APPENDIX E

THE PENNSYLVANIA-MARYLAND INSTREAM FLOW STUDY IMPACT ANALYSIS PROGRAM

E1.0 INTRODUCTION

The Pennsylvania/Maryland Instream Flow Study Impact Analysis Program is designed to estimate the potential impact of water withdrawals on trout habitat in cold-water streams. This analysis considers the study region in which the stream is found, the hydrology of the stream, the drainage area, the distance from the headwaters to the point of withdrawal, and the fish species composition in the stream. The program utilizes fishery habitat information, developed for specific study streams using the Instream Flow Incremental Methodology (IFIM). It is designed to predict the effects of a withdrawal on any stream that has not been studied, based on the average of the effects on studied streams in the same study region.

The computer program is written in Microsoft™ Excel 7.0 spreadsheet format. The minimum system requirements are an IBM™ compatible computer, with an 80486 processor; Microsoft™ Windows 95 operating system; and Microsoft™ Excel 5.0 program.

The Impact Analysis Program includes the detailed analysis and preliminary analysis programs, which are closely related. There are three main differences between these programs:

1. The detailed analysis program provides in-depth analysis of the effects of withdrawals on flows and habitat in terms of Renormalized Minimum Weighted Usable Area (RMWUA). The preliminary analysis program provides only a general overview of impacts of a proposed withdrawal over a range of potential passby flows. As a result, the output from the preliminary analysis program is much less detailed than the detailed analysis program.

2. The detailed analysis program allows the input of any passby flow, and the passby flows can vary seasonally. The preliminary analysis program automatically uses 13 different passby flows, ranging from 0 to 60 percent ADF, in 5 percent ADF increments. These flows cannot vary seasonally.

3. The two programs use different algorithms to compute average seasonal impacts to RMWUA.

There are a variety of ways to evaluate impacts to trout habitat using the various outputs produced from these programs. The detailed analysis program is designed to estimate average impacts on median monthly flow, or RMWUA, for a particular type of fishery on a monthly, seasonal, and annual basis. It also calculates changes in monthly, seasonal, and annual duration of flow and RMWUA. The program estimates the average impact on streamflow, or RMWUA, given the hydrology, drainage area, average daily flow, and species composition of a particular site, based on the streams studied in the specific class. The duration analyses are presented in tabular format but can also be graphed. The preliminary analysis program only estimates changes in seasonal and annual average RMWUA, and seasonal and annual median RMWUA, resulting from a given withdrawal combined with the preselected passby flows. Outputs such as duration analyses of the effects of withdrawal on flow and habitat are not computed in the preliminary analysis program. The abbreviated format of the preliminary analysis program allows a general evaluation of the effect of a wide range of passby flows for any given withdrawal, while reducing the run time necessary to analyze the same number of passby flows with the detailed analysis program.

The program also can perform analyses for other time steps (e.g., annual, daily) provided that hydrologic data file limits are not exceeded.

E2.0 DATA NEEDS AND CALCULATION METHODS

E2.1 Detailed Analysis Program

The detailed analysis program requires:

1. The natural median monthly flows for a period of years for the site from which the withdrawal is proposed (project stream). These flows should be synthesized using the regional hydrology procedures described in section 6.6.3.

2. The proposed withdrawal and passby flows for the project stream for each season. The proposed withdrawal and passby flows are entered in units of either cfs, csm, mgd, or percent ADF. The withdrawal and passby flow information can vary with season. One combination of withdrawal and passby flow must be entered for each season for each run.

3. Other required data such as the stream name, distance from the headwaters to the taking point, the study region, drainage area, and ADF at the taking point, and the trout species (brook, brown, or combined) to be considered.

4. The appropriate RMWUA versus flow tables, based on the study region. Tables for the Ridge and Valley Freestone, Ridge and Valley Limestone, and Unglaciated Plateau study regions are presently included in the program. Tables for the 12 study streams in the Piedmont Upland study region also are included.

The detailed analysis program:

1. Converts all median monthly flows to percent ADF.

2. Modifies the existing flow record for the effect of withdrawals and passby flows so that predictions of impacts on flow and habitat can be based on comparison of the existing (unimpacted by the proposed withdrawal) flow and habitat and the flow and habitat available as affected by the proposed withdrawal.

3. Converts the flows in the RMWUA versus flow tables for each study site in that class of streams to percent ADF, so that flow values for the project stream and each of the study streams can be directly related to each other.

4. Determines the stream segment class, based on length of stream.

5. Develops unimpacted and impacted median monthly RMWUA tables for each study stream, using the unimpacted and impacted median monthly flow tables for the project stream and the RMWUA versus flow relationships for each of the study streams.

6. Estimates the average monthly, seasonal, and annual RMWUA, both with and without the withdrawal, for each study stream, using the RMWUA values from the tables developed in step 5. Seasonal averages for each study stream are computed from all the individual monthly values in the period of record for each study stream. Thus, if there are three months in the season, and 50 years in the period of record, the average seasonal RMWUA for that particular season would be calculated using 150 values.

7. Estimates the average change and average percent change in RMWUA for each month, season, and year, for each study stream in the appropriate class of streams, based on the flows for the project stream.

8. Computes the average monthly, seasonal, and annual impact of the withdrawal on RMWUA for the project stream by averaging all the individual monthly, seasonal and annual outputs for all the study streams in the stream class (steps 5 and 6 above) across years and then across streams (stream variation method). Standard deviations and 95 percent confidence intervals also are calculated for the average data sets. For example, if there are 19 study streams in a particular class of streams, the average impact to RMWUA in March would be calculated from the average of the 19 average March impacts, one from each of the 19 study streams, and the sample size used in the confidence interval calculation would be 19.

9. Computes the average monthly, seasonal, and annual impact of the withdrawal on RMWUA for the project stream by averaging all the individual monthly, seasonal and annual outputs for all the study streams in the stream class (steps 5 and 6 above) across streams and then across years (yearly variation method). Standard deviations and 95 percent confidence intervals also are calculated for this case. The sample size used to compute standard deviations and confidence intervals is equal to the number of years of record used to develop the hydrology for the stream.

10. Develops a table of average median monthly RMWUAs by averaging all the corresponding individual median monthly values from the individual RMWUA tables for each study stream in the stream class. The size of the resulting table of RMWUAs will be 12 months times the number of years in the estimated hydrology for the project stream.

11. Computes duration analyses of flow and RMWUA with and without the withdrawal, using the table described in step 8. Monthly duration analyses use all the monthly values for each month in the period of record. Seasonal duration analyses use all the monthly values from each season. Thus, if there are three months in a season and 20 years in the period of record, 60 values would be used in the seasonal duration analysis. Annual duration analyses use all the monthly values in the table. Thus, if there are 20 years in the period of record, 240 values would be used in the annual duration analysis.

The differences between the stream variation method and the yearly variation method generally appear in the values of standard deviations and confidence limits. The averages should be similar.

E2.2 Preliminary Analysis Program

Data entry for the preliminary analysis program is identical to that of the detailed analysis program, except that passby flows are not entered. The program automatically estimates the impacts of the proposed withdrawal with 13 preset passby flows. The program performs the following data manipulations and calculations:

1. Develops unimpacted and impacted median monthly RMWUA tables for each study stream, using the same process described in steps 1-4 for the detailed analysis program.

2. Estimates the average seasonal and average annual RMWUA, both with and without the withdrawal, for each study stream, using the RMWUA values from the tables developed in step 1. First, the RMWUA values for the months in a season are averaged, resulting in one

seasonal value for each year. Then, the seasonal averages for each year for each study stream are averaged across years to obtain a seasonal average for each study stream. Thus, if there are three months in a season, three values are averaged for each year, for each stream, to obtain a seasonal average for the year. Then, if there are 50 years in the period of record, 50 values (one seasonal value per year) are averaged to derive the seasonal average. This differs from the algorithm used to derive seasonal averages in the detailed analysis program. (See step 5 above for the detailed analysis program.) The difference is that the preliminary analysis program first averages the months in each season in each year to derive seasonal averages for each year. It then averages each of these seasonal values for the entire period of record. The detailed analysis program skips this first step. Consequently, the results may be slightly different.

3. Estimates the average percent change in seasonal and annual RMWUA for each study stream in the appropriate class of streams using the flows from the project stream.

4. Estimates the average seasonal and annual impact of the withdrawal on RMWUA for the project stream by averaging all the individual seasonal and annual outputs from all the study streams in the stream class (steps 2 and 3 above).

5. Estimates the median seasonal and annual RMWUA, with and without the withdrawal, and the absolute and percentage change in median RMWUA. The same process described in steps 2-4 above is used, except that the median of the RMWUA values in each year in the period of record is determined for each study stream, and not the average as in step 2. This is a different algorithm than is used in the detailed analysis program, where the median values can be derived from the duration analysis described in steps 8 and 9 of the detailed analysis program. As a result, the answers will likely be slightly different from those calculated using the detailed analysis program.

E3.0 PROGRAM INSTALLATION

This program includes two files, **PA-MD Instream Flow Study.XLS** and **Output.XLT**, which are distributed on two 3.5 inch floppy diskettes, and requires at least 15 MB of free hard drive space. The two files must be installed on the hard drive in the Excel directory in a folder named **PA-MD IF Study.** If the folder does not already exist, it will be created automatically. The files are compressed, and will automatically decompress to the folders listed above.

To install, place floppy disk 1 into the computer, access the file on the disk, double click on the file **Pa-Md IF STUDY**, and follow the instructions on the screen. Do not change the **unzip to** location during installation, because the file is programmed to unzip to the correct folders.

E4.0 PROGRAM LAUNCH, INPUT, OUTPUT, AND OPERATION

To launch the program, open the file **C:\EXCEL\Pa-Md IF STUDY\PA-MD Instream Flow Study.XLS**. The program will open to the Main Menu for the Detailed Analysis and Preliminary Analysis Programs, shown in Figure E1. There are four buttons on this screen. The button labeled “Info: Getting Started” leads to an introductory screen that provides information regarding use of the program. The “Detailed Analysis Program” or “Preliminary Analysis Program” buttons lead to the respective programs.

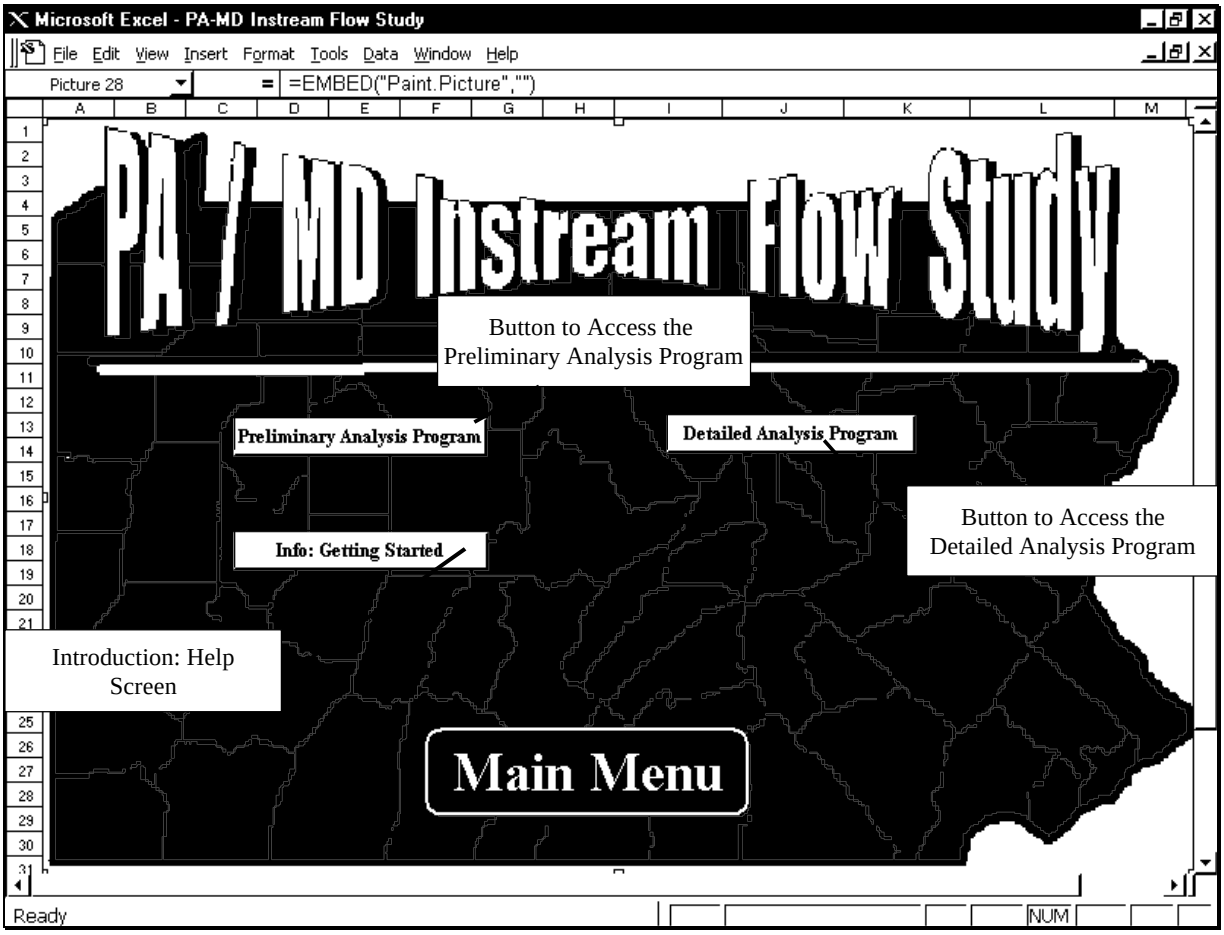


Figure E1. Instream Flow Impact Analysis Program Main Menu

E4.1 Detailed Analysis Program

E4.1.1 Input data

To access the Detailed Analysis Program, press the Detailed Analysis Program button on the Main Menu (Figure E1). The Streamflow Data Form, shown in Figure E2, appears automatically. Enter the median monthly flow time series for the study site in this table. If hydrologic data has been previously entered in the program, press the Clear Monthly Medians button to clear the data file, before entering new data. Hydrologic data can be entered either from the keyboard, or by pasting data from a previously computed file, but must be in units of cubic feet per second (cfs). Be sure to copy only the years and flow values, without any headings or other description. The analysis programs can handle up to 75 years of hydrologic data.

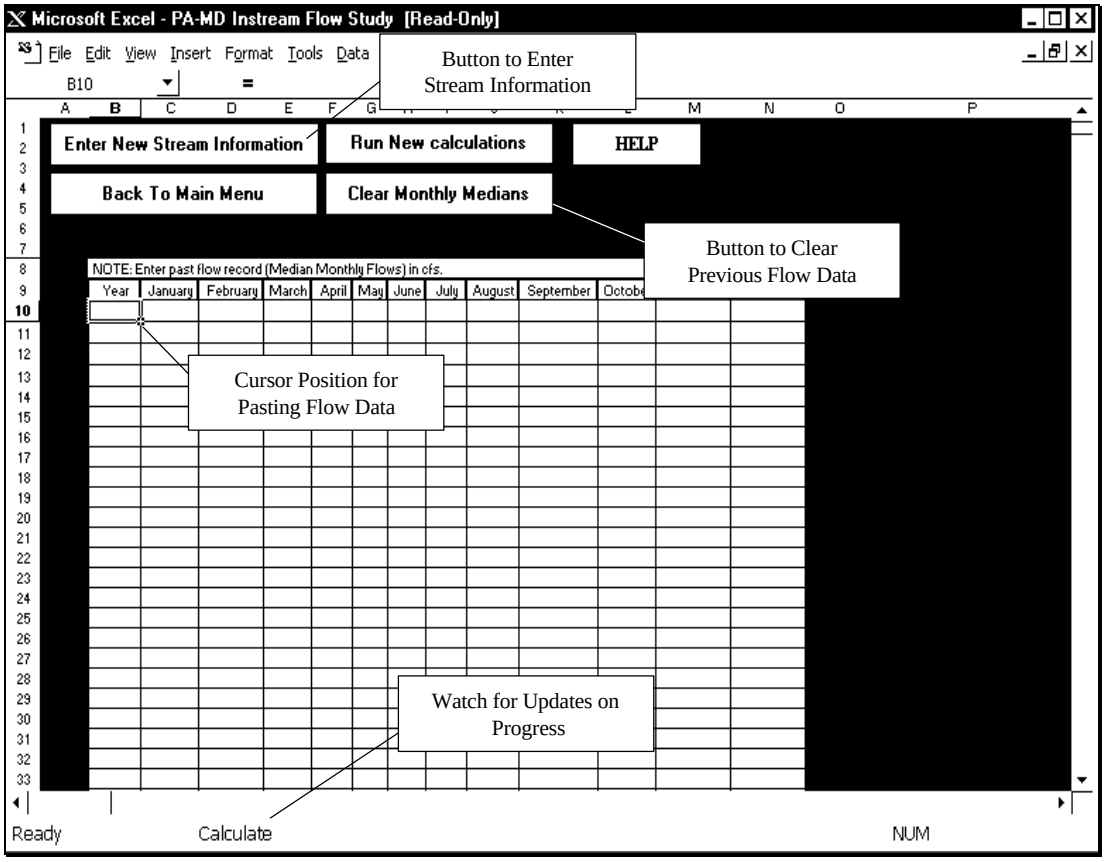


Figure E2. Streamflow Data Form

When the hydrologic data have been entered, press the Enter New Stream Information button to display the Stream Information dialog box shown in Figure E3. This dialog box is used to enter information regarding the project stream. Use the TAB key to scroll between data fields.

Enter the name of the project stream in the first data field. In this dialog box there are three list boxes that allow the user to pick the relevant information from a previously defined list, rather than typing it into a box. The Distance from Headwaters to Taking Point is selected in the first list box. The distance is divided into 5-mile increments, so that the options are 0-5.0 miles, 5.1-10.0 miles, 10.1-15.0 miles, 15.1-20.0 miles, and greater than 20.1 miles. Simply select the appropriate category for the project stream from the list. Because there are no study streams longer than 20.0 mi. at this time, selection of that category results in an error message.

The Study Region is selected from the next list box. The study region may be either Ridge and Valley Limestone, Ridge and Valley Freestone, or Unglaciated Plateau. Although RMWUA data for the Piedmont study streams are included in the data file, studies are incomplete, and hydrology is not provided at this time. Therefore, the Piedmont study stream data should not be utilized at this time.

The trout species and type of population present in the project stream are selected in the third list box. The following options are allowed: wild brook trout; wild brown trout; wild combined brook and brown trout; stocked adult brook trout; stocked adult brown trout; stocked adult combined brook and brown trout; stocked fingerling brook trout; stocked fingerling brown trout; and stocked

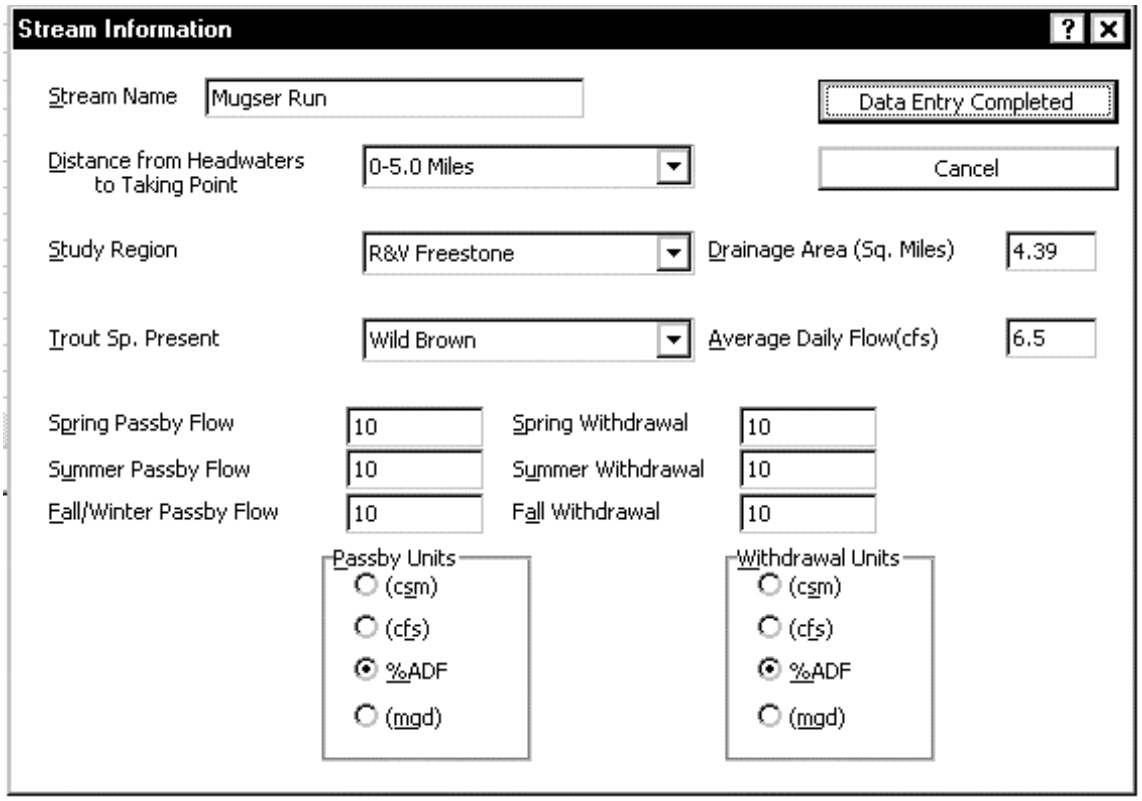


Figure E3. Detailed Analysis Program Stream Information Dialog Box

fingerling combined brook and brown trout. The differences in the evaluation of wild and stocked populations are described in section 6.6.2.1.

After completing the three list boxes, enter the drainage area at the site of the withdrawal, the corresponding average daily flow, and the passby and withdrawal flow rates for each season, in the respective boxes. Then press the box for the appropriate units for both withdrawal and passby flows. Note that the average daily flow must be entered in units of cfs, but the withdrawal and passby flows can be entered in several alternative units. The program automatically converts all flow data to percent ADF.

The Cancel button on this dialog box clears all new stream information and returns control to the flow data input screen (Figure E2).

Once this information is entered, press the Data Entry Completed button to return to the streamflow data screen (Figure E2). Then press the Run New Calculations button at the top of that screen to run the detailed analysis program**.** This program may take several minutes to compute the results depending on the computer's processor speed, and the number of streams in the class. Check the status bar at the bottom left corner to see the progress. Experience shows that with a Pentium 133 mhz processor, the computations require about 45 seconds for each combination of withdrawal and passby flow.

E4.1.2 Output table structure and interpretation

When the computations are complete, the output table will be displayed. The table includes buttons that control program operation, the input data, and the output data. The output data includes three main sections, the stream variation section, the duration analysis section, and the yearly variation section, as shown schematically in Figure E4. The first and third sections summarize the RMWUA computations for the respective methods described in the Data Needs and Computations section of this appendix. The duration analysis section summarizes duration analyses of flow and RMWUA, which do not depend on the method used to summarize the computations.

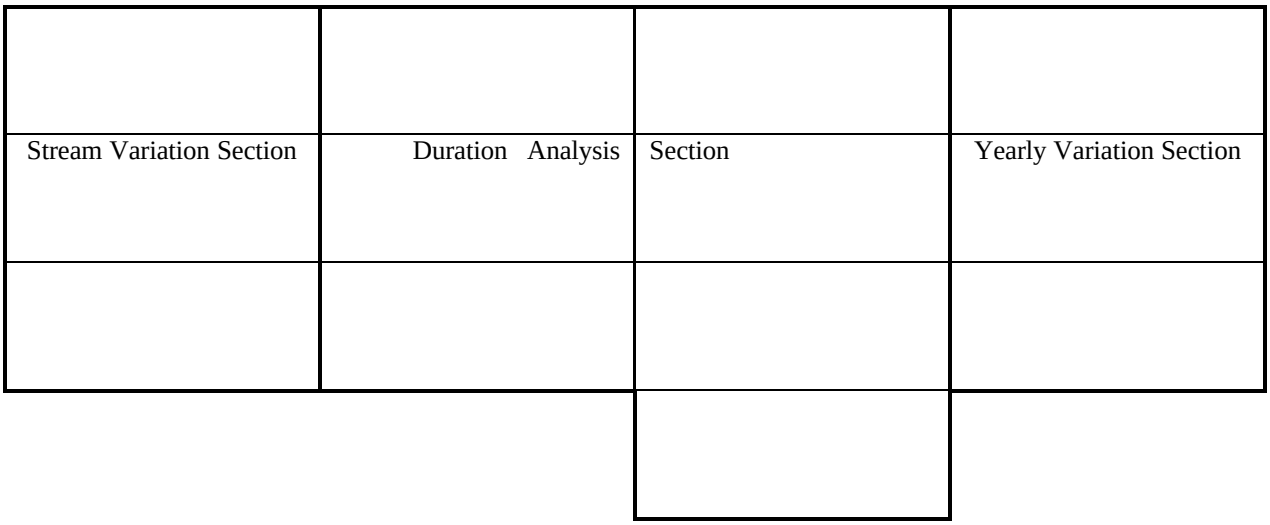
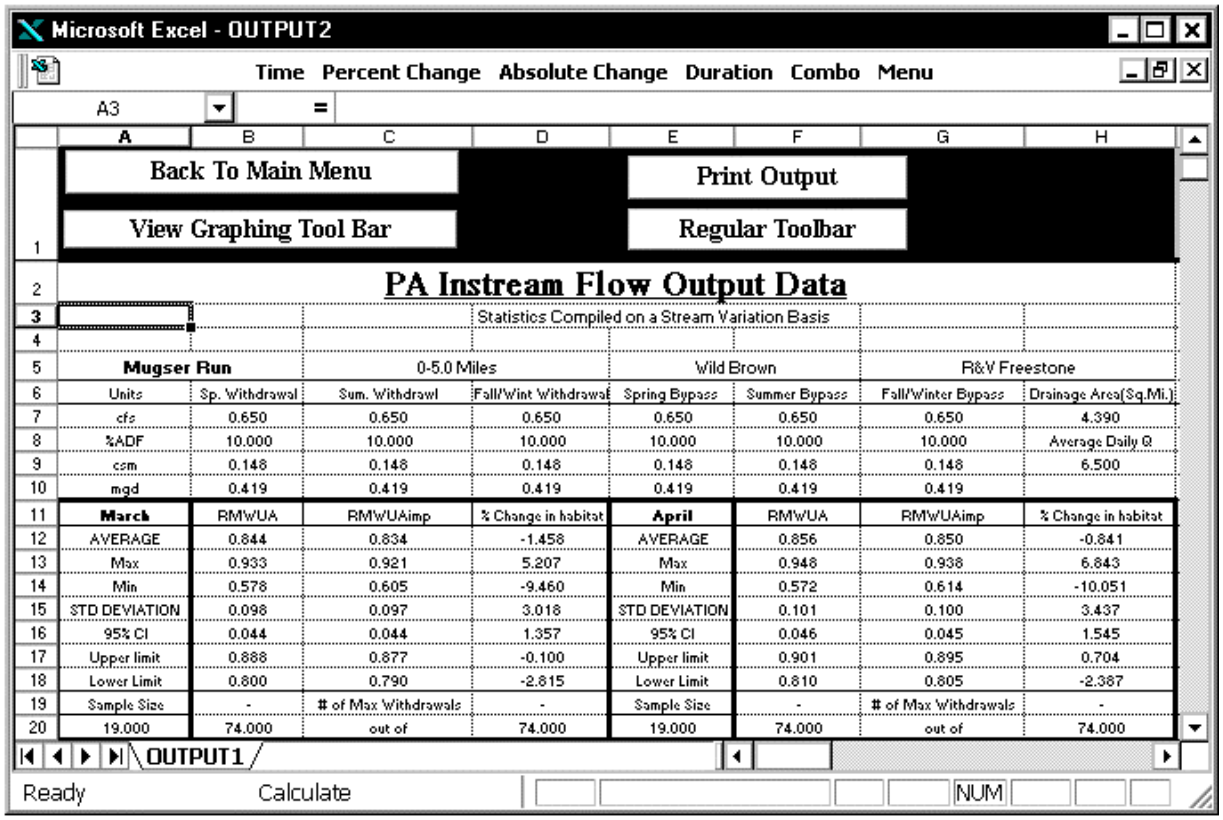


Figure E4. Schematic of Output Table Sections

The stream variation and the yearly variation sections of the output table are essentially identical in form. The first six lines of output show the input data, including seasonal withdrawals and passby flows. The remainder of these sections is divided into groups of 10 lines for each month, and the table is split vertically so that two months are included in each group of 10 lines. The first month shown is March, because it is the beginning of the spring season.

A sample of the monthly part of the stream variation section of the output table is shown in Figure E5. A summary explanation of the monthly output data included in this part of the table is shown in Table E1. Similar seasonal, combined monthly and annual statistics also are provided.



Microsoft Excel - OUTPUT2

Time Percent Change Absolute Change Duration Combo Menu

Back To Main Menu | Print Output | View Graphing Tool Bar | Regular Toolbar

PA Instream Flow Output Data

Statistics Compiled on a Stream Variation Basis

Mugser Run		0-5.0 Miles		Wild Brown		R&V Freestone	
Units	Sp. Withdrawal	Sum. Withdrawl	Fall/Wint Withdrawal	Spring Bypass	Summer Bypass	Fall/Winter Bypass	Drainage Area(Sq.Mi.)
cfs	0.650	0.650	0.650	0.650	0.650	0.650	4.390
%ADF	10.000	10.000	10.000	10.000	10.000	10.000	Average Daily Q
csm	0.148	0.148	0.148	0.148	0.148	0.148	6.500
mgd	0.419	0.419	0.419	0.419	0.419	0.419	
March	RMWUA	RMWUAimp	% Change in habitat	**April**	RMWUA	RMWUAimp	% Change in habitat
AVERAGE	0.844	0.834	-1.458	AVERAGE	0.856	0.850	-0.841
Max	0.933	0.921	5.207	Max	0.948	0.938	6.843
Min	0.578	0.605	-9.460	Min	0.572	0.614	-10.051
STD DEVIATION	0.098	0.097	3.018	STD DEVIATION	0.101	0.100	3.437
95% CI	0.044	0.044	1.357	95% CI	0.046	0.045	1.545
Upper limit	0.888	0.877	-0.100	Upper limit	0.901	0.895	0.704
Lower Limit	0.800	0.790	-2.815	Lower Limit	0.810	0.805	-2.387
Sample Size	-	# of Max Withdrawals	-	Sample Size	-	# of Max Withdrawals	-
19.000	74.000	out of	74.000	19.000	74.000	out of	74.000

OUTPUT1

Ready Calculate NUM

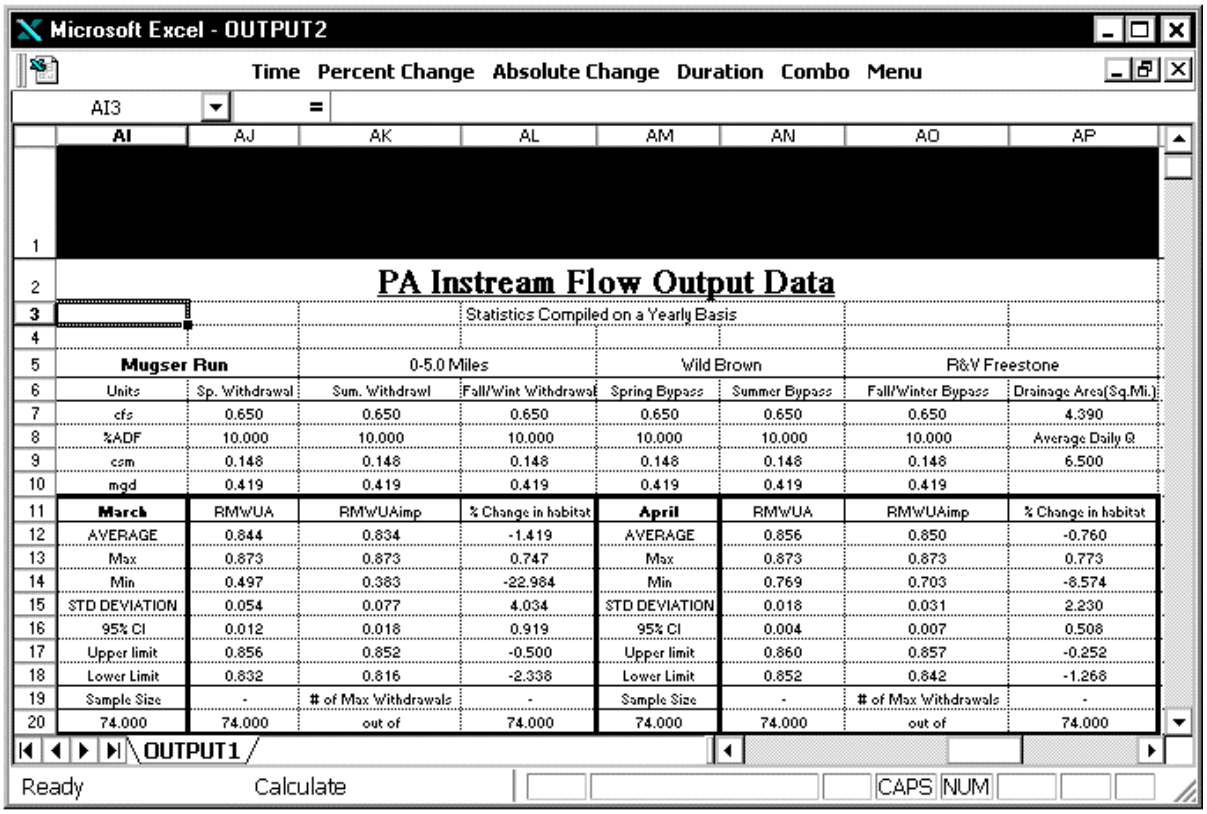
Figure E5. Sample Detailed Analysis Program Output Table, Stream Variation Method

Table E1. Explanation of Monthly RMWUA Statistics, Stream Variation Method

[Month]	RMWUA (Natural Conditions)	RMWUAimp (Impacted Conditions)	%Change in Habitat
AVERAGE	Average of average habitat (RMWUA) values, one for each study stream, for month shown	Average of average habitat (RMWUAimp) values, one for each study stream, for month shown	Average of values described below*
Max	Maximum of average habitat (RMWUA) values, one for each study stream, for month shown	Maximum of average habitat (RMWUAimp) values, one for each study stream, for month shown	Maximum of values described below*
Min	Minimum of average habitat (RMWUA) values, one for each study stream, for month shown	Minimum of average habitat (RMWUAimp) values, one for each study stream, for month shown	Minimum of values described below*
STD DEVIATION	Standard deviation of average habitat (RMWUA) values, one for each study stream, for month shown	Standard deviation of average habitat (RMWUAimp) values, one for each study stream, for month shown	Standard Deviation of values described below*
95% CI	95th Percentile Confidence Interval of the average habitat RMWUA values, one for each study stream, for month shown	95th Percentile Confidence Interval of the average habitat RMWUA values, one for each study stream, for month shown	95th Percentile Confidence Interval of percent change in habitat.
Upper Limit	Upper limit of the 95% confidence band	Upper limit of the 95% confidence band	Upper limit of the 95% confidence band
Lower Limit	Lower limit of the 95% confidence band	Lower limit of the 95% confidence band	Lower limit of the 95% confidence band
Sample Size	**# of Max Withdrawals**		
Number of study streams in region	Number of years over period-of-record in which entire withdrawal is available in month shown	**out of**	Number of years over period-of-record in which month shown occurs

*For a given month, for each study stream, the model calculates a percent change in habitat value for each year of record. An average for the period-of-record is then calculated for each stream by averaging the yearly values. These averages across years are averaged across streams, and the result is shown in the first row. The maximum, minimum, standard deviation, and confidence interval across streams are shown in the appropriate rows.

A sample of the monthly part of the yearly variation section of the output table is shown in Figure E6. A summary of the output data included in the yearly variation section is shown in Table E2. Similar statistics are provided for the spring, summer, and fall/winter seasons and for combined monthly and yearly periods.



Microsoft Excel - OUTPUT2

Time Percent Change Absolute Change Duration Combo Menu

AI3 =

PA Instream Flow Output Data

Statistics Compiled on a Yearly Basis

Mugser Run		0-5.0 Miles		Wild Brown		R&V Freestone	
Units	Sp. Withdrawal	Sum. Withdrawl	Fall/Wint Withdrawal	Spring Bypass	Summer Bypass	Fall/Winter Bypass	Drainage Area(Sq.Mi.)
cfs	0.650	0.650	0.650	0.650	0.650	0.650	4.390
%ADF	10.000	10.000	10.000	10.000	10.000	10.000	Average Daily Q
csm	0.148	0.148	0.148	0.148	0.148	0.148	6.500
mgd	0.419	0.419	0.419	0.419	0.419	0.419	
March	RMWUA	RMWUAimp	% Change in habitat	**April**	RMWUA	RMWUAimp	% Change in habitat
AVERAGE	0.844	0.834	-1.419	AVERAGE	0.856	0.850	-0.760
Max	0.873	0.873	0.747	Max	0.873	0.873	0.773
Min	0.497	0.383	-22.984	Min	0.769	0.703	-8.574
STD DEVIATION	0.054	0.077	4.034	STD DEVIATION	0.018	0.031	2.230
95% CI	0.012	0.018	0.919	95% CI	0.004	0.007	0.508
Upper limit	0.856	0.852	-0.500	Upper limit	0.860	0.857	-0.252
Lower Limit	0.832	0.816	-2.338	Lower Limit	0.852	0.842	-1.268
Sample Size	-	# of Max Withdrawals	-	Sample Size	-	# of Max Withdrawals	-
74.000	74.000	out of	74.000	74.000	74.000	out of	74.000

OUTPUT1

Ready Calculate CAPS NUM

Figure E6. Sample Detailed Analysis Program Output Table, Yearly Variation Method

Table E2. Explanation of Monthly RMWUA Statistics, Yearly Variation Method

[Month]	RMWUA (Normal Conditions)	RMWUAimp (Impacted Conditions)	% Change in Habitat
AVERAGE	Average of average habitat (RMWUA) values, one for each year in period-of-record, for month shown	Average of average habitat (RMWUAimp) values, one for each year in period-of-record, for month shown	Average of values described below*
Max	Maximum of average habitat (RMWUA) values, one for each year in period-of-record, for month shown	Maximum of average habitat (RMWUAimp) values, one for each year in period-of-record, for month shown	Maximum of values described below*
Min	Minimum of average habitat (RMWUA) values, one for each year in period-of-record, for month shown	Minimum of average habitat (RMWUAimp) values, one for each year in period-of-record, for month shown	Minimum of values described below*
STD DEVIATION	Standard deviation of average habitat (RMWUA) values, one for each year in period-of-record, for month shown	Standard deviation of average habitat (RMWUAimp) values, one for each year in period-of-record, for month shown	Standard Deviation of values described below*
95% CI	95th Percentile Confidence Interval of average habitat (RMWUA) values, one for each year in period-of-record, for	95th Percentile Confidence Interval of average habitat (RMWUAimp) values, one for each year in period-of-record,	95th Percentile Confidence Interval of values described below*
Upper Limit	Upper Limit of the 95% confidence band	Upper Limit of the 95% confidence band	Upper Limit of the 95% confidence band
Lower Limit	Lower limit of the 95% confidence band	Lower limit of the 95% confidence band	Lower limit of the 95% confidence band
Sample Size	**# of Max Withdrawals**		
Number of times month shown occurs in period-of-record	Number of years over period-of-record in which entire withdrawal is available in month shown	**out of**	Number of years month shown occurs in period-of-record

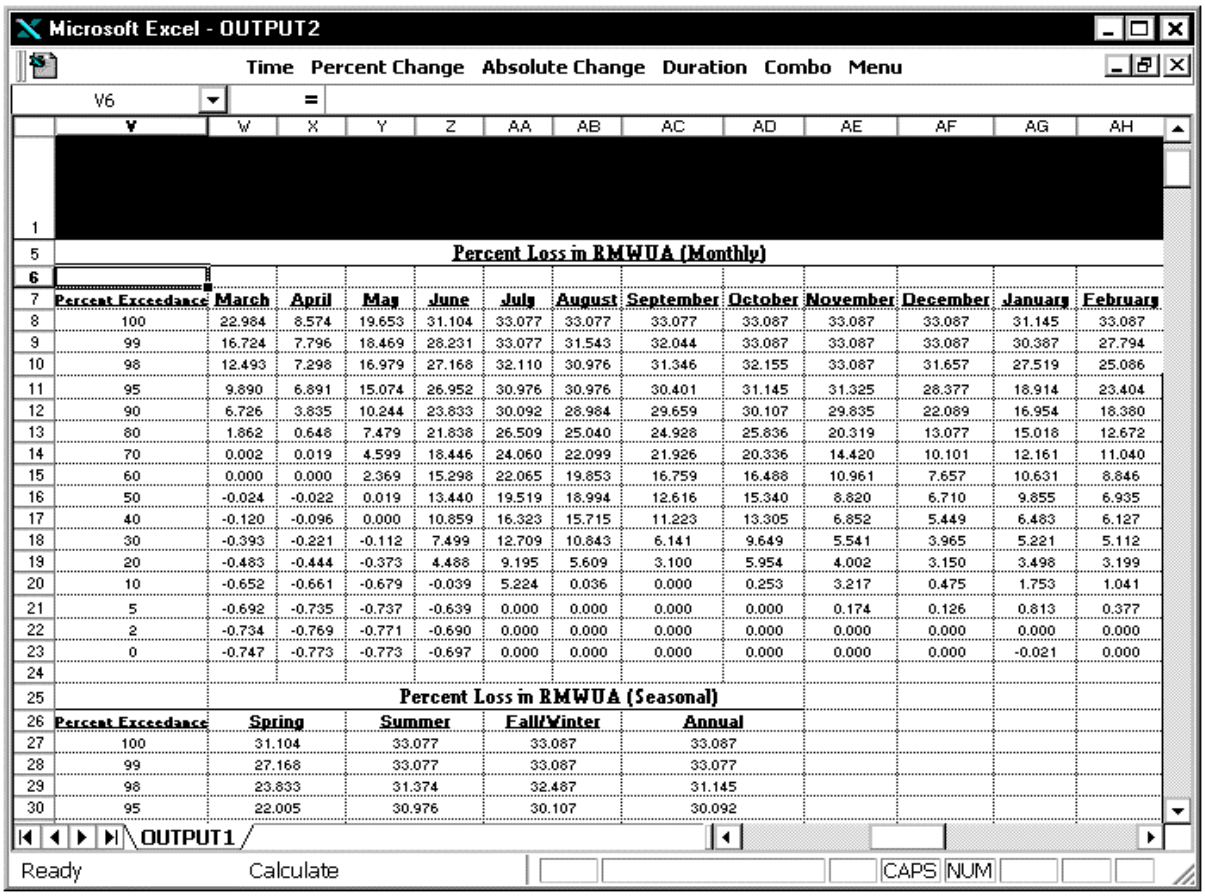
*For a given month, for each year in the period-of-record, the average natural and average impacted RMWUA values are calculated from the monthly natural and impacted RMWUA values for each study stream. A percent change in habitat value is then calculated for each year from the difference between the average natural and average impacted RMWUA values. The average, maximum, minimum, standard deviation, confidence interval, and limits of confidence band of those yearly values are then reported in the output in the respective rows.

The duration analysis section of the output table includes five parts, as shown schematically in Figure E7. Each column of data is calculated independently; thus, the flow duration can not be estimated from the RMWUA duration, and vice versa.

Duration Table of Unimpacted and Impacted Monthly Median Flows	Duration Table of Percent Loss in RMWUA (Monthly, Seasonal, and Annual) (Figure E8)
Duration Table of Unimpacted and Impacted Monthly RMWUAs	Duration Table of Actual Loss in RMWUA (Monthly, Seasonal, and Annual)
Seasonal and Annual Duration Table of Unimpacted and Impacted Flows and RMWUA	Duration Table of Percent Loss in Flow (Monthly, Seasonal, and Annual)
	Duration Table of Actual Loss in Flow (Monthly, Seasonal, and Annual)

Figure E7. Schematic of Duration Analysis Section of Output Table

A sample RMWUA duration table is shown in Figure E8. The other duration tables have a similar form. Each section of the duration table is printed on a separate page. Each page includes one subsection shown in Figure E7, and the pages are printed in column order.



Microsoft Excel - OUTPUT2

Time | Percent Change | Absolute Change | Duration | Combo | Menu

Percent Loss in RMWUA (Monthly)

Percent Exceedance	March	April	May	June	July	August	September	October	November	December	January	February
100	22.984	8.574	19.653	31.104	33.077	33.077	33.077	33.087	33.087	33.087	31.145	33.087
99	16.724	7.796	18.469	28.231	33.077	31.543	32.044	33.087	33.087	33.087	30.387	27.794
98	12.493	7.298	16.979	27.168	32.110	30.976	31.346	32.155	33.087	31.657	27.519	25.086
95	9.890	6.891	15.074	26.952	30.976	30.976	30.401	31.145	31.325	28.377	18.914	23.404
90	6.726	3.835	10.244	23.833	30.092	28.984	29.659	30.107	29.835	22.089	16.954	18.380
80	1.862	0.648	7.479	21.838	26.509	25.040	24.928	25.836	20.319	13.077	15.018	12.672
70	0.002	0.019	4.599	18.446	24.060	22.099	21.926	20.336	14.420	10.101	12.161	11.040
60	0.000	0.000	2.369	15.298	22.065	19.853	16.759	16.488	10.961	7.657	10.631	8.846
50	-0.024	-0.022	0.019	13.440	19.519	18.994	12.616	15.340	8.820	6.710	9.855	6.935
40	-0.120	-0.096	0.000	10.859	16.323	15.715	11.223	13.305	6.852	5.449	6.483	6.127
30	-0.393	-0.221	-0.112	7.499	12.709	10.843	6.141	9.649	5.541	3.965	5.221	5.112
20	-0.483	-0.444	-0.373	4.486	9.195	5.609	3.100	5.954	4.002	3.150	3.498	3.199
10	-0.652	-0.661	-0.679	-0.039	5.224	0.036	0.000	0.253	3.217	0.475	1.753	1.041
5	-0.692	-0.735	-0.737	-0.639	0.000	0.000	0.000	0.000	0.174	0.126	0.813	0.377
2	-0.734	-0.769	-0.771	-0.690	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0	-0.747	-0.773	-0.773	-0.697	0.000	0.000	0.000	0.000	0.000	0.000	-0.021	0.000

Percent Loss in RMWUA (Seasonal)

Percent Exceedance	Spring	Summer	Fall/Winter	Annual
100	31.104	33.077	33.087	33.087
99	27.168	33.077	33.087	33.077
98	23.833	31.374	32.487	31.145
95	22.005	30.976	30.107	30.092

OUTPUT1

Ready | Calculate | CAPS | NUM

Figure E8. Sample Duration Analysis Table

4.1.3 Graphics

The output table screens (Figures E5 and E6) automatically show the graphics menu tool bar. The output can be displayed graphically by pressing one of the graphics menu shortcuts.

An expanded view of the graphics menu tool bar is shown in Figure E9. When any of the buttons (except Menu) is selected, the dropdown box shown in Figure E9 under “Percent Change” appears, which allows selection of graphs of RMWUA or flow. The "Percent Change", "Absolute Change", and "Duration" menu choices also provide options (not shown here) to graph either monthly, seasonal, or annual data. The “Time” button graphs the appropriate time series of absolute change in RMWUA or flow caused by the withdrawal. The “Percent Change” button graphs the difference in RMWUA, or flow, expressed as a percentage of the unimpacted values for a specified period, across years, versus probability of exceedance in percent. The specified period may be a particular month, or season, or all the annual values. The “Absolute Change” button produces the same graphs for the absolute change in RMWUA, or flow. The “Duration” button graphs the probability of exceedance (duration) of median monthly RMWUA, or flow, for the entire record used, for both unimpacted and impacted conditions. The Combo button combines similar graphs for different combinations of withdrawal and passby flow. Simply press the appropriate menu item to create a graph of that variable on a separate output sheet.

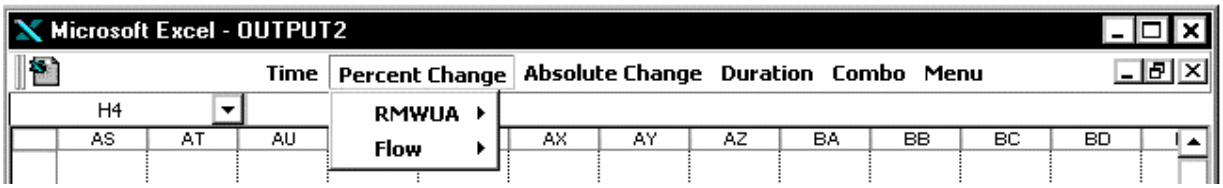


Figure E9. Graphical Output Menu Bar

Graphs of similar items can be overlaid by pressing the combo menu item. This is particularly useful when evaluating impacts of different combinations of withdrawal and passby flow on the same stream. Two different combinations can be plotted on one graph.

To create a combo graph, run the Detailed Analysis Program with both desired combinations of withdrawal and passby flow, and save the output files. After completing each program run, create the individual graphs, leave both charts open, write down the name of the file (e.g., Chart 7 and Chart 9), but do not save them. Then overlay them by pressing "Combo" on the Graphical Output Menu Bar, and then press the “Create Overlay Chart" command that appears immediately below the Combo menu item. The Overlay Graphs dialog box shown in Figure E10 appears. The numbers of the charts to be overlaid (e.g., Chart 7 and Chart 9) can be selected by scrolling each of the list boxes shown. Then press the Create Chart button to create the combined graph.

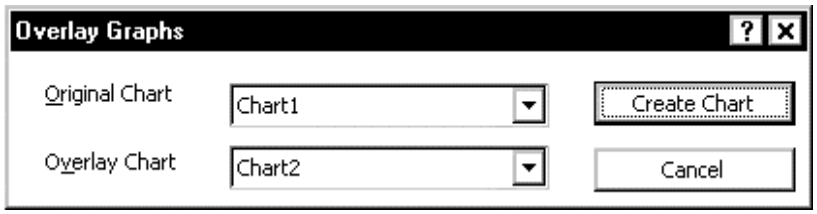


Figure E10. Graph Overlay Dialog Box

E4.1.4 Operation

The output spans many pages, and is most easily analyzed after it is printed. To print the output, press the Print Output button on the Output Data screen shown in Figure E5. The printout of the output table is 13 pages long.

The output table is calculated from an Excel template. The filename for the template is OUTPUTx, where x is a number. If the output from a particular run is not saved in a separate file, it will be overwritten by a subsequent run. To save the output for a particular run for further analysis, change the graphics tool bar on the output screen (Figure E5) to a regular tool bar by pressing the Regular Tool Bar button. Then press the File/Save As command on the toolbar, and enter an appropriate filename in the dialog box that appears. To save graphics, press the Window menu item on the regular toolbar, and select the chart to be saved from the list of open files. Then press the File/Save As command and enter the file name.

After completing a run of either program, close the output file. To close the detailed analysis program output file, press the *lower* close button (lower X shown in upper right corner of Figure E8). Control is transferred to the Streamflow Data Form (Figure E2). If the upper icon is pressed, the entire program will be closed, and control will be transferred to the WINDOWS START screen. Be sure to close the file before exiting the program. There may be problems with subsequent runs if the upper icon is pressed without closing the output file.

The information, as summarized in this program, is different than that contained in the Preliminary Analysis Program, as described in the Data Needs and Calculation Methods section of this appendix.

E4.2 Preliminary Analysis Program

The monthly median time series data is entered in the Preliminary Analysis Program, in the same manner as for the Detailed Analysis Program. This data entry screen differs from the corresponding screen for the detailed analysis program (Figure E2) only in that this data entry screen includes a button called View Last Output that can be used to view the output from a previous run. The data entry part of the data entry screens are identical.

When the streamflow data has been entered, press the Enter New Stream Information button to display the stream data entry dialog box shown in Figure E11. The data is entered in this form in the same manner as for the Detailed Analysis Program. The data entry forms are similar, except that passby flows are not entered for this program. After entering these data, press the Data Entry Complete button to return to the flow data entry screen (Figure E2). Then press the Run New Calculations button on that screen to run the Preliminary Analysis Program. This program will take several minutes to compute the results. Check the status bar at the bottom left corner of the screen to see progress. Run time depends on the computer processor speed and number of streams in the class.

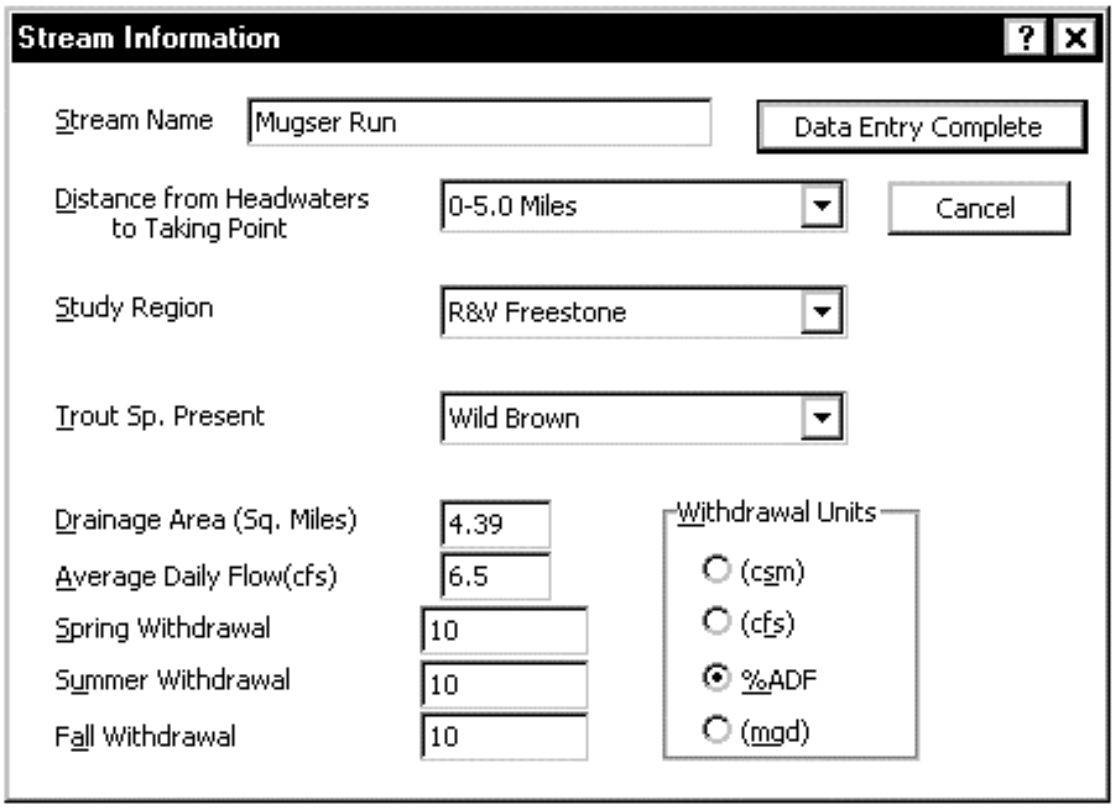
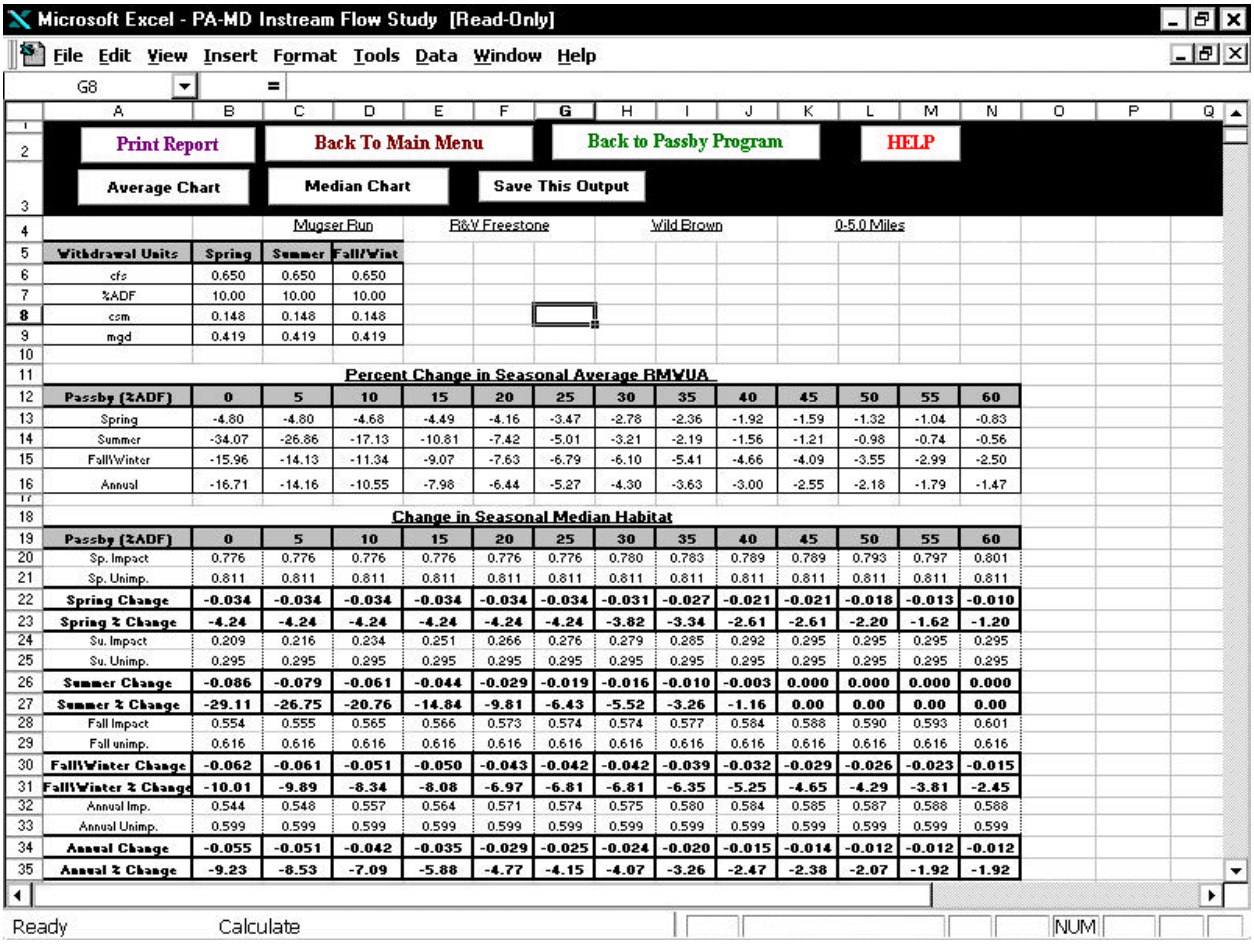


Figure E11. Preliminary Analysis Program Stream Information Dialog Box

When the calculations are completed, an output table similar to that shown in Figure E12 will appear. The table shows the impacts of the specified withdrawal in terms of percent change in seasonal average habitat, as well as absolute and percent change in median seasonal habitat.



Microsoft Excel - PA-MD Instream Flow Study [Read-Only]

File Edit View Insert Format Tools Data Window Help

G8 =

Print Report | Back To Main Menu | Back to Passby Program | HELP

Average Chart | Median Chart | Save This Output

		Mugser Run	R&V Freestone	Wild Brown	0-5.0 Miles
Withdrawal Units	Spring	Summer	Fall/Wint		
cfs	0.650	0.650	0.650		
%ADF	10.00	10.00	10.00		
csm	0.148	0.148	0.148		
mgd	0.419	0.419	0.419		

Percent Change in Seasonal Average RMWUA

Passby (%ADF)	0	5	10	15	20	25	30	35	40	45	50	55	60
Spring	-4.80	-4.80	-4.68	-4.49	-4.16	-3.47	-2.78	-2.36	-1.92	-1.59	-1.32	-1.04	-0.83
Summer	-34.07	-26.86	-17.13	-10.81	-7.42	-5.01	-3.21	-2.19	-1.56	-1.21	-0.98	-0.74	-0.56
Fall\Winter	-15.96	-14.13	-11.34	-9.07	-7.63	-6.79	-6.10	-5.41	-4.66	-4.09	-3.55	-2.99	-2.50
Annual	-16.71	-14.16	-10.55	-7.98	-6.44	-5.27	-4.30	-3.63	-3.00	-2.55	-2.18	-1.79	-1.47

Change in Seasonal Median Habitat

Passby (%ADF)	0	5	10	15	20	25	30	35	40	45	50	55	60
Sp. Impact	0.776	0.776	0.776	0.776	0.776	0.776	0.780	0.783	0.789	0.789	0.793	0.797	0.801
Sp. Unimp.	0.811	0.811	0.811	0.811	0.811	0.811	0.811	0.811	0.811	0.811	0.811	0.811	0.811
Spring Change	**-0.034**	**-0.034**	**-0.034**	**-0.034**	**-0.034**	**-0.034**	**-0.031**	**-0.027**	**-0.021**	**-0.021**	**-0.018**	**-0.013**	**-0.010**
Spring % Change	**-4.24**	**-4.24**	**-4.24**	**-4.24**	**-4.24**	**-4.24**	**-3.82**	**-3.34**	**-2.61**	**-2.61**	**-2.20**	**-1.62**	**-1.20**
Su. Impact	0.209	0.216	0.234	0.251	0.266	0.276	0.279	0.285	0.292	0.295	0.295	0.295	0.295
Su. Unimp.	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295
Summer Change	**-0.086**	**-0.079**	**-0.061**	**-0.044**	**-0.029**	**-0.019**	**-0.016**	**-0.010**	**-0.003**	**0.000**	**0.000**	**0.000**	**0.000**
Summer % Change	**-29.11**	**-26.75**	**-20.76**	**-14.84**	**-9.81**	**-6.43**	**-5.52**	**-3.26**	**-1.16**	**0.00**	**0.00**	**0.00**	**0.00**
Fall Impact	0.554	0.555	0.565	0.566	0.573	0.574	0.574	0.577	0.584	0.588	0.590	0.593	0.601
Fall unimp.	0.616	0.616	0.616	0.616	0.616	0.616	0.616	0.616	0.616	0.616	0.616	0.616	0.616
Fall\Winter Change	**-0.062**	**-0.061**	**-0.051**	**-0.050**	**-0.043**	**-0.042**	**-0.042**	**-0.039**	**-0.032**	**-0.029**	**-0.026**	**-0.023**	**-0.015**
Fall\Winter % Change	**-10.01**	**-9.89**	**-8.34**	**-8.08**	**-6.97**	**-6.81**	**-6.81**	**-6.35**	**-5.25**	**-4.65**	**-4.29**	**-3.81**	**-2.45**
Annual Imp.	0.544	0.548	0.557	0.564	0.571	0.574	0.575	0.580	0.584	0.585	0.587	0.588	0.588
Annual Unimp.	0.599	0.599	0.599	0.599	0.599	0.599	0.599	0.599	0.599	0.599	0.599	0.599	0.599
Annual Change	**-0.055**	**-0.051**	**-0.042**	**-0.035**	**-0.029**	**-0.025**	**-0.024**	**-0.020**	**-0.015**	**-0.014**	**-0.012**	**-0.012**	**-0.012**
Annual % Change	**-9.23**	**-8.53**	**-7.09**	**-5.88**	**-4.77**	**-4.15**	**-4.07**	**-3.26**	**-2.47**	**-2.38**	**-2.07**	**-1.92**	**-1.92**

Ready Calculate NUM

Figure E12. Sample Preliminary Analysis Program Output Table

The output table is a single sheet with three sections that summarize the input and output data. Withdrawal rates for each season are displayed in the first section, in several different units. The percent change in seasonal *average* RMWUA is displayed in the second section for all three seasons, and annually. The seasonal *median* unimpacted and impacted RMWUA, and the percent change in seasonal RMWUA, for each of the preset passby flows (percent ADF) are displayed in the third section for each season, and annually. The unimpacted and impacted RMWUA values are shown, along with the percentage change.

To print the output table, press the Print Report button on the Passby Program output screen (Figure E12). To save this output table to a file, press the Save This Output button to display a pop-up menu, which allows entry of a name for the file. If the file is not saved, it will be overwritten by the next program run.

The output can be displayed graphically by pressing either the Average Chart or the Median Chart buttons on the output screen. The Average Chart button produces a graph of the seasonal average RMWUA versus passby flow, with one curve for each season. The Median Chart button produces a

similar graph of seasonal median RMWUA versus passby flow. Both graphs will be printed automatically.

To close the preliminary analysis program output, press either the Back to Main Menu button or the Back to Passby Program button on the output screen (Figure E12). If the first button is pressed, control is transferred to the Main Menu (Figure E1). If the second button is pressed, control will be transferred to the passby program streamflow data input screen, which is identical to the Streamflow Data Form, shown in Figure E2.

The information contained in the report can be used to determine feasible passby flows for each season. The impacts of feasible combinations of withdrawal and passby flow should be evaluated using the detailed analysis program.

Key to Study Sites Shown on Plate 1

Stream Name	Number
Bear Run	1
Big Fill Run, Seg. 1	2
Big Fill Run, Seg. 2	3
Big Run	4
Fowler Hollow, Seg. 1	6
Fowler Hollow, Seg.2	7
Green Creek, Seg. 1	9
Green Creek, Seg. 2	10
Green Creek, Seg. 3	11
Horning Run	12
Kansas Valley Run	13
Laurel Run (Juniata)	15
Mile Run	16
Mugser Run, Seg. 1	17
Mugser Run, Seg.2	18
Rapid Run, Seg. 1	19
Rapid Run, Seg. 2	20
Rapid Run, Seg. 3	21
Salem Creek	22
Sand Spring Run	23
Swift Run	24
Vanscoyoc Run	26
Wapwallopen Creek, Seg. 1	27
Wapwallopen Creek, Seg. 2	28
Wapwallopen Creek, Seg. 3	29
Wapwallopen Creek, Seg. 4	30
Antes Creek	31
Big Spring Creek	32
Boiling Spring Run	33
Bushkill Creek, Seg. 1	34
Bushkill Creek, Seg. 2	35
Cedar Creek (Lehigh)	36
Cedar Run (Centre)	37
Cedar Run (Cumberland)	38
Falling Spring Run	39
Honey Creek	40
Letort Creek, Seg. 1	41
Letort Creek, Seg. 2	42
Lick Creek	43
Little Fishing Creek	44
Long Hollow Run	45
Monocacy Creek, Seg. 1	46
Monocacy Creek, Seg. 2	47
Monocacy Creek, Seg. 3	48
Nancy Run	49
Penns Creek, Seg. 1	50
Penns Creek, Seg. 2	51
Penns Creek, Seg. 3	52
Potter Creek	53

Stream Name	Number
Spring Creek (Berks)	54
Spring Creek, Seg. 1	55
Spring Creek, Seg. 2	56
Spring Creek, Seg. 3	57
Spring Creek, Seg. 4	58
Trindle Spring Run	59
Trout Creek	60
Beech Run	61
Benner Run	62
Bloomster Hollow	63
Cherry Run	64
Coke Oven Hollow	65
Cush Creek, Seg. 1	66
Cush Creek, Seg. 2	67
Dunlap Run	68
E. Br. Spring Creek, Seg.2	70
Fall Creek, Seg. 1	71
Fall Creek, Seg. 2	72
Findley Run	73
Lower Two Mile Run, Seg. 1	74
Lower Two Mile Run, Seg. 2	75
Lyman Run	76
McClintock Run	77
McEwen Run	78
Meyers Run	79
Mill Run	80
Red Run	82
Seaton Run	83
Strange Hollow	84
Tannery Hollow	85
Warner Brook	86
Whites Creek, Seg. 1	88
Whites Creek, Seg. 2	89
E. Br. Raven Creek	90
Granville Run	91
Laurel Run (Huntingdon)	92
Baisman Run	93
Basin Run, Seg. 1	94
Basin Run, Seg. 2	95
Cooks Branch	96
First Mine Branch	97
Gillis Falls, Seg. 1	98
Gillis Falls, Seg. 2	99
Greene Branch	100
Norris Run	101
Piney Run	102
Third Mine Branch	103
Timber Run	104