sign of the continuous record.

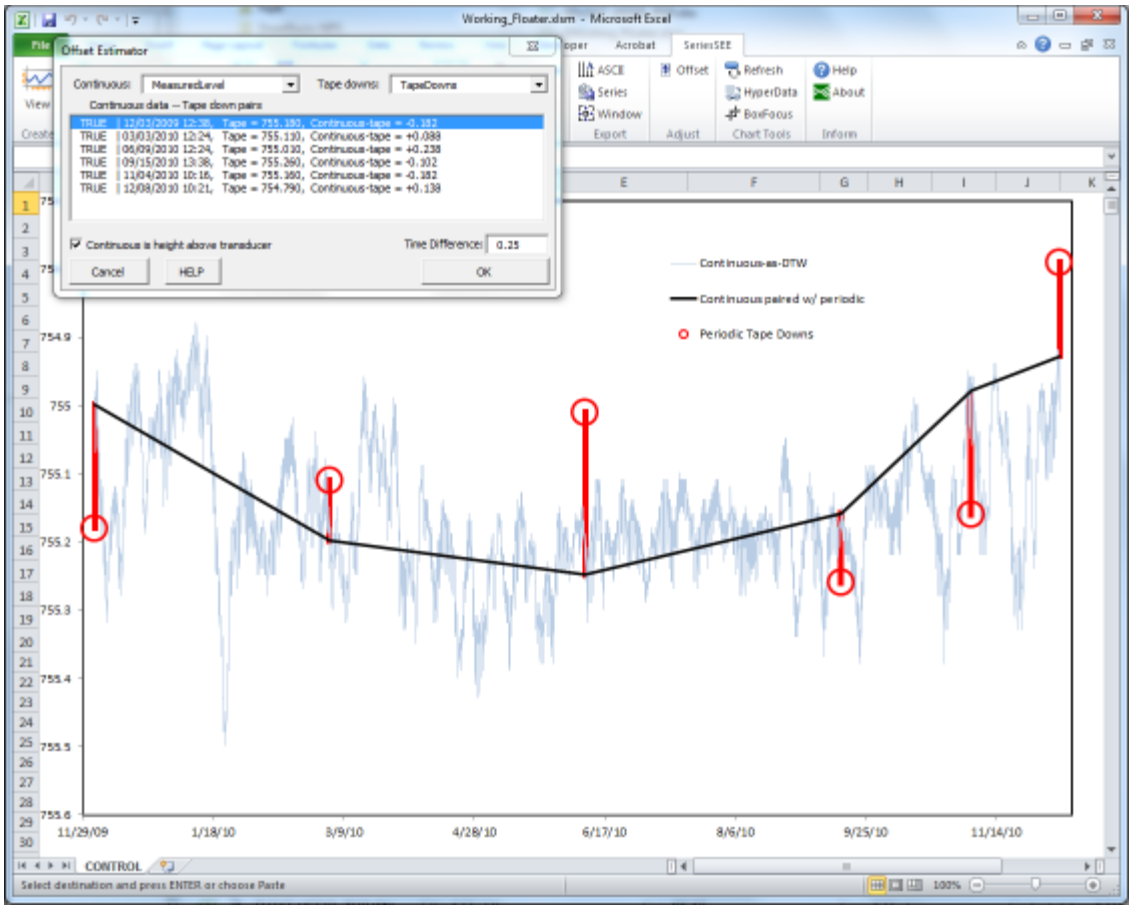
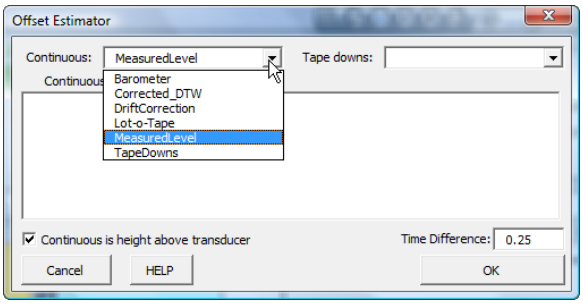
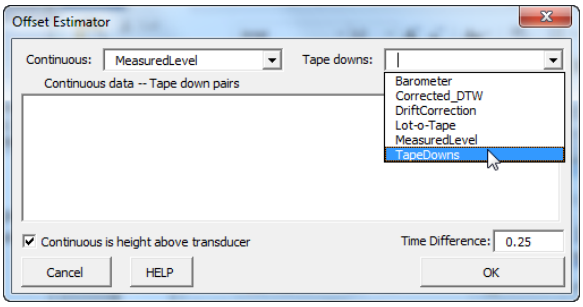
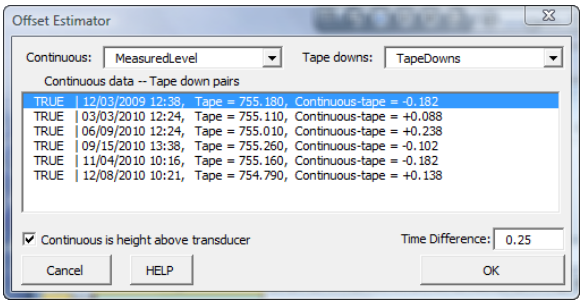
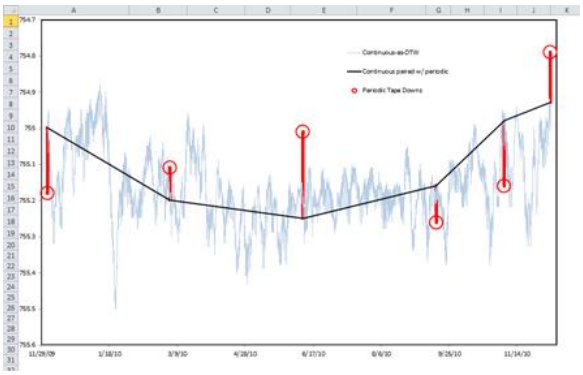
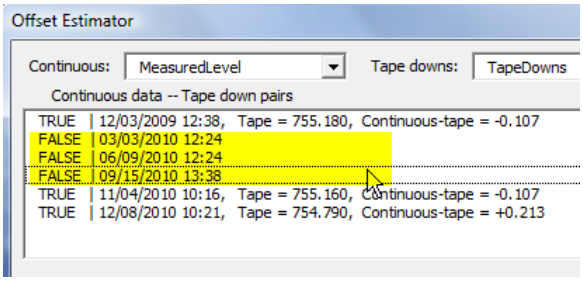
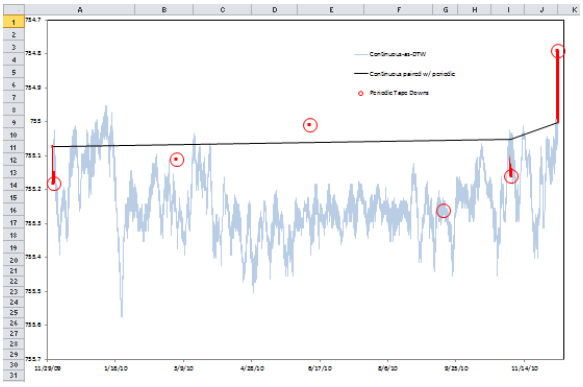
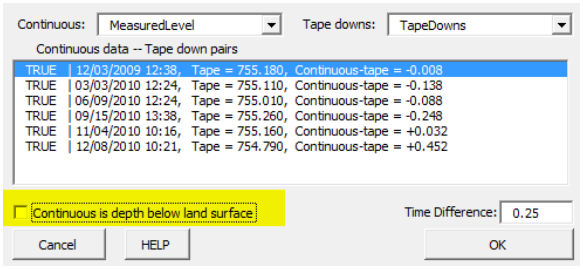
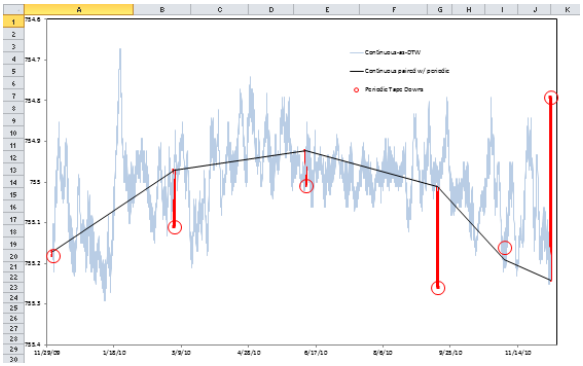
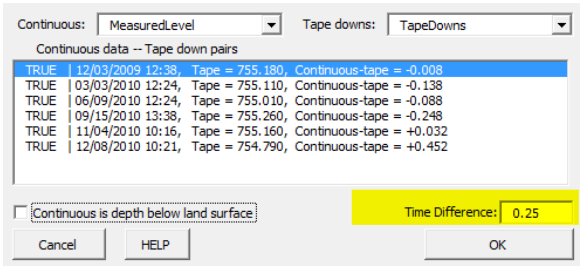
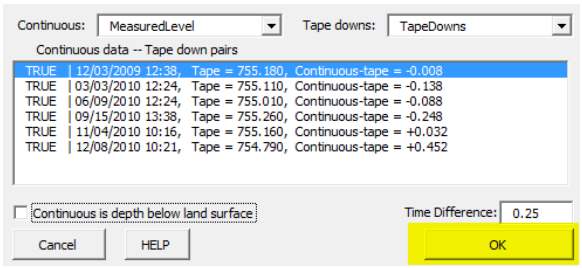
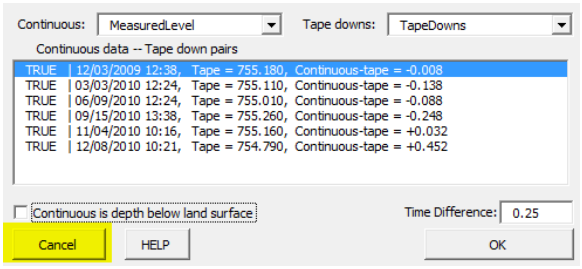


Figure 15.—Form for reconciling continuous water-level records with periodic measurements and temporary workbook for viewing continuous water-level records, periodic measurements, and differences between continuous and periodic measurements where all are displayed consistently as depth to water.

Instructions for reconciling continuous and periodic measurements, FLOAT

The first visible series is assumed to be the continuous water-level measurements that will be reconciled with tape downs. Another visible series can be selected on the form. A tracked series is specified and cannot be changed.	
The series of tape downs must be selected by the user.	
Selection of a series of tape downs triggers pairing between the continuous water-level measurements and tape downs. Pairings are displayed as a list on the form. The average difference initially is computed with all pairs as indicated by the TRUE in each line of the list. A temporary workbook, Working_Floater.xlsm, also is created that charts tape downs, corrected continuous measurements, and differences between tape downs and continuous measurements.	 

Pairs can be ignored while computing the average difference between continuous and periodic measurements. Double-clicking a line in the list will toggle the TRUE/FALSE label. Pairs that have been labeled FALSE are ignored while computing the average difference.	
The charted connector between tape downs and continuous measurements in the temporary workbook is eliminated for pairs that have been labeled FALSE.	
Change the continuous water levels from “height above a transducer” to “depth below land surface” by unchecking the checkbox. The corrected continuous measurements will be inverted in the temporary workbook because the sign has been reversed.	 

Pairing between continuous water-level measurements and tape downs is limited by the “Time Difference,” which is specified in days. Tape downs that were not within 0.25 days of the nearest continuous water-level measurement would be rejected in this example.	
Click OK to REPLACE the original continuous water-level measurements with the reconciled series.	
Select Cancel to exit the Float utility without changing the series.	

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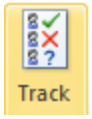
Track Utility

Changes to a series can be logged with the 

utility. A limited subset of SeriesSEE utilities can be used to eliminate spurious measurements, handle missing data, apply shifts, reduce sampling frequency by averaging, reconcile tape downs and continuous series, and convert units. Limited utility availability is denoted by graying of the unavailable utilities in the SeriesSEE menu (Figure 16). The original “dirty” series, revised “clean” series, and changes are recorded to a tracking workbook that is created by the track utility. Explanatory comments are added after each data change that is performed with a SeriesSEE utility. This occurs automatically as a commenting form appears after each action is completed.

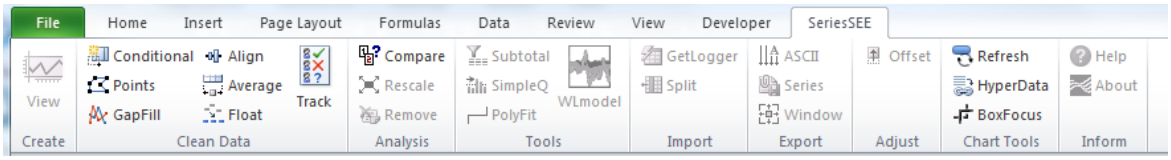
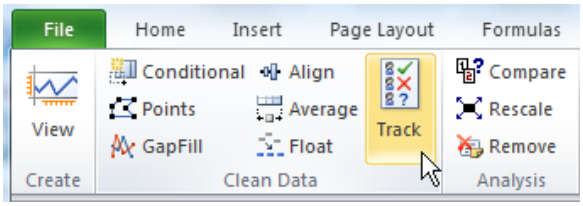
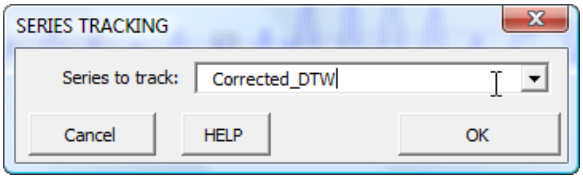
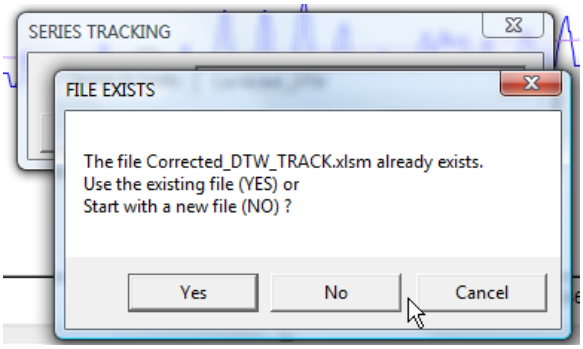
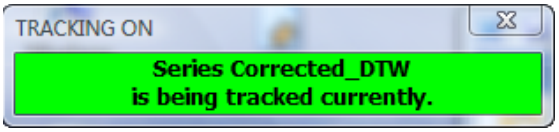
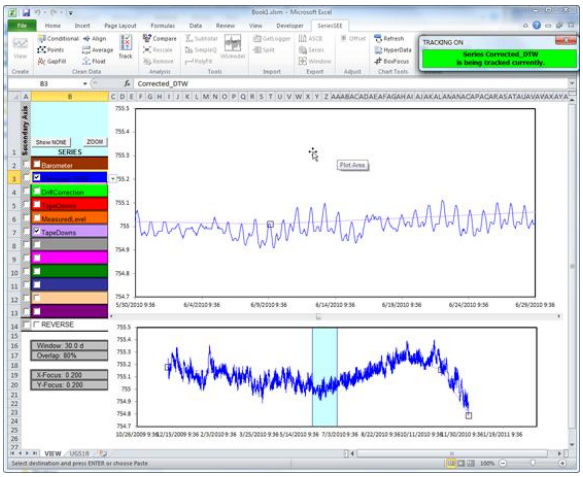


Figure 16.—SeriesSEE menu with tracking on with a limited subset of utilities.

Activating Tracking File

Click TRACK to start logging changes to a series.	
The first visible series is assumed to be the series to be tracked. Another visible series can be selected on the form.	
FILE EXISTS is an optional query and appears if a tracking file was created previously. Selecting YES replaces the tracked series in the SeriesSEE viewer with the CLEAN series in the tracking file. Selecting NO replaces the tracking file with a blank tracking file, and the tracked series in the SeriesSEE viewer is written to the DIRTY series in the tracking file.	
A “TRACKING ON” form appears and will remain active while changes to a series are being tracked.	

The SeriesSEE viewer will appear the same while tracking occurs, except for graying of unavailable utilities in the SeriesSEE menu. The TRACKING ON form can be moved to a more convenient location than the default upper, left corner of the screen.	

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Adding comments & documenting changes

The COMMENT ADDER form is launched after each a series is changed and the SeriesSEE utility is dismissed (Figure 17). Standard and verbose comments can be added. Standard comments are short descriptors, such as transducer pulled, well sampled, or transducer replaced. Standard comments are entered by the user, are added to a cumulative list, and can be retrieved through a pull-down menu. Verbose comments can be lengthy descriptors of the woes that transpired in the field and fully explain why a transducer was pulled.

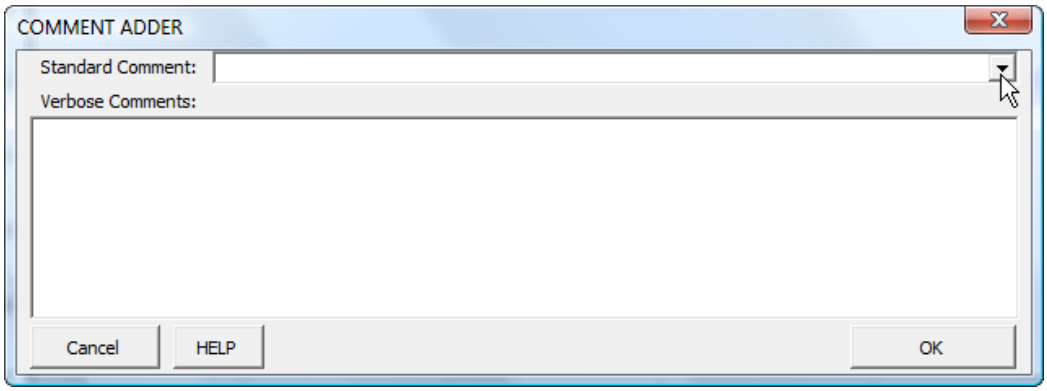
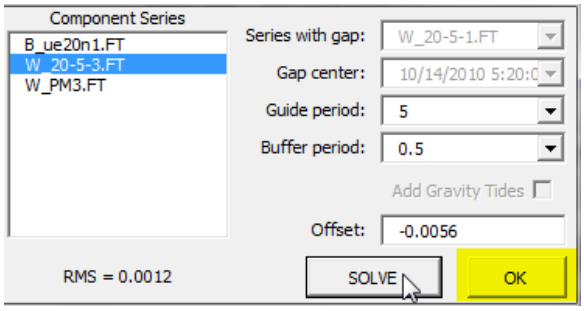
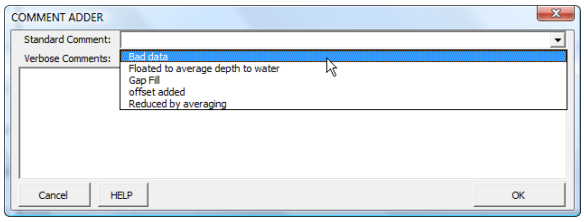
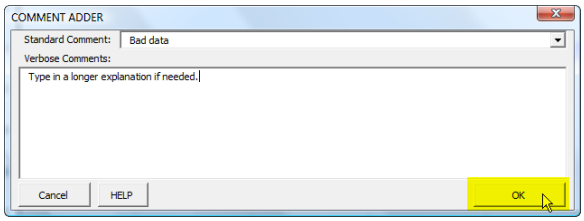


Figure 17.—Form for finding directory with data-logger files and an example directory with multiple data-logger files.

Comment Adder form

Completing a change to a series with a SeriesSEE utility launches the COMMENT ADDER form. For example, a segment of a series was offset with the Align utility. Clicking OK enacts changes to a series and launches the COMMENT ADDER form while tracking is active.	
Standard comments are typed or selected from the pull-down menu of previous entries.	
Explain the standard comment fully with the verbose comment if needed. Select OK to log comments in the tracking file.	

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Stop Tracking

The tracking workbook that was created in the same directory as the SeriesSEE viewer file is closed after tracking stops. The tracking workbook contains the original, “dirty,” series, revised “clean,” series, and recorded changes (Figure 18). Recorded changes log a standard comment, verbose comment, altered time in series, altered value in series, when the change occurred, and descriptive summary of changes by the SeriesSEE utility.

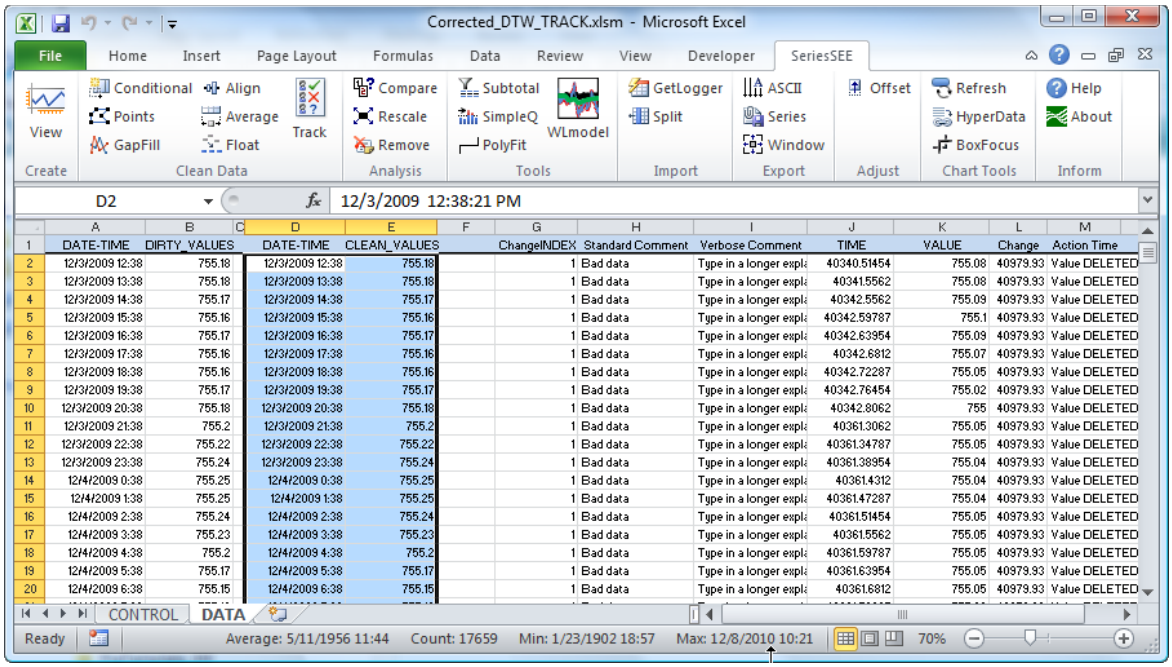
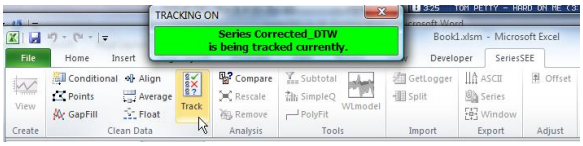
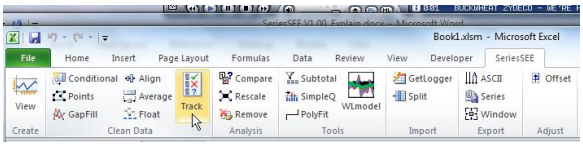


Figure 18.—Series tracking file with original series (DIRTY_VALUES), cleaned series (CLEAN_VALUES), and tracked changes that were logged.

Close Tracking File

Click “Track” to stop logging changes to a series and close the TRACK workbook.	
All SeriesSEE utilities will be restored to an active state on the ribbon and the “TRACKING ON” form will disappear.	

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Analysis

Data can be smoothed, differenced, compared, and rescaled with analysis utilities in SeriesSEE (Figure 19). New series that are created with the analysis utilities are tracked as derived series. These derived series can be reviewed

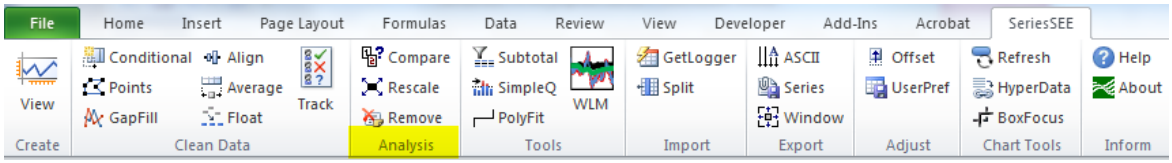

Figure 19.—Analysis group for analyzing data and managing derived series.

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Compare Utility

Rudimentary comparisons between series can be performed with the Compare utility. All series are available from drop-down menus on the “COMPARE SERIES” form (Figure 20). Comparisons are limited to addition, subtraction, multiplication, and division. The second series is interpolated to times or depths in the first series for comparison. A constant offset or multiplier can be applied by entering a value in the second drop-down menu instead of selecting another series.

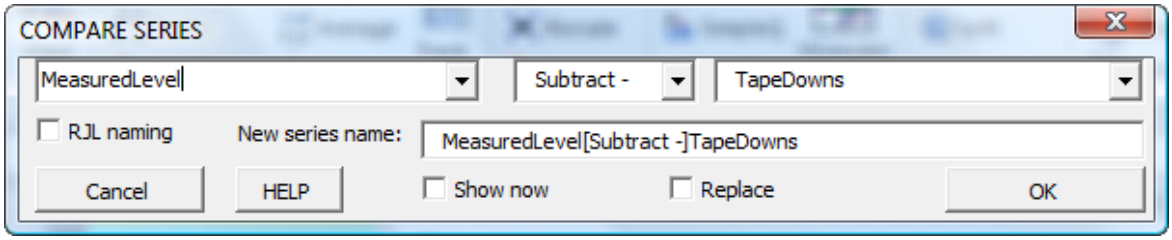
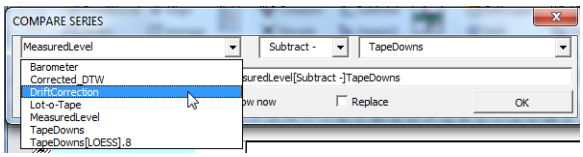
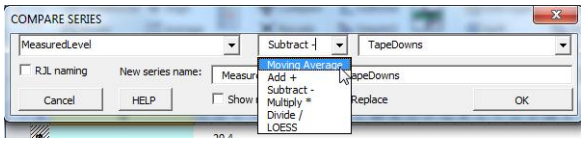
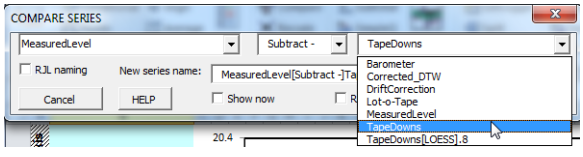
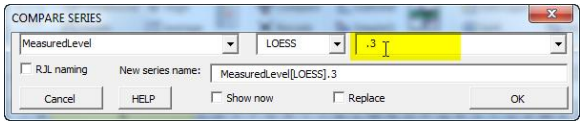
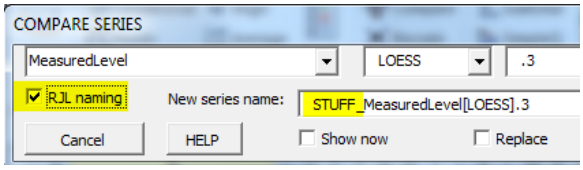


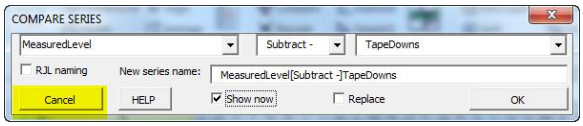
Figure 20.—Form for comparing series.

Series can also be smoothed with a moving average or a LOWESS curve. The new series is appended to the time or depths from the first series for moving averages. Regularly spaced times are created for the period of record if a series is smoothed with a LOWESS curve. Smoothing functions are disabled if changes to a series are being tracked.

Instructions for Comparing Series

Select a primary series, S1, for deriving a new series. For example, subtracting a second series, S2, from S1 will read: S1 – S2 = New Series A tracked series is specified and cannot be changed.	
Select an operation: Moving average, Addition, Subtraction, Multiplication, Division, or LOWESS. Moving average and LOWESS functions are disabled if a series is being tracked.	
Either select a second series or enter a number to operate on the first series.	

Entry should be limited to a numeric entry for moving average or LOWESS operators. **Moving average**: value is the number of measurements in each moving average, which typically range 3-100. **LOWESS**: value ranges 0.2 – 1 which is a fraction of the period of the entire time series and defines the local period for each LOWESS estimate. These functions are disabled if a series is being tracked.	 
A new series name is created automatically after the 3 upper fields are filled. This name can be modified or replaced by the user.	
New series will replace last available series name and be shown immediately after pressing the OK button if the “Show now” option is checked. This functions is disabled if a series is being tracked because the series is already displayed.	
Checking The naming, show now, and replace functions are disabled if a series is being tracked.	
Checking RJL naming appends the prefix “STUFF_” to the new series name.	
Select OK to create the new derived series.	

Select Cancel at any time to exit Compare Series without changing or creating anything.	

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Rescale Utility

Series can be normalized to common scales with the Rescale utility. Each series is normalized to either the range between minimum and maximum or the standard deviation. Series are either normalized from 0 to 1 or scaled to the range of the first series in the “Scaled Series” list. Visible series are added to the “Scaled Series” list by default (Figure 21).

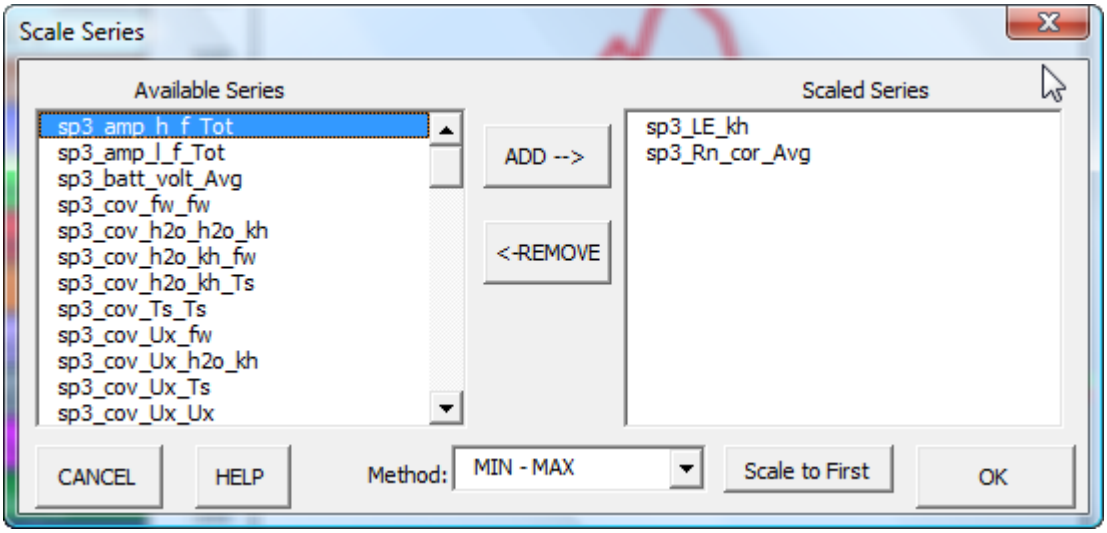
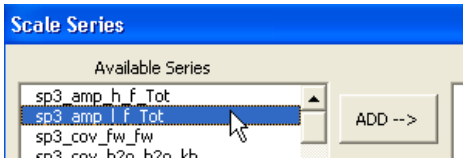
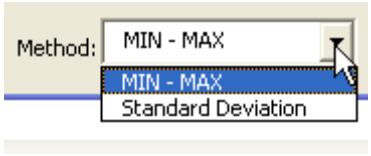
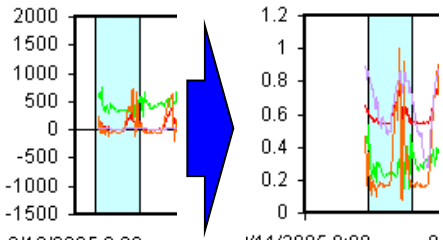


Figure 21.—Form for scaling series to a common range.

Instructions for Scaling Series

All visible series are added to the “Scaled Series” list by default. Under the “Available Series” list, either double-click a series label or select a label and press “ADD” to add a series.	
Select scaling to either the range between minimum and maximum or standard deviation of a range.	
Scale values to either the range of the first visible series or between 0 and 1.	

	
Select OK, and the normalized series will be substituted for the original series and displayed.	
Correlations are easier to observe where changes are less sensitive to the measured units.	

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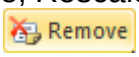
Remove Utility

Derived series that are created by Compare, Rescale, SimpleQ, PolyFit, or WLmodel utilities can be removed with the  utility. All derived series are available for removal (Figure 22). Visible series are added to the "Series to REMOVE" list by default. Under the "Available Series" list, either double-click a series label or select a label and press "ADD" to add a series to the removal list. Select OK to remove the selected series.

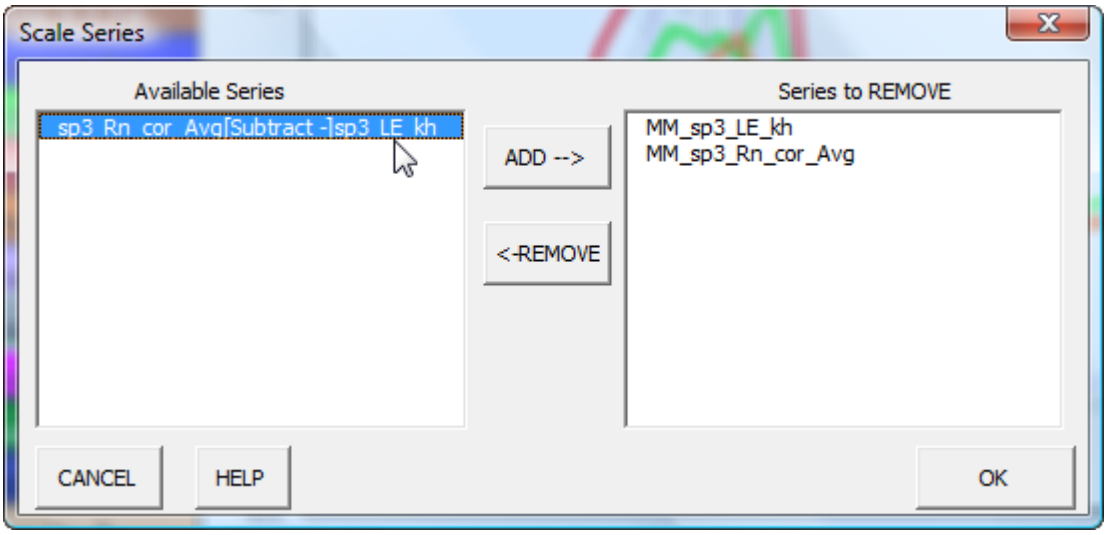


Figure 22.—Form for removing derived series selectively.

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Period Utility

Weights that emphasize fitting peaks and troughs of periodic measurements are created at user-specified intervals with the 

utility (Figure 23). The array of weights are created at intervals defined by bins and bounded by a specified tolerance. A reduced form of non-zero weights can also be created for a condensed table.

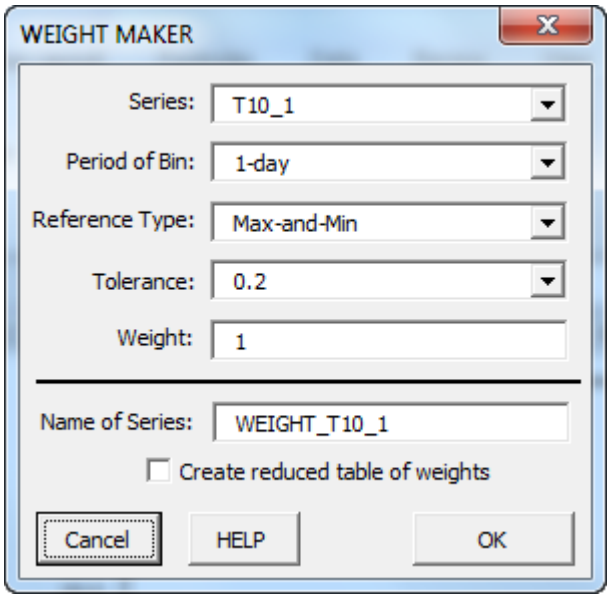
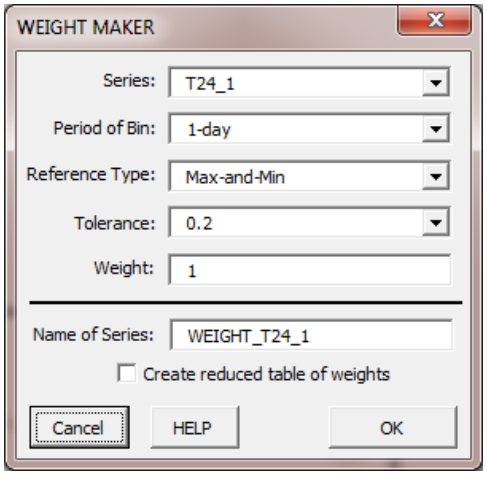
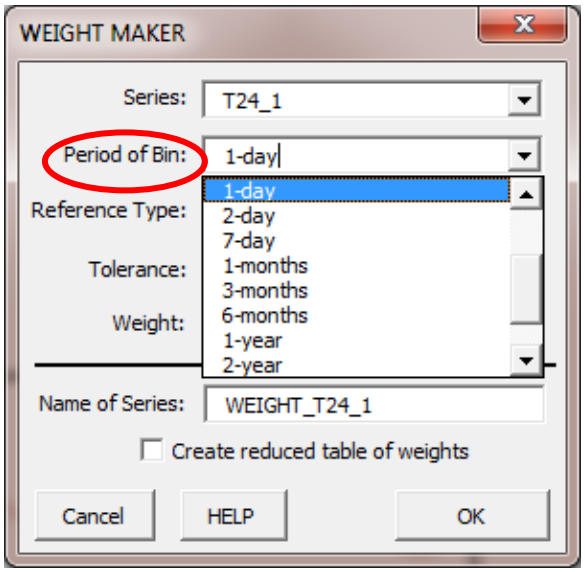
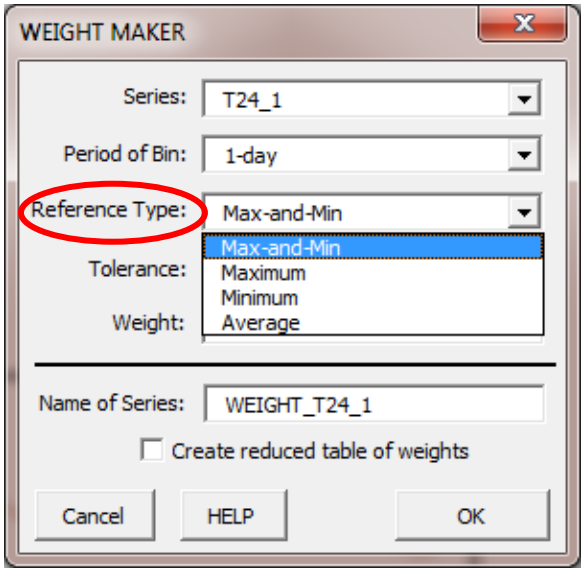
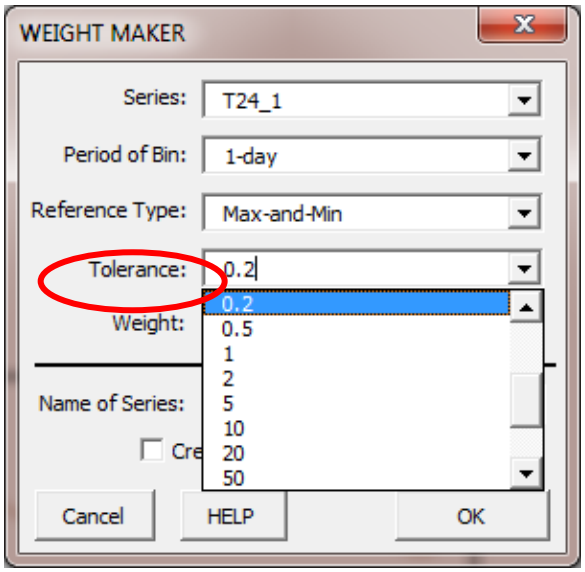
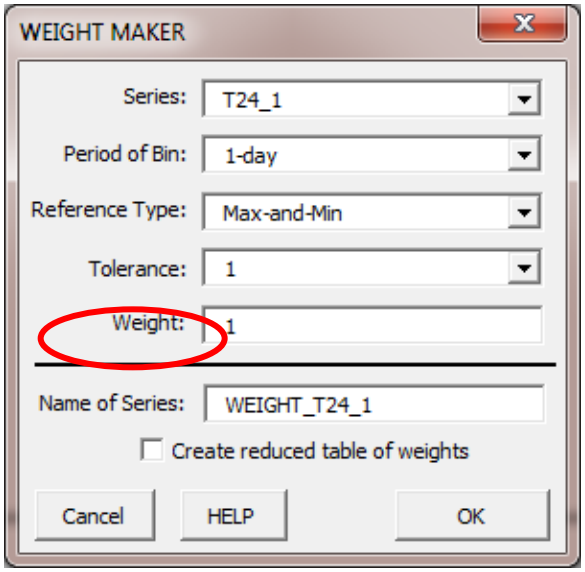


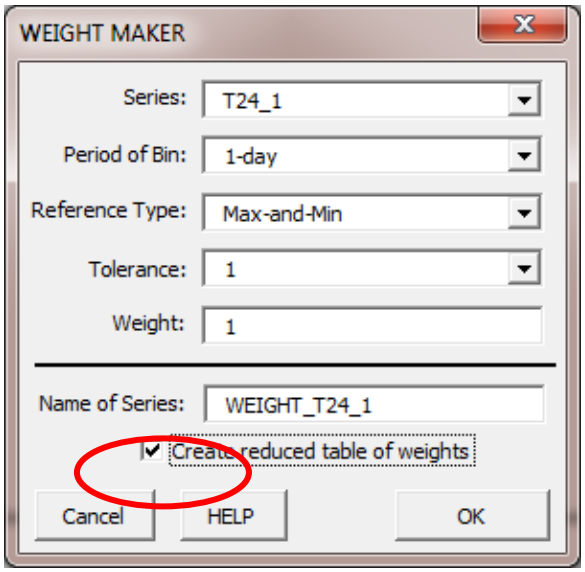
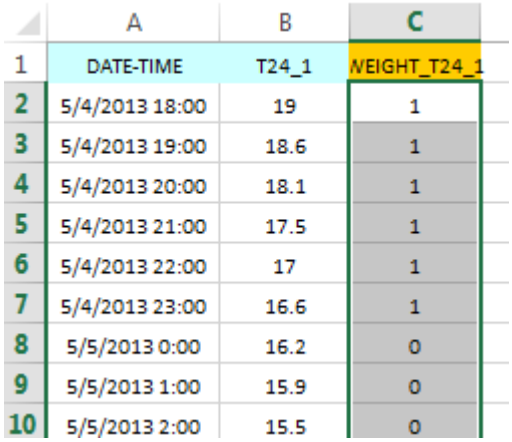
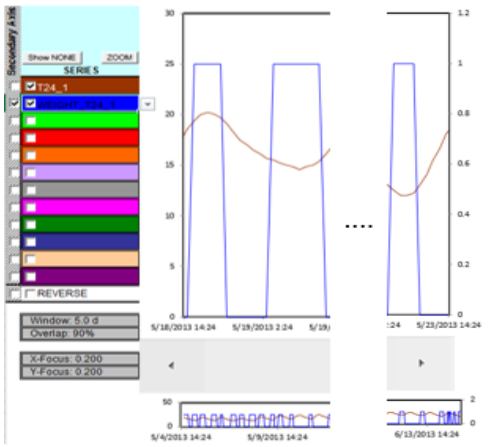
Figure 23.—Form for weighting periodic measurements.

Instructions for Creating Periodic Weights

Launch the Period Utility	 Period
The “Weight Maker” form will appear.	

On the selected Series data, the “Period of Bin” is selected for specifying the frequency of the weights on the basis of the “reference type” calculation.	
Select the “Reference Type” calculation. In this case we wish to specify a weight on the maximum and minimum of the series array on a daily Period.	

Specify the extent to which weights are specified near the minimum and maximum occurrence on the time-series data. Larger “Tolerance” values will result in additional weights near the maximum and minimum values daily values. Lower “Tolerance” will return only few number of weights near the maximum and minimum daily values.	
Specify the weight value for each occurrence on the maximum and minimum daily value. If “1” is selected, the utility will return a time-series array with values “1” at the occurrence of the daily maximum and minimum value and zeros for every other time.	

Creating a reduced table of weights will return an array of 1 near the maximum and minimum daily values defined by the tolerance. Unclicking this box, will return the entire time-series array with values of the Weight (1) and zeros. Click OK to create array of weights	
An example of weights specified at the occurrence of the daily maximum and minimum values with tolerance of 1.	
Plotted results of specified weights (0, 1) relative to original time-series data.	

	A	B	C
1	DATE-TIME	T24_1	WEIGHT_T24_1
2	5/4/2013 18:00	19	1
3	5/4/2013 19:00	18.6	1
4	5/4/2013 20:00	18.1	1
5	5/4/2013 21:00	17.5	1
6	5/4/2013 22:00	17	1
7	5/4/2013 23:00	16.6	1
8	5/5/2013 0:00	16.2	0
9	5/5/2013 1:00	15.9	0
10	5/5/2013 2:00	15.5	0

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Tools

Data can be smoothed, differenced, compared, and rescaled with analysis utilities in SeriesSEE (Figure 24).

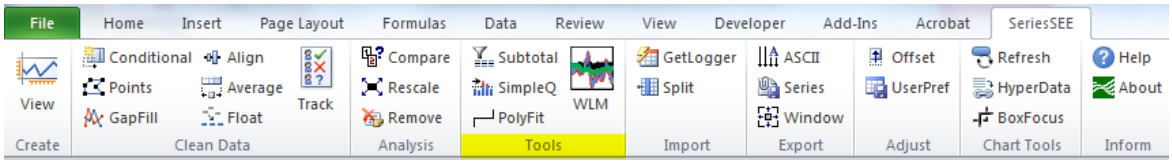

Figure 24.—Analysis group for analyzing data and managing derived series.

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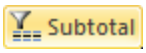
Subtotal Utility

Statistics are computed by period with the subtotal function 

(Figure 25). Data in each selected series are binned by periods or depth intervals, not by the number of measurements. All visible series are added to the “Series to Subtotal” list by default.

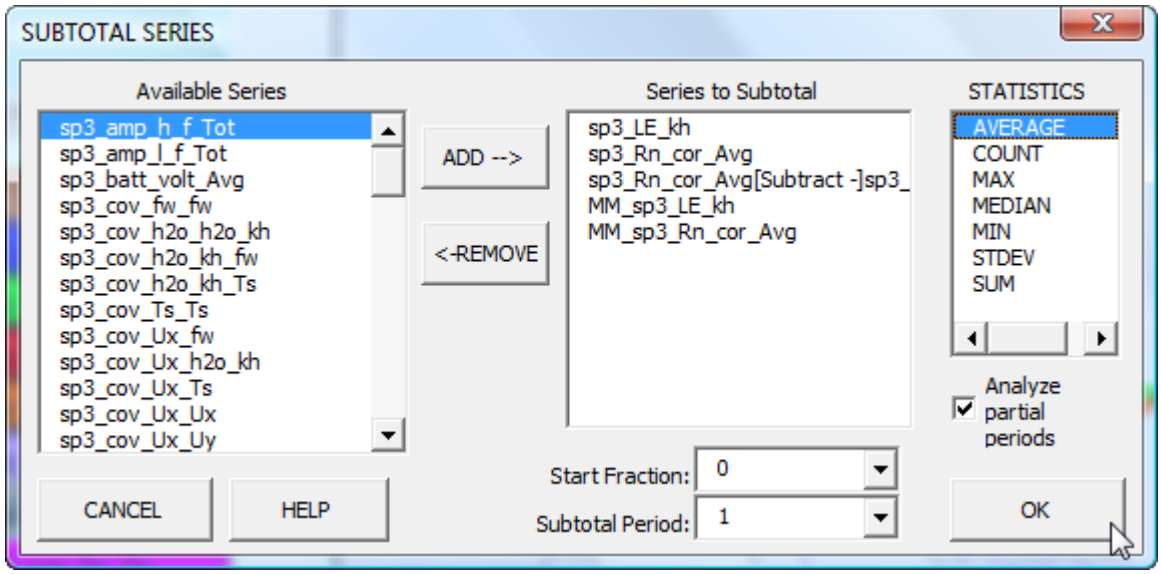
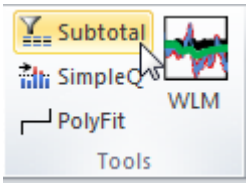
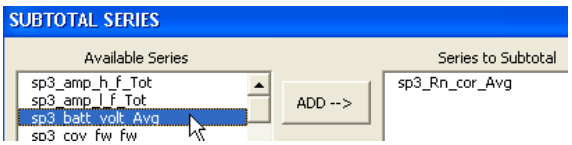
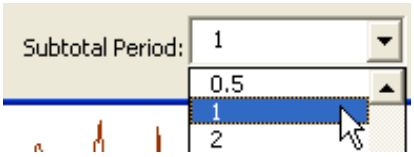
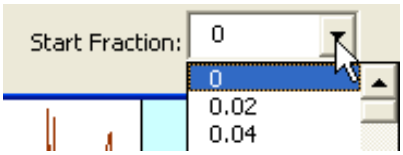
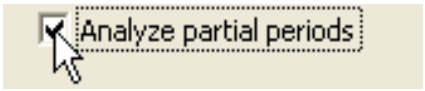
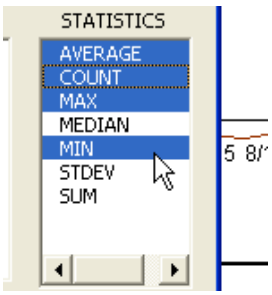
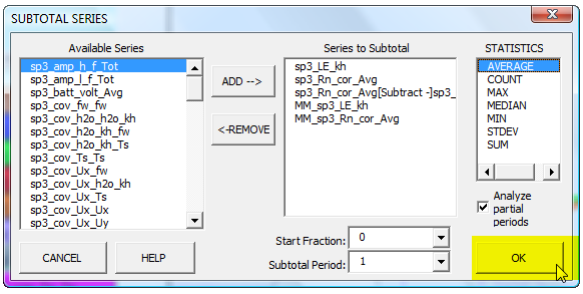
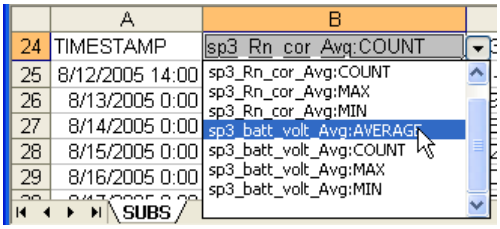


Figure 25.—Form for subtotaling series with available statistics in a new workbook.

Instructions for Subtotaling Series

Select the Subtotal utility in the Tools group.	

All visible series are added to the “Series to Subtotal” list by default. Under the “Available Series” list, either double-click a series label or select a label and press “ADD” to add a series.	
Subtotal period defines duration for computing statistics which defaults to the “Window:” period in cell B16.	
Start fraction defines start of subtotaling as a fraction of period length. For example, 1-d periods are subtotaled midnight to midnight for a 0 fraction and noon to noon for a 0.5 fraction.	
Partial periods at the beginning and end of each series are analyzed if checked.	
Select multiple statistics by holding the SHIFT or CTRL key as selecting.	
Press the OK button to compute subtotals after defining series, period, and statistics.	
View subtotal results in new workbook. Change the bar chart with the menu in cell B24.	

Subtotaled series can be viewed individually in the new workbook (Figure 26). A pull-down menu of the subtotaled series exists in cell B24. Select a series and the bar chart will display the selected series. The new subtotal workbook is not saved automatically and will be destroyed if it is closed without saving.

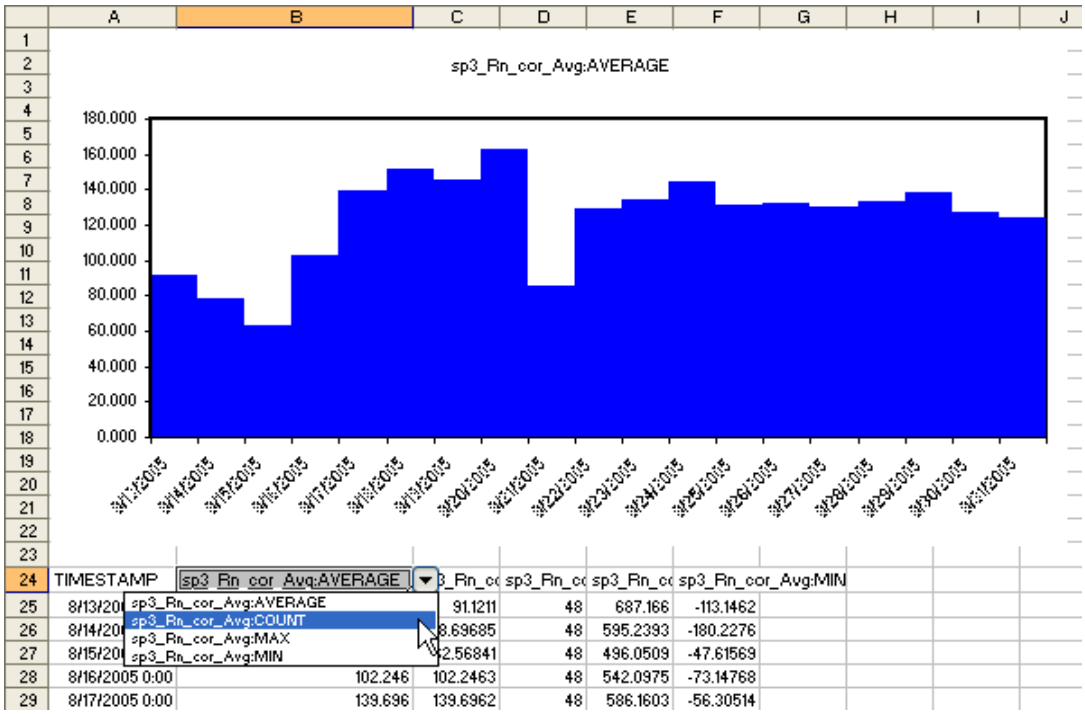


Figure 26.—Example workbook that was created with the Subtotal utility with the subtotaled series menu in cell B24 activated.

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SimpleQ Utility

Continuous records of flow rates can be reduced to relatively few step changes with the SimpleQ utility. For example, 5,154 flow rates were measured during two step tests (Figure 27). Fluctuations and changes in flow rate were recorded accurately at frequencies of 5-seconds to 2-minutes but simulating 5,154 changes in flow rate is cumbersome for both analytical and numerical solutions. Flow-rate changes were reduced from 5,154 to 51 where the simplified pumping schedule departed from the original schedule less than 10 gpm during the 9-hour period.

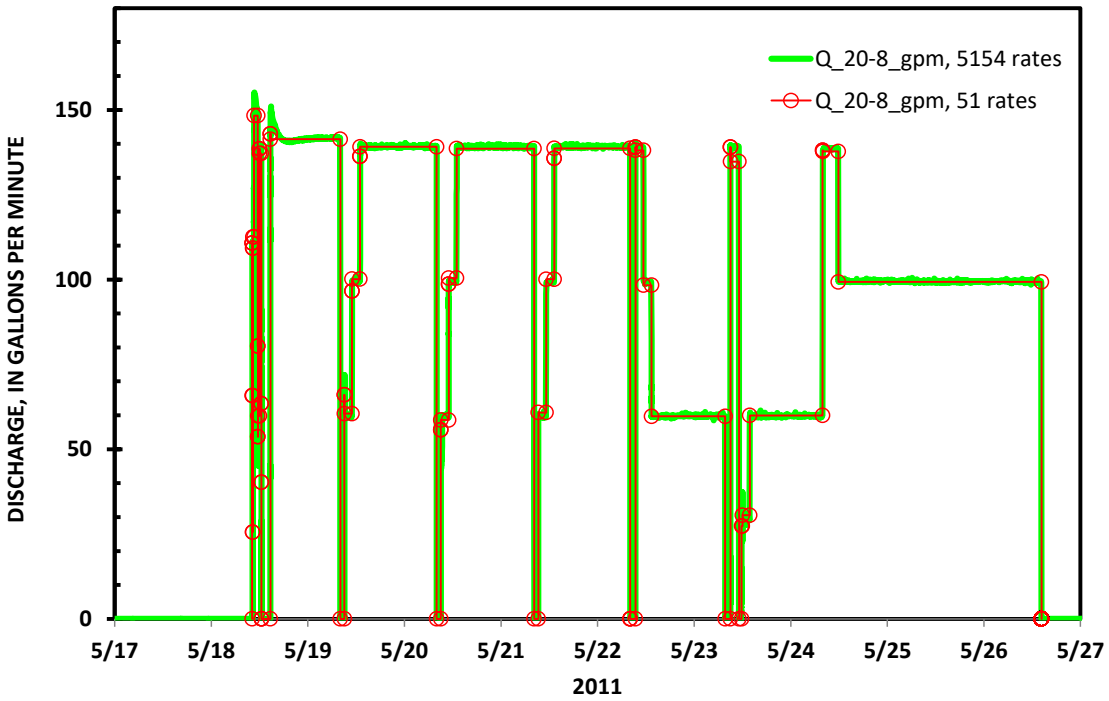

Figure 27.—Example of reducing 5,154 flow measurements to 51 step changes.

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Reduced Pumping Changes Form

Elapsed time, instantaneous changes in flow rate, minimum volume produced, and cumulative change in flow rate between measurements are the user-specified criteria for approximating continuous records with minimum number of step changes (Figure 28). Criteria are specified, and a simplified pumping schedule is computed with the Revise command. The process continues iteratively until a simplified pumping schedule is accepted by the user.

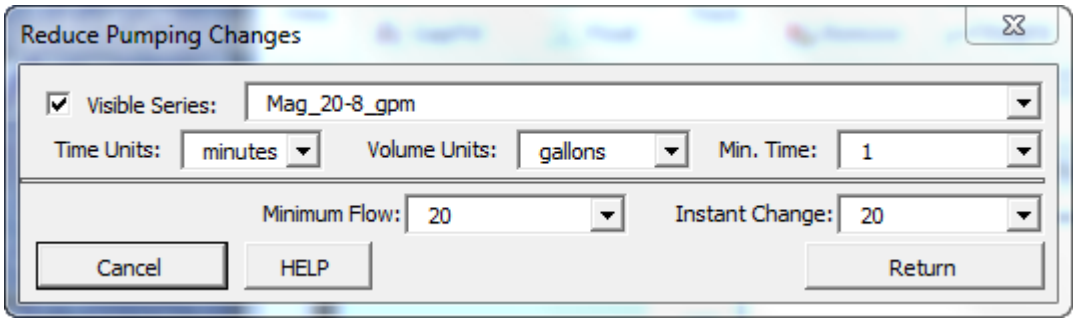
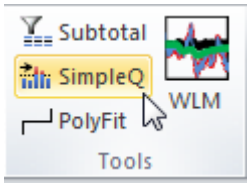
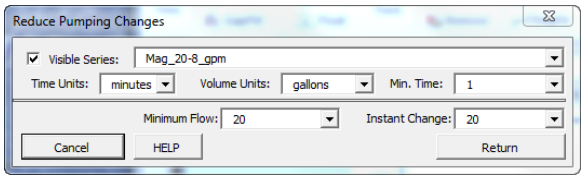
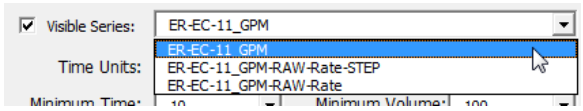
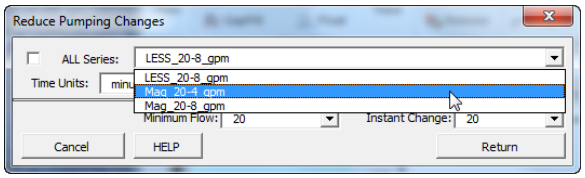
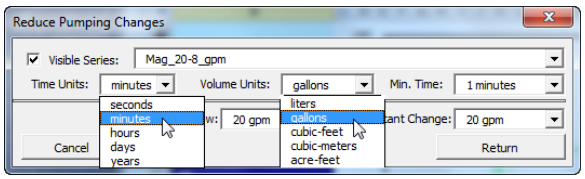
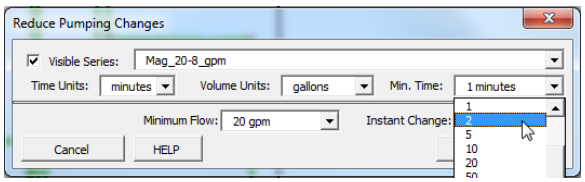
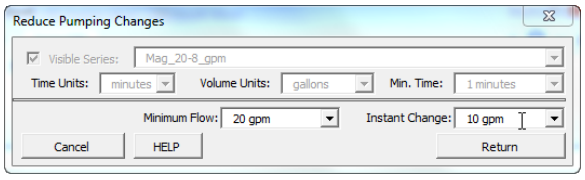
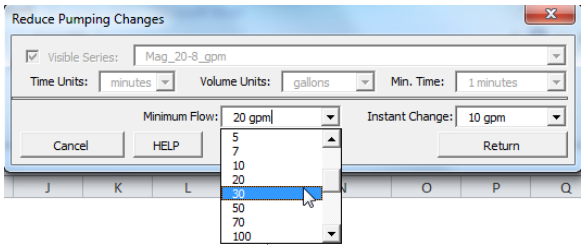
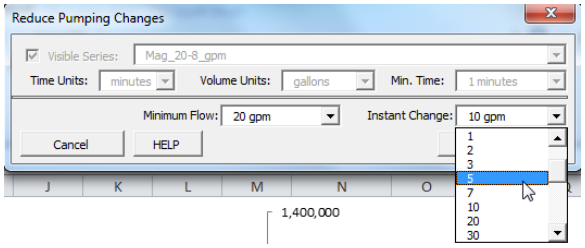
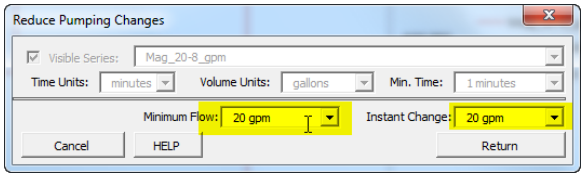


Figure 28.—Form for reducing and simplifying a pumping schedule.

Instructions for Reducing Flow Rates

Select the SimpleQ utility in the Tools group.	
The “Reduce Pumping Changes” form appears. The first visible series is the default series, which is assumed to be the pumping schedule to reduce.	
Select another visible series if the first entry is not the schedule of pumping to be reduced.	
Uncheck the visible series, and a schedule of pumping to be reduced can be selected from all series.	
Specify units of time and value before changing other criteria.	
“Min. Time” specifies an initial data reduction period. For example, 5-second data would be reduced from 12 measurements per minute to 1 value by averaging if “Min. Time” equals 1 minute.	
Entering and exiting the “Minimum Flow” or “Instant Change” dialog disables entry in the upper half of the form and creates the temporary workbook for reducing pumping rates.	

“Minimum Flow” specifies the lowest pumping rate that will be considered non-zero. For example, a well was pumped at rates of 50, 100, and 150 gpm and a Minimum Flow of 10 gpm was specified. All logged rates of less than 10 gpm are assumed to be noise and are changed to 0 gpm.	
“Instant Change” specifies the smallest change in pumping rate that will be considered real. Measurement times are preserved when pumping rates change more than the specified “Instant Change.”	
Entering and exiting the “Minimum Flow” or “Instant Change” dialogues recalculates the reduced pumping schedule that is displayed in the temporary workbook.	

Adequacy of a reduced pumping schedule is evaluated graphically in a temporary workbook (Figure 29). A user can experiment with the reduction criteria on the “Reduced Pumping Changes” form and revise the reduced pumping schedule. The raw pumping rates, reduced pumping schedule, and cumulative volume of produced water are charted to evaluate adequacy of fit.

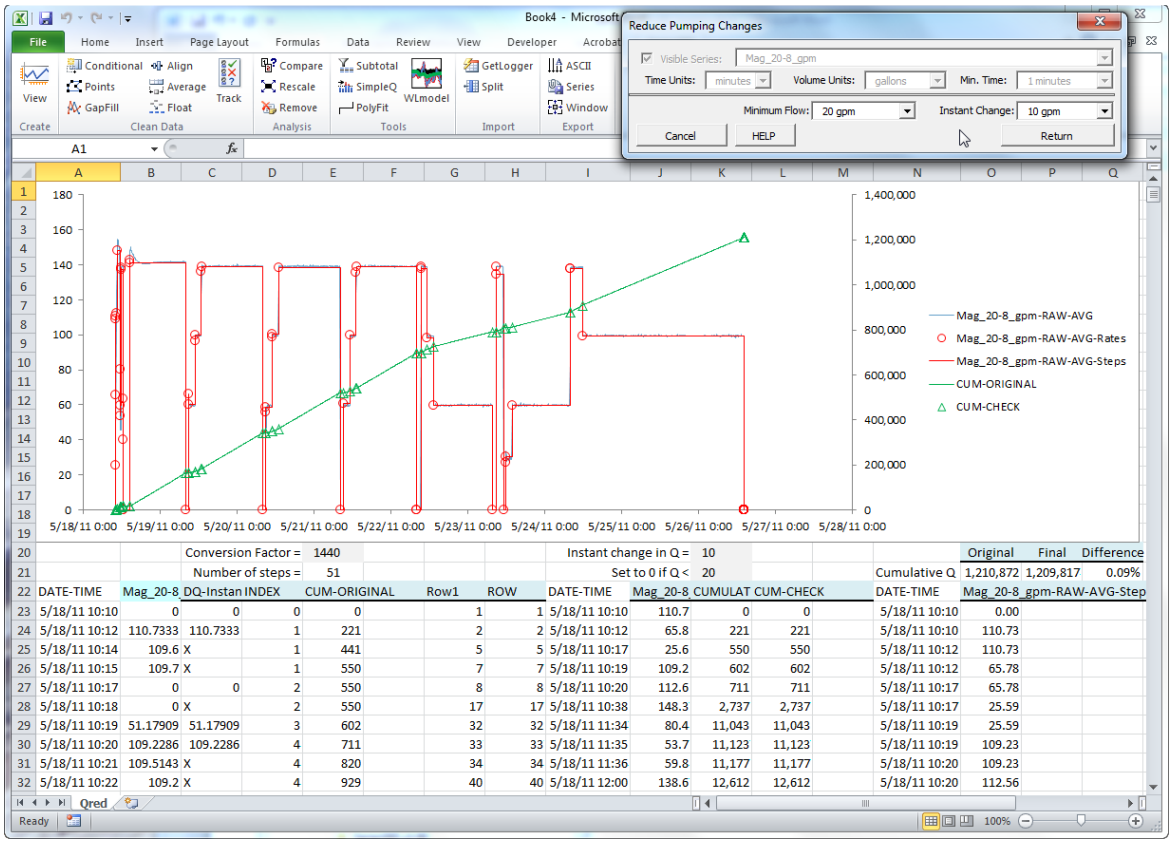


Figure 29.—Temporary workbook and user form for simplifying a pumping schedule.

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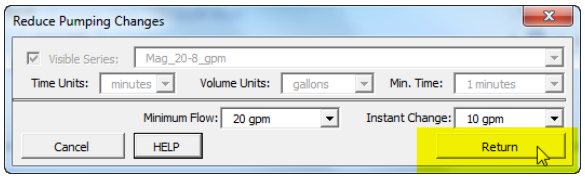
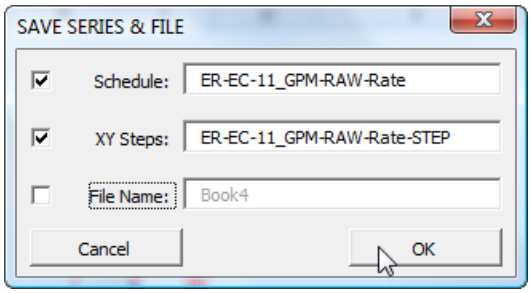
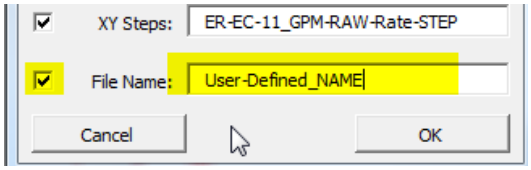
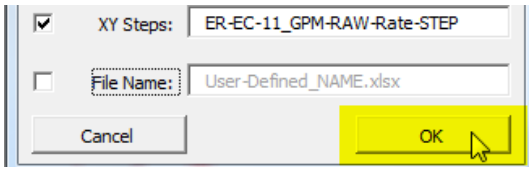
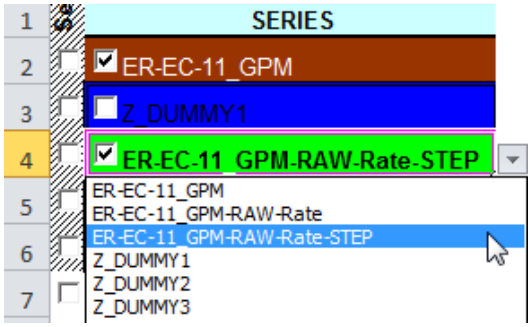
Returning Reduced Pumping Schedule

The reduced pumping schedule and step approximation of the reduced pumping schedule are the default series that will be returned to the SeriesSEE viewer. The temporary workbook can be saved if the user intervenes, but the file will be deleted by default. All series and file names can be changed from the default names that are created by SeriesSEE.

Returning Simplified Pumping Schedule to SeriesSEE Viewer

Select Return to close the “Reduce Pumping Changes” form, and open the “SAVE SERIES & FILE” form.	

A “SAVE SERIES & FILE” form replaces the previous form, which queries for returning the pumping schedule and step approximation of the pumping schedule. The pumping reduction workbook can be saved, but the default is to delete the file.	
Check the File Name if the pumping reduction workbook is to be saved. Series and file names can be changed by the user.	
Select OK to close the form and return the simplified pumping schedule and step approximation to the SeriesSEE Viewer.	
The simplified pumping schedule and step approximation can be plotted after returning to the SeriesSEE Viewer. Use the drop-down menus in cells B2:B13 on the VIEW page. Markers added in the magnifier window will be retained and presented in both windows by unselecting and selecting a series.	

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PolyFit Utility

Geophysical logs are approximated with a simple polyline using the PolyFit utility, PolyFit, (Figure 30). Regular fluctuations that are assumed to be noise initially are reduced by averaging measurements in bins of equal depth. The polyline is fit sequentially to the binned geophysical log. Polylines can be constrained to increase monotonically along the X-axis, Y-axis, or both. Polylines also can be fitted to time series, but the algorithms are not optimized for time series.

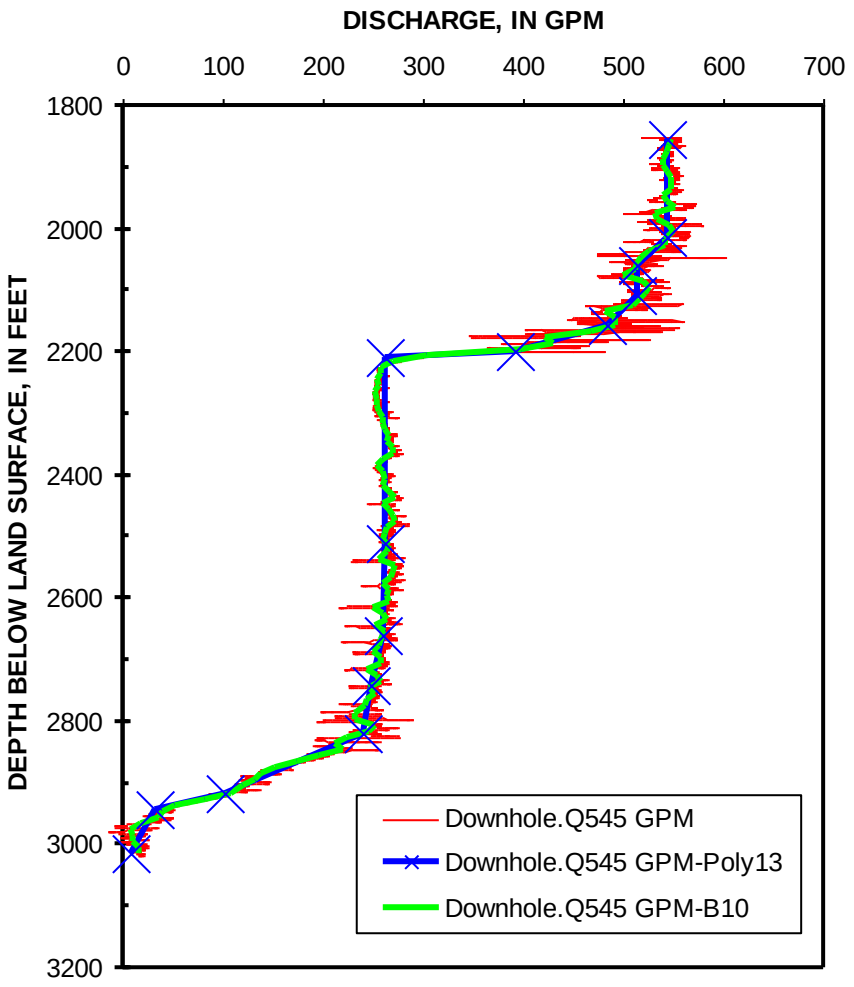

Figure 30.—Initial flow log, binned, flow log, and polyline that was fit monotonically to the binned flow log.

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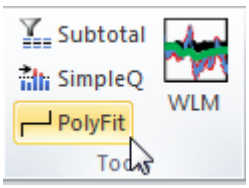
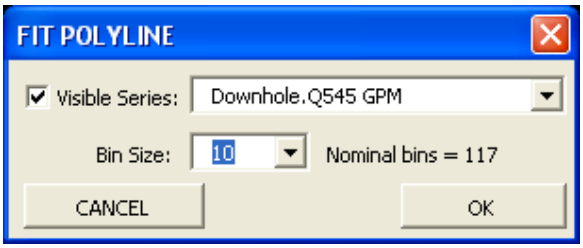
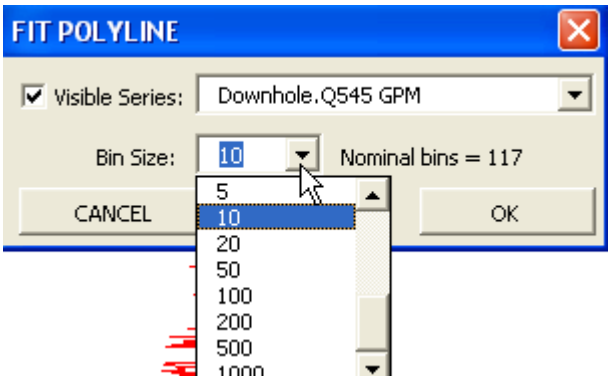
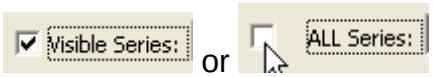
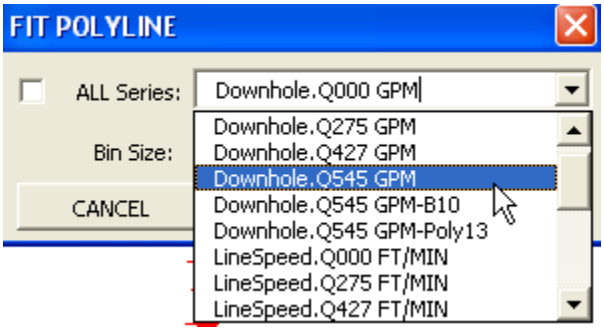
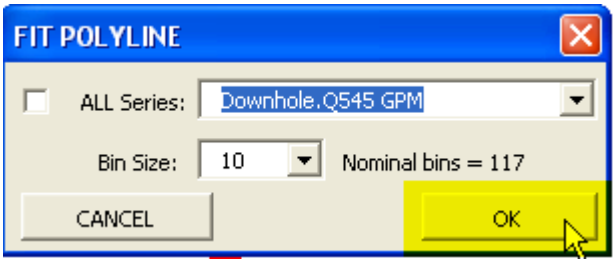
FIT POLYLINE form

The series to be approximated with a polyline and the bin size for suppressing noise by averaging are specified with the FIT POLYLINE form. Visible series are specified by default, but the selection can be expanded to all series from the form.

Launch polyline fitting workbook

Select the PolyFit utility in the Tools group. All visible series are added to the PolyFit list by default. Fill data gaps with the "Gap Fill" utility	

The FIT POLYLINE form will appear.	
Select a bin size that is large enough to average the highest frequency variations in a log.	
All series can be made available by unchecking the Visible Series box.	
The pull-down menu will list all series after unchecking the Visible Series box.	
Select OK after correctly identifying the series to be approximated with a polyline and specifying an appropriate bin size. A polyline fitting workbook will be created, and the “ADD or LOSE segments” form will appear.	

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Polyline fitting workbook

The polyline fitting workbook is temporary space where a user can experiment with fitting a polyline to a log (Figure 31). Segments are added sequentially to fit the polyline to the binned log. The segment with the greatest sum-of-squares, SS, error is subdivided. The RMS error of the entire polyline is reduced by estimating

the position of the vertices except the top and bottom depths. Vertex position estimates are constrained to monotonic changes as specified by the user. Vertex positions are estimated after each segment is subdivided. Vertices are removed sequentially to create the least increase in RMS error.

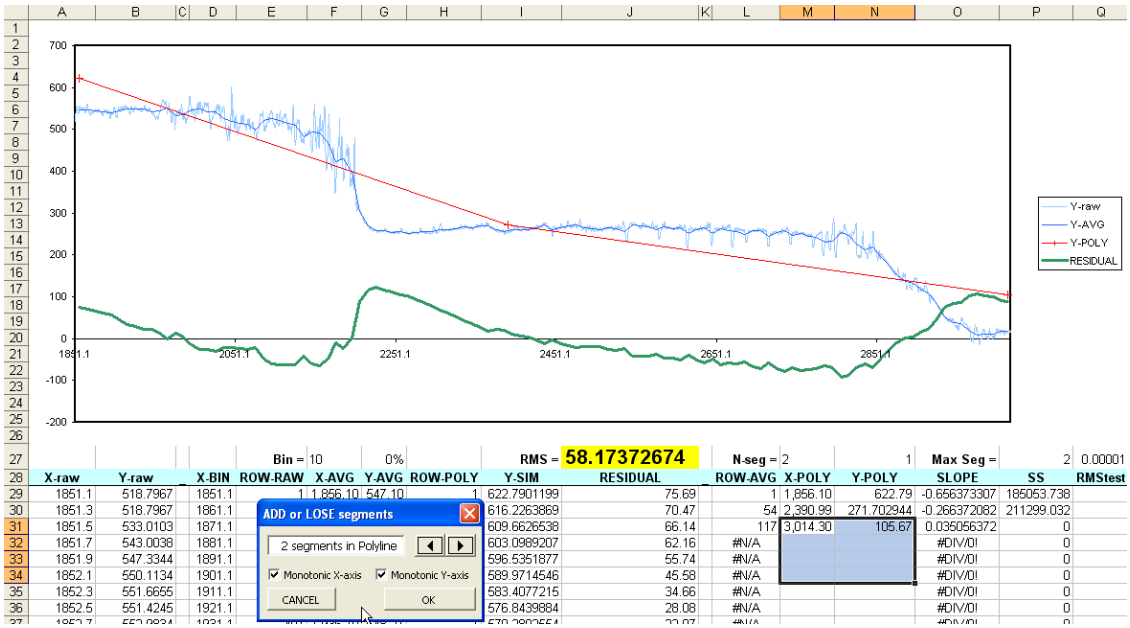
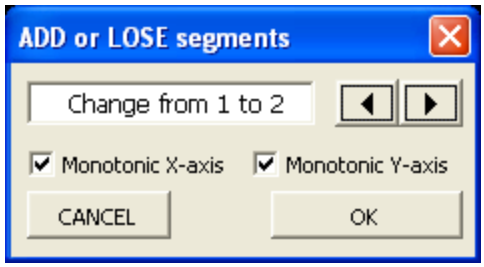
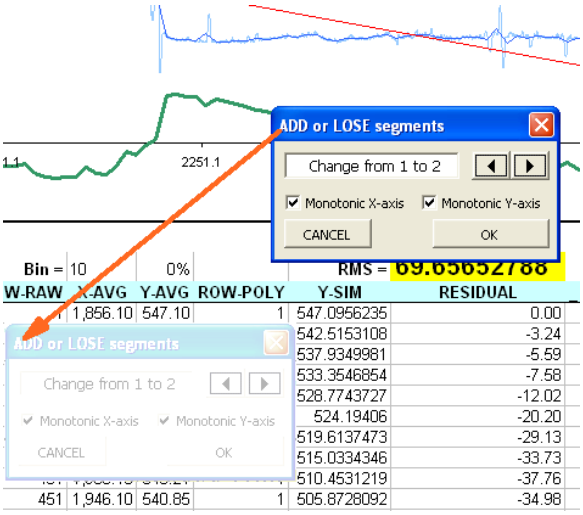
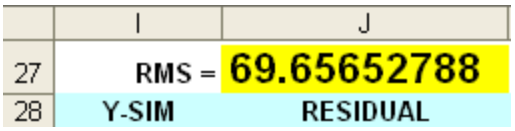
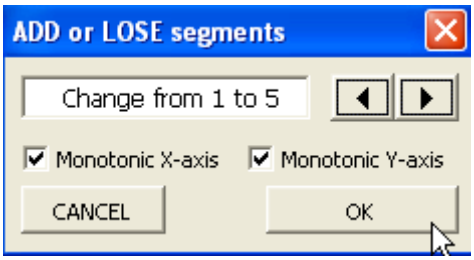
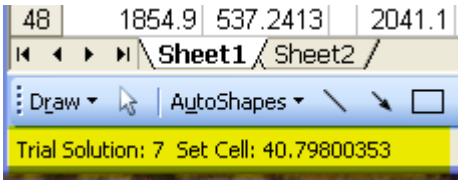
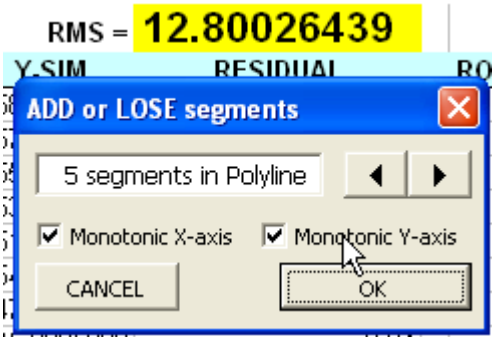
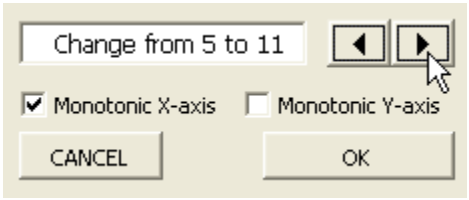
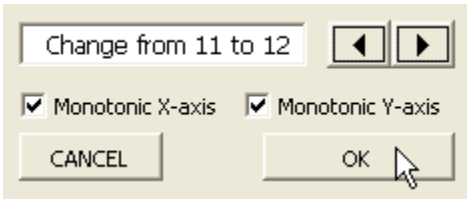
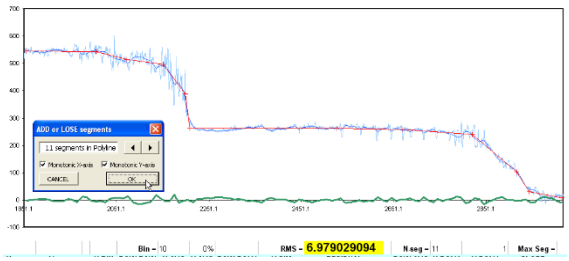
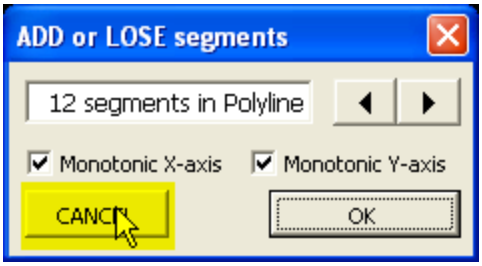
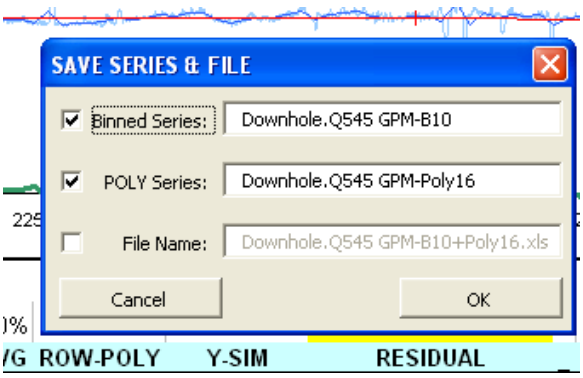


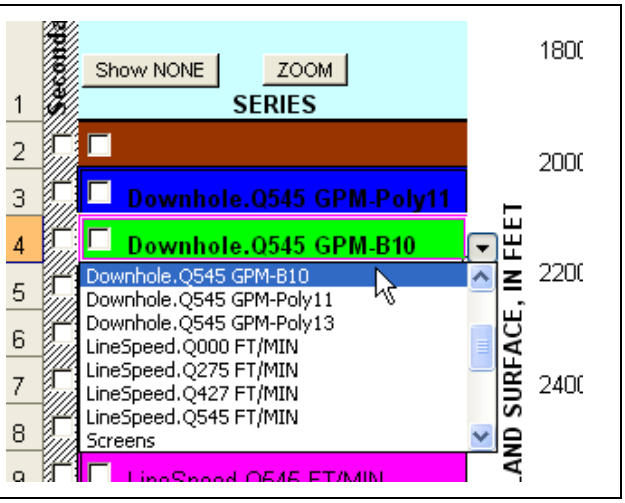
Figure 31.—Polyline fitting workbook where initial log, binned log, polyline, and RMS error are displayed and "ADD or LOSE segments" form that controls fitting process of polyline.

Fitting polyline to binned geophysical log

The "ADD or LOSE segments" form will appear. Textbox reports how the polyline will be changed after selecting OK. Checked boxes force polyline to change monotonically along an axis.	

The “ADD or LOSE segments” form defaults to the center of workbook window, which usually obstructs the RMS error cell and the graph. Move the form before using.	
Root-Mean-Square, RMS, error between polyline and binned log is reported in cell J27.	
Segments are added or subtracted with the  buttons. Requested change is reported in the text box. Select the OK button to start the fitting process.	
RMS error change is reported in the lower, left corner of the workbook, while the Solver fits the polyline to the binned log.	
Text box reports the number of segments in the polyline after all segments have been added or deleted and the Solver is finished.	

Unchecking the “Monotonic Y-axis” option can improve the initial distribution of segments.	
Check the “Monotonic Y-axis” option before finishing to ensure that results are physically plausible.	
Polyline is completed when additional segments minimally reduce the RMS error or the RMS error is less than the noise in the initial log.	
Select cancel to stop adjusting the polyline and return estimates to the SeriesSEE viewer.	
A “SAVE SERIES & FILE” form replaces the previous form, which queries for returning the binned series and polyline. The polyline fitting workbook can be saved, but the default is to delete the file. Series and file names can be changed by the user.	

The binned series and polyline can be plotted after returning to the SeriesSEE viewer. Use the drop-down menus in cells B2:B13 on the VIEW page. Markers added in the magnifier window will be retained and presented in both windows by unselecting and selecting a series.	

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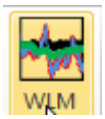
WLM Utility



Water levels and other time series can be modeled with the WLM utility to differentiate environmental (natural) water-level fluctuations from pumping responses in observation wells. Drawdowns are differentiated from environmental fluctuations by modeling synthetic water levels that simulate environmental water-level fluctuations and pumping effects. Environmental water-level fluctuations are simulated by summing individual time-series of barometric pressure, tidal potential, and background water levels. Pumping responses are simulated by superposition of Theis solutions.

Environmental water-level fluctuations are simulated with time series of barometric pressures, earth tides, and water levels from background wells. Background wells are assumed close enough to the observations wells to be affected by similar environmental fluctuations, yet distant enough to be unaffected by pumping. Water levels from background wells are critical because they are affected by tidal potential–rock interaction, imperfect barometric coupling, and seasonal climatic trends. These effects also are assumed to be present in the observation wells.

Pumping responses are modeled with a superposition Theis model, where multiple pumping periods are simulated by superimposing multiple Theis solutions. Superposition Theis models served as simple transform functions, where step-wise pumping records are translated into approximate water-level responses. Numerical experiments have confirmed that superposition Theis models closely approximate water-level responses through hydrogeologically complex aquifers. This approach is referred to as the Theis transform model here.

Synthetic water levels are fit to measured water levels by minimizing a sum-of-squares objective function. Amplitude and phase are adjusted in each time series that simulates environmental water-level fluctuations. Transmissivity and storage

coefficient are adjusted in the Theis transform model. Estimated values of transmissivity and storage coefficient from the Theis transform model generally are not valid estimates of aquifer properties because the assumptions of the underlying Theis solution are significantly violated.

Fitting results are not degraded and spurious drawdowns are not estimated, if extraneous time series are included. For example, environmental fluctuations in a background well, but not in the observation well, are ignored during the fitting process. Extraneous time series, that is, those that do not correlate with fluctuations in the observation well, are eliminated functionally because amplitude estimates approach zero. Simulated pumping responses also can be eliminated functionally by Theis parameters becoming very large. Drawdown estimates are the summation of all Theis transforms and the differences (residuals) between synthetic and measured water levels.

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Water-Level Modeling utility

The WLmodel utility in SeriesSEE creates a new workbook for Water-Level Modeling (WLM). Water levels to be modeled, component series, period of analysis, and WLM components are defined interactively with forms (Figure 32). This occurs prior to creating a WLM workbook and fitting synthetic water levels to measured water levels. Water levels are simulated with a FORTRAN program that applies all transforms each WLM component. Drawdowns are estimated by summing all Theis transforms and differences between synthetic and measured water levels.

Differences between synthetic and measured water levels are minimized with PEST. Parameter estimates, transformed WLM components, synthetic water levels, and differences are imported automatically into the WLM workbook after PEST finishes. Model fit is defined by RMS error and evaluated graphically (Figure 32). Parameters are estimated and WLM results are evaluated iteratively until the user deems the fit to be adequate.

Drawdowns and transformed WLM components are returned to the SeriesSEE viewer once the user accepts a WLM (Figure 32). Drawdowns and transformed WLM components are selected individually so the number of returned series can range between zero and all. The WLM workbook also can be archived as a macro-free workbook that can be re-activated.

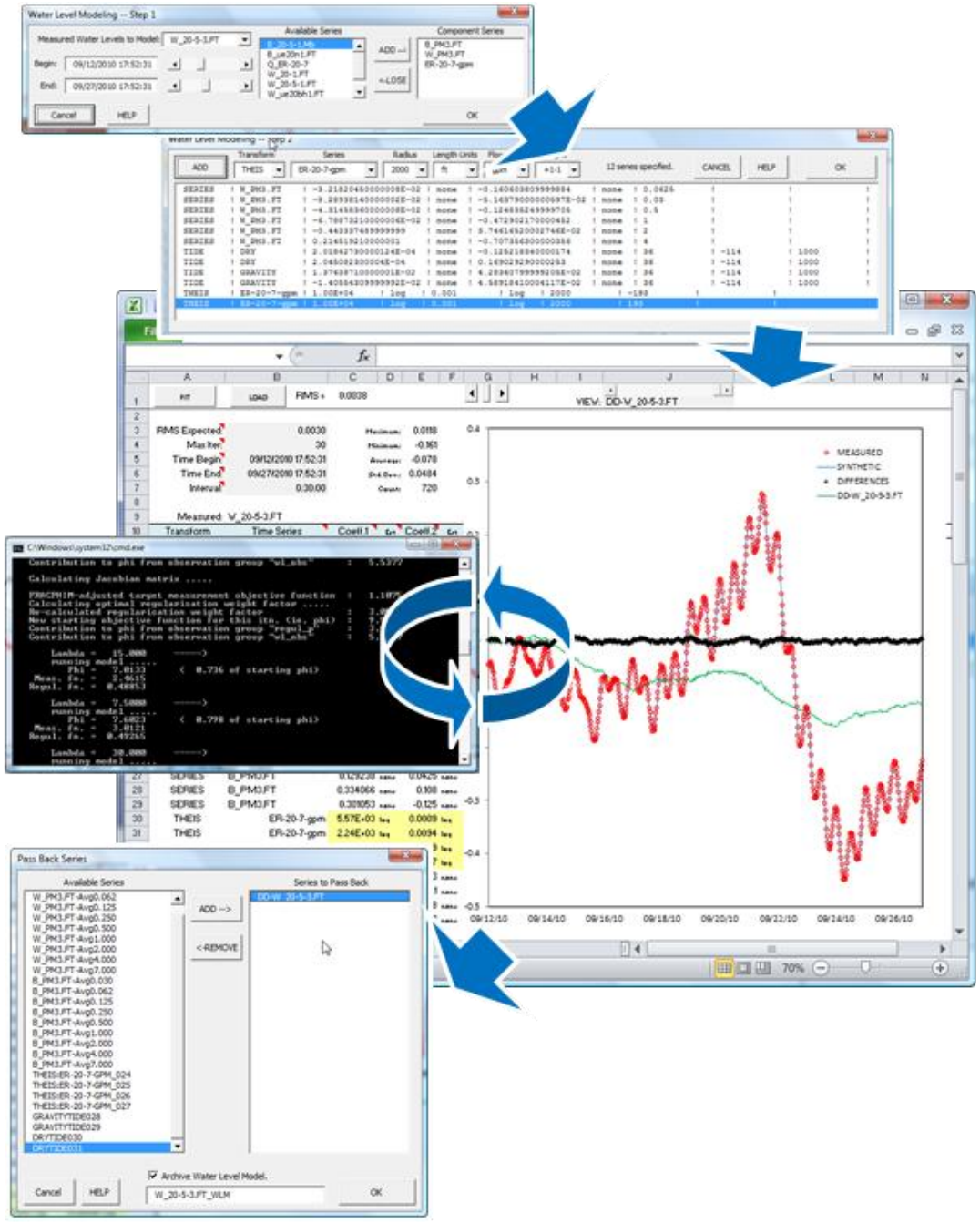

Figure 32.—WLM creation forms, WLM workbook, command-line calls, form for returning WLM results created by the WLM utility.

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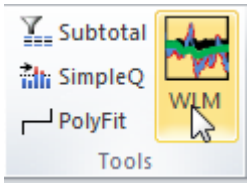
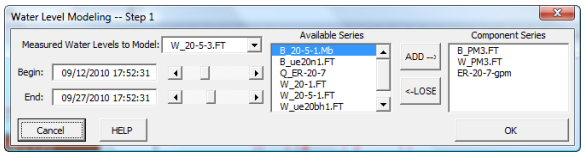
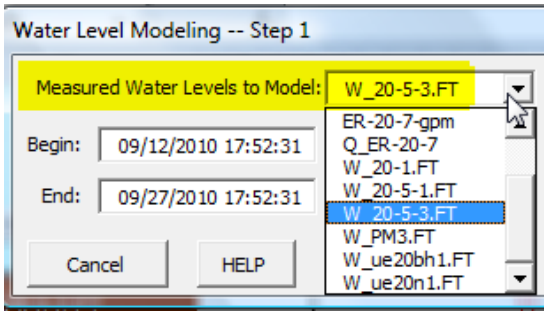
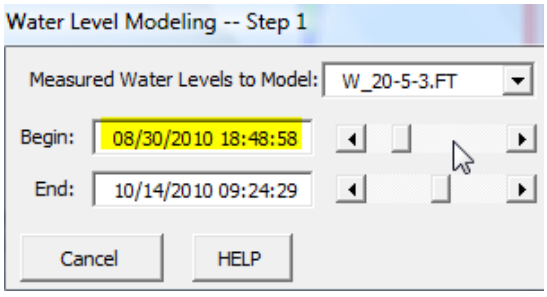
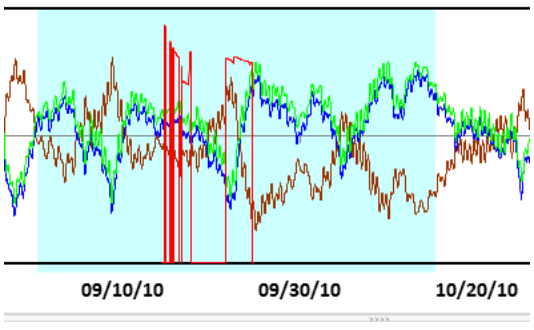
Selection of series and period of analysis

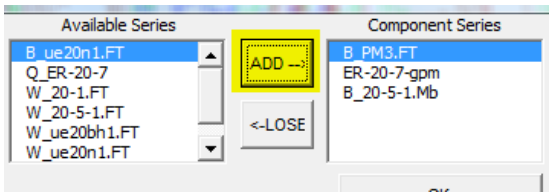
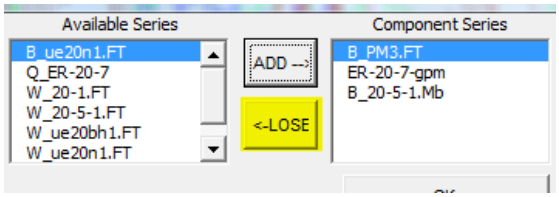
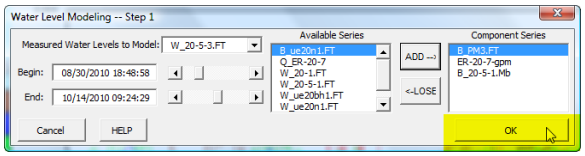
Water levels to be modeled, component series, and period of analysis are defined with the first form, “Water-Level Modeling – Step 1” (Figure 33). Water levels to be modeled default to the first visible series, but can be changed on the form. Component series default to the all visible series except the first, but can be changed on the form. The period of analysis defaults to the previously selected

period if data exist within the previously selected period. This period can be re-defined graphically or by entering specific dates and times.

Figure 33.—First Water-Level Modeling Form for selecting series and the period of analysis.

Instructions for Completing First Water-Level Modeling Form

Select the WLmodel utility in the Tools group.	
The "Water-Level Modeling – Step 1" form will appear.	
The first visible series is assumed to be measured water levels. This can changed on the form if another series is to be modeled.	
Adjust beginning and ending of analysis period with scroll bars. Selecting areas between slider and end arrows will move beginning and ending. Beginning and ending of windowed period also can be entered directly.	
Highlighted area in lower, overview window depicts the analysis period.	

Under the “Available Series” list, either double-click a series or select a series and press “ADD” to add a series to the “Component Series” list.	
Under the “Component Series list, either double-click a series or select a series and press “REMOVE” to move a series back to the “Available Series” list.	
Select OK. A water-level modeling workbook will be created with the specified measured water-level series, component series, and analysis period.	

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Defining Water-Level Model Components

Water-Level Modeling (WLM) components are defined with the second form, “Water-Level Modeling – Step 2” (Figure 34). A WLM component generally is a transform of one of the component series where five transforms can be applied (Table 1). Environmental fluctuations primarily are simulated with SERIES transformations, where moving averages of a component series are adjusted by changing the amplitude and phase. More than a half dozen WLM components frequently are created from a single component series because multiple averaging periods are specified. The SLOPE+OFFSET is a non-optional component that defines a linear trend and a constant. The default slope is 0 and is not estimated.

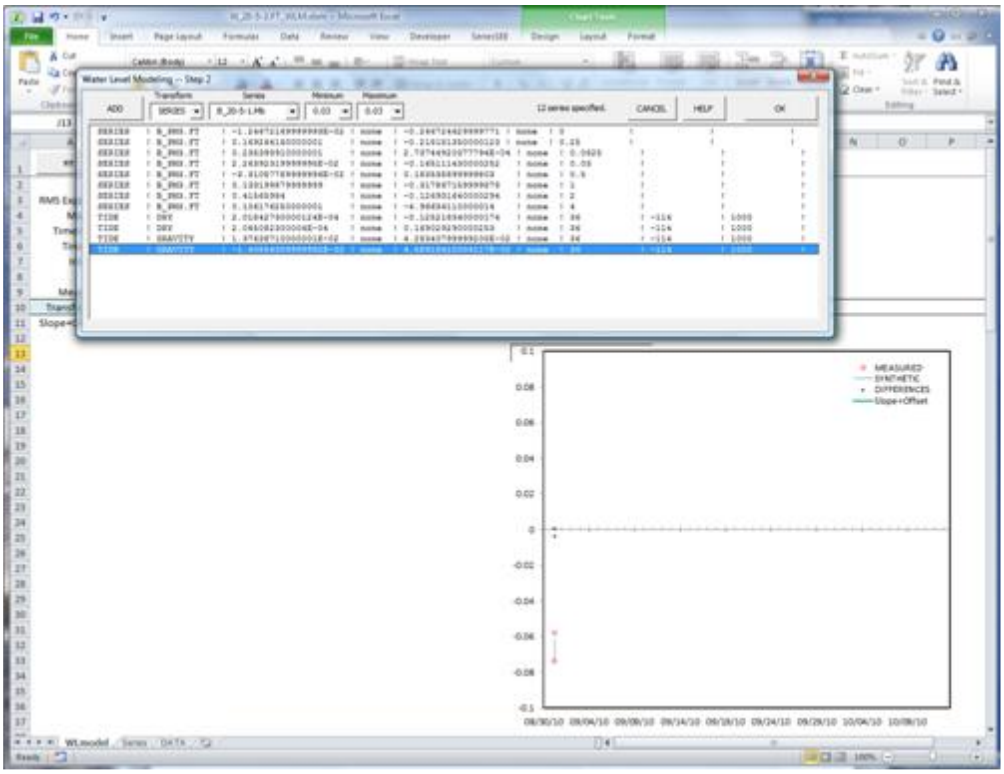


Figure 34.—Water-level modeling workbook that is created after closing the "Water Level Modeling – Step 1" form and the "Water Level Modeling – Step 2" form.

STEP, THEIS, TIDE, or UNSAT transforms can be applied to a WLM component in addition to the SERIES transform (Table 1). The STEP transform simulates transducer displacement with a shift at a user-specified time where the magnitude of the shift can be estimated. THEIS transforms pumping schedules to water-level changes at the observation well where transmissivity and storage coefficient are estimated. TIDE computes one of the six tide components as defined by Harrison (1971). UNSAT transforms barometric-pressure changes at land surface to air-pressure changes at the water table.

Table 1.—Definition of coefficients for each transform.

[-- is not applicable.]

Transform	Time Series	COEFFICIENT 1	2	3	4	5
SLOPE+OFFSET	--	Slope	Shift	--	--	--
SERIES	Any Series	Multiplier	Phase	Averaging Period	--	--
STEP	--	Time	Offset	--	--	--
THEIS	Pumping Schedule	Transmissivity	Storage Coefficient	Radius	Flow Rate Conversion	--
TIDE	Computed	Multiplier	Phase	Latitude	Longitude	Altitude
AirLAG [a]	Barometric Pressure	K_{AIR}	S_{AIR}	Thickness of Unsaturated Zone	--	--
GAMMA [1]	Precipitation	Multiplier	k	n	Time conversion	Multiplication Series

[a] Hydraulic properties of the Pneumatic-lag transform, K_{AIR} & S_{AIR}, are with respect to air. K_{AIR} is hydraulic conductivity of air and about 60 times greater than K_{WATER}. S_{AIR} is average air-filled porosity divided by mean air pressure.

[1] The k and n terms represent scale and shape parameters, respectively in the Gamma PDF.

Variables for each WLM component are labeled with the generic coefficient 1, 2, 3, 4, and 5 (row 10, Figure 35). The coefficients represent different properties or are unused depending on selected transform (Table 1). For example, coefficient 1 is an amplitude, a date, a transmissivity, or a hydraulic conductivity of air for the SERIES, STEP, THEIS, or UNSAT transforms, respectively. Coefficients 1 and 2 are estimable, which is controlled by entries in the column right of the coefficient column. Fixed, none, or log specify that a coefficient will not be estimated, estimated as is, or the log-value will be estimated, respectively. Fixed, none, and log are the same keywords that PEST uses. Coefficients 3, 4, and 5 are supporting entries such as an averaging period or distance that cannot be estimated.

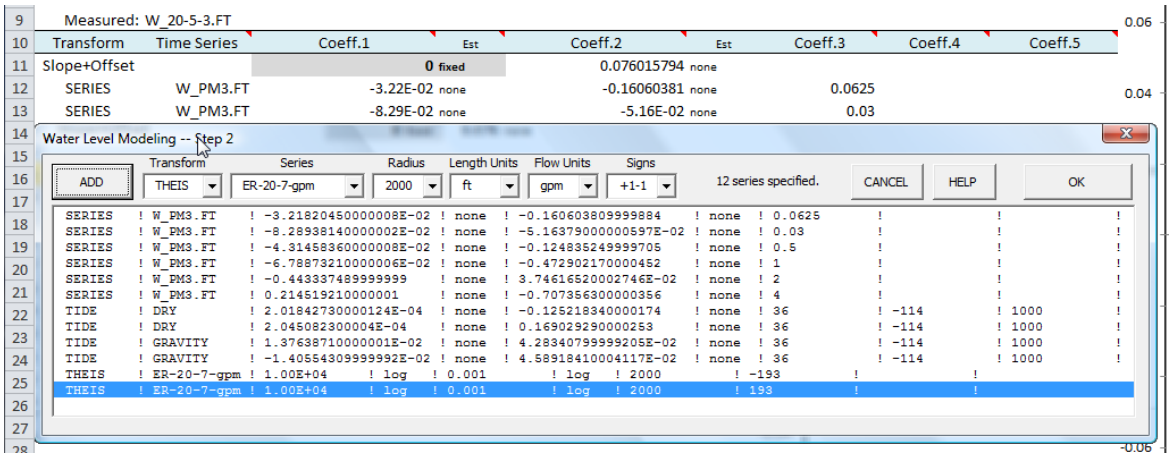
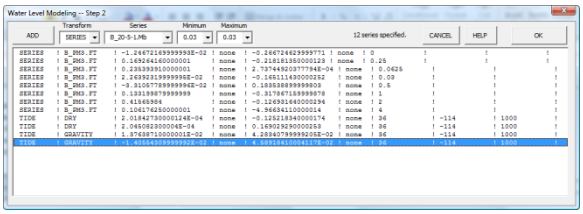
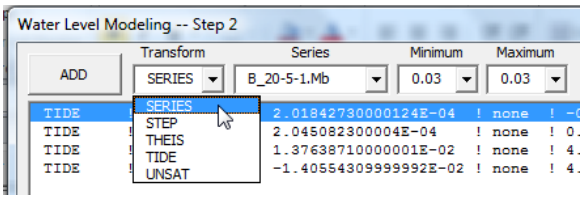
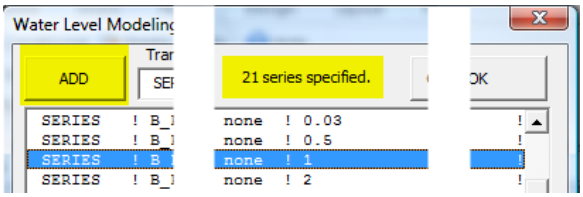
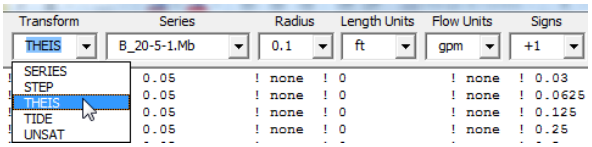
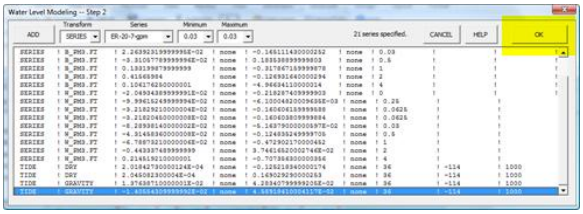


Figure 35.—The "Water Level Modeling – Step 2" form for adding components to a water-level model superimposed with the destination columns in the water-level modeling workbook.

WLM components are shown on the second form, "Water-Level Modeling – Step 2" as they will be assigned to the water-level modeling workbook (Figure 35). Coefficients 1 and 2 are specified from previous WLM exercises or pre-programmed initial estimates. WLM results are not overly sensitive to these initial estimates. Coefficients 3, 4, and 5 can differ from entries in the pull-down menus, which define general conversions and the number of WLM components to be added (Figure 35). For example, coefficient 4 converts flow rates in a series to consistent units for the THEIS transform and is defined by specifying length and flow units.

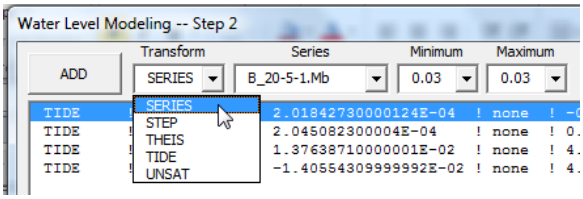
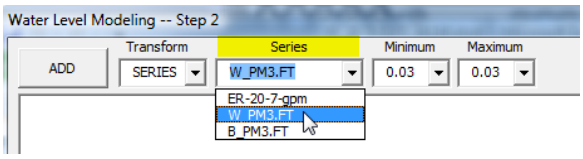
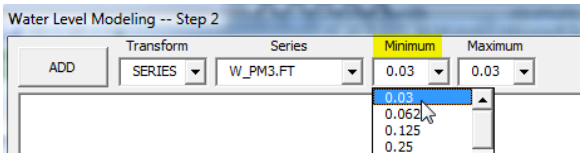
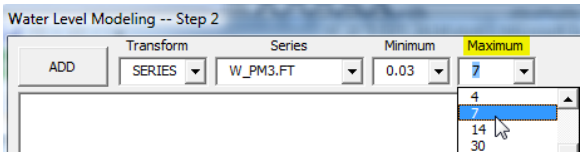
Overview—Second Water-Level Modeling Form

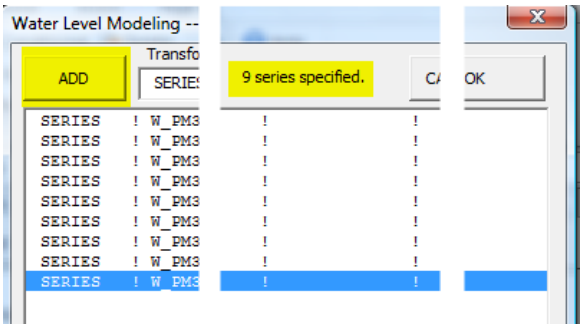
"Water-Level Modeling – Step 2" form is launched after the water-level modeling workbook is created. WLM components automatically are added to the form where component series have been used previously and the current analysis period overlaps the previous analysis period.	
A transform must be selected first because the pull-down menus right of the transform change with the selected transform.	

The number of selected WLM components is reported in the upper, middle of the form and is updated after the ADD button is pressed. WLM components are deleted by double-clicking a highlighted line in the table.	
Changing the transform changes the pull-down menus right of the selected transform.	
Click OK in the upper, right corner of the form after all WLM components have been defined.	

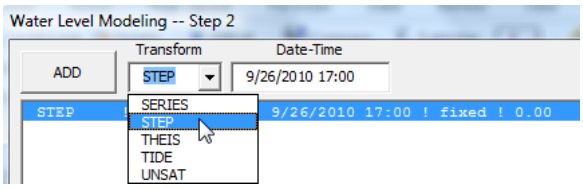
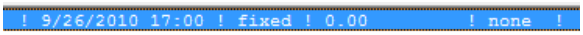
Entry for each transform is described individually because the dialog on the “Water-Level Modeling – Step 2” changes for each transform.

Adding SERIES components—Second Water-Level Modeling Form

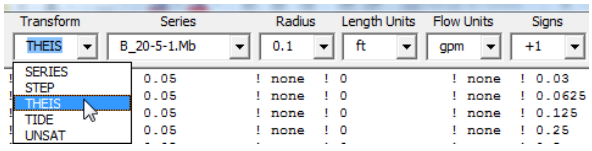
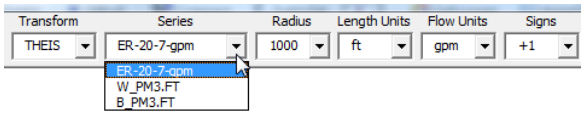
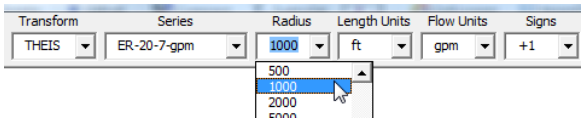
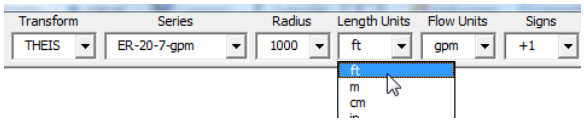
Select the SERIES transform.	
Select a series.	
Define the shortest period for a moving average with the Minimum menu.	
Define the longest period for a moving average with the Maximum menu.	

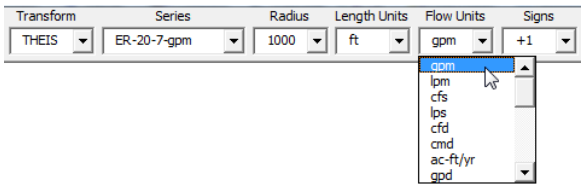
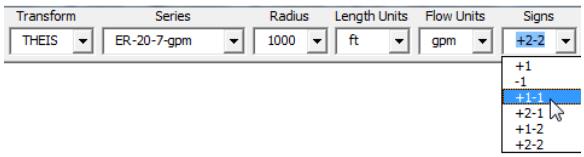
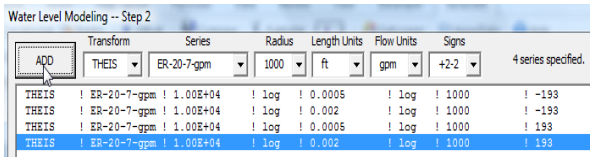
Select ADD and 9 WLM components will be added to the form. These WLM components will differ by moving average period. The averaging periods are defined in the WLM utility and are 0.03, 0.06, 0.13, 0.25, 0.5, 1, 2, 4, 7, 14, 30, 60, 120, 365, 730, 1460, 1825, 3650 days.	

Adding STEP components —Second Water-Level Modeling Form

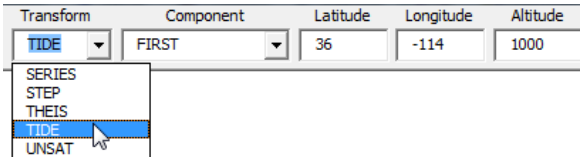
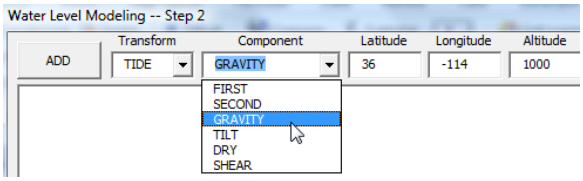
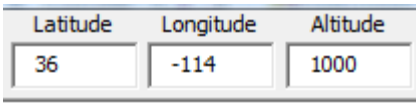
Select the STEP transform. Specify the date-time of the step change.	
A WLM component will be added to the form where the date is not estimated, and the step change can be estimated.	

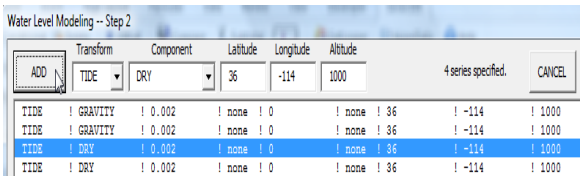
Adding THEIS components—Second Water-Level Modeling Form

Select the THEIS transform.	
Select a series with a pumping schedule.	
Select a radial distance between pumping and observation wells. Do NOT fret the exact distance for this crude approximation.	
Specify the length units of the radial distance.	

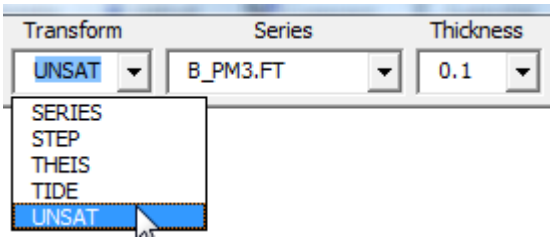
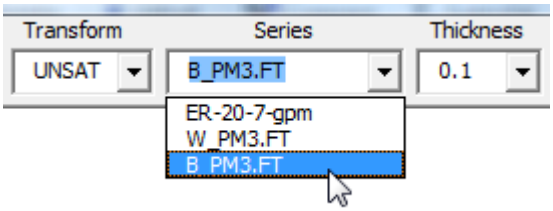
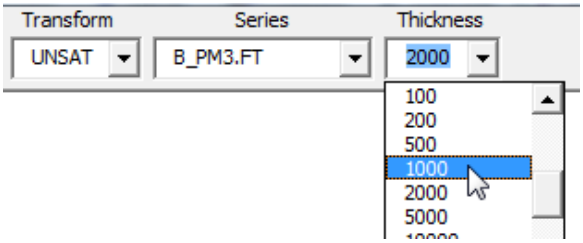
Specify the flow-rate units for converting rates in the series to length units-cubed per day.	
Specify the number and signs of Theis transforms. -1 adds 1 WLM component with a negative conversion factor. +1-1 adds 2 WLM components, one conversion factor is positive and the other conversion factor is negative. Positive and negative components are specified when the direction of displacement is unknown, because sign cannot change as occurs when estimating amplitudes.	
Select ADD, 4 WLM components were added because “+2-2” was selected in the Signs menu.	

Adding TIDE components—Second Water-Level Modeling Form

Select the TIDE transform.	
Select a tide component.	
Specify decimal latitude, decimal longitude, and altitude. Results are affected minimally by the entries because phase and amplitude are estimated.	

Select ADD, and a WLM component will be added. Tides work best in pairs that initially have a phase difference of 0.5 day.	

Adding UNSAT components—Second Water-Level Modeling Form

Select the UNSAT transform.	
Select a series with a barometric record.	
Select an approximate thickness of the unsaturated zone. Do NOT fret the exact distance for this crude approximation.	
Select ADD, and a WLM component will be added. Unit conversions are not specified because the barometric change and thickness of the unsaturated zone are assumed to be equivalent length scales.	

Previous –●– Next

Water-Level Modeling Workbook

Fitting, experimenting, and evaluating goodness of fit between synthetic and measured water levels occurs in the water-level modeling workbook (Figure 36). Water levels are simulated with a FORTRAN program that applies all transforms each WLM component. Differences between synthetic and measured water levels

are minimized with PEST. Model fit is defined by RMS error and evaluated graphically (Figure 36). Parameters are estimated and WLM results are evaluated iteratively until the user deems the fit to be adequate.

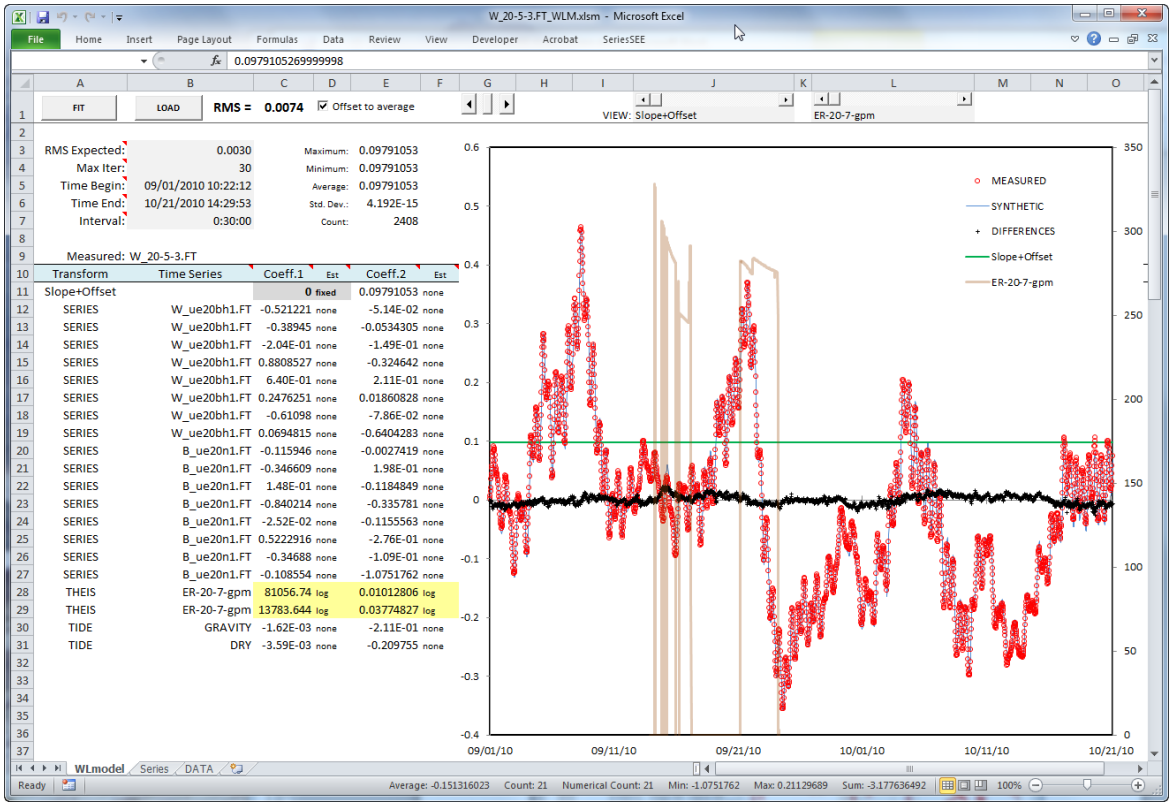
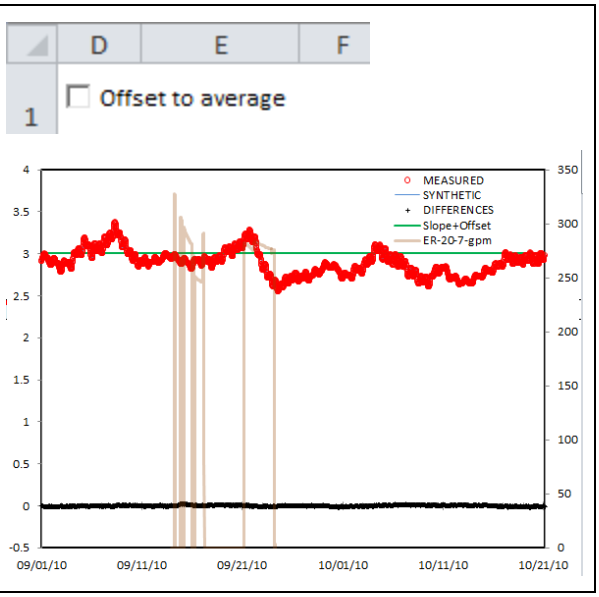


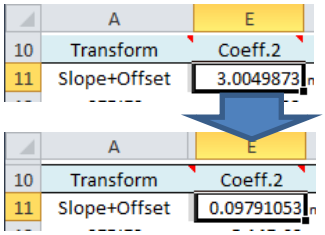
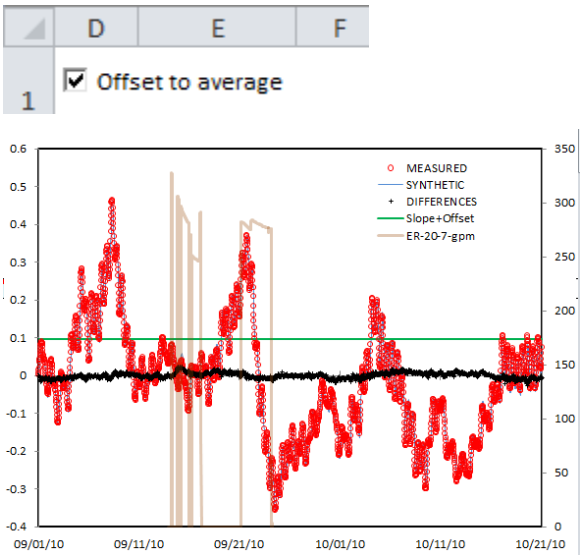
Figure 36.—Water-level modeling workbook after fitting the water-level model to measured water levels and with estimated drawdowns.

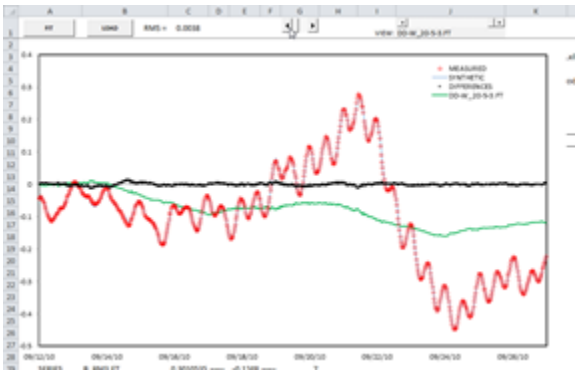
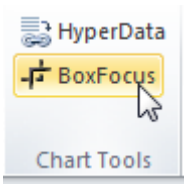
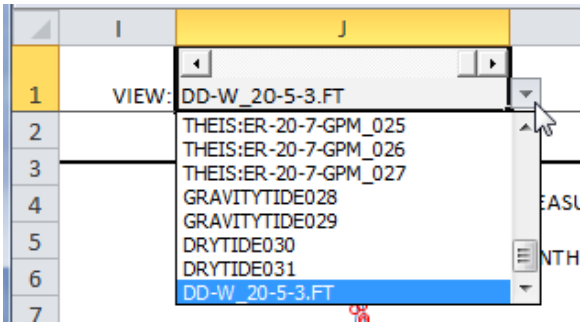
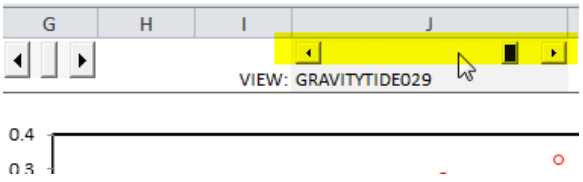
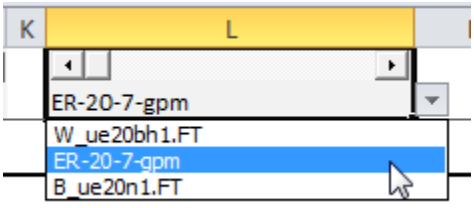
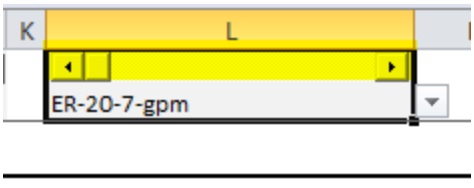
Viewing Controls in the Water-Level Model workbook

Measured water levels are plotted as imported from the SeriesSEE viewer by default.

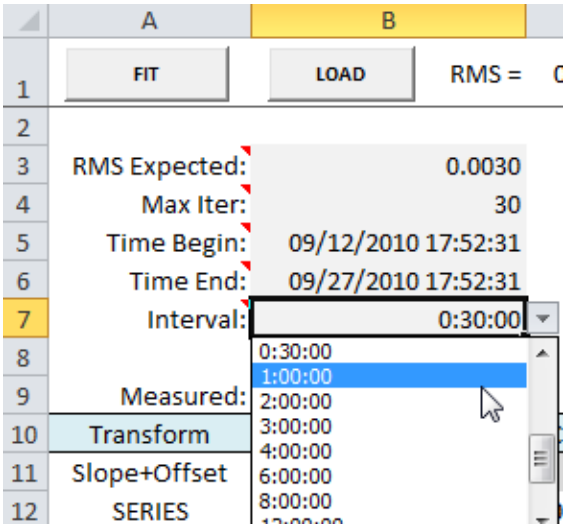
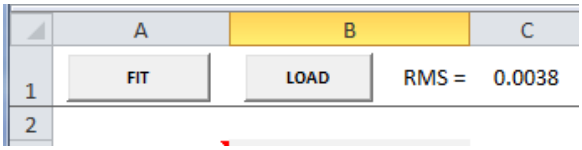
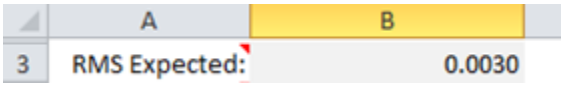
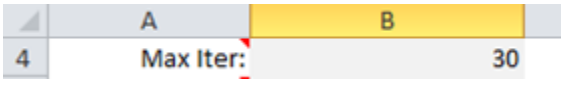
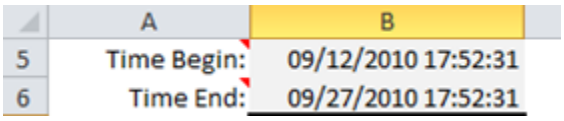
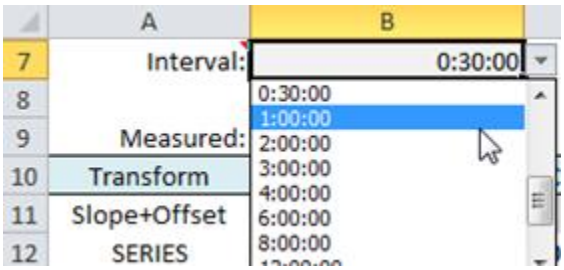
Fluctuations in measured water levels, simulated water levels, and differences can be rendered invisible if the average water level is big relative to the fluctuations.



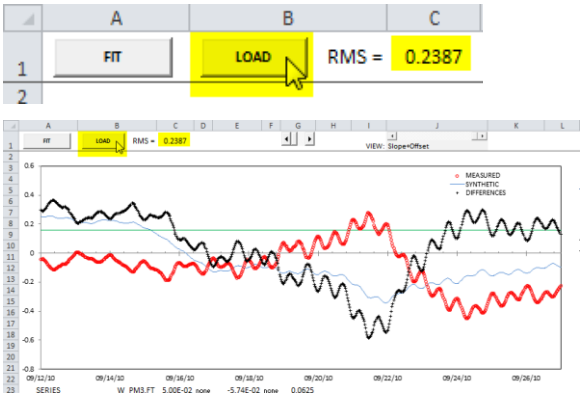
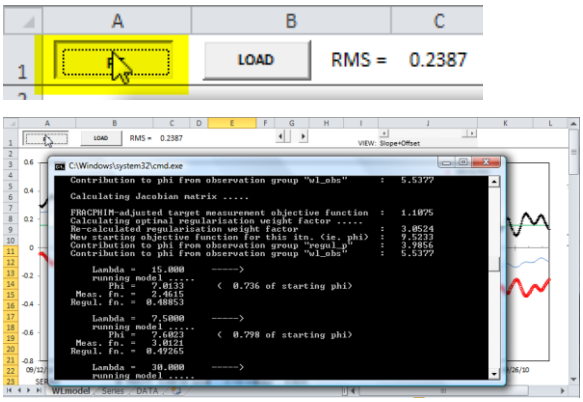
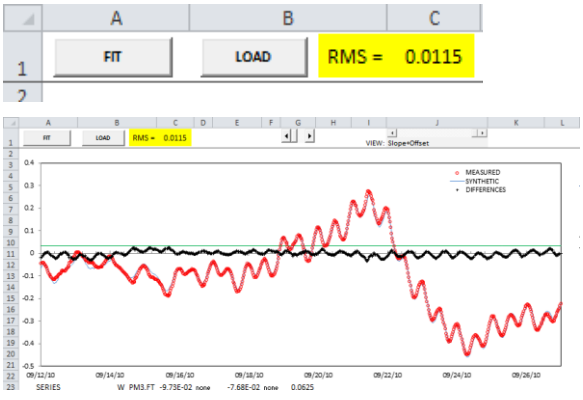
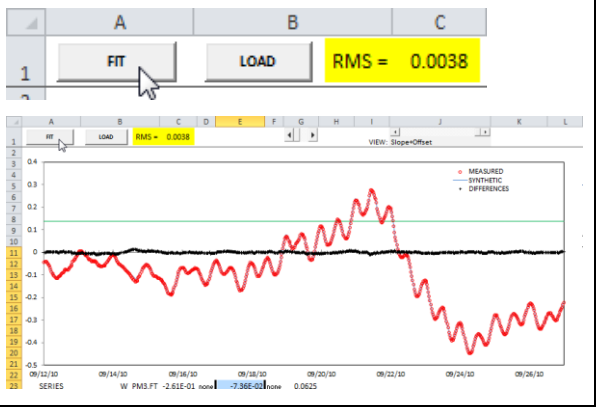
Checking the “Offset to average” toggle will subtract the average measured water level from measured water levels in the WLmodel input. The average measured water level also will be subtracted from the offset coefficient in cell E11.  Plotted series will change after pressing the LOAD or FIT buttons.	
The three-position, scroll bar in cell G1 controls the extent of the charted area.	
The rightmost position,  , aligns the left edges of column J and the chart so that coefficients are visible.	
The center position,  , aligns the left edges of column G and the chart so estimable coefficients and the PEST controls that define parameter usage are visible. Coefficients3, 4, and 5 in columns G, H, and I are obscured.	

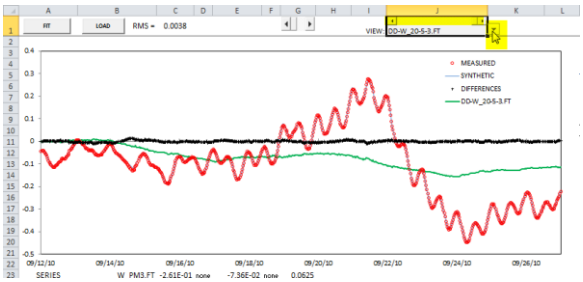
The leftmost position,  , extends the chart across the visible screen except for row 1.	
Any area of the chart can be magnified with the BoxFocus utility, which is on the SeriesSEE menu.	
WLM components and the drawdown estimate are selected with a drop-down menu in cell J1. The last series with the prefix “DD-” is the drawdown estimate, which is the sum of all Theis transforms and differences between synthetic and measured water levels.	
WLM components also can be selected with the scroll bar in cell J1.	
Component series from the SeriesSEE viewers are selected with a drop-down menu in cell L1. Delete entry in cell L1 to not view a component series.	
Component series also can be selected with the scroll bar in cell L1.	

Parameter Estimation Controls in the Water-Level Model workbook

All parameter estimation controls are in the upper, left corner of the Water-Level Model workbook. All files necessary for the FORTRAN WL model and PEST are created by the FIT or LOAD button. PEST is called immediately after all files are written. WL model and PEST results are imported automatically into the Water-Level Model workbook	
The FIT button calls PEST and estimates parameters. The LOAD button calls the WLmodel once with the current parameters. RMS error is reported in cell C1.	
RMS expected specifies PHIMLIM in the PEST control file to control the Tikhonov regularization.	
"Max Iter" is the maximum number of optimization iterations PEST can execute.	
The analysis period can be modified manually provided that the new period is within the original analysis period.	
Interval controls the sampling interval from the measured water levels. The fitting process can be accelerated by increasing the interval. Changing the interval also acts as a small perturbation when testing the final fit.	

Instructions for Fitting Water-Level Model

Press LOAD to determine the initial RMS error and see differences between synthetic and measured water levels during the analysis period.	
Press FIT. A command prompt will appear with PEST minimizing differences. PEST will grind for 10 to 60 seconds. Let PEST grind. Do NOT kill the window.	
WLmodel results and parameter estimates will load after the command prompt window closes. RMS error, synthetic water levels, and differences will be revised.	
Press FIT again. PEST typically needs to be called two or three times to reach a minimum error.	

Determine adequacy of fit by viewing WLM components and the drawdown estimate. Changing the selection in cell J1 to view a WLM component or the drawdown estimate.	

WLM components can be added or deleted manually in the water-level modeling workbook (Figure 37). Each additional component should be defined from left to right as the time series/component list is defined by the selected transform. The generic coefficients 1, 2, 3, 4, and 5 that define each WLM component (Table 1) are defined in comments for each coefficient heading (Figure 37). Time series are limited to the series that were selected when the workbook was created. The analysis period can be modified manually provided that the new period is within the original analysis period.

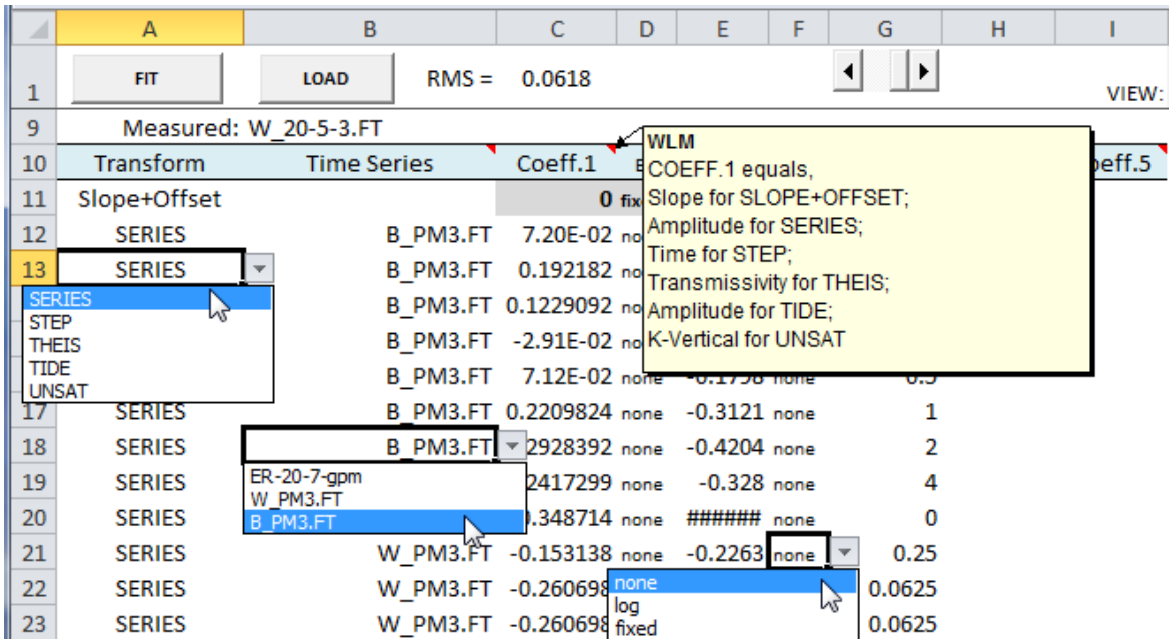
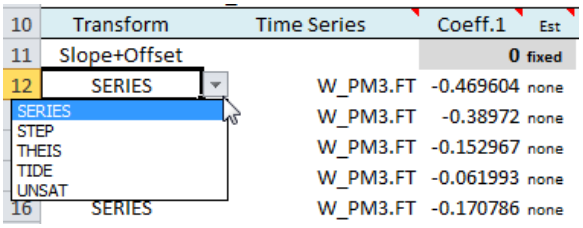
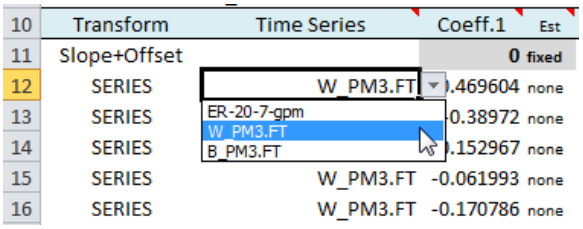
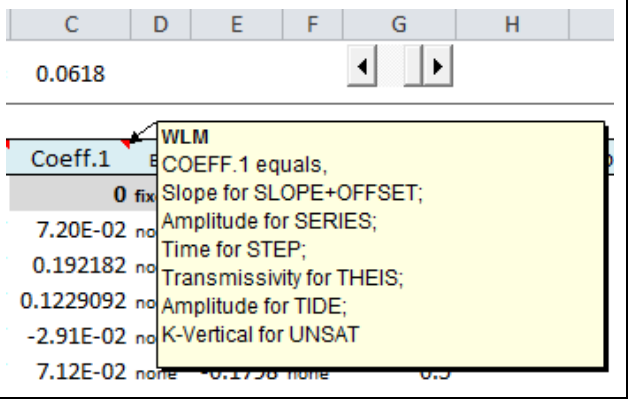


Figure 37.—Pull-down menus and coefficient definitions in comments that assist manually adding WLM components in an existing water-level modeling workbook.

Manually Adding or Deleting Water-Level Model Components

Select a transform in column A of a blank row to start adding a WLM component. Time series will be available in the column B, Time Series heading, if the SERIES, THEIS, or UNSAT transform is selected. Tidal components will be available in the column B, Time Series heading, if the TIDE transform is selected.	
Select a time series or tidal component in column B.	
Coefficients are user defined. Amplitudes of 0.02 and 0.001 work well as initial estimates for most time series and tidal components, respectively. Comments for each coefficient heading define how a coefficient is applied for each transform (Table1).	

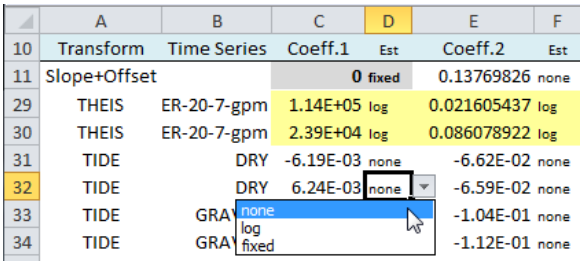
Parameter estimation with PEST is defined in the “Est” columns that follow coefficients 1 and 2.

“None” specifies that a parameter is estimated as-is.

“Log” specifies that the log-transform of a parameter is estimated and is highlighted in yellow

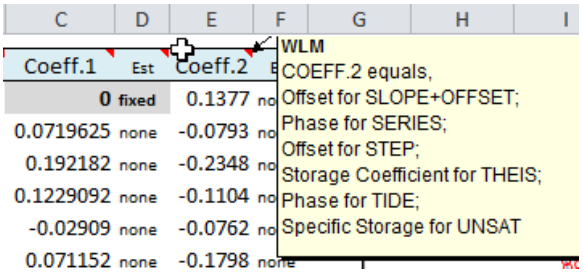
“Fixed” specifies that the parameter is not estimated and is highlighted in gray.

The keywords “none,” “log,” and “fixed” are the same keywords that are defined in a PEST control file.



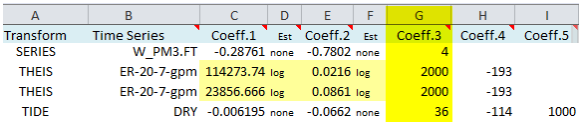
A phase of 0 works well for initial estimates.

Comments for each coefficient heading define how a coefficient is applied for each transform.



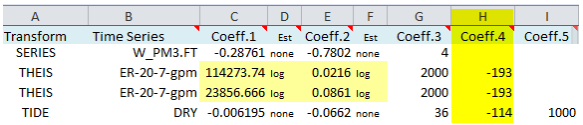
Coefficient 3 is not estimated, but must be defined for all but the STEP transform.

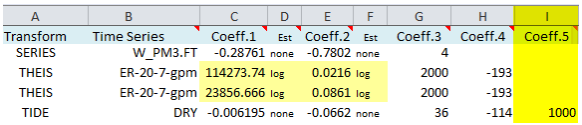
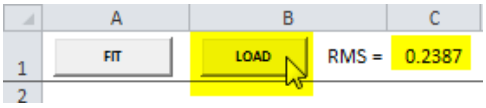
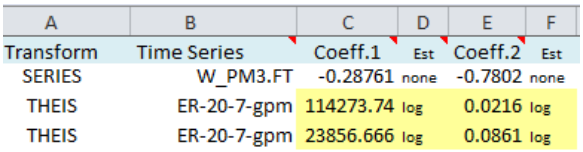
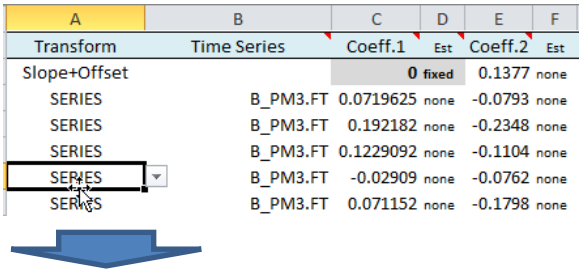
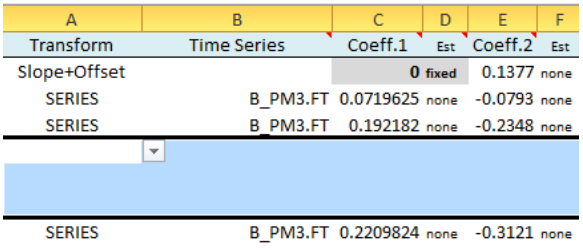
WLM
COEFF.3 equals,
Moving average period, days for SERIES;
Radial Distance for THEIS;
Latitude for TIDE;
Length for UNSAT



Coefficient 4 is not estimated, but must be defined for the THEIS and TIDE transforms.

WLM
COEFF.4 equals,
Unit conversion & sign convention for THEIS;
Longitude for TIDE



Coefficient 5 is not estimated, but must be defined for the TIDE transform. WLM COEFF. 5 Altitude for TIDE, meters	 A B C D E F G H I Transform Time Series Coeff.1 Est Coeff.2 Est Coeff.3 Coeff.4 Coeff.5 SERIES W_PM3.FT -0.28761 none -0.7802 none 4 THEIS ER-20-7-gpm 114273.74 log 0.0216 log 2000 -193 THEIS ER-20-7-gpm 23856.666 log 0.0861 log 2000 -193 TIDE DRY -0.006195 none -0.0662 none 36 -114 1000
Theis transforms can be sensitive to initial estimates of transmissivity and the storage coefficient. Users should test initial parameter estimates with the LOAD button. Observable Theis transforms that are of similar magnitude as fluctuations in the measured water levels typically are good initial estimates.	 A B C 1 FIT LOAD RMS = 0.2387 2  A B C D E F Transform Time Series Coeff.1 Est Coeff.2 Est SERIES W_PM3.FT -0.28761 none -0.7802 none THEIS ER-20-7-gpm 114273.74 log 0.0216 log THEIS ER-20-7-gpm 23856.666 log 0.0861 log
Deleting all entries in a row removes an unwanted WLM component. All WLM components are sorted each time WLM and PEST files are written to avoid gaps.	 A B C D E F Transform Time Series Coeff.1 Est Coeff.2 Est Slope+Offset 0 fixed 0.1377 none SERIES B_PM3.FT 0.0719625 none -0.0793 none SERIES B_PM3.FT 0.192182 none -0.2348 none SERIES B_PM3.FT 0.1229092 none -0.1104 none SERIES B_PM3.FT -0.02909 none -0.0762 none SERIES B_PM3.FT 0.071152 none -0.1798 none  A B C D E F Transform Time Series Coeff.1 Est Coeff.2 Est Slope+Offset 0 fixed 0.1377 none SERIES B_PM3.FT 0.0719625 none -0.0793 none SERIES B_PM3.FT 0.192182 none -0.2348 none SERIES B_PM3.FT 0.2209824 none -0.3121 none

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Data Return and Archiving

Drawdowns and transformed WLM components are returned to the SeriesSEE viewer once the user accepts a WLM (Figure 38). Drawdowns and transformed WLM components are selected individually so the number of returned series can range between zero and all. The WLM workbook also can be archived as a macro-free workbook that can be re-activated.

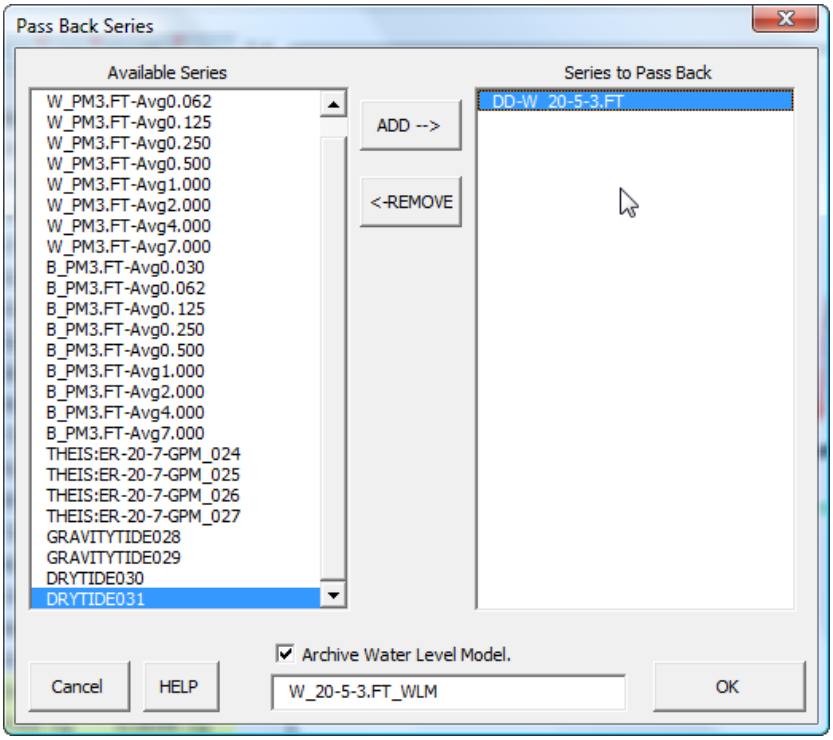
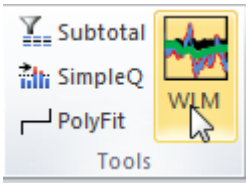
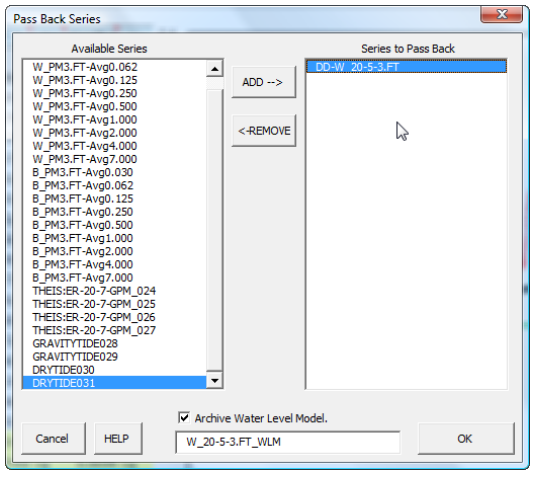
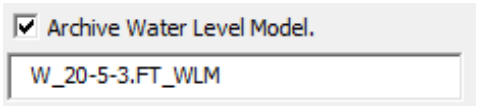
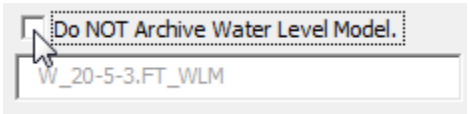
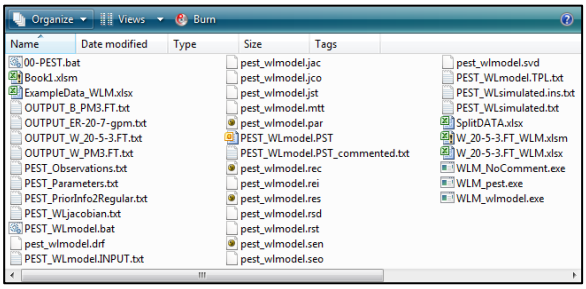
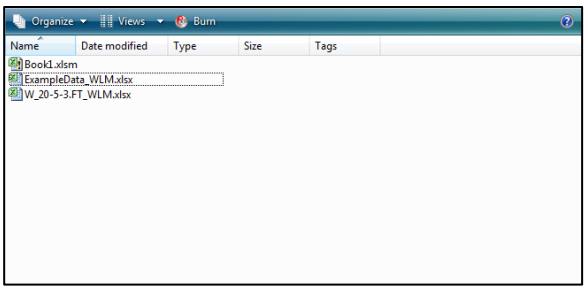


Figure 38.—Form for specifying series to return to the SeriesSEE viewer and archiving the water-level model.

Returning Data, Archiving Water-Level Model Results, and Housekeeping

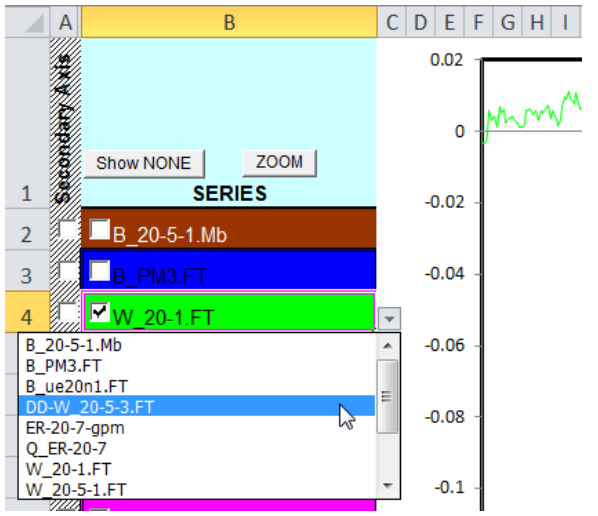
Select the WLmodel utility in the Tools group.	
The “Pass Back Series” form appears with all the WLM components and the estimate of pumping signal. The series “DD-*” is the pumping signal.	

Under the “Available Series” list, either double-click a series or select a series and press “ADD” to add a series to the “Series to Pass Back” list.	
Under the “Series to Pass Back,” either double-click a series or select a series and press “REMOVE” to move a series back to the “Available Series” list.	
The WLM workbook will be archived by default in a macro-free workbook. The default file name is the measured series name and the suffix “_WLM,” which can be changed by the user. Uncheck to delete the WLM workbook and not create an archive copy.	 or 
Working folder with original files and all files that were created by the WLmodel utility.	
Working folder with just original files and an archive workbook after the ancillary files that were created by the WLmodel utility were deleted.	

All series returned from the WLM utility can be plotted in the SeriesSEE viewer.

Use the drop-down menus in cells B2:B13 on the VIEW page.

Markers added in the magnifier window will be retained and presented in both windows by unselecting and selecting a series.



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Reactivating Archived Water-Level Models

Water-level models can be checked quickly by reactivating an archived WLM workbook where all controls and macros have been stripped from the original workbook (Figure 39). Data and settings are ported to a new active WLM workbook when an archived WLM workbook is reactivated. Supporting files and FORTRAN executables also are copied from the SeriesSEE add-in directory to the working directory.

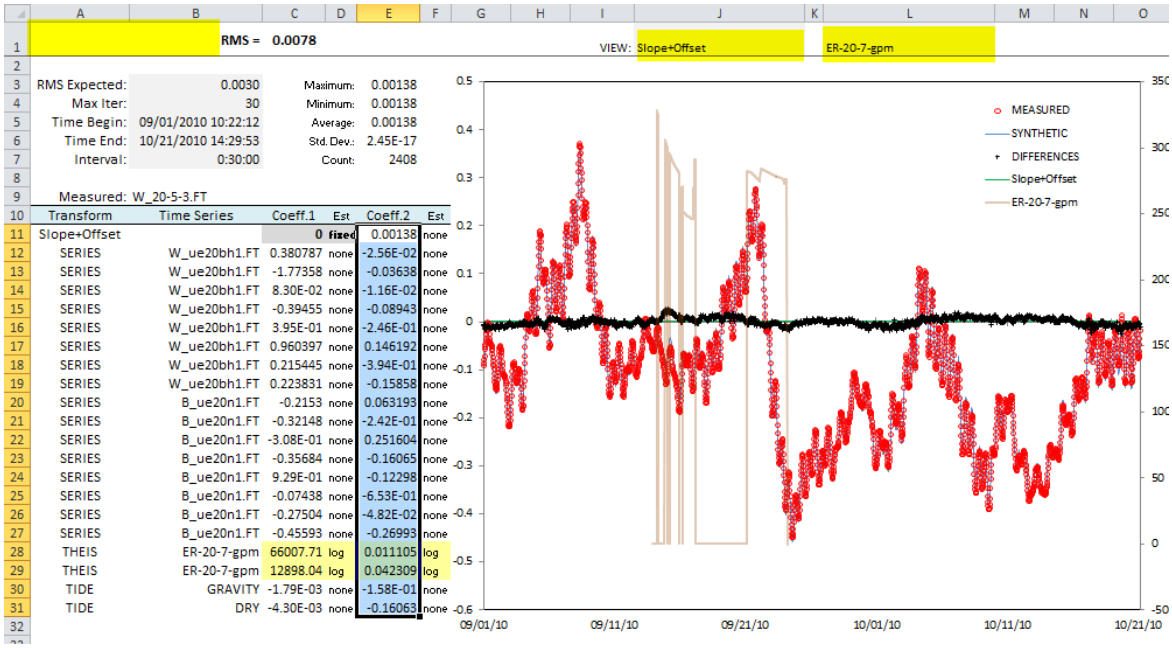
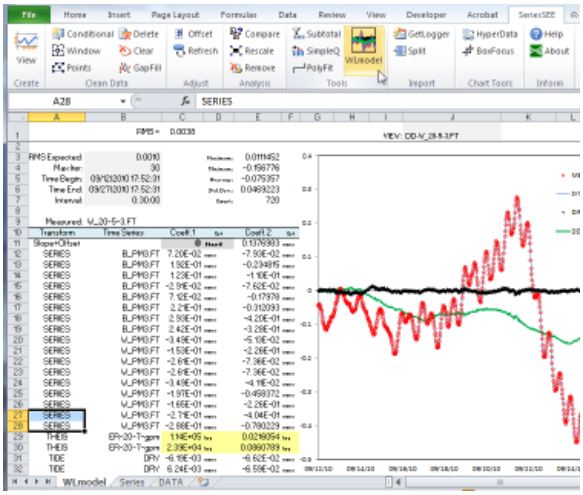
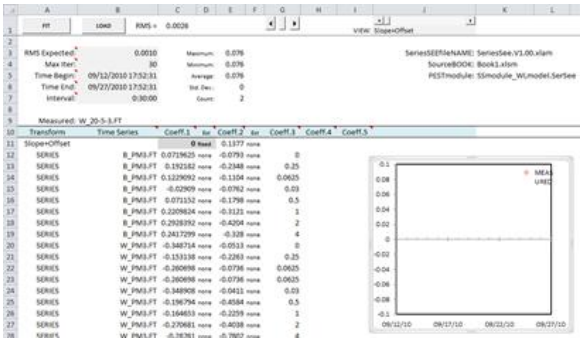
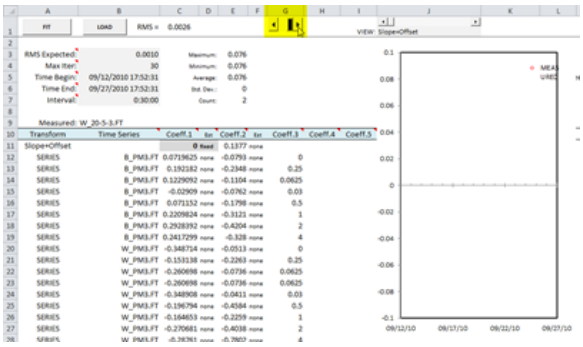


Figure 39.—Archived Water-Level Model workbook with highlighted areas where controls were removed during archiving.

Reactivating Archived Water-Level Models

Select the WLmodel utility in the Tools group while an archived Water-Level Model workbook is open.	
Data and settings are ported to a new active WLM workbook.	
Click the three-position, scroll bar in cell G1 to restore the chart area.	

Press LOAD to resolve the archived water-level model.	

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Import

Time-series data can be imported from multiple ASCII files that were created from data loggers with the GetLogger utility in the Import group (Figure 40). Time series in a three-column format of site name, date-time, and measured value are translated to the SeriesSEE data format with the Split utility in the Import group. The Split utility also works with geophysical data where the depths are in the 2nd column rather than times.

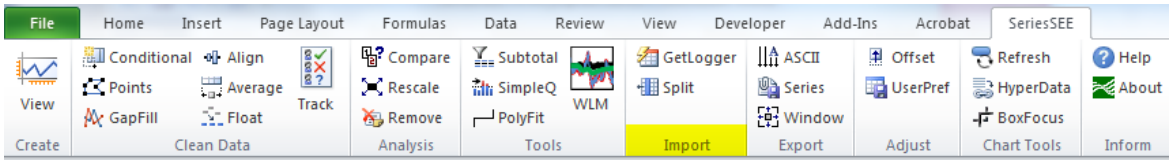

Figure 40.—Analysis group for analyzing data and managing derived series.

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GetLogger Utility

Series from data-logger files are read interactively and concatenated in a SeriesSEE format with the GetLogger utility (Figure 41). Multiple series from a site are concatenated as a single continuous series. Data loggers that report date and time in the conventional month/day/year and hour:minute:second formats are supported. Date and time can be imported in a column or two columns. Separate date and time columns will be reduced to a single column during file import. Empty rows and trailing text are eliminated.

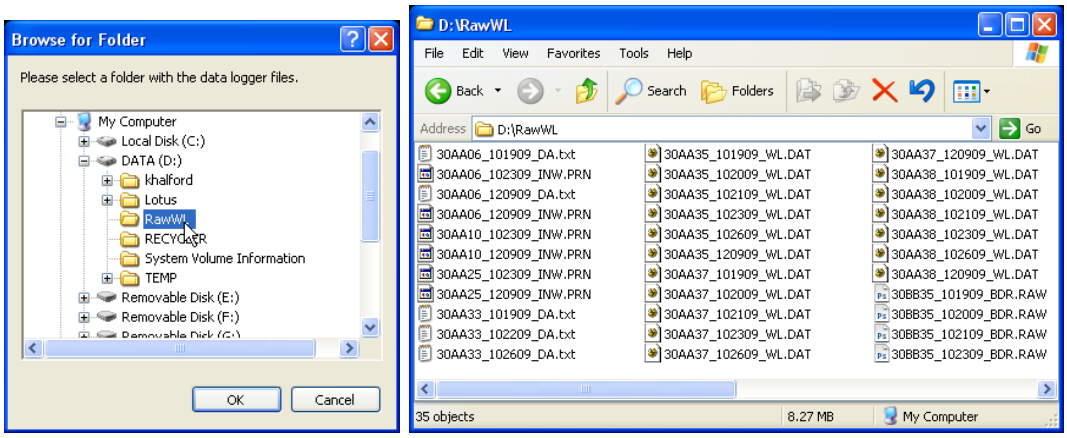

Figure 41.—Form for finding directory with data-logger files and an example directory with multiple data-logger files.

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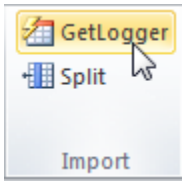
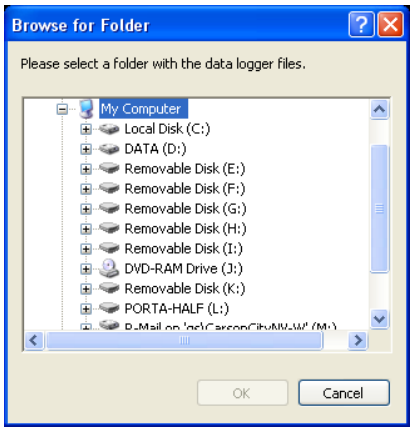
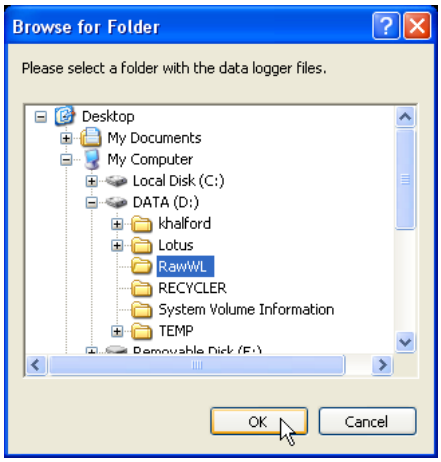
Selecting Logger Files

Locating data-logger files

Launch GetLogger	
The directory search form will appear. The dumb thing always starts on “My Computer.”	

Navigate to the folder that contains the data-logger files to be imported. Files with the extensions DA.txt, INW.PRN, WL.DAT, BDR.RAW, .CSV, .prn, and .lev will be loaded in the “Acquire data files” form.	

Files with the extensions DA.txt, INW.PRN, WL.DAT, BDR.RAW, .CSV, .prn, and .lev can be selected for importing in the “Acquire data files” form (Figure 42). Files to be imported are selected individually or as a single group in the “Acquire data files” form.

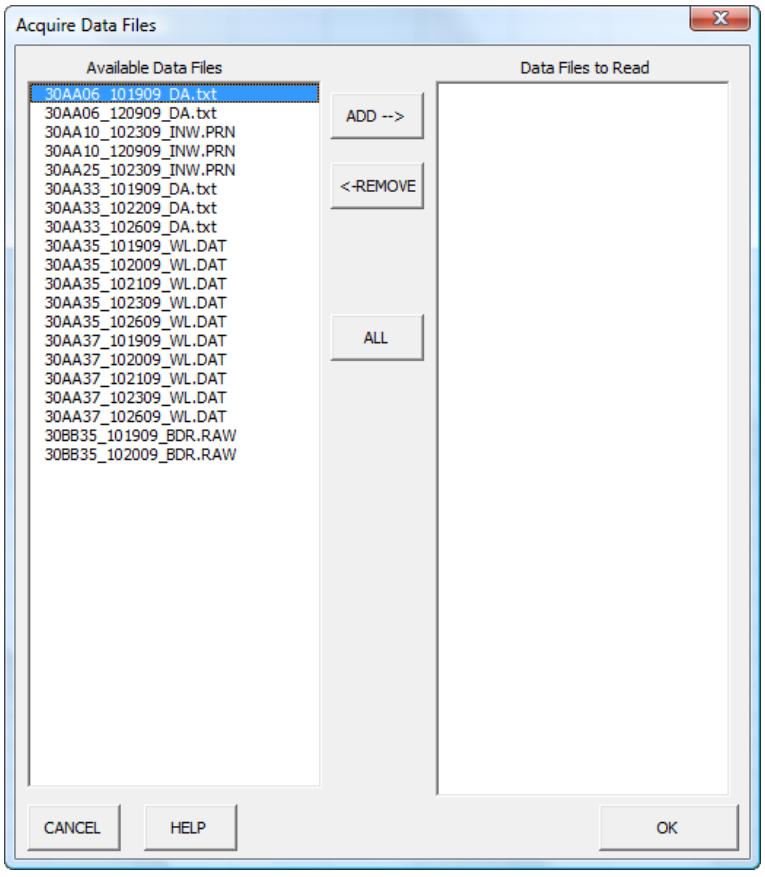
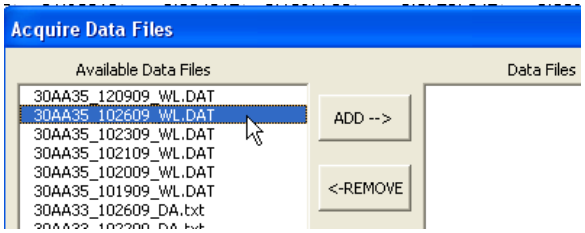
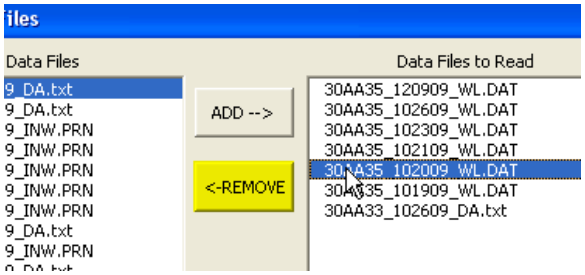
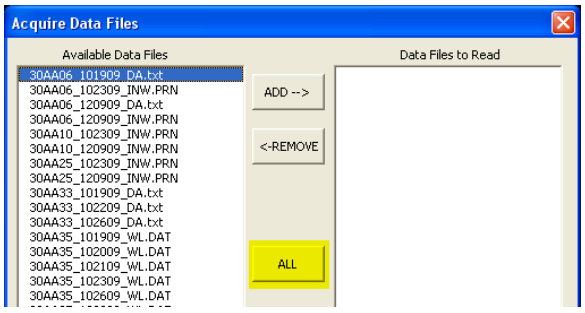
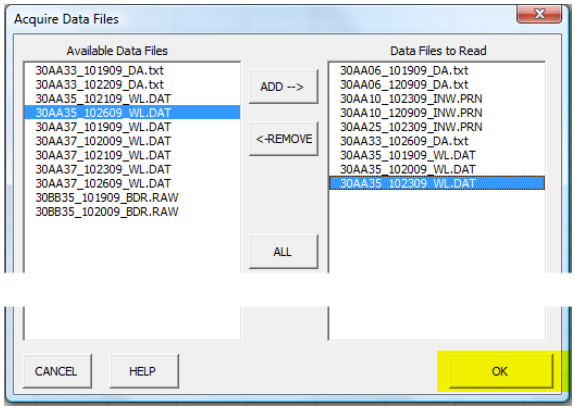


Figure 42.—The “Acquire data files” form for selecting which data-logger files will be imported.

Selecting data-logger files

Under the “Available Data Files” list, either double-click a file name or select a file name and press “ADD” to add a file to the “Data Files to Read” list.	
Under the “Data Files to Read” list, either double-click a file name or select a file name and press “REMOVE” to move a file back to the “Available Data Files” list.	
All files can be moved between “Available Data Files” and “Data Files to Read” lists by selecting a file and pressing “ALL.”	
Select OK to process and import the selected data-logger files.	

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Reading Data from Logger Files

Date, time, and data columns are specified interactively through the " Set Data Fields " form (Figure 43). References to cells in the first row of data are specified by typing or with the mouse. Labels for each data field to be imported are entered manually. Labels for sites that were read in previous files can be specified with pull-down menus.

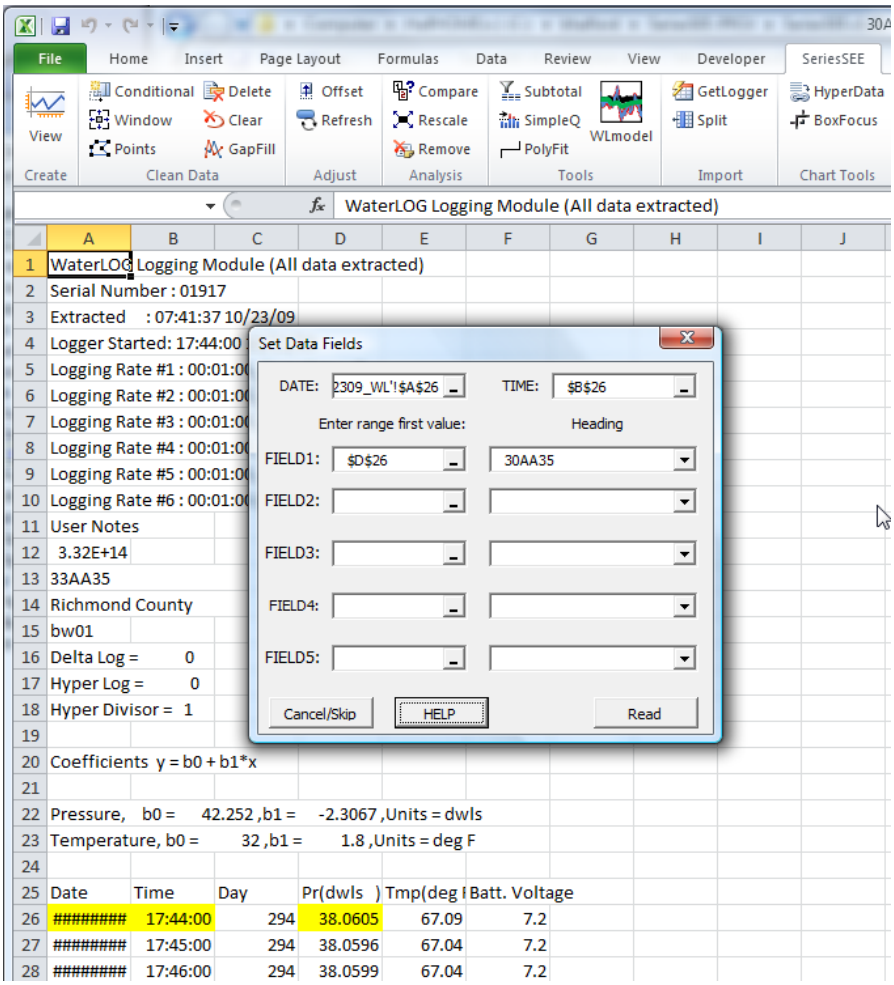
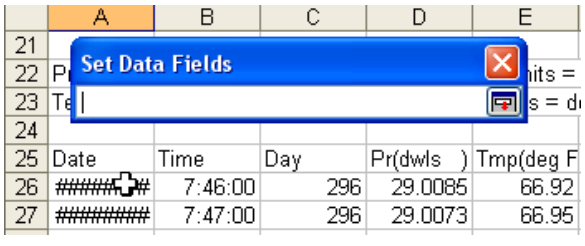
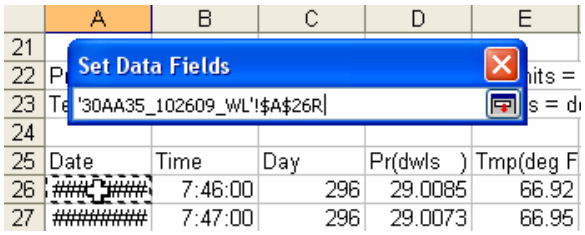
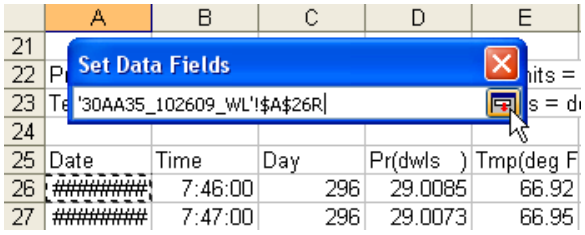
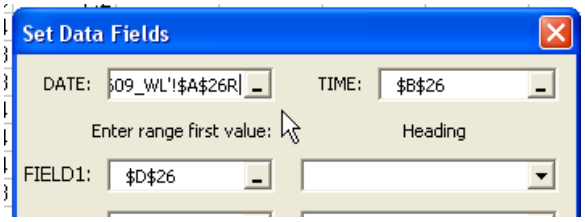
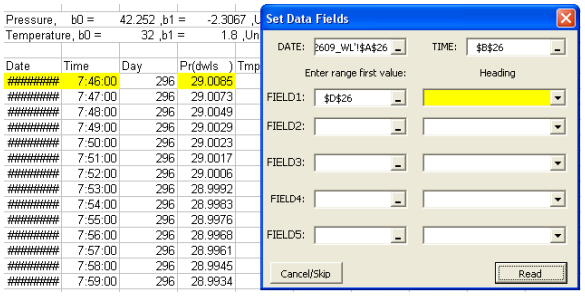
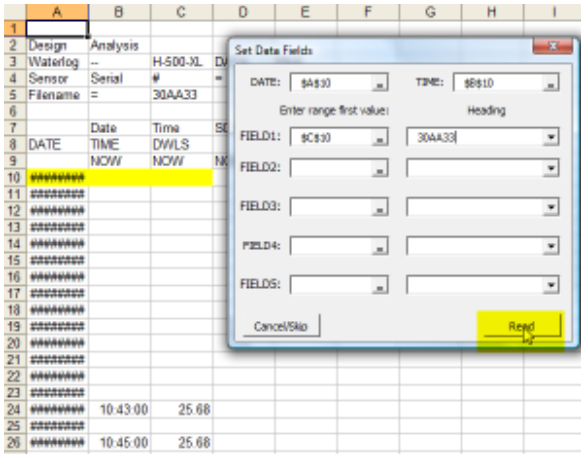
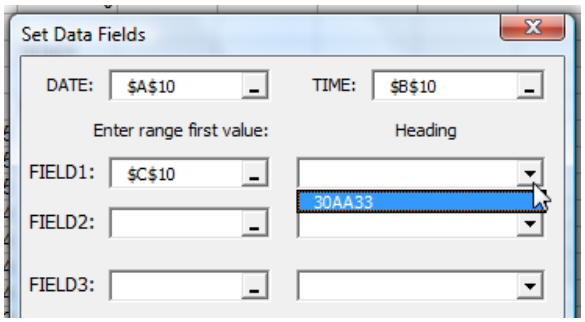
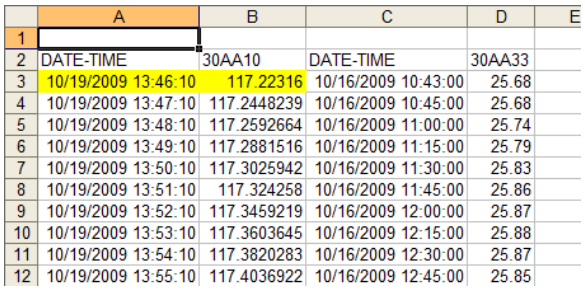


Figure 43.—The "Set Data Fields" form for specifying the first row of data, date column, time column, and columns with data to be imported.

Specifying data fields to be imported

Data fields are specified with reference edit dialogues, which end with ▬. Selecting ▬ allows navigation of the worksheet and specification of cells.	
Selecting ▬ causes the form to be replaced with the smaller range selector.	

Selecting a cell will write the address to the range selector.	
Selecting  will close the range selector, restore the form, and write the specified address to the selected reference edit dialogue.	
Labels for each data field are entered manually under the heading column.	
All cells must reference the first row of data. Specified cells are highlighted yellow on the worksheet as headings are entered on the form. Unpaired cell references and headings are errors that are highlighted in yellow on the form after selecting "Read."	
All entries should be on a single row, which will be apparent from the yellow highlighting on the worksheet. Select "Read." Empty rows and unwanted columns are deleted. Date and time are summed in a column. The specified data are copied to the new workbook that will hold all of the imported data. Data-logger files are closed without changes.	

Labels for sites that were read in previous files can be specified with pull-down menus. Additional data for an existing site are appended to existing columns in the new workbook.	
The final result is a new workbook with all imported data in format that can be viewed and cleaned by SeriesSEE.	

	A	B	C	D	E
1					
2	DATE-TIME	30AA10	DATE-TIME	30AA33	
3	10/19/2009 13:46:10	117.22316	10/16/2009 10:43:00	25.68	
4	10/19/2009 13:47:10	117.2448239	10/16/2009 10:45:00	25.68	
5	10/19/2009 13:48:10	117.2592664	10/16/2009 11:00:00	25.74	
6	10/19/2009 13:49:10	117.2881516	10/16/2009 11:15:00	25.79	
7	10/19/2009 13:50:10	117.3025942	10/16/2009 11:30:00	25.83	
8	10/19/2009 13:51:10	117.324258	10/16/2009 11:45:00	25.86	
9	10/19/2009 13:52:10	117.3459219	10/16/2009 12:00:00	25.87	
10	10/19/2009 13:53:10	117.3603645	10/16/2009 12:15:00	25.88	
11	10/19/2009 13:54:10	117.3820283	10/16/2009 12:30:00	25.87	
12	10/19/2009 13:55:10	117.4036922	10/16/2009 12:45:00	25.85	

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Split Utility

Water level and other time series data frequently are in a three-column format that can be converted to SeriesSEE format with the Split utility (Figure 44). The three columns are site identifier, date-time, and water level, where a site identifier is repeated for all measurements associated with one. The split utility also can export selected series to a three-column format in a delimited ASCII file.

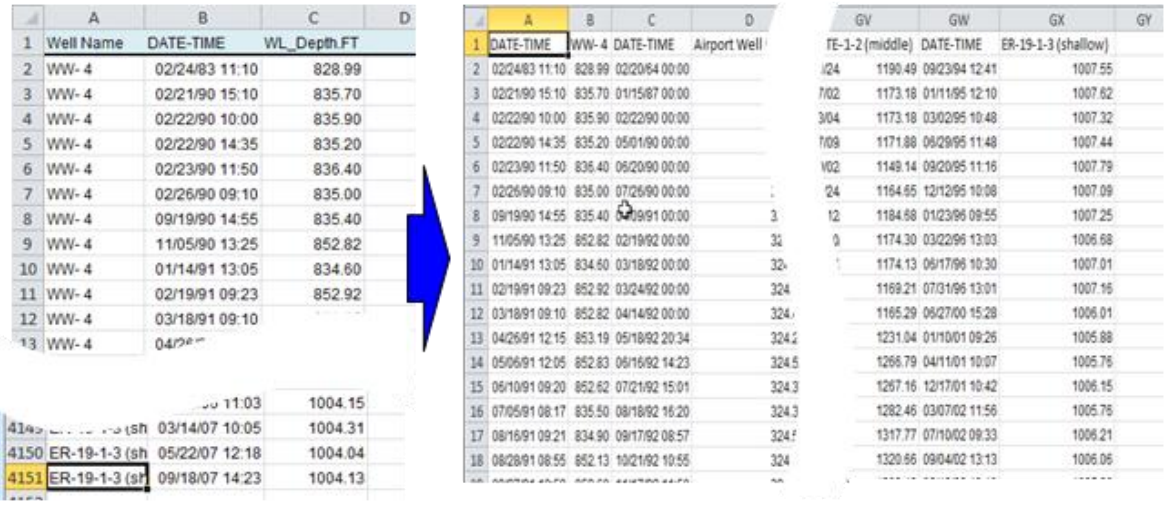
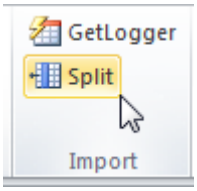
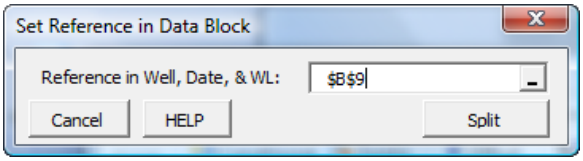
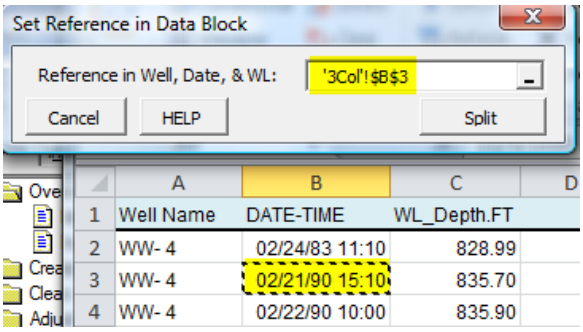
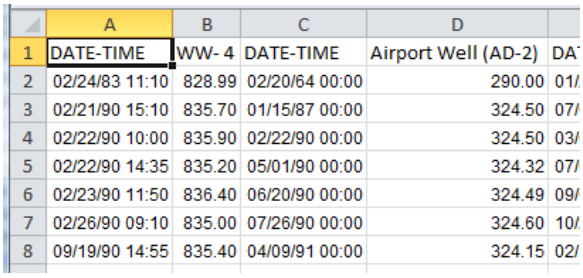
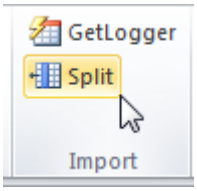


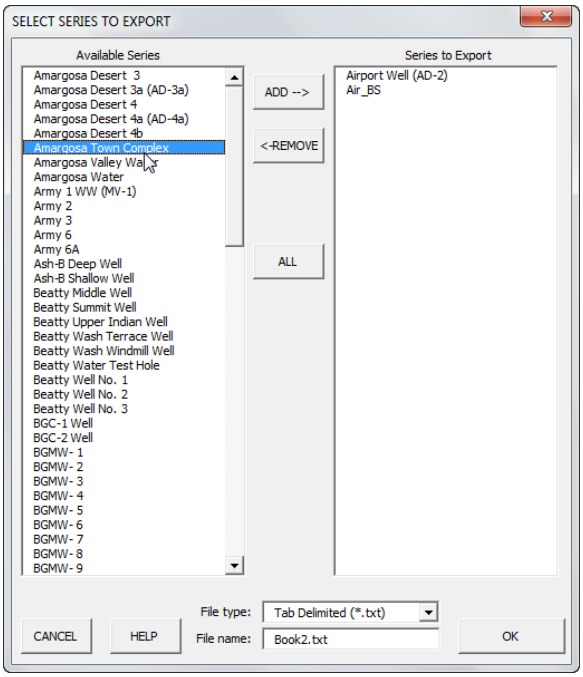
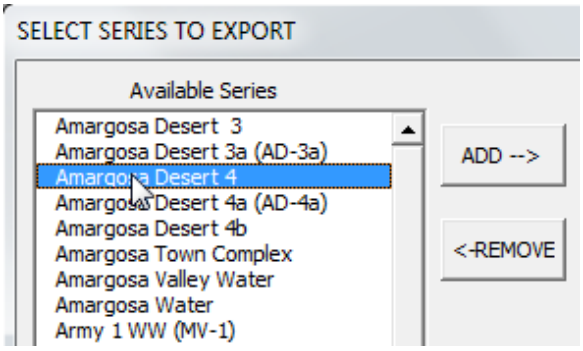
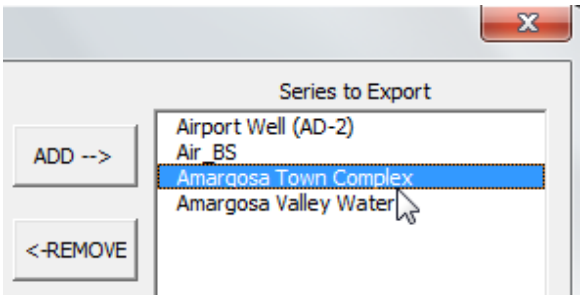
Figure 44.—Data in three-column format and data converted to SeriesSEE format by the Split utility.

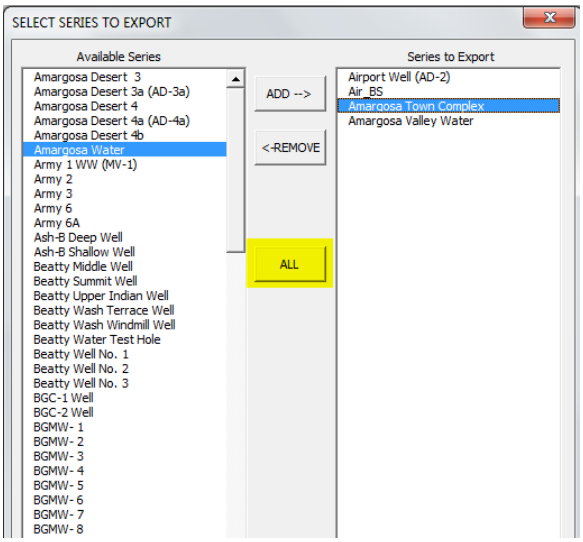
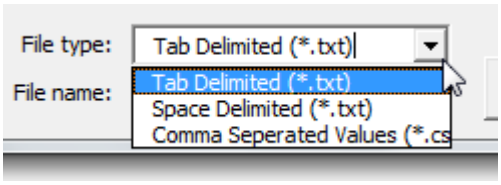
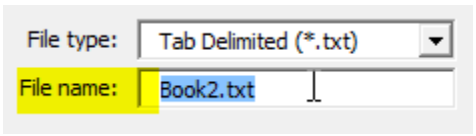
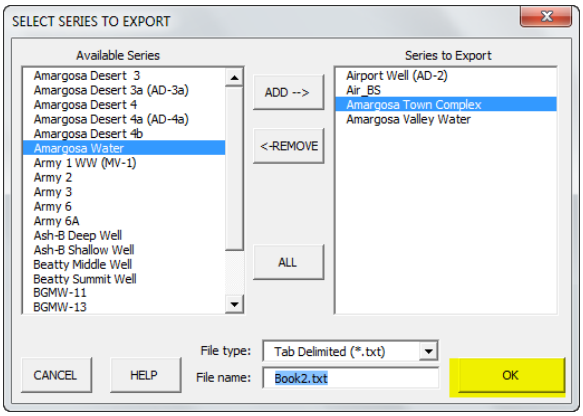
Splitting lists to SeriesSEE format

Select an open workbook with three-column data that is not a SeriesSEE viewer. Launch the Split utility.	
The “Set Reference in Data Block” form will appear.	
Select a reference in the three-column data block if the specified reference is not in the three-column data block.	
Select Split.	
A new workbook will be created in the SeriesSEE format, which can be viewed and manipulated with SeriesSEE.	

Exporting series from SeriesSEE to a three-column format

Select an open SeriesSEE viewer. Launch the Split utility	

The “SELECT SERIES TO EXPORT” form will appear.	
Under the “Available Series” list, either double-click a file name or select a file name and press “ADD” to add a file to the “Series to Export” list.	
Under the “Series to Export” list, either double-click a file name or select a file name and press “REMOVE” to move a file back to the “Available Series” list.	

All files can be moved between “Available Series” and “Series to Export” lists by selecting a file and pressing “ALL.”	
Select tab, space, or comma delimiters.	
Specify name of ASCII output file that will be written to the directory with the SeriesSEE viewer.	
Select OK to process and export the selected series to ASCII files.	

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Export

Data can be exported from SeriesSEE viewer and tracking files to new workbooks, ASCII output files, or pictures with utilities in the Export group (Figure 45). Series in a viewer file can be exported selectively to ASCII files with the

ASCII utility. Estimated drawdowns can be converted to elapsed time, reduced by averaging during periods, and exported for interpretation with the Series utility. Data in the current SeriesSEE viewer are reduced to a user-specified period and copied to a new workbook with the Window utility. Selected series can be displayed in individual pictures of charts at fixed or variable scales with the Pix utility.

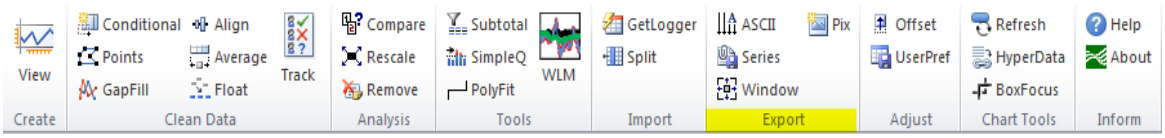

Figure 45.—Analysis group for analyzing data and managing derived series.

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ASCII Utility

Series in a viewer file can be exported selectively to ASCII files with the ASCII utility.

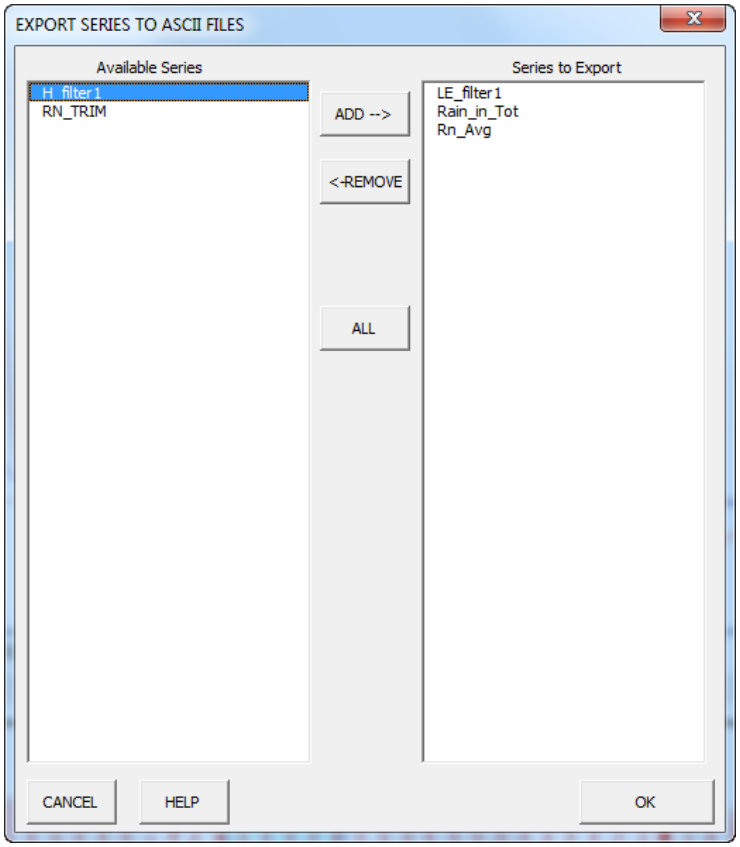
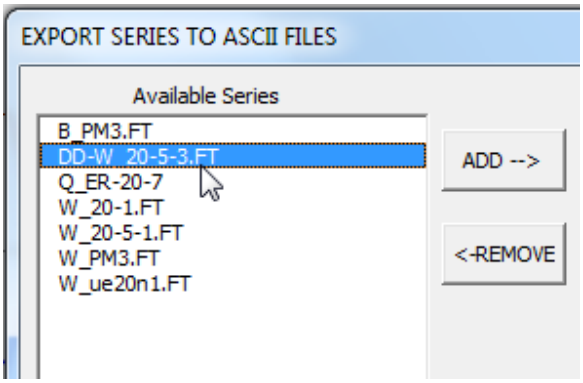
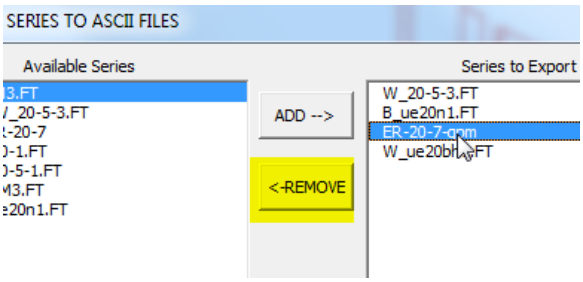
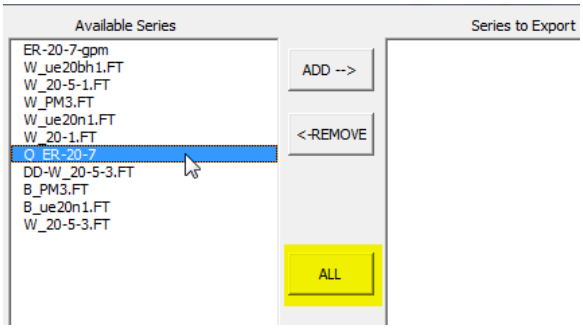
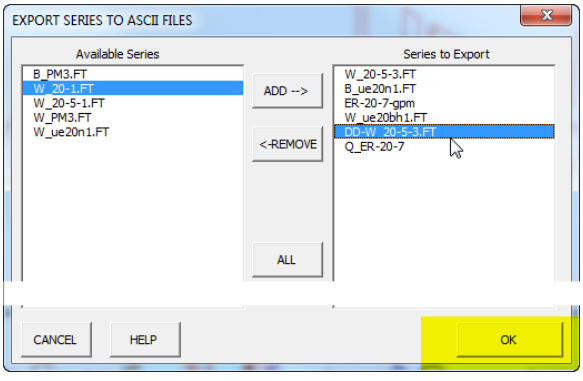


Figure 46.—Form for selecting tracking workbooks to be processed.

Exporting ASCII files

Under the “Available Series” list, either double-click a file name or select a file name and press “ADD” to add a file to the “Series to Export” list.	
Under the “Series to Export” list, either double-click a file name or select a file name and press “REMOVE” to move a file back to the “Available Series” list.	
All files can be moved between “Available Series” and “Series to Export” lists by selecting a file and pressing “ALL.”	
Select OK to process and export the selected series to ASCII files.	

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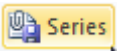
Series Utility

Estimated drawdowns can be converted to elapsed time, reduced by averaging during periods, and exported for interpretation with the 

utility. The period of analysis can be defined graphically or by entering specific dates and times (Figure 47). Drawdown series default to all visible series, but can be changed on the form.

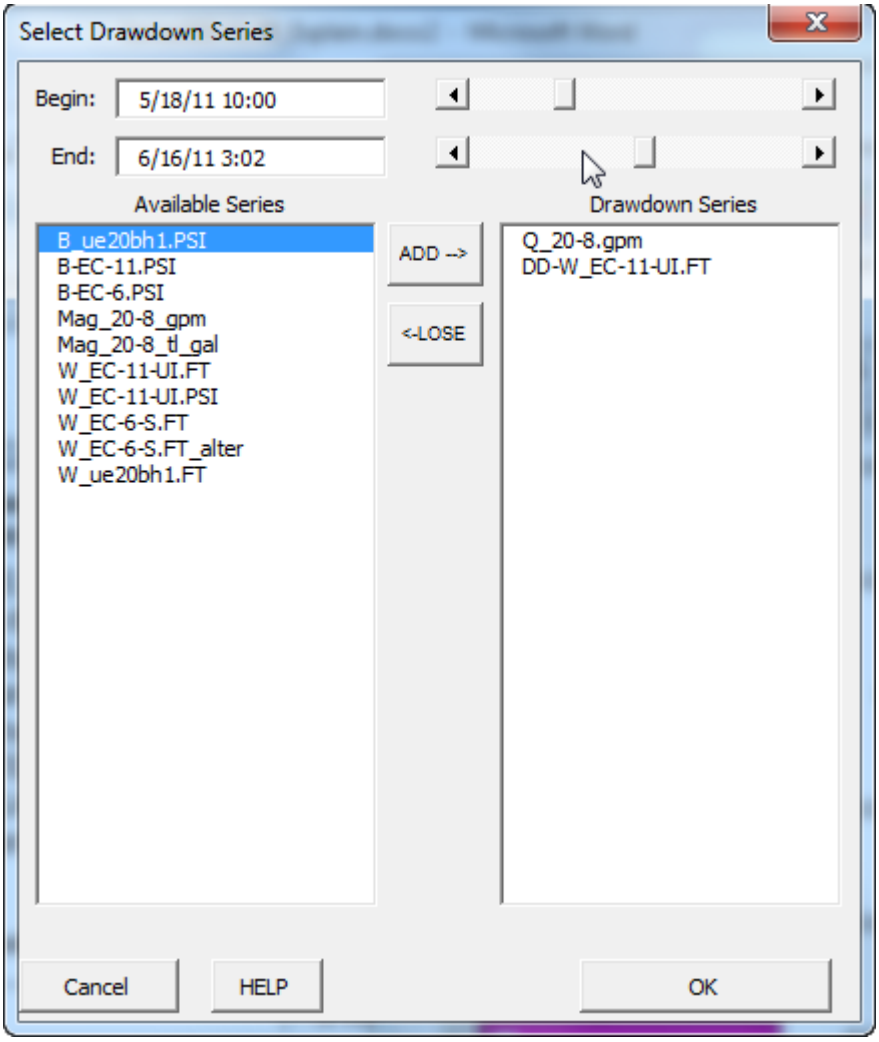
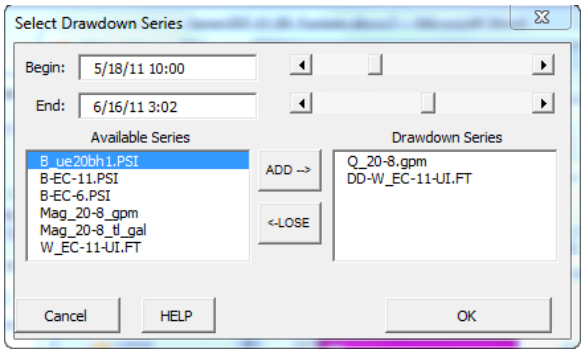
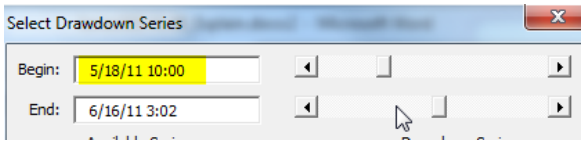
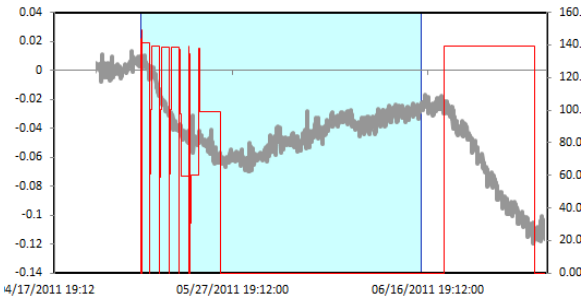
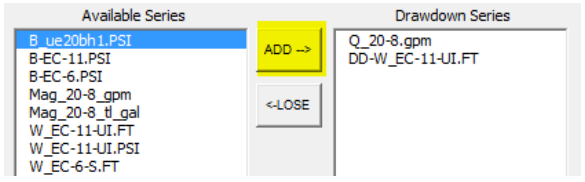
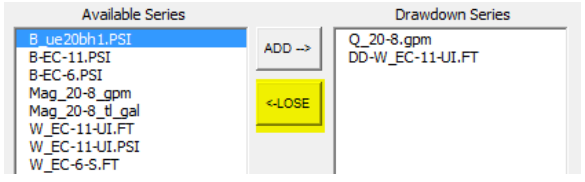
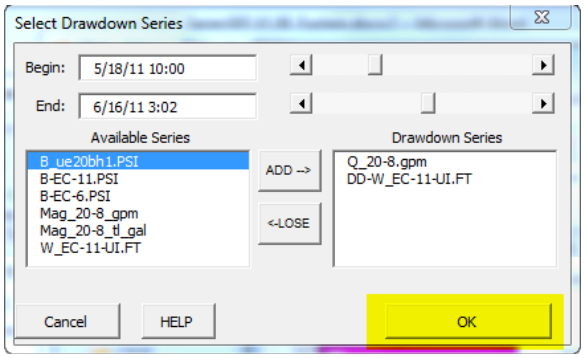


Figure 47.—Form for specifying period of analysis and drawdown series to be exported.

Selecting period of analysis and drawdown series

Select the Series utility in the Export group.	

The “Select Drawdown Series” form will appear.	
Adjust beginning and ending of analysis period with scroll bars. Selecting areas between slider and end arrows will move beginning and ending. Beginning and ending of windowed period also can be entered directly.	
Highlighted area in lower, overview window depicts the analysis period.	
Under the “Available Series” list, either double-click a series or select a series and press “ADD” to add a series to the “Drawdown Series” list.	
Under the “Drawdown Series list, either double-click a series or select a series and press “REMOVE” to move a series back to the “Available Series” list.	

Select OK. Selected series that have been trimmed to begin and end times will be written to a new workbook. The drawdown output form will appear to specify data reduction and output files.	

Files, output format, and degrees of data reduction are specified through the "Drawdown Output" form (Figure 48). All ASCII output files are tab delimited.

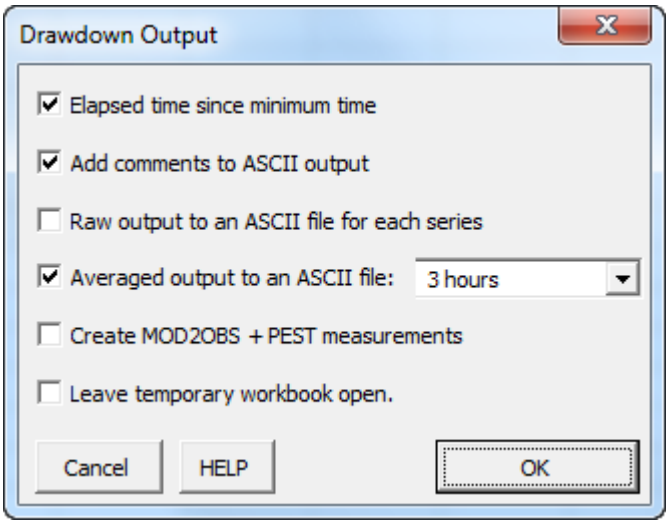
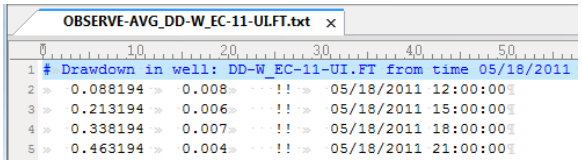
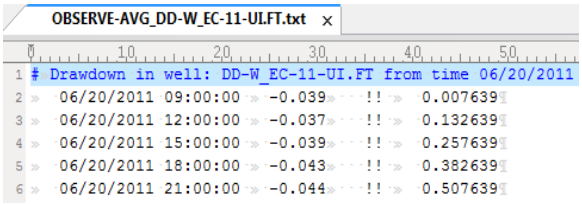
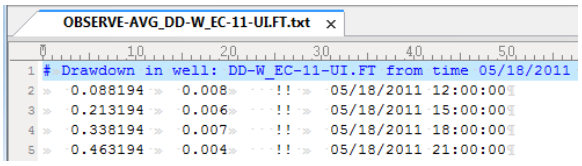
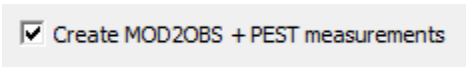
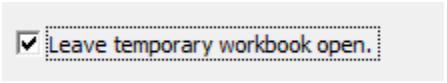
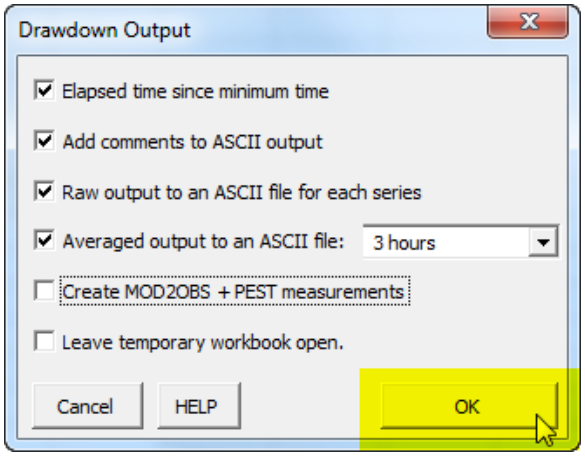


Figure 48.—The "Drawdown Output" form for defining data reduction and output files.

Specifying output options

Elapsed time in days is written with drawdowns, where ☑ Elapsed time since minimum time	
Date and time in the format, mm/dd/yyyy hh:mm:ss, is written with drawdowns, where ☐ Elapsed time since minimum time	

Well name and date-time of 0 elapsed time are added as a commented header. Date-time or elapsed time is commented after each observation, where ☑ Add comments to ASCII output	OBSERVE-AVG_DD-W_EC-11-UI.FT.txt 1 # Drawdown in well: DD-W_EC-11-UI.FT from time 05/18/2011 2 0.088194 0.008 !! 05/18/2011 12:00:00 3 0.213194 0.006 !! 05/18/2011 15:00:00 4 0.338194 0.007 !! 05/18/2011 18:00:00 5 0.463194 0.004 !! 05/18/2011 21:00:00
Time-drawdowns pairs alone are written, where ☐ Add comments to ASCII output	OBSERVE-AVG_DD-W_EC-11-UI.FT.txt 1 0.083333 0.008 2 0.208333 0.006 3 0.333333 0.007 4 0.458333 0.004 5 0.583333 0.004 6 0.708333 0.001
All time-drawdown pairs are written, where ☑ Raw output to an ASCII file for each series Message box reports file names, number of files created, and directory where written.	RAW ASCII OUTPUT Estimated drawdowns were written to the files; RAW_DD-W_EC-11-UI.FT.txt, These 1 files were written to the directory, D:\khalford\SeriesSEE-PROJ\WORKING_ExampleWLmodel OK
Example RAW ASCII output with elapsed time and comments.	RAW_DD-W_EC-11-UI.FT.txt 1 # Drawdown in well: DD-W_EC-11-UI.FT from time 05/18/2011 2 0.018750 0.007 !! 05/18/2011 10:20:00 3 0.039583 0.007 !! 05/18/2011 10:50:00 4 0.060417 0.009 !! 05/18/2011 11:20:00 5 0.081250 0.008 !! 05/18/2011 11:50:00 6 0.102083 0.009 !! 05/18/2011 12:20:00 7 0.122917 0.010 !! 05/18/2011 12:50:00 8 0.141782 0.009 !! 05/18/2011 13:17:10
A reduced set of time-drawdown pairs are written to ASCII files. Time-drawdown pairs are reduced by averaging during sub-periods as specified here: ☑ Averaged output to an ASCII file: 3 hours Message box reports file names, original and reduced numbers of time-drawdown pairs, number of files created, and directory where written.	AVERAGED ASCII OUTPUT Estimated drawdowns were written to the files; OBSERVE-AVG_DD-W_EC-11-UI.FT.txt, Reduced 1329 to 222 values, well DD-W_EC-11-UI.FT. These 1 files were written to the directory, D:\khalford\SeriesSEE-PROJ\WORKING_ExampleWLmodel OK

Example AVERAGED ASCII output with elapsed time and comments.	
Does nothing because it is not coded.	
The temporary workbook with selected series that have been trimmed to begin and end times is left open but is not saved. Temporary workbook is closed and disappears if this option is not checked.	
Click OK to write files and dismiss the ASCII utility.	

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Window Utility

Data in the current SeriesSEE viewer is reduced to a user-specified period and copied to a new workbook with the Window utility. Time or depth data are windowed, which depends on if data are time series or geophysical logs, respectively. Time is discussed exclusively although data can be cropped by either time or depth. Beginning time and period of window are defined through the WINDOW DATA form (Figure 49). The specified period is viewed in the magnifier window of the SeriesSEE viewer. The WINDOW DATA form initializes with the beginning time and period of the current magnifier window.

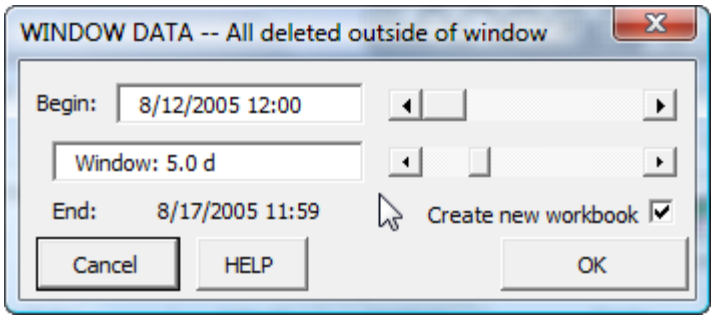
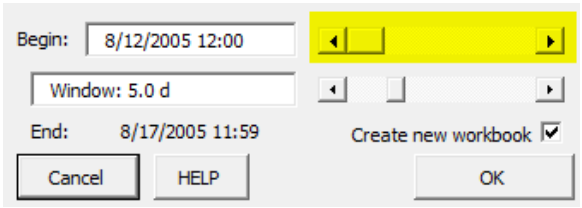
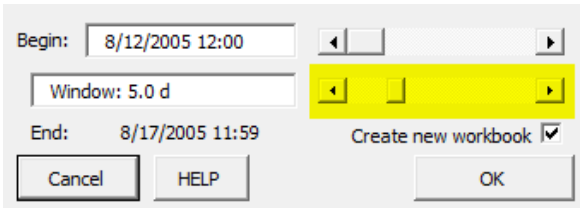
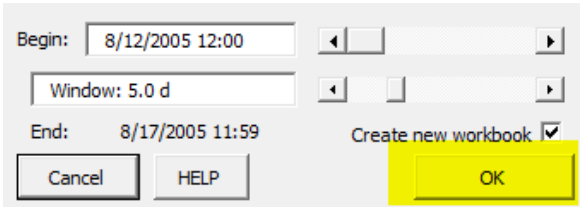


Figure 49.—Form for creating a new workbook with data limited to user-specified period or depths.

Instructions for Windowing Data

Adjust beginning of data window to be cropped with upper scroll bar. Selecting areas between slider and end arrows will move beginning one window period. Beginning of windowed period can be entered directly.	
Adjust window period with lower scroll bar. Window period can range between 10 percent of the initial window period to half of the entire data period. Windowing period also can be entered directly.	
Press OK to create a new workbook with the cropped data set. Empty series are eliminated.	

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Pix Utility

Pictures of the magnify chart are exported to a folder of GIF files with the Pix utility where selected series differ between each picture (Figure 50). The range of the primary vertical axis can be specified so that all exported charts have the same vertical range. Minimum and maximum values of the vertical axes will differ to allow for differences between mean values of selected series. For example, two series of depth to water are exported, where depths to water average 44 and

2016 ft. A 10-ft range is specified so the respective axes range from 39 to 49 ft and 2011 and 2021 ft, below land surface.

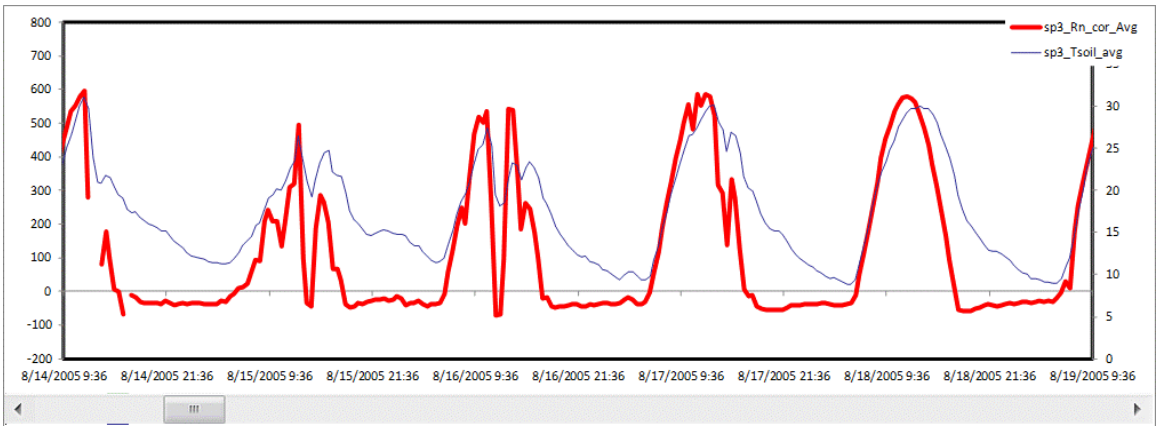
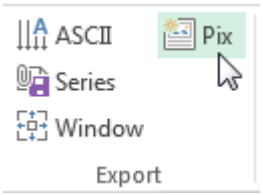
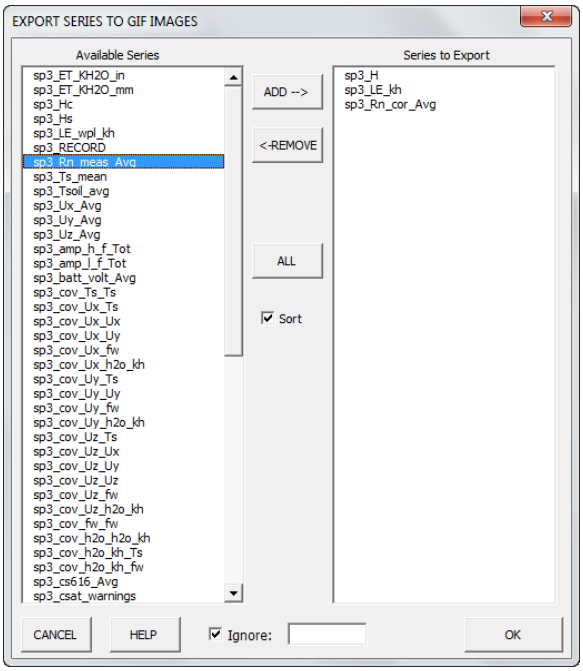
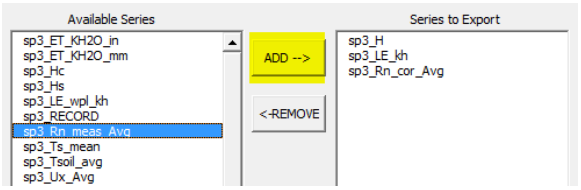
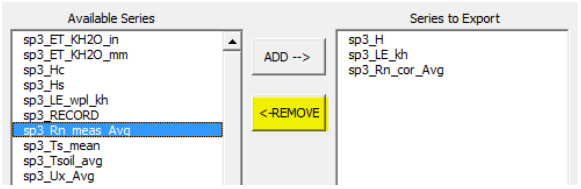
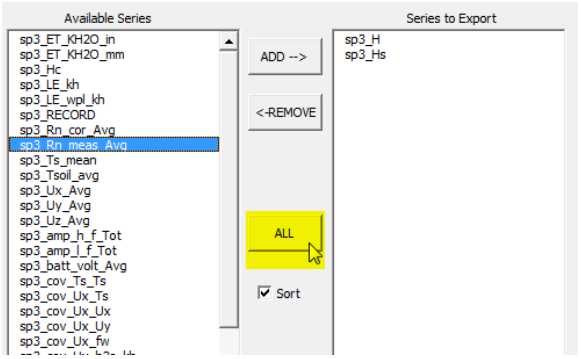
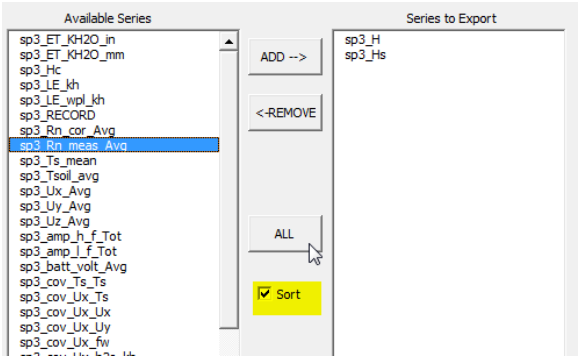
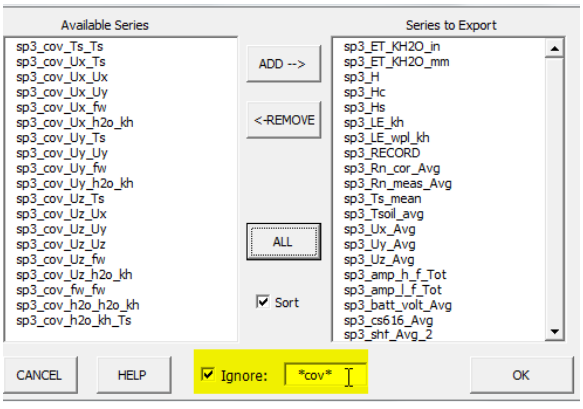
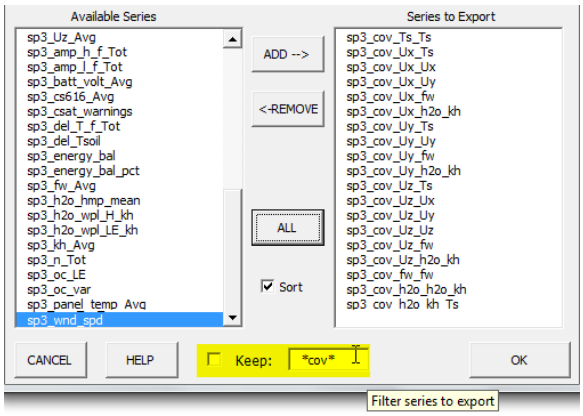
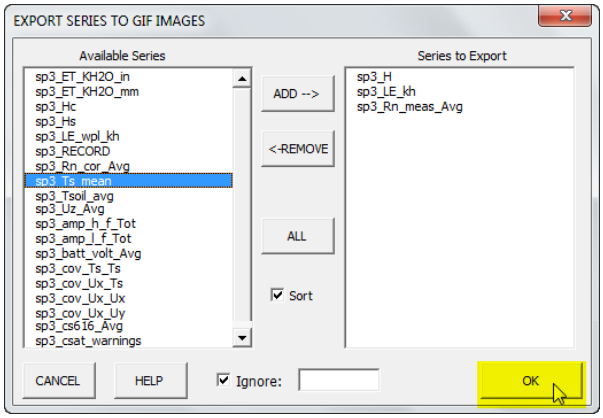


Figure 50.—Example of magnify chart exported to a GIF file with the PIX utility.

Instructions for Exporting Pictures

Select the Pix utility in the Export group.	
The “EXPORT SERIES TO GIF IMAGES” form will appear.	

Under the “Available Series” list, either double-click a series or select a series and press “ADD” to add a series to the “Series to Export” list.	
Under the “Series to Export” list, either double-click a series or select a series and press “REMOVE” to move a series back to the “Available Series” list.	
All series can be moved between the “Available Series” and the “Series to Export” lists with the ALL button.	
Listed series in “Available Series” and the “Series to Export” lists will be sorted if the sort option is checked.	
A filter is applied so that all series matching the filter remain in the “Available Series” list and all others go to the “Series to Export” list when the ALL button is clicked.	

A filter is applied so that all series matching the filter go to the “Series to Export” list and all others remain in the “Available Series” list when the ALL button is clicked.	
Select OK. The first visible series will be replaced with a series from the export list and GIF picture of the revised magnify chart will be written to a GIF file. This process is repeated for a series in the “Series to Export” list. For example, three GIF files will be created if three series are specified. A secondary form “SPECIFY OUTPUT” appears before series are exported.	

Range of the primary vertical axis and the output subdirectory are defined with the SPECIFY OUTPUT form (Figure 51). Primary vertical axis can be set to a fixed scale for ease of comparison between figures or allowed to scale automatically. Exported GIF files are written to a subdirectory that will be created if it does not exist.

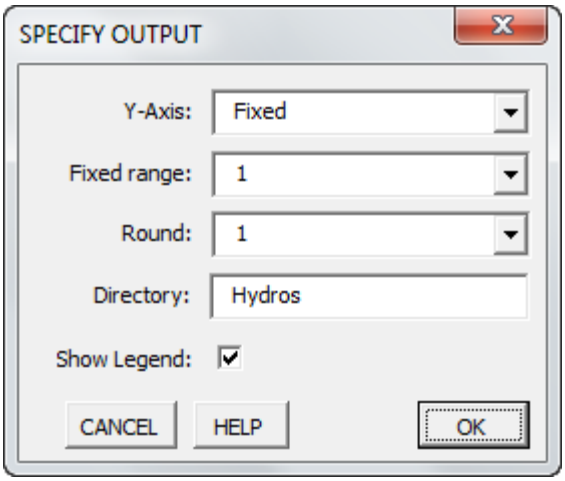
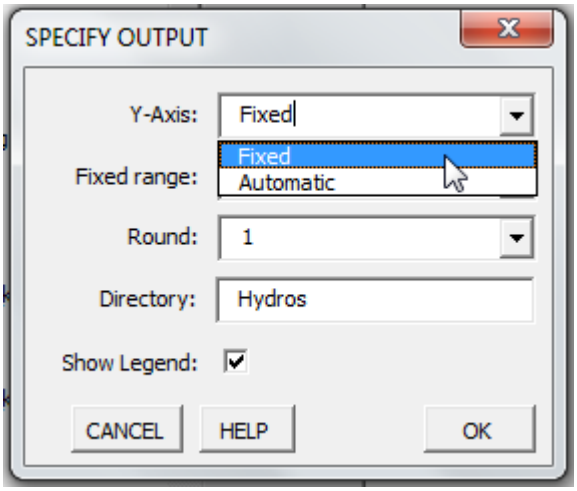
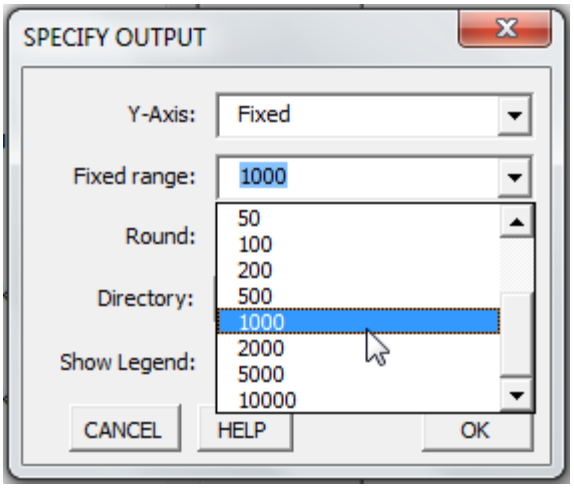
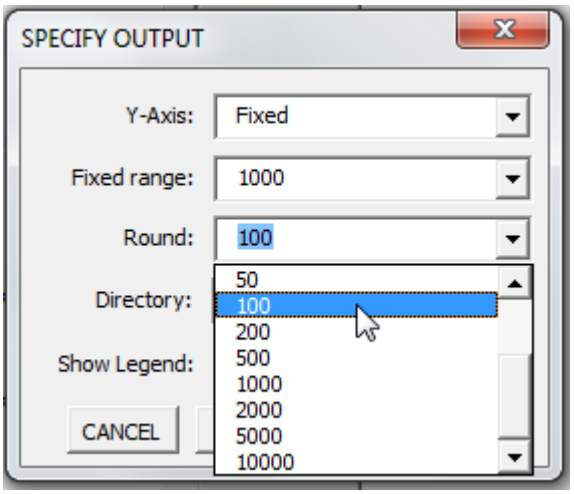
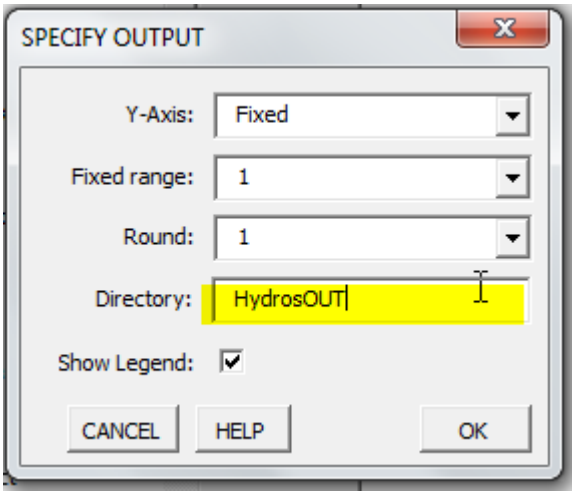
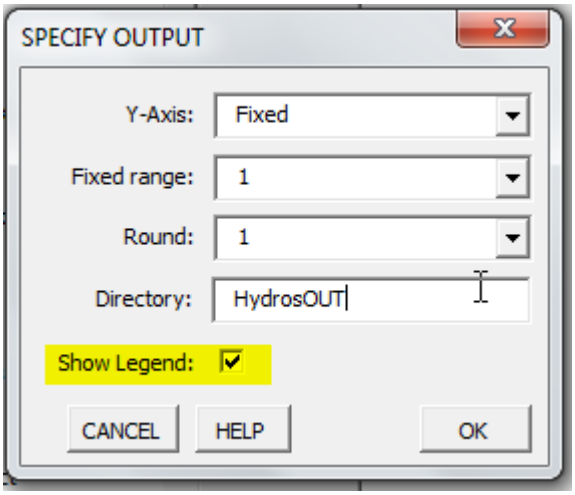
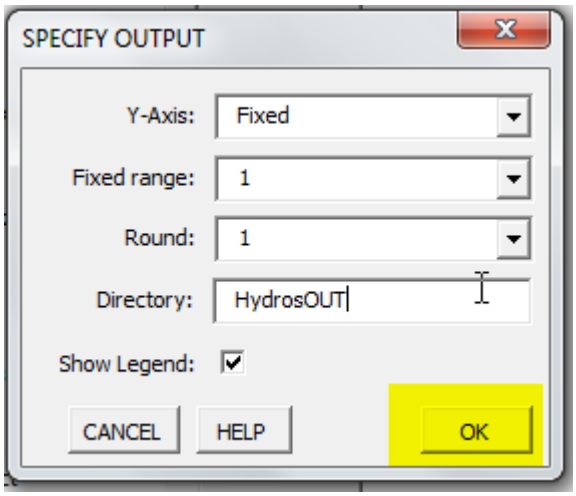


Figure 51.—Form for specifying range and rounding of dependent axis and name of subfolder that holds exported GIF files.

Specifying Hydrograph Dimensions in Pictures

All exported charts will share a common, user-specified range of the primary y-axes if Fixed is selected.	
Fixed range can be specified from the pull-down menu or other values can be entered directly. Other values can be less than 1. Minimum and maximum values will differ between charts because the fixed range is centered on the average value of the output series during the period in the chart.	

Minimum and maximum values are rounded to the specified multiple. Multiples less than 1 or greater than the fixed range are ignored.	
GIF files will be written to the specified subdirectory that is named Hydros by default. A subdirectory will be created if does not exist.	
A standard Excel legend is added to the magnify chart if checked. This option exists because the default legend in SeriesSEE is not part of the chart and is not exported.	

Select OK and GIF images of the magnify chart will be written to the specified subdirectory. One image for each specified series.	

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Adjust

Adjust position of individual series on Y-axis with the Offset utility (Figure 52). Window size, window overlap, series preferences, and window zoom settings are saved with the UserPref utility.

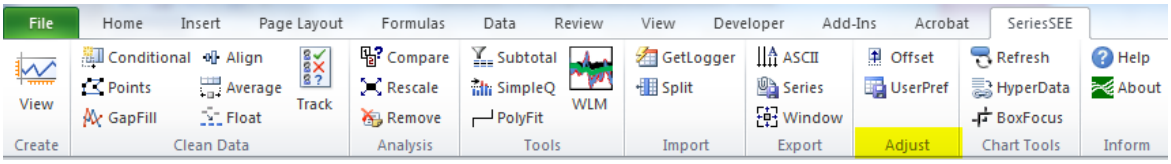

Figure 52.—Adjust group for displacing series, manually adding series, and resizing the viewing windows in an existing SeriesSEE viewer file.

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Offset Utility

Individual, selected, or all series can be shifted with the Offset utility. Series are shifted such that the average, minimum, maximum, or first value will equal zero in the shifted series (Figure 53). The Offset function is handy for comparing fluctuations in series where references differ significantly. Series affected by the Offset function are modified exclusively in an active SeriesSEE viewer. The Offset function will fail if used when a SeriesSEE viewer is not active.

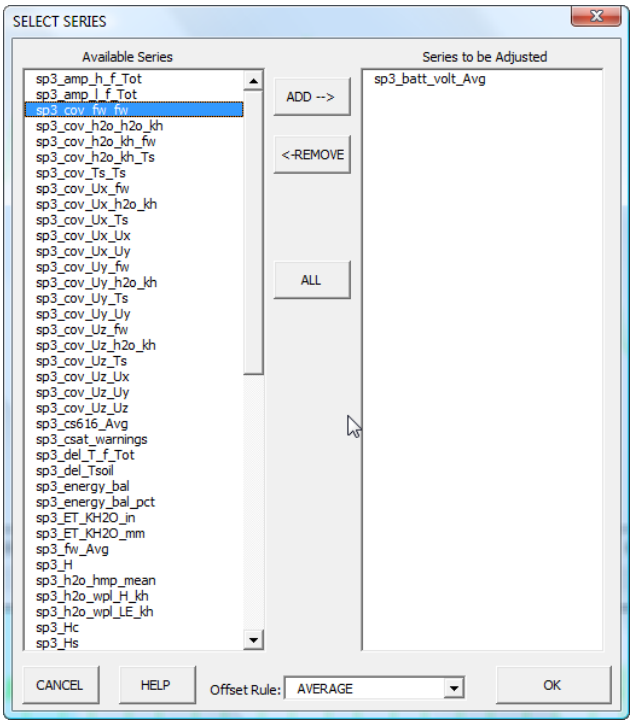
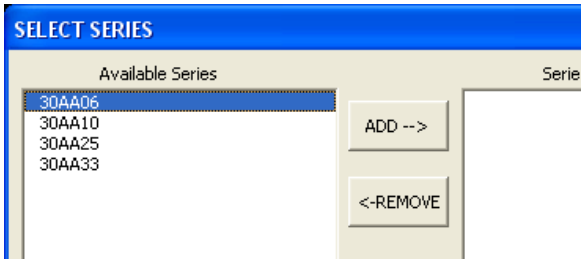
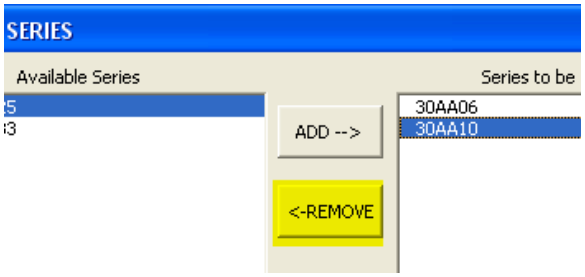
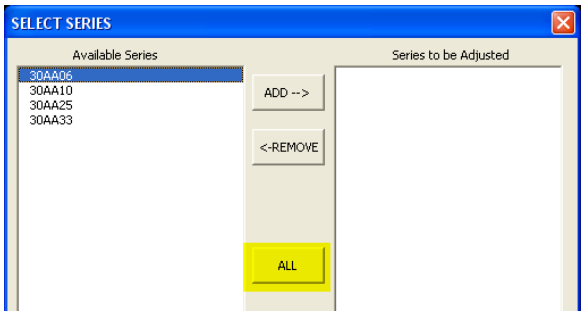
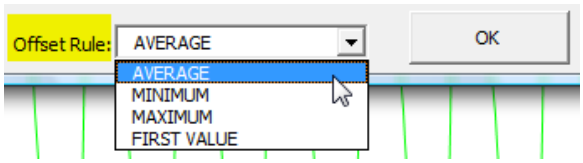
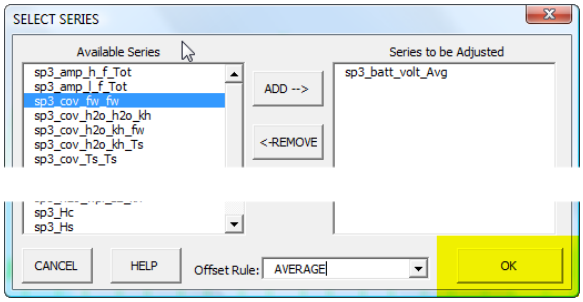


Figure 53.—Ribbon group, command, and form for selecting series to shift in an existing SeriesSEE viewer.

Instructions for Offset

Under the “Available Series” list, either double-click a file name or select a file name and press “ADD” to add a file to the “Series to be Adjusted” list.	
Under the “Series to be Adjusted” list, either double-click a file name or select a file name and press “REMOVE” to move a file back to the “Available Series” list.	

All files can be moved between “Available Series” and “Series to be Adjusted” lists by selecting a file and pressing “ALL.”	
Select new reference for shifted series with the Offset Rule menu. The zero reference can be the average, minimum, maximum, or first value of a series.	
Select OK to process selected series.	

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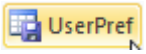
UserPref

Window size, window overlap, series preferences, and window zoom settings are saved with the  utility. Series preferences include color, line weight, symbol selection, and symbol size.

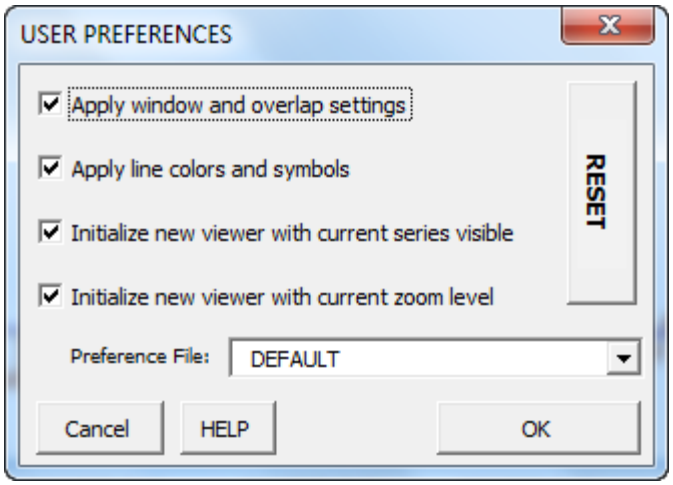
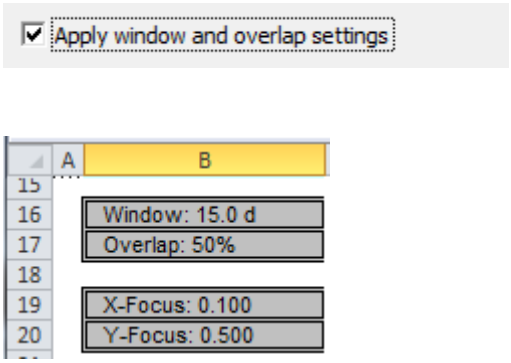
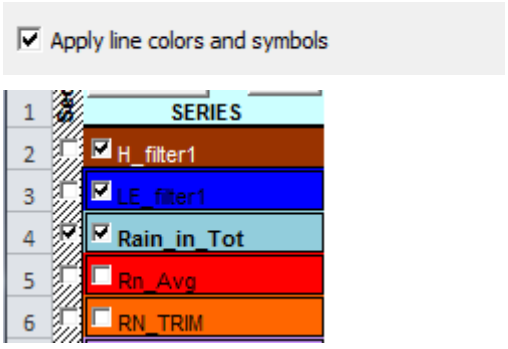
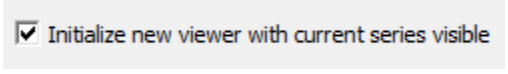
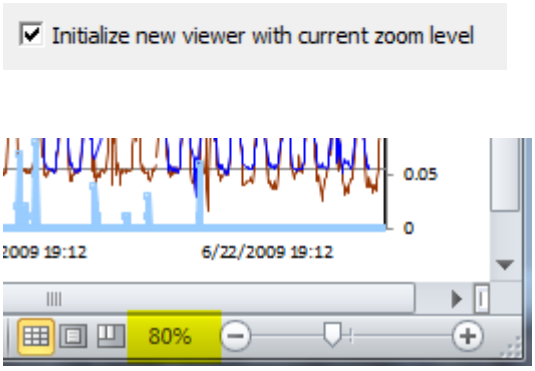
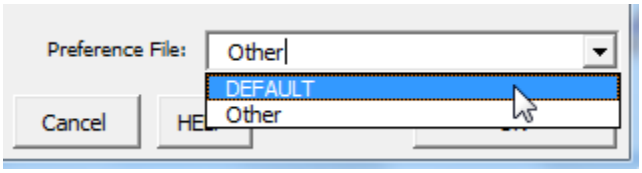
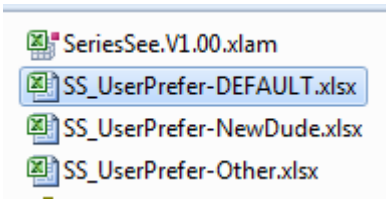
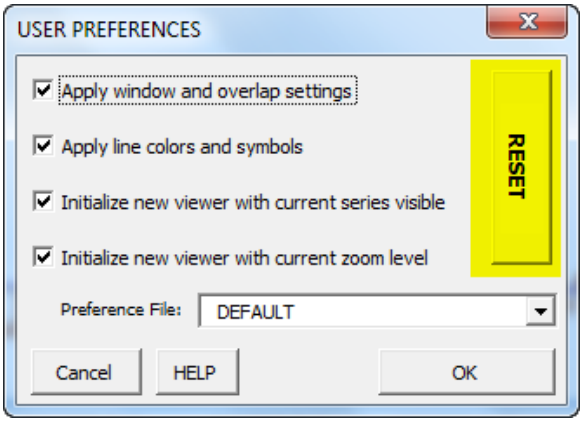


Figure 54.—Form for specifying user preferences that will be applied to the next viewer file created with SeriesSEE.

Save User Preferences

Current window width (B16), overlap (B17), X-Focus (B19), and Y-Focus (B20) settings are saved and applied to the next Viewer file if checked.	
Colors, line weight, and symbol selection in cells B2:B13 are saved and applied to the next Viewer file if checked.	
Current charted series will be charted automatically to the next Viewer file if checked.	

Current window zoom level is saved and applied to the next Viewer file.	
Multiple user-preference files can be created by typing a new file rather than selecting from the list. The selected user-preference file will be used to create the next Viewer file. User-preference files are stored in the SeriesSEE Add-In folder with the naming convention of ***SS_UserPrefer-*.xlsx***, where the selected preference file label is substituted for the *.	 
All user-preference files are deleted with the RESET button.	

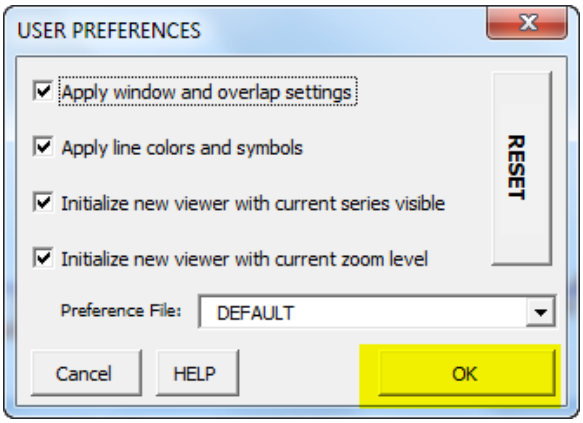
Select OK to save user-preferences.	

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Chart Tools

Charted series and data are linked interactively and XY charts can be scaled interactively with the chart tools (Figure 55).

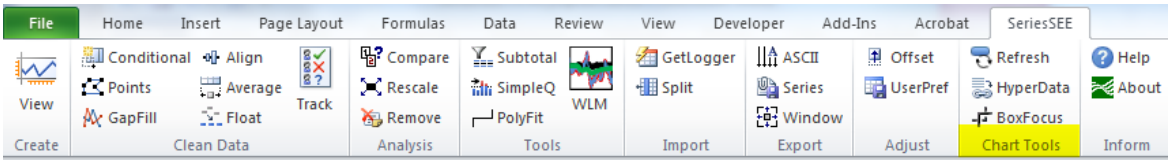

Figure 55.—Chart Tools group for hyperlinking between charted series and source data and graphically zooming in a XY chart.

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Refresh Utility

Refresh the list of available series to chart and resize viewing charts with the Refresh utility. This function is needed if the user manually adds series by pasting data or adding columns of equations in a SeriesSEE viewer on the data page. The Refresh utility removes non-existent series from the list of available series after deleting columns of data.

Viewing charts and the scrollbar are resized to the visible area after adjusting the size of an Excel window or the zoom setting within a window. For example, a SeriesSEE viewer was created in an Excel window that was shrunk (Figure 56). Shrinking the window obscured much of the viewing charts and scrollbar. The area of the viewing charts and scrollbar were resized to the new window area with the Refresh utility (Figure 56).

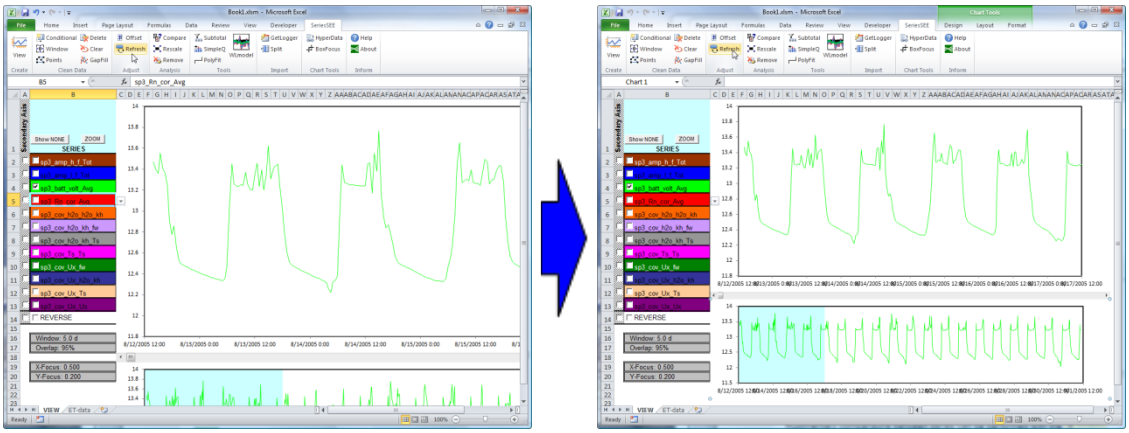

Figure 56.—Resizing the viewing charts and scroll bars with the refresh utility.

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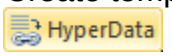
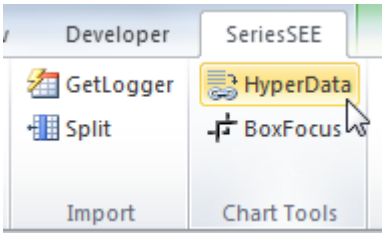
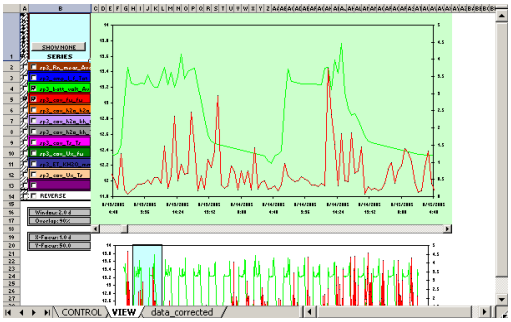
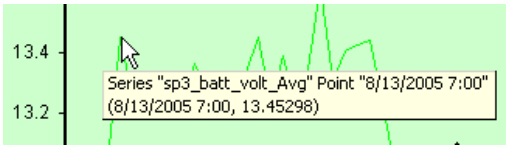
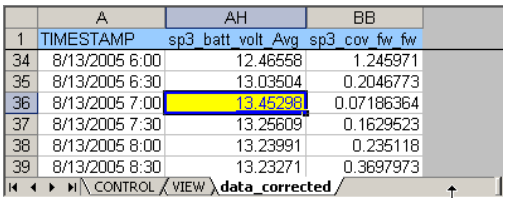
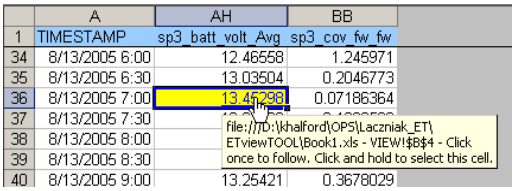
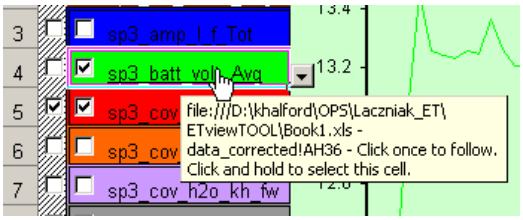
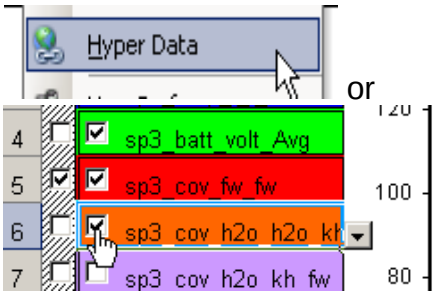
HyperData Utility

Create temporary hyperlinks between visible series and source data with the 

utility. All columns that contain source data are hidden except for the visible series. Selecting a point in a series creates hyperlinks between the datum point and the checkbox for the selected series. The visible window will change from the chart on the VIEW page to the source cell of the datum point.

Instructions for Hyper Data Analysis

Activate Hyper Data from the Chart Tools Group in the SeriesSEE tab.	
The background color of the magnify window will change color.	
Select a point in a series to hyperlink to the data source. The data page becomes visible, and the data cell is selected.	

All columns that contain source data are hidden except for the visible series. Hyperlinked cells are shaded yellow.	
The hyperlink in the data cell sends the focus back to the series selection cell on the VIEW page.	
The hyperlink in the series selection cell sends the focus back to the data cell on the data source page.	
Deactivate Hyper Data from the main menu of SeriesSEE or by adding a new series. Hyperlinks and yellow backgrounds are removed from all hyperlinked cells after deactivating.	

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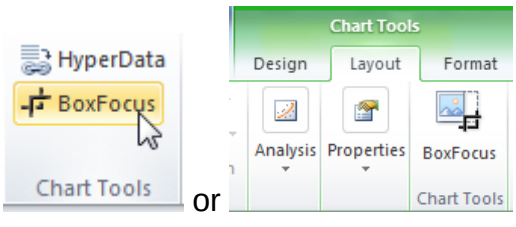
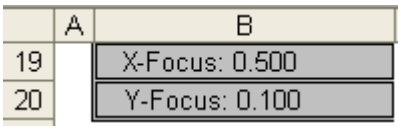
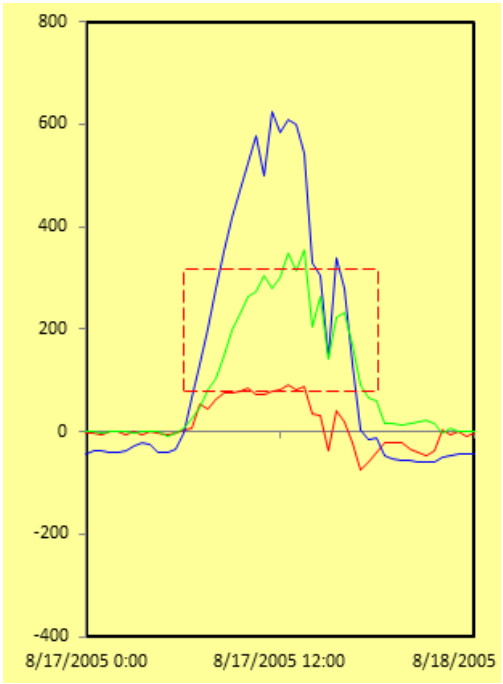
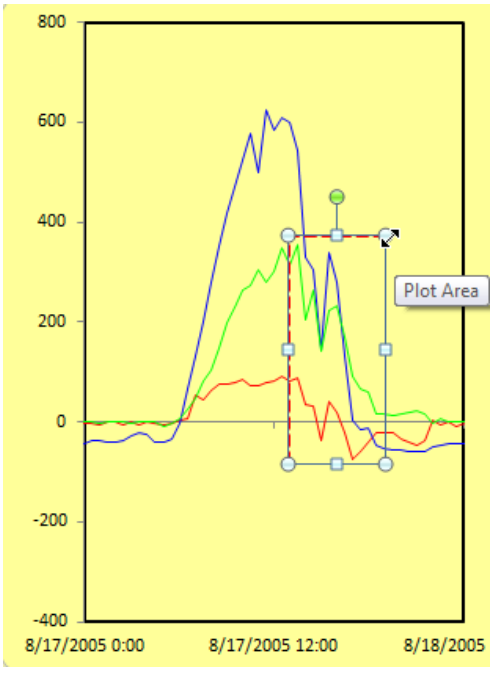
BoxFocus Utility

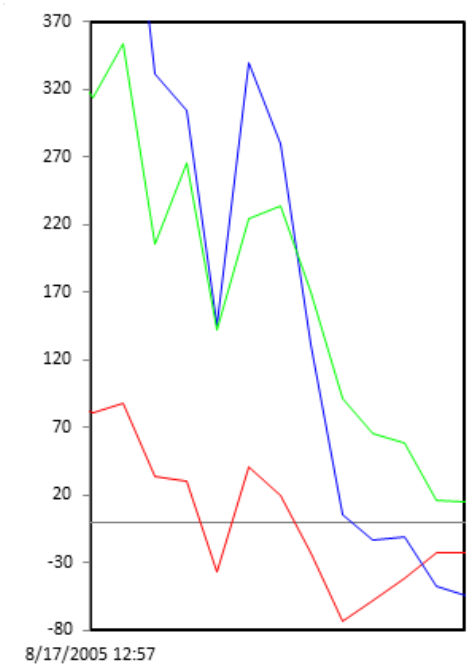
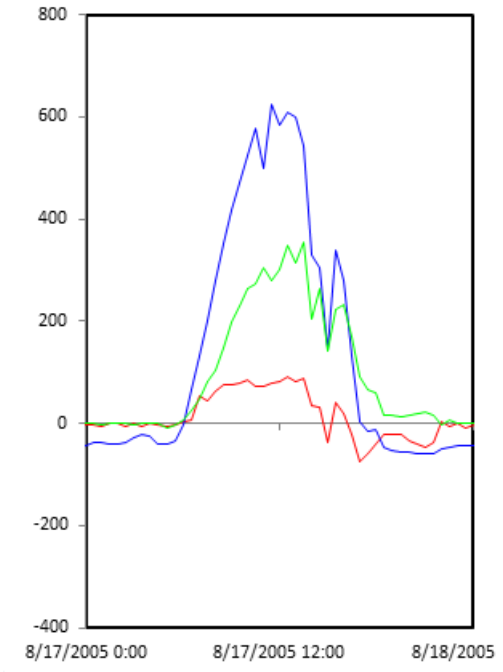
Magnify subareas of plots to a user-defined box with the 

utility. The first click adds a rectangle to the selected plot area and changes the background color. The second click re-scales both axes to the area defined by the rectangle and removes the rectangle. The third click restores the chart to the original scales.

Instructions for Box Focus utility

The Box Focus utility appears in the Chart Tools group of the SeriesSEE and Chart Tools, Layout tabs when a chart is selected.	

The default size of the Box Focus utility are specified as fractions of the X-axis length and Y-axis height.	
Select BoxFocus to add a rectangle to the selected plot area. Background color also changes.	
Delineate area to magnify by moving and resizing rectangle.	

Select BoxFocus to re-scale both axes to the area defined by the rectangle. Rectangle for defining the magnification area is removed.	
Select BoxFocus to restore the chart to the original scales. Chart is restored to the original state.	

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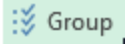
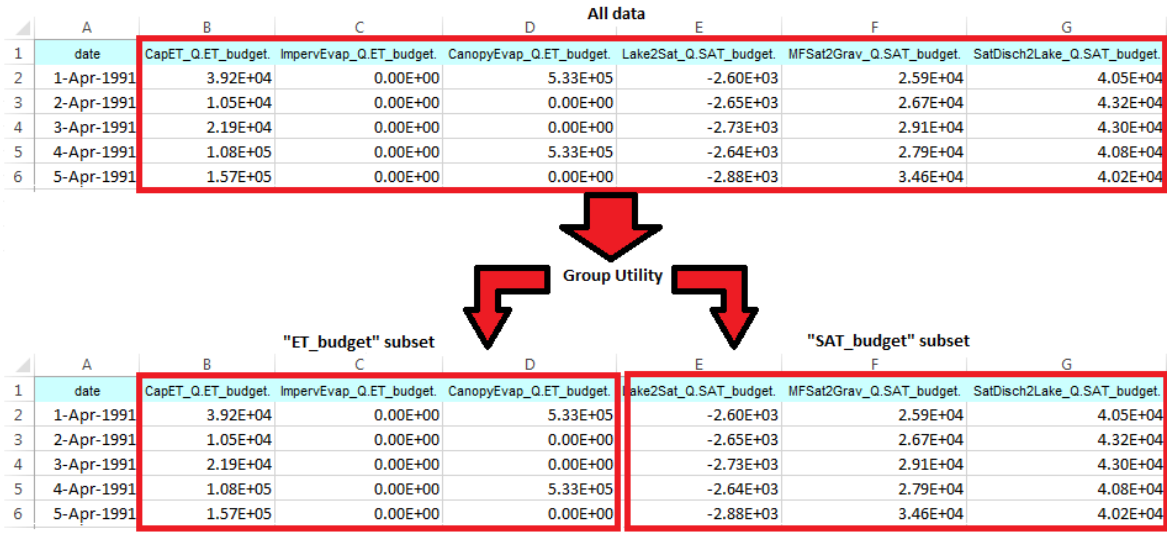
Group Utility

The  utility allows the user to quickly organize and plot data subsets from a larger dataset. Each subset is denoted by a tag that is delimited from series name. Figure 57 shows two data subsets (i.e., “ET_budget” and “SAT_budget”) for example that are separated from the series name in the header row by a

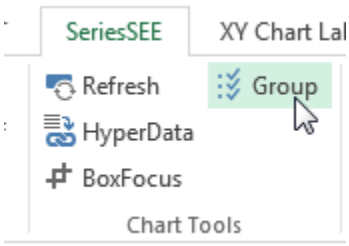
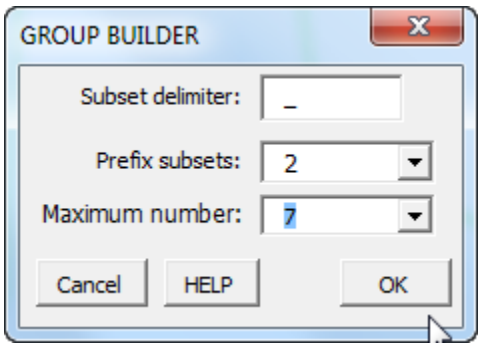
period delimiter (e.g., “CapET_Q.ET_budget”). The Group utility allows the user to quickly group and plot these data subsets.

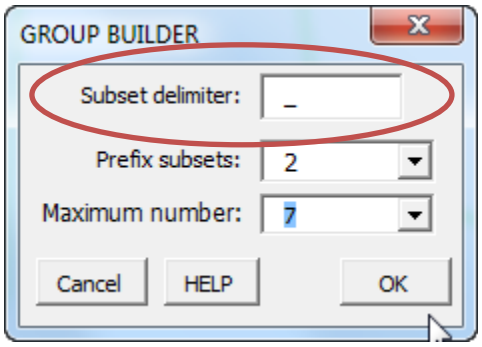
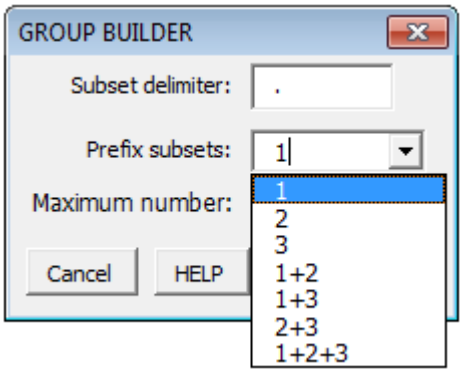
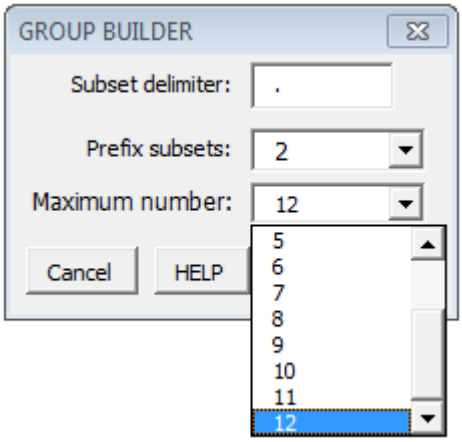


	A	B	C	D	E	F	G
1	date	CapET_Q.ET_budget.	ImpervEvap_Q.ET_budget.	CanopyEvap_Q.ET_budget.	Lake2Sat_Q.SAT_budget.	MFSat2Grav_Q.SAT_budget.	SatDisch2Lake_Q.SAT_budget.
2	1-Apr-1991	3.92E+04	0.00E+00	5.33E+05	-2.60E+03	2.59E+04	4.05E+04
3	2-Apr-1991	1.05E+04	0.00E+00	0.00E+00	-2.65E+03	2.67E+04	4.32E+04
4	3-Apr-1991	2.19E+04	0.00E+00	0.00E+00	-2.73E+03	2.91E+04	4.30E+04
5	4-Apr-1991	1.08E+05	0.00E+00	5.33E+05	-2.64E+03	2.79E+04	4.08E+04
6	5-Apr-1991	1.57E+05	0.00E+00	0.00E+00	-2.88E+03	3.46E+04	4.02E+04

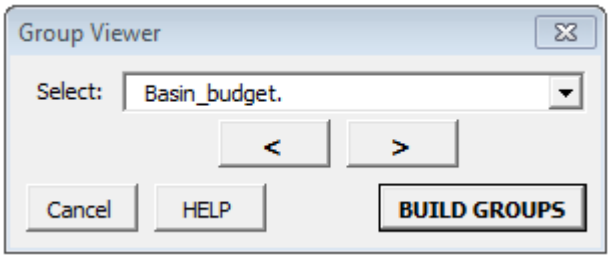
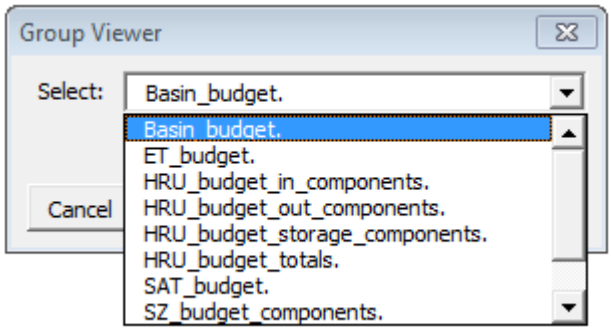
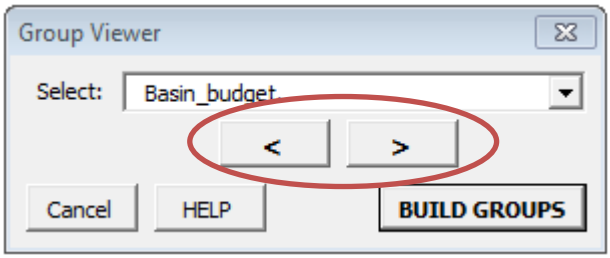
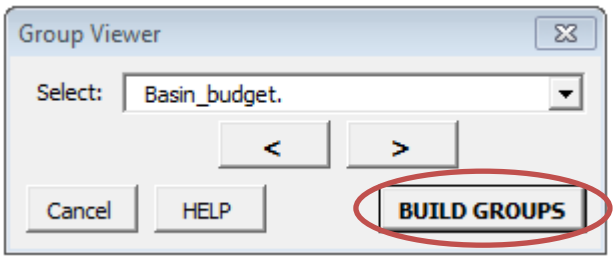
Figure 57.— Data organized into subsets with the Group utility.

Viewing series by groups in SeriesSEE – Group Builder menu

Launch the Group utility	
The “GROUP BUILDER” form will appear.	

In the “Subset Delimiter” box, enter the delimiter used in the header row. The delimiter character (e.g., period, comma, underscore, etc.) separates each subset of information in the header for each series.	
Specify which subsets will be used to group the series in the “Prefix subsets” dropdown list. For example, if “1” is selected, the utility will group the series by the first subset in the header (i.e., the prefix, in this case). If “1+2” is selected, the utility will display series grouped by both the 1st and 2nd subsets in the header.	
Specify the maximum number of series to be displayed in the Viewer file with the “Maximum number” dropdown list. The maximum number of series that can be displayed is 12. Click OK to advance to the “Group Viewer” form.	

Viewing series by groups in SeriesSEE – Group Viewer menu

Once the subset delimiter, prefix subsets, and maximum number are selected in the “GROUP BUILDER” form, click OK and the “Group Viewer” form will appear. .	
Each group that was specified will be shown in the “Select” dropdown list. Select a group to display in the viewer file from the dropdown list, or toggle through the groups with the left and right arrows	 
To build a new grouping configuration, click the “BUILD GROUPS” button to return to the “GROUP BUILDER” form.	

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Inform

Direct access to Help and About utilities (Figure 58).

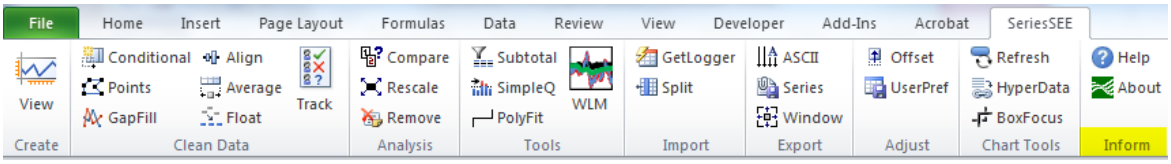

Figure 58.—Inform group for launching help and spouting-off about SeriesSEE.

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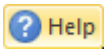
Help Utility

Launch SeriesSEE help browser to default topic. 

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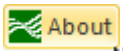
About Utility

Display ad copy about SeriesSEE and version number, 

. Version number is 1.20 as of April 30, 2016.

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