

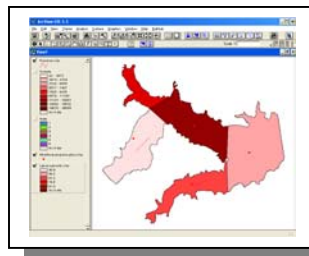
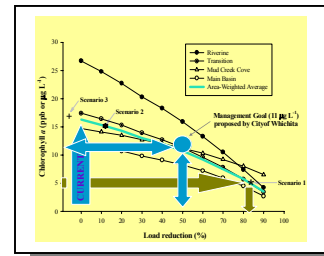
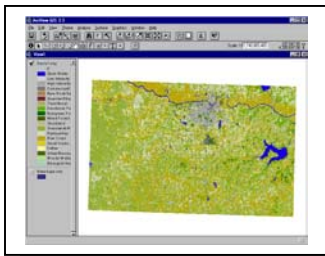
GIS EXTENSION FOR BATHTUB

ARCVIEW INTERFACE -- USERS MANUAL

KBS PUBLICATION NO. 122



EUTROPHICATION ASSESSMENT



JANUARY 2005

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CENTRAL PLAINS CENTER FOR BIOASSESSMENT
KANSAS BIOLOGICAL SURVEY
AND
DEPARTMENT OF GEOGRAPHY
UNIVERSITY OF KANSAS
AND
U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION VII

Table of Contents

Chapter	Title	Page
1.	INTRODUCTION.....	1
2.	LOADING THE EXTENSION	2
3.	CALCULATING LAKE SEGMENT PARAMETERS	4
3.1.	Calculating Segment Morphometric Parameters	4
3.1.1.	<i>Segment Morphology tool.....</i>	<i>4</i>
3.1.2.	<i>Segment Length tool.....</i>	<i>6</i>
3.1.3.	<i>Segment Connectivity tool.....</i>	<i>6</i>
3.2.	Calculating Segment Water Quality Parameters.....	8
3.2.1.	<i>Water sample processing.....</i>	<i>8</i>
3.2.2.	<i>Calculating segment water quality.....</i>	<i>10</i>
4.	CALCULATING LAKE TRIBUTARY PARAMETERS	12
4.1.	Obtaining Tributary Water Quality Parameters from AnnAGNPS Output	12
4.2.	Creating Reach ID Shapefile.....	14
4.3.	Tributary within Segments	16
4.4.	Editing Tributary Name and Type.....	18
4.5.	Calculating Tributary Baseflow	20
4.6.	Editing Tributary Table.....	22
5.	GENERATING BATHTUB PROJECT FILE.....	24
6.	VISUALIZING BATHTUB OUTPUTS	26
	REFERENCE	29

Table of Figures

Figure 1.	ArcView extensions.....	2
Figure 2.	ArcView platform after loading the GeoBathtub extension.....	3
Figure 3.	ArcView platform with Segment Morphology menu item highlighted.	5
Figure 4.	Dialog with Segment Morphology inputs.	5
Figure 5.	Table created by the Segment Morphology tool.	6
Figure 6.	Dialog when the Segment Length tool is selected.....	6
Figure 7.	Dialog when the Segment Connectivity tool is selected.	7
Figure 8.	Segment Connectivity tool with the “from segment” highlighted.	7
Figure 9.	Interface with the Segment Water Quality menu item highlighted.....	8
Figure 10.	Dialog used to calculate water quality for each sampling location.....	9
Figure 11.	On-site water quality table.....	9
Figure 12.	Laboratory water quality table.....	10
Figure 13.	Interface with the Calculate Segment Water Quality menu item highlighted.	10
Figure 14.	Dialog with the Calculate Segment Water Quality tool.	11
Figure 15.	Segment water quality table calculated from water samples.....	11
Figure 16.	Interface with Tributary Water Quality from AnnAGNPS menu item highlighted.	12
Figure 17.	AnnAGNPS Event Output File dialog.	13
Figure 18.	AnnAGNPS output file.....	13
Figure 19.	Dialog showing the selection of reaches and simulated period.....	14
Figure 20.	Output from the Tributary Water Quality from AnnAGNPS tool.	14
Figure 21.	Interface with Tributary ID Calculation menu item highlighted.....	15
Figure 22.	Dialog with the Create Reach ID Shapefile tool.	16
Figure 23.	The newly created reach ID shapefile highlighted in red.....	16
Figure 24.	Interface with Tributary within Segment menu item highlighted.	17
Figure 25.	Tributary within Segments dialog.	17
Figure 26.	An example of AnnAGNPS reach file.	18
Figure 27.	Interface with Edit Tributary Name and Type menu item highlighted.	19
Figure 28.	Dialog with tributary water quality input.	19
Figure 29.	The Edit Tributary Name and Type Dialog.....	19
Figure 30.	Interface with Tributary Baseflow menu item highlighted.	20
Figure 31.	Dialog with Tributary and Baseflow inputs	21
Figure 32.	Baseflow sample table.....	21
Figure 33.	The Tributary Baseflow dialog.....	21
Figure 34.	Interface with Edit Tributary Parameters menu item highlighted.....	22
Figure 35.	Tributary Table dialog.....	22
Figure 36.	The Edit Tributary Table dialog.....	23
Figure 37.	Interface with Create Bathtub Input File menu item highlighted.....	24
Figure 38.	Dialog with Create Bathtub Input Text File inputs.	25
Figure 39.	An example BATHTUB project file.	25
Figure 40.	Interface with BATHTUB Visualization menu item highlighted.	26
Figure 41.	The BATHTUB Profile Output.....	26
Figure 42.	BATHTUB profile output text file.....	27

Figure 43.	The BATHTUB Profile Visualization dialog.....	27
Figure 44.	Visualization of simulated turbidity in BATHTUB profile output file.....	28

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1. INTRODUCTION

Unlike natural lakes, reservoirs are relatively new and complex aquatic ecosystems that are constructed by the human with a life span of approximately 100-200 years (deNoyelles, et al., 2003; Mankin et al., 2003). In general, there are a number of significant differences exist between reservoirs and natural lakes. First, construction of a reservoir greatly disturbs the abiotic and biotic environment. Second, reservoirs tend to have relatively large contributing watersheds. Coupled, these two factors create a highly unstable aquatic environment. As a result, watershed conditions and stressors greatly influence the artificial ecosystems associated with reservoirs. This in turn directly affects reservoir health and stability (e.g., nutrient enrichment and sedimentation).

With passage of the Clean Water Act of 1972 and Safe Drinking Water Act of 1974, nonpoint sources are the single largest remaining source of reservoir water quality impairments in the Central Plains of the United States. Excess nutrients and siltation, both of which result from intensive agricultural activities, contribute most to eutrophication. According to the National Water Quality Report to Congress, 50% of assessed U.S. lakes and a higher percentage of reservoirs in the Midwest were considered eutrophic (USEPA, 2000). In Kansas, 193 of the 240 publicly owned reservoirs evaluated were eutrophic and frequently showed symptoms of eutrophication, including nuisance algal blooms, reduced water transparency, and depleted levels of hypolimnetic dissolved oxygen.

To predict eutrophication and derive nutrient criteria for lake management, a variety of modeling tools have been used to evaluate in-lake trophic conditions and estimate loading from a watershed. Of which, BATHTUB has proven to be an effective tool for water quality assessment and management (Ernst et al., 1994), and been used in many states (e.g., MN, SD, KS). BATHTUB is an empirical model designed to assess eutrophication for morphometrically complex reservoirs (Walker, 1996). Major advantages of BATHTUB over other models in the Midwest are 1) its use of simple steady-state calculations to address eutrophication processes, which reduces data demands greatly; and 2) the windy, relatively flat agricultural landscape of the Central Plains creates well mixed and turbid lentic waterbodies (O'Brien, 1975; Randtke and deNoyelles, 1985), thus rendering the comparatively simple BATHTUB model as more appropriate to use than the more complex two or three dimensional models (Cole and Buchak, 1995).

Though BATHTUB is an effective tool for reservoir water quality assessment, data preparation and modeling procedures make its application tedious and time consuming. Therefore, automation of the data preparation and processing becomes necessary. ArcView[®] BATHTUB extension (GeoBathtub) is a user-friendly tool developed to assist modelers and decision-makers to conduct easier, effective reservoir water quality assessments. The extension assists users to extract required segment and tributary data from field water samples and AnnAGNPS modeling outputs, generates BATHTUB project file, and visualizes BATHTUB modeling results. This manual documents the functionality of the BATHTUB extension.

2. LOADING THE EXTENSION

All ArcView extensions have the .avx file extension and are located under ArcView extension folder EXT32, which is under your ArcView installation folder. A typical default ArcView installation folder is C:\ESRI\AV_GIS30\ARCVIEW. The Bath tub ArcView extension is called GeoBath tub.avx. To use the extension, it needs to be copied to the EXT32 folder.

Once the extension is in the EXT32 folder, then open View (version 3.3) GIS program. Click on **File** menu and then click on **Extensions**. Figure 1 shows the Extensions dialog with the GeoBath tub extension checked. Because the GeoBath tub extension uses some functions of the Spatial Analyst extension, the Spatial Analyst extension will be automatically added while the GeoBath tub extension is loading.

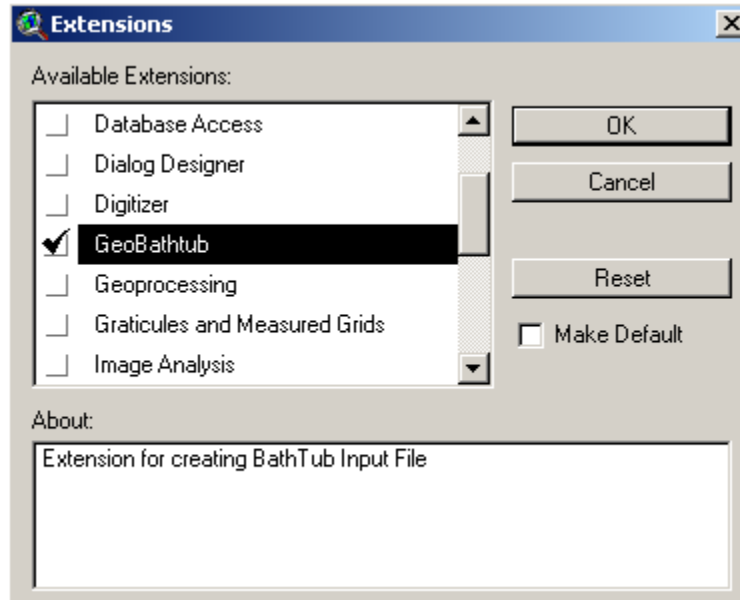


Figure 1. ArcView extensions

After loading the GeoBathtub extension, a menu bar and several buttons will appear on standard ArcView platform. Figure 2 shows what the ArcView platform will look like after the GeoBathtub extension has been loaded. The Bathtub menu serves as an alternate means to accessing the functionality in the extension. The first row of buttons provides several dialog boxes to manipulate BATHTUB data, while the bottom two tools on the tool bar allow user to interact with the data.

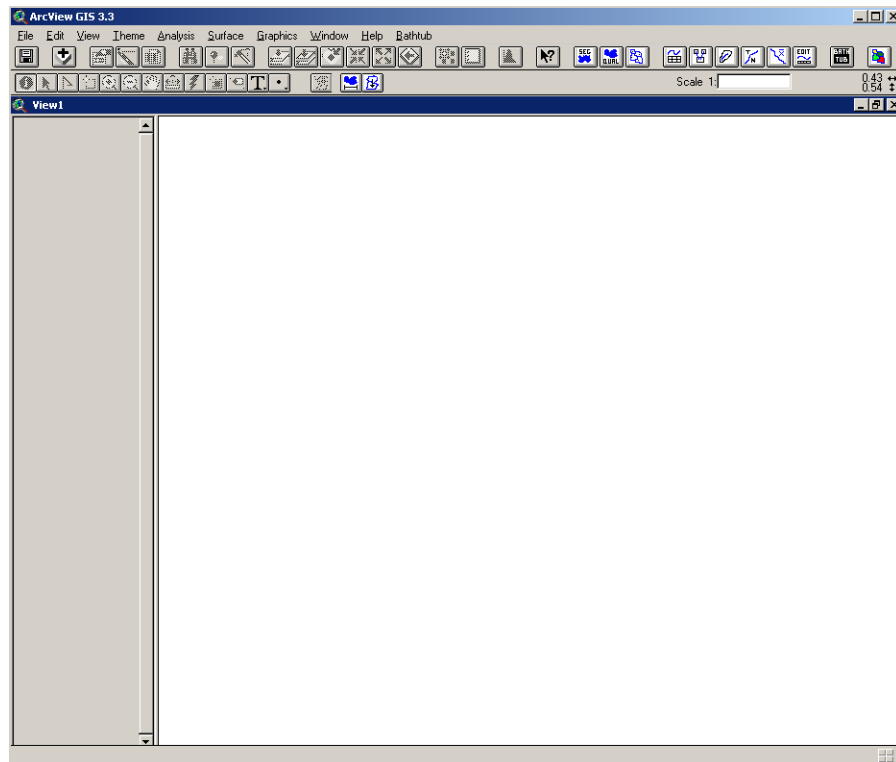


Figure 2. ArcView platform after loading the GeoBathtub extension.


3. CALCULATING LAKE SEGMENT PARAMETERS

BATHTUB divides a complex lake into several connected segments. Two types of segment parameters are needed in BATHTUB model. The first set of parameters includes segment morphometric measurements such as segment area and length, while the second group of parameters requires water quality measurements in the segments. To calculate segment parameters, segment and sampling location shapefiles are needed, along with the two water-quality tables. One table holds temperature-depth information measured in the field while the other holds water quality measurements analyzed in laboratory. The outputs of segment processing are two tables, one stores segment morphometric data while the other contains segment water quality variables.

3.1. Calculating Segment Morphometric Parameters

Three tools, segment morphology, segment length, and segment connectivity, could be used to calculate segment morphometric parameters. The segment morphology tool creates a table and populates it with basic segment attributes, such as segment surface area, ID, name, and group number. The connectivity and length tool allow a user to interactively define segment connectivity and length.

3.1.1. *Segment Morphology tool*

The first step in creating Bathtub input file is to calculate morphometric information from the lake segment shapefile. At this point, the lake segment shapefile should be added to ArcView. The segment shapefile must have an attribute table that contains at least two fields -- SID and SName. The SID field stores the unique number assigned to each segment while the SName field stores segment names. To calculate segment morphology, select either the **Segment Morphology** menu item under the **Bathtub** menu (Figure 3) or click on the Segment Morphology button .

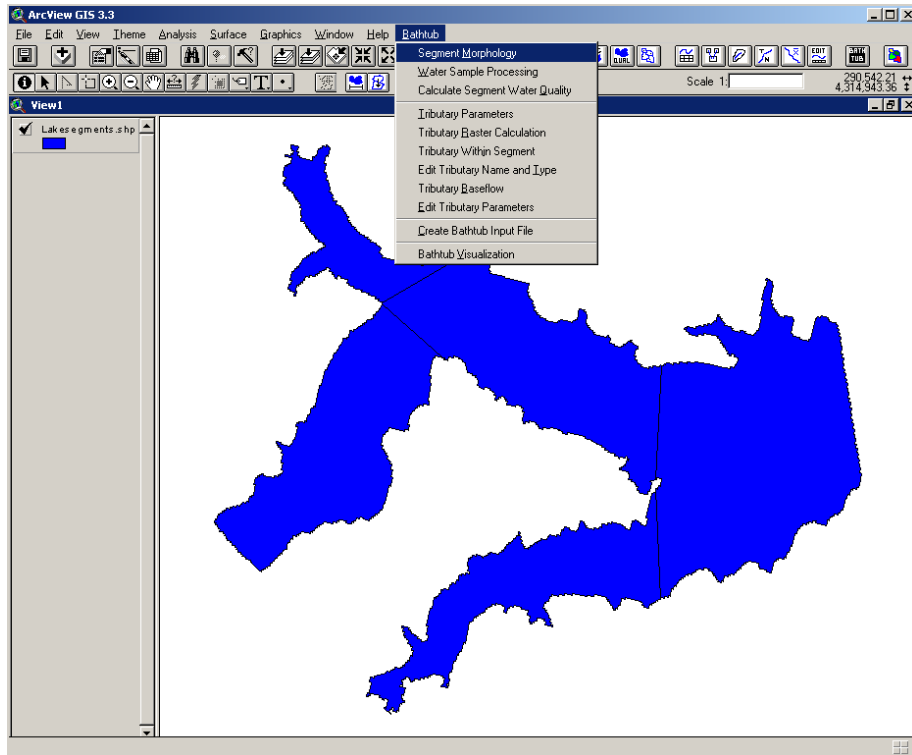


Figure 3. ArcView platform with Segment Morphology menu item highlighted.

A dialog box will open (Figure 4) and asks for the segment shapefile and the path as well as the name of segment morphology output table. The segment shapefile can be selected from the drop down list that includes only polygon shapefiles. The output table name can either be typed directly into the box or the Browse button can be clicked to navigate to a specific location. The default name for the output table is segmorph.dbf. Once the segment shapefile and the output table have been specified, click the OK button.

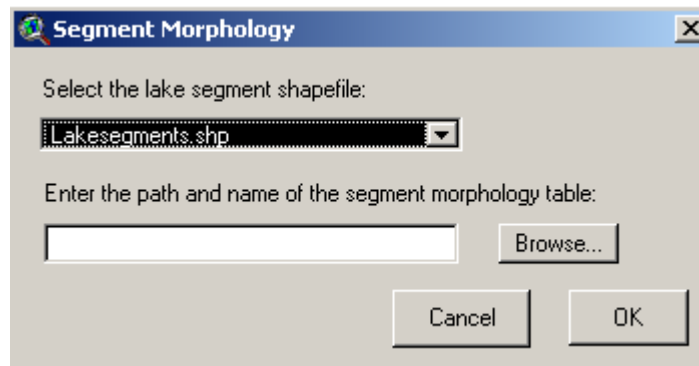
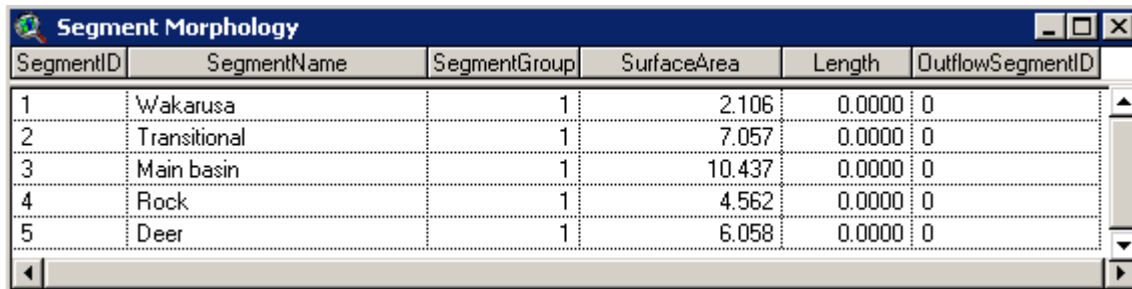


Figure 4. Dialog with Segment Morphology inputs.

A new table is created (Figure 5) and will be added into the current ArcView project. The table contains basic information (ID, name, group number, and surface area) for the


segments. The Length and OutflowSegmentID fields in the table can be populated by the segment length and connectivity tool.



SegmentID	SegmentName	SegmentGroup	SurfaceArea	Length	OutflowSegmentID
1	Wakarusa	1	2.106	0.0000	0
2	Transitional	1	7.057	0.0000	0
3	Main basin	1	10.437	0.0000	0
4	Rock	1	4.562	0.0000	0
5	Deer	1	6.058	0.0000	0

Figure 5. Table created by the Segment Morphology tool.

3.1.2. Segment Length tool

The Segment Length tool allows a user to interactively define the length of each segment. This process requires that the user is knowledgeable of the approximate flow path in a segment. To use the tool, click the Segment Length button . A dialog box (Figure 6) will be open and promptly asks for the path and name of the table in which the Length field is defined and will be updated.

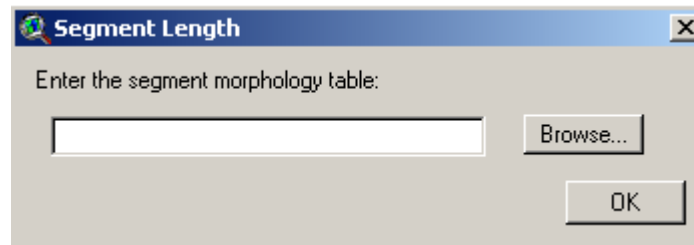



Figure 6. Dialog when the Segment Length tool is selected.

Once the table is specified and the OK button is clicked, the cursor will change to a crosshair while within the map window. To define segment length, start at one end of a segment and click along its approximate flow path. Once the end of the segment has been reached, double click to end the line. The flow path (line) will flash and then disappears. The length of the flow path is calculated and the length of the segment that contains the flow path will be updated in the specified table.

3.1.3. Segment Connectivity tool

Segment connectivity represents the water flow between segments. Again, the user must have the knowledge of how the water flows in a lake to ensure proper hydrologic connectivity. To use the tool, click on the  button. Similar to the Segment Length tool, this will bring up a dialog box (Figure 7), which will ask for the path and name of the table in which the flow to field is defined and will be updated.

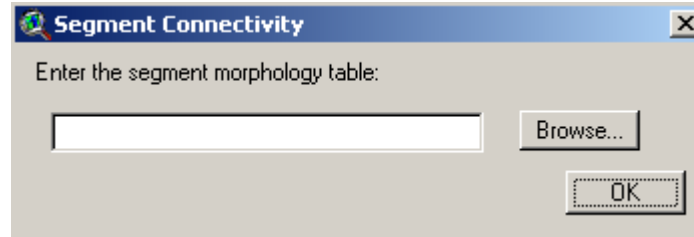


Figure 7. Dialog when the Segment Connectivity tool is selected.

Once the table is specified and the OK button is clicked, the cursor will change to a finger when within the map window. To define segment connectivity, click inside a segment, which will become highlighted, and then click inside another segment into which the first segment flows. Figure 8 shows the highlighted segment after the first click. The connectivity for the segment that flows out of the lake is defined by default.

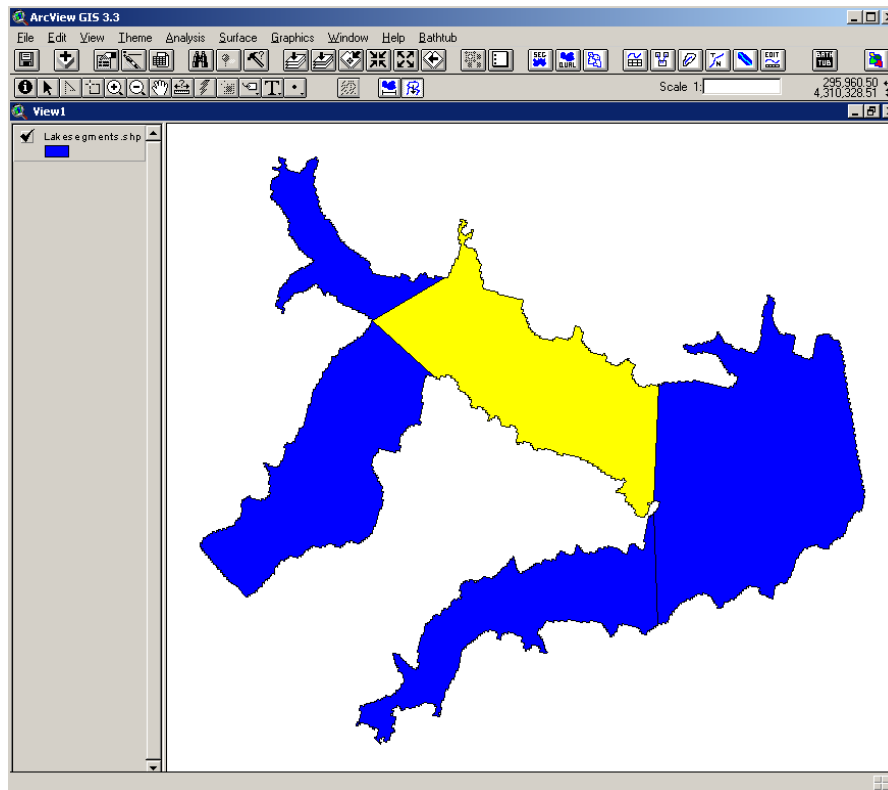



Figure 8. Segment Connectivity tool with the “from segment” highlighted.

At this point, segment morphometric calculation is completed. Segment morphometric parameters are saved in the segment morphology table (Figure 5). The next step is to calculate segment water quality parameters from water samples.

3.2. Calculating Segment Water Quality Parameters

Tools in this section calculate segment water quality parameters based on water samples taken within the lake. Water samples may be taken at different locations and depths within a lake and on different dates. BATHTUB model requires segment water quality above what is called Mixed Layer Depth (MLD), which reflects a significant vertical water temperature change in the lake. The Water Sample Processing tool calculates a MLD for each sampling location and date. The MLDs are then used to calculate the average water quality at each sample point for all the dates. The segment water quality tool first averages all the averaged sample water quality inside a segment and then assigns the average values to the segment.

3.2.1. Water sample processing

The **Water Sample Processing** menu item (Figure 9) or the button  can be used to calculate MLD and to average water quality at each sample point for all dates.

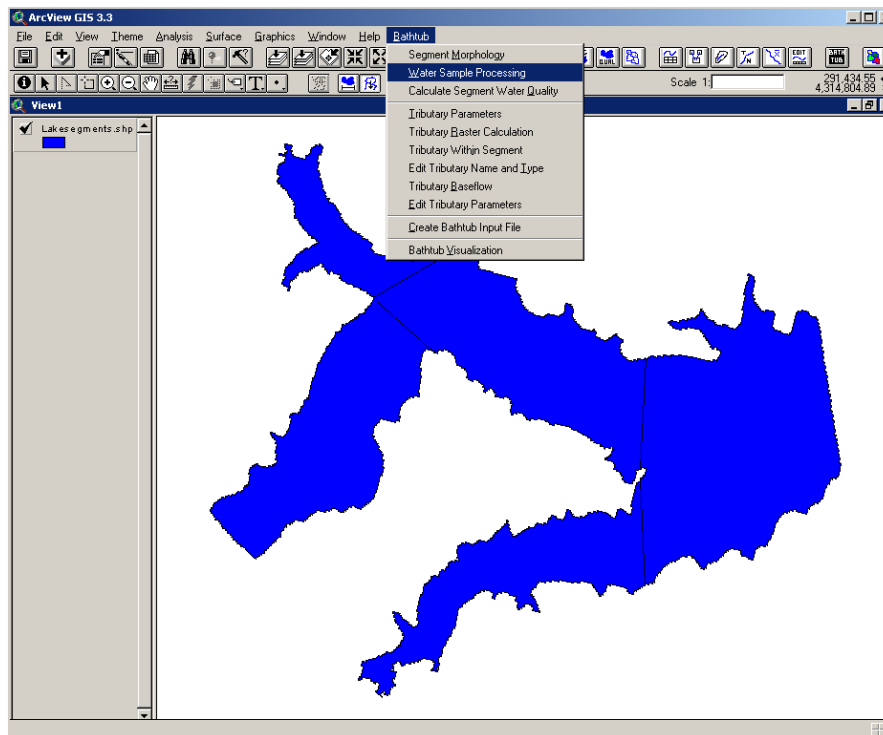


Figure 9. Interface with the Segment Water Quality menu item highlighted.

The Water Sample Processing dialog (Figure 10) requires several input tables from users. The first input table contains water quality information directly measured in the field. An example table is shown in Figure 11. This table must have several required fields. The “Station” field holds the unique number for each water sample. The “Date” field holds the date of sampling. The “Depth” field holds the depth at which the measurement is

taken. The “Temperatur”, “Turbidity”, and “Secchitran” fields store the temperature, turbidity, and Secchi depth measurement, respectively. The Depth and Temperatur fields are used to calculate MLDs for each sampling point and date. A temperature difference threshold value is needed to determine significant temperature change while calculating MLDs. The second table requires an input table of water quality measurements obtained through the analysis of water samples in laboratory. An example table is shown in Figure 12. This table must have several required fields too. The “Sampleid” field stores the unique water sample ID. The “Date” and “Depth” fields are the same as the first input table. The “Ntotal”, “Organicn”, “PO4”, “Ptotal”, “Organicp”, and “Chlorophyll” fields store total N, organic N, PO₄, total P, organic P, and chlorophyll measurement, respectively. The path and name of the output table, which contains the averaged water quality for each sample point and date, need to be specified in the dialog.

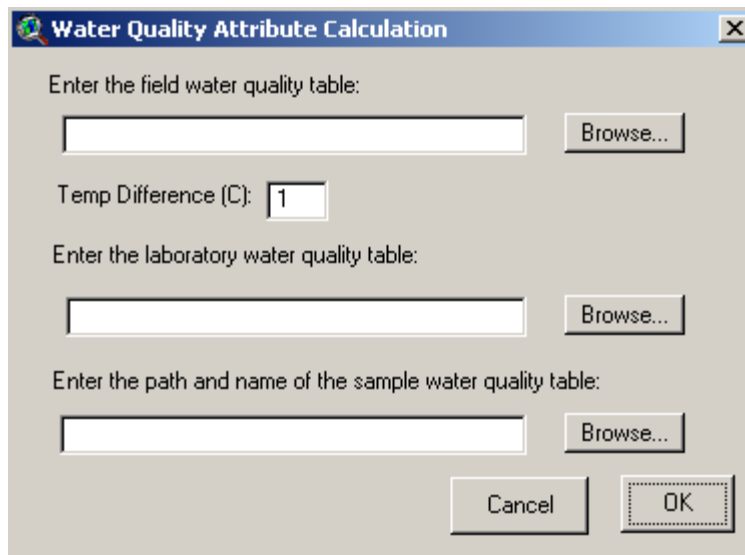


Figure 10. Dialog used to calculate water quality for each sampling location.


Station	Date	Depth	Temperatur	Turbidity	Secchitran
1	20020507	0.25	19.0	64	28
1	20020507	1.50	19.0	68	
1	20020507	3.00	19.0	68	
2	20020507	0.25	20.2	270	13
2	20020507	1.50	20.2	290	
2	20020507	3.00	20.1	299	
3	20020507	0.25	18.5	29	41
3	20020507	1.50	18.5	30	
3	20020507	3.00	18.4	28	
3	20020507	5.50	18.4	31	
4	20020507	0.25	19.3	66	26
4	20020507	1.50	19.4	68	

Figure 11. On-site water quality table

Sampleid	Date	Depth	No3na2	No2	Nh3	Ntotal	Organicn	PO4	Ptotal	Organicp	Chlorophyll
1	20020507	0.25	0.48	0.00	106.80	0.94	0.35	28.60	76.73	48.13	3.7
1	20020507	1.50	0.38	0.00	113.72	0.84	0.35	28.85	76.08	47.23	3.3
1	20020507	3.00	0.40	0.01	118.22	0.84	0.32	28.06	76.37	48.31	3.3
2	20020507	0.25	0.45	0.00	107.64	1.09	0.53	29.98	145.12	115.14	4.9
2	20020507	1.50	0.43	0.00	121.73	1.06	0.51	29.89	143.76	113.87	4.6
2	20020507	3.00	0.47	0.00	118.75	1.13	0.54	30.89	155.96	125.07	4.8
3	20020507	0.25	0.25	0.00	87.22	0.65	0.31	23.71	47.69	23.98	3.3
3	20020507	1.50	0.24	0.00	83.64	0.59	0.27	22.67	47.70	25.03	3.3
3	20020507	3.00	0.24	0.00	89.00	0.63	0.30	24.25	45.12	20.87	2.0
3	20020507	5.50	0.23	0.00	75.99	0.85	0.54	25.23	166.21	140.98	4.6
4	20020507	0.25	0.33	0.00	95.71	0.77	0.34	21.59	66.08	44.49	5.5
4	20020507	1.50	0.32	0.00	80.33	0.74	0.34	21.38	66.26	44.88	5.1

Figure 12. Laboratory water quality table.

3.2.2. Calculating segment water quality

Averaged water quality data has to be associated with segments where sampling points were located. A sampling point shapefile, which stores the location of each water sample, is needed. This shapefile's attribute table must contain the Sid field, which stores the unique ID number for each water sample. The Calculate Segment Water Quality tool selects all the points inside a segment, and then averages the water quality measurements at those points, and assigns the average to the segment. The tool can be accessed by clicking the **Sample Points Within Segments** menu item (Figure 13) or the button  for multiple sampling points in a segment.

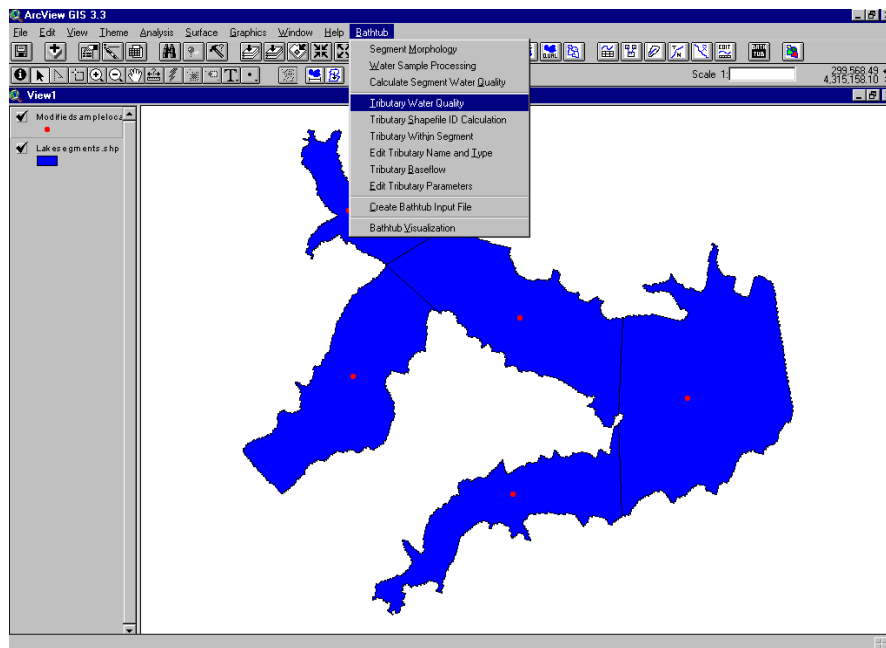


Figure 13. Interface with the Calculate Segment Water Quality menu item highlighted.

After activate the tool, the Calculate Segment Water Quality dialog appears asks for several user inputs (Figure 14). The processed water sample table, created by the Water Sample Processing tool, needs to be specified first. The next two inputs (segment and water sample shapefile) are selected from dropdown list boxes. The output table that contains segment water quality calculated from the water samples has to be specified. Figure 15 show an example segment water quality table calculated from water samples.

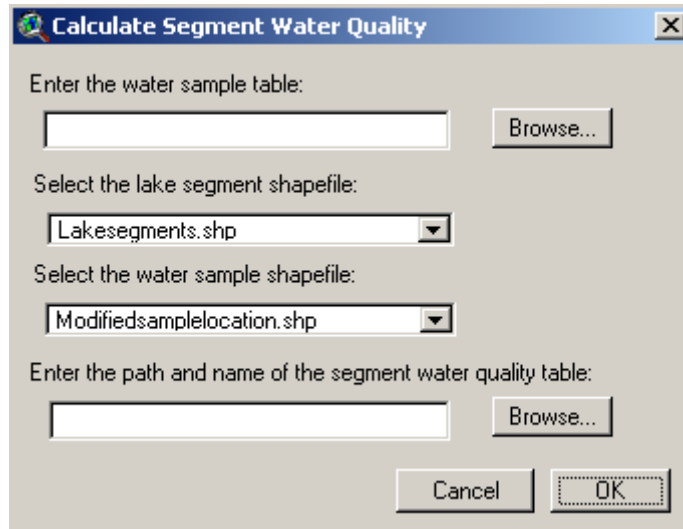


Figure 14. Dialog with the Calculate Segment Water Quality tool.

SegmentID	Avg NTotal	Avg PTotal	Avg Chlorophyll	Avg Organic	Avg
1	743.3000	85.1133	14.7750	513.3000	
2	825.5000	112.7482	18.9636	614.5000	
3	566.7000	51.0556	11.9111	413.9000	
4	592.2000	64.4889	10.2333	434.4000	
5	488.7000	37.3448	7.2870	337.4000	


Figure 15. Segment water quality table calculated from water samples.

At this point, the calculation of segment parameters required by the BATHTUB model is accomplished. The next step is to prepare the tributary inputs for the BATHTUB model.

4. CALCULATING LAKE TRIBUTARY PARAMETERS

Each segment in the BATHTUB model can be connected to one or several tributaries. Each connected tributary requires several water quality parameters. Tributary water quality can be either measured in the field or modeled using water quality models such as AnnAGNPS. This Chapter discusses the tools available in the GeoBathtub extension to process AnnAGNPS outputs and determine segment-tributary connectivity.

4.1. Obtaining Tributary Water Quality Parameters from AnnAGNPS Output

The Tributary Water Quality from AnnAGNPS tool processes the event output file from AnnAGNPS (version 2.2). It finds all the reaches and the simulated period in an AnnAGNPS event output file. A user can select one or several reaches and a time period to calculate water quality parameters for the selected reaches. To use the tool, select the **Tributary Water Quality** menu item (Figure 16) or click the button .

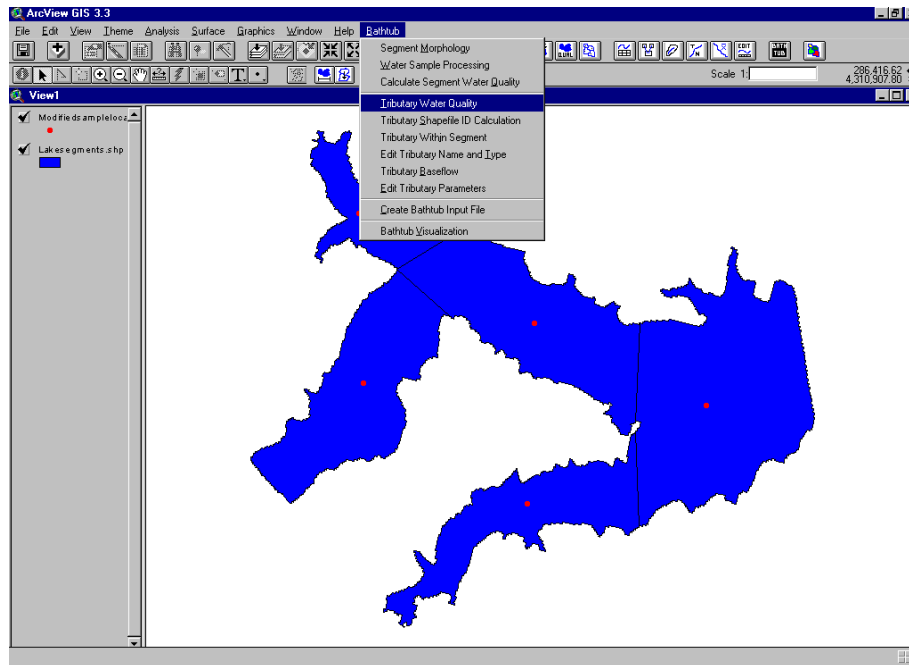


Figure 16. Interface with Tributary Water Quality from AnnAGNPS menu item highlighted.

The AnnAGNPS Event Output File dialog asks for the AnnAGNPS event output file that contains all the reaches simulated in the model (Figure 17). The AnnAGNPS event output file contains header information and is organized by reach ID, as shown in Figure 18.

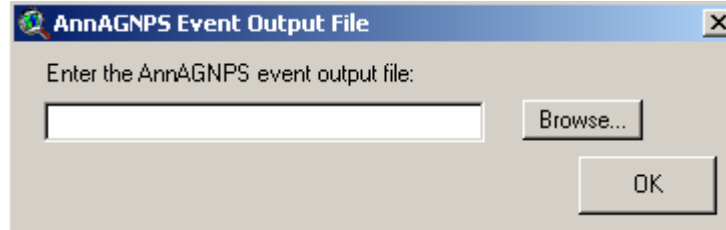


Figure 17. AnnAGNPS Event Output File dialog.

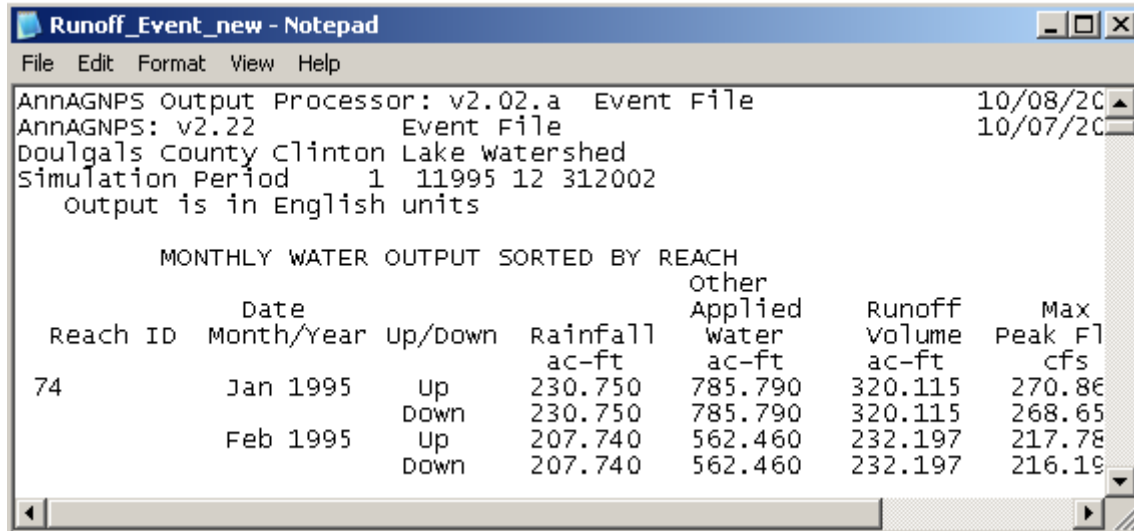


Figure 18. AnnAGNPS output file

Once the AnnAGNPS event file is specified, the Tributary Water Quality from AnnAGNPS dialog box opens up (Figure 19). The list box on the left lists all the reach IDs found in the AnnAGNPS event file. Users can select one or multiple reaches from the list. If multiple reaches are desired, simply hold down the Shift key while clicking the ID numbers. The “From Date” and “To Date” list boxes on the left provide the simulated period found in the AnnAGNPS event file. Use the dropdown boxes to select the target period from which tributary water quality parameters will be derived. The output table has to be specified too.

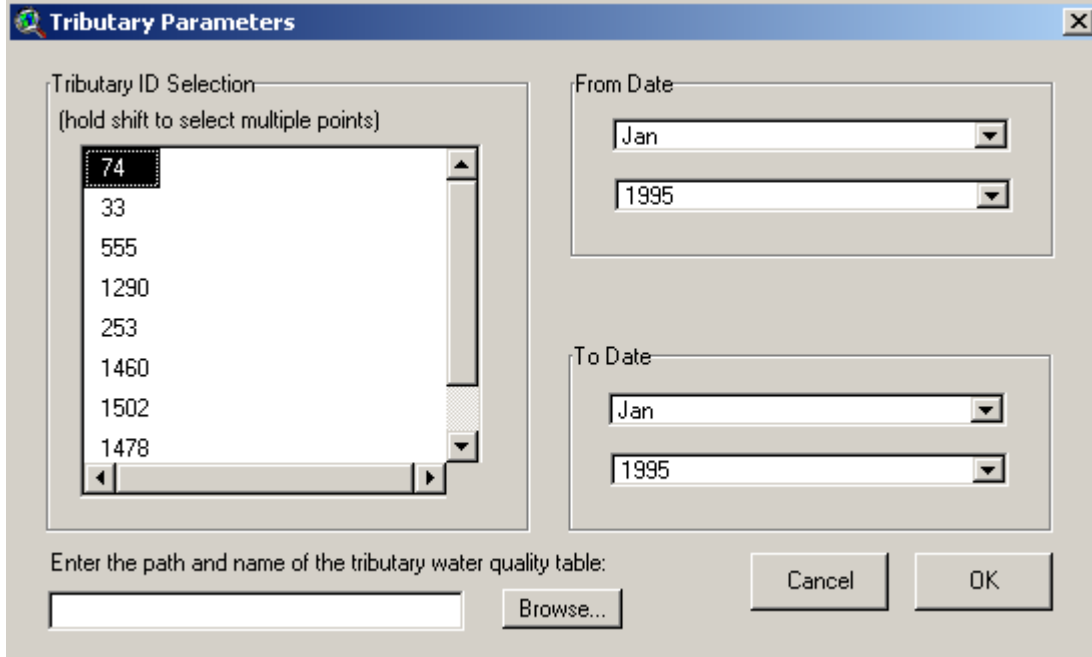


Figure 19. Dialog showing the selection of reaches and simulated period


Because of the large size of the AnnAGNPS event output file, calculating all of the water quality parameters for the selected reaches from the file may take some time. A progress bar, which informs how far along the process is, appears at the bottom of the ArcView platform. Based upon the selected period, the tool scales the water quality parameters to a yearly basis, which is recommended by the BATHTUB model. All of the water quality parameters are written to the output table specified in Figure 19. Figure 20 is an example of the output table.

ReachID	Ave_orthoP	Ave_Ptotal	Ave_inorganicN	Ave_Ntotal	Ave_runoff total	Ave_sub_con	CV_2
33	45.9456	676.4433	750.0336	2003.4615	11.7481	0.0000	
74	60.5556	1101.6617	1033.2882	3136.7014	6.8463	0.0000	
253	37.2276	332.0779	767.3325	1344.4644	73.9096	0.0000	
555	33.3358	329.2026	632.6697	1209.2754	49.7733	0.0000	
1290	80.8483	1108.6228	1944.1458	3972.1142	3.3550	0.0000	
1460	86.9393	766.7561	1290.8068	2532.1065	0.7513	0.0000	
1478	66.3948	785.2363	1106.9288	2522.6544	5.2058	0.0000	
1502	71.0861	910.8856	1352.1491	3016.2452	2.3992	0.0000	

Figure 20. Output from the Tributary Water Quality from AnnAGNPS tool.

4.2. Creating Reach ID Shapefile

In order to establish the connectivity between reaches and segments, reaches location must be obtained. Two raster layers (watershed and stream network order) generated by

AnnAGNPS have to be added into the ArcView project. The Create Reach ID tool will first generate a raster layer that stores reach IDs in the watershed. The tool re-classifies the stream network order raster, multiplies the re-classified raster with the watershed raster, and then divide the multiplication by 10 to obtain reach ID raster. This raster reach ID is then converted to a shapefile. To use the tool, click on the **Tributary Shapefile ID Calculation** menu option (Figure 21) or click the button .

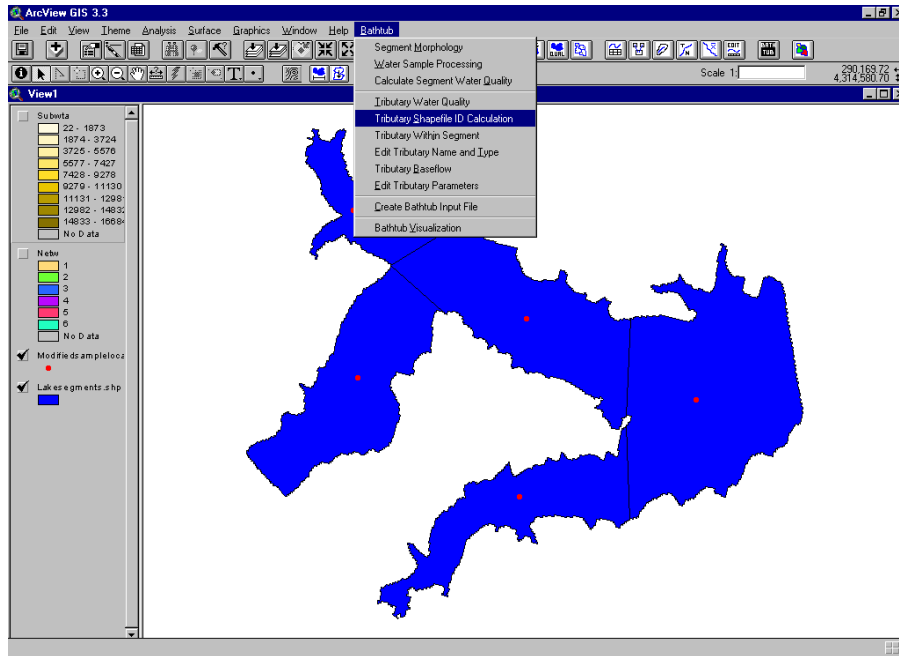


Figure 21. Interface with Tributary ID Calculation menu item highlighted.

The Create Reach ID Shapefile dialog asks for two raster layers and the path and name of the reach ID shapefile that will be created (Figure 22). The first dropdown box asks for the watershed stream order raster layer. The second dropdown box asks for the watershed raster layer. The textbox at the bottom asks for the path and name of the output reach ID shapefile. Once the **OK** button is clicked, the reach ID shapefile is created and added to the ArcView project, as shown in the red highlight box in Figure 23.

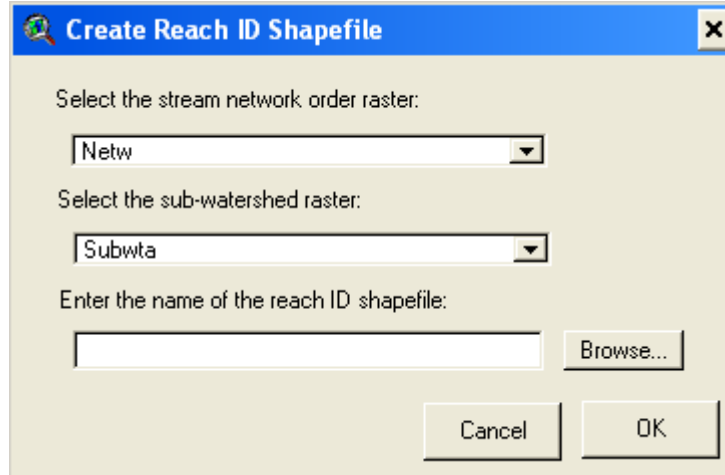


Figure 22. Dialog with the Create Reach ID Shapefile tool.

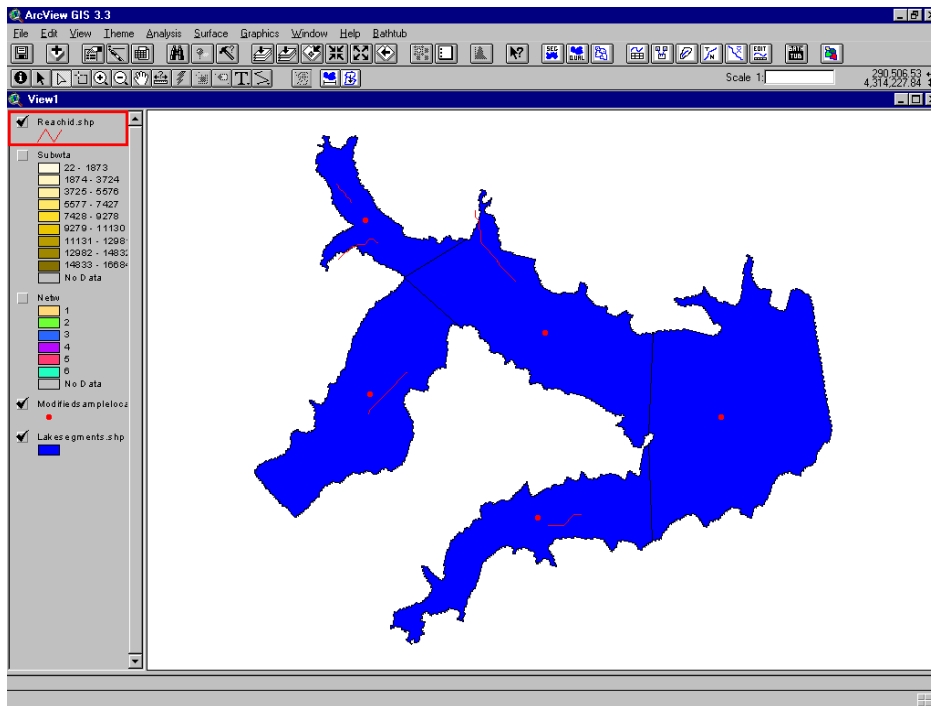



Figure 23. The newly created reach ID shapefile highlighted in red.

4.3. Tributary within Segments

The reach ID shapefile is used to establish the linkage between tributaries (reaches in AnnAGNPS terminology) and segments. The Tributary within Segment tool determines within which segments the tributaries fall. The tool takes the vectorized reach IDs and determines which tributaries are contained in the segments. The tool can be accessed by selecting the **Tributary within Segments** (Figure 24) or by clicking the button .

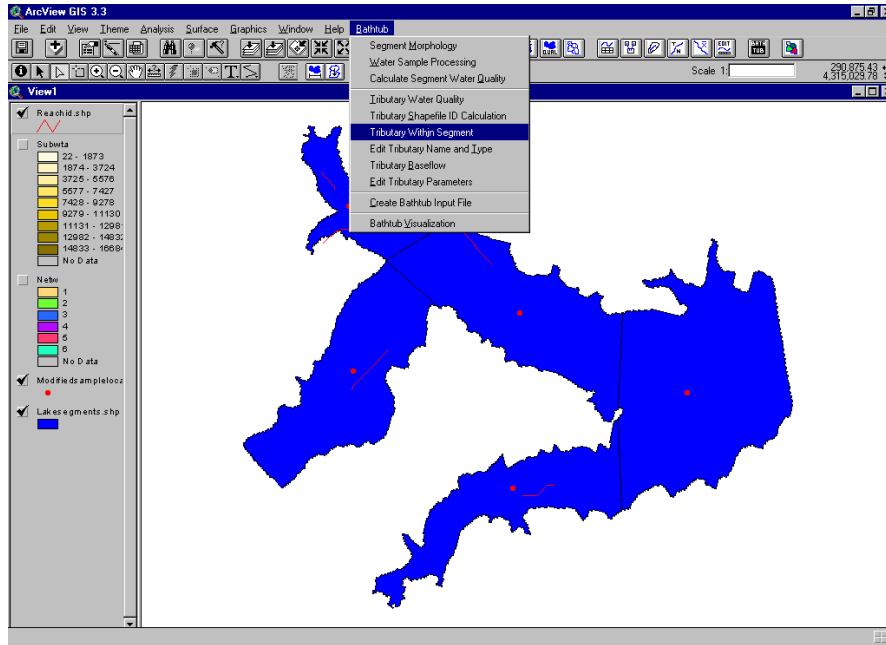


Figure 24. Interface with Tributary within Segment menu item highlighted.

The Tributary within Segments dialog asks for several inputs (Figure 25). First, the segment shapefile must be selected from the first dropdown list. Similarly, the newly created reach ID shapefile should be selected from the list of arc layers in the next dropdown list. The next input is the AnnAGNPS reach file that contains each reach’s watershed area. An example of AnnAGNPS reach file is shown in Figure 26. Finally, the dialog asks for the reach water quality table calculated from AnnAGNPS event output file in Chapter 4.1.

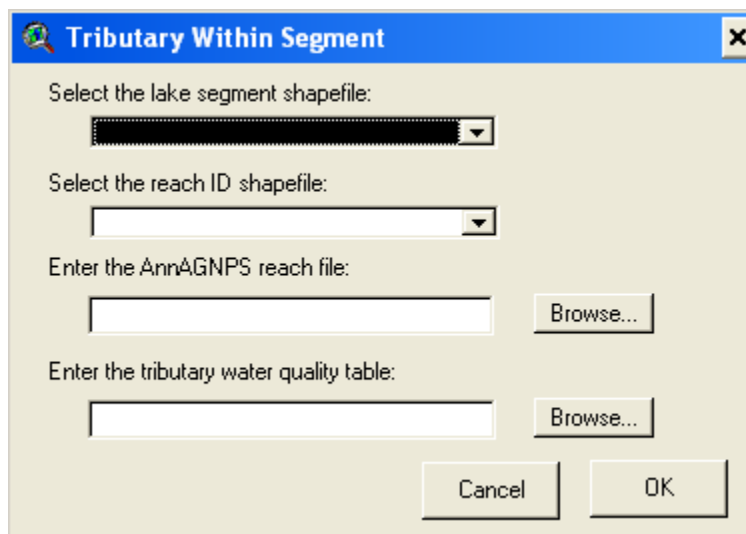


Figure 25. Tributary within Segments dialog.

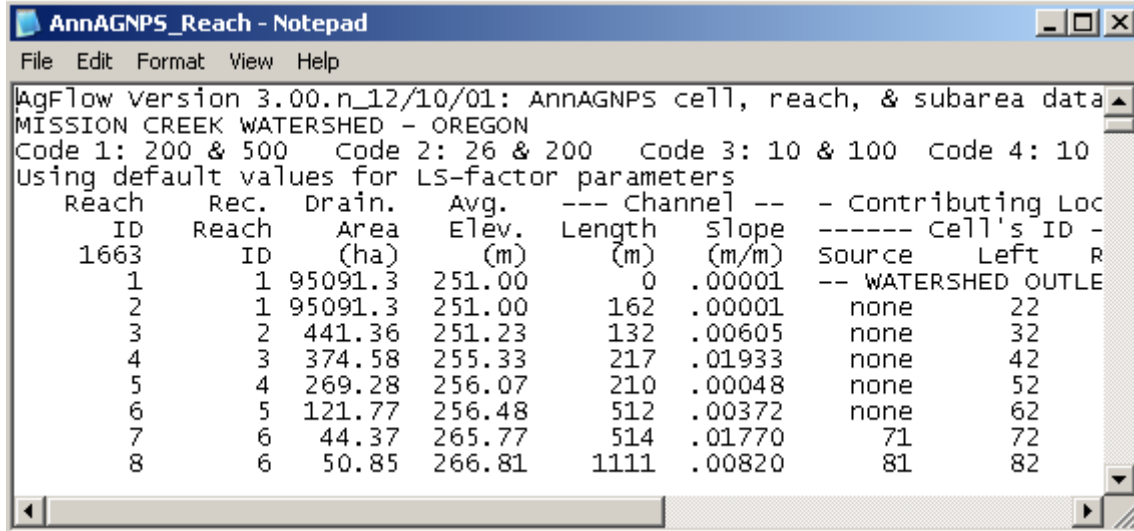



Figure 26. An example of AnnAGNPS reach file.

4.4. Editing Tributary Name and Type

The Edit Tributary Name and Type tool is used to edit tributary name and type. The tool can be accessed through the Edit Tributary Name and Type menu item (Figure 27) or the button . Upon accessing this tool, the tributary water quality table will be needed, as well as the newly created reach ID shapefile (Figure 28). In the Edit Tributary Name and Type dialog (Figure 29), users can select a tributary by its ID, enter a new name, and choose one of the BATHTUB tributary types. Upon selected a tributary ID from the dropdown list box, the coinciding tributary arc will be highlighted in the ArcView map. This will assist in naming each of the tributaries.

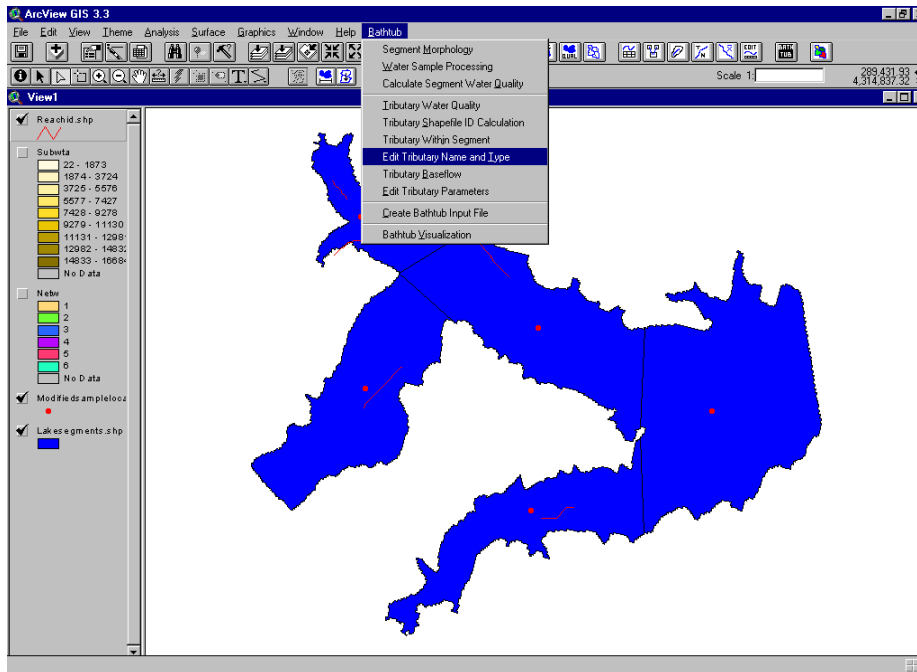


Figure 27. Interface with Edit Tributary Name and Type menu item highlighted.

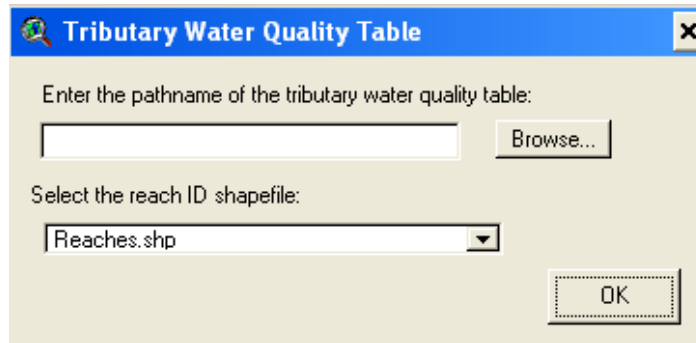


Figure 28. Dialog with tributary water quality input.

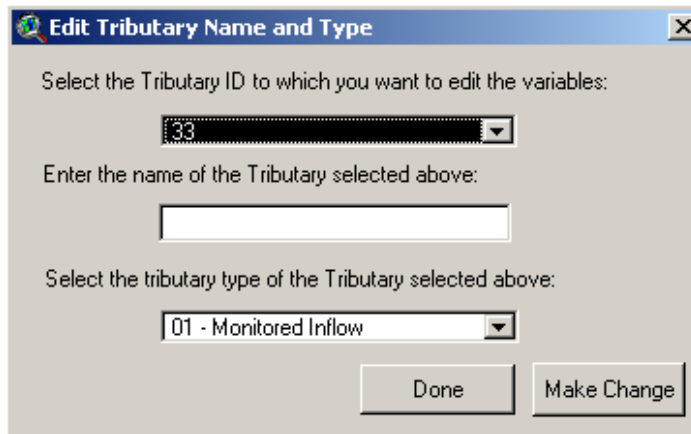



Figure 29. The Edit Tributary Name and Type Dialog.

4.5. Calculating Tributary Baseflow

The tributary water quality parameters calculated from the AnnAGNPS event file are event runoff. Each tributary also has a base flow associated with it. Although base flow water quality is typically measured in the field, its flow rate is usually estimated from simulated tributary event runoff. The Tributary Baseflow tool calculates the base flow rate based on a user specified event runoff percentage. It also adds a base flow tributary to the water quality table. To use the tool, select the **Tributary Baseflow** menu item (Figure 30) or click on its corresponding button .

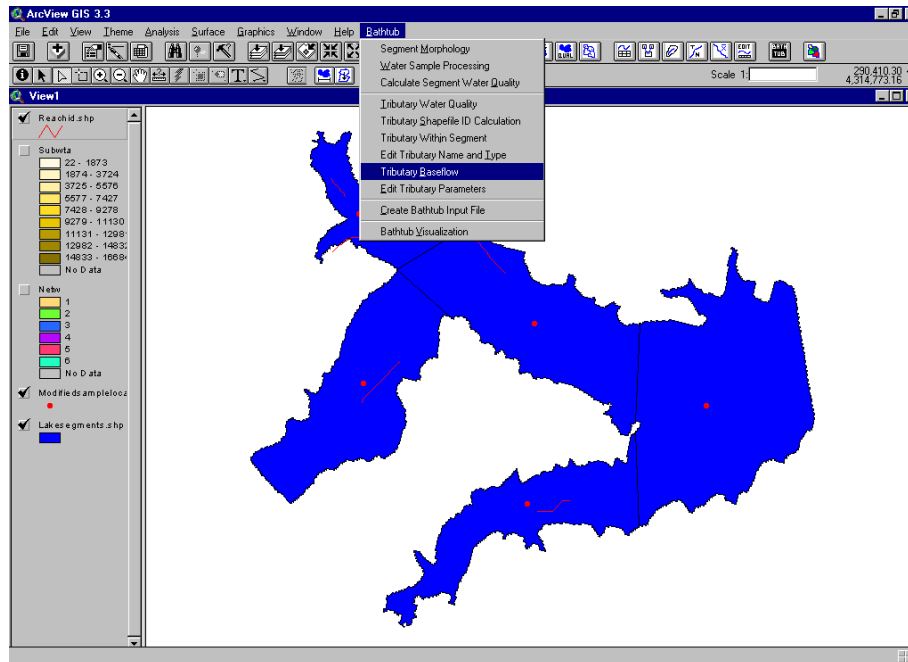


Figure 30. Interface with Tributary Baseflow menu item highlighted.

The Tributary and Baseflow Table dialog will open up (Figure 31). The dialog asks for the tributary water quality table created in Chapter 4.1 and updated in Chapter 4.3. It also needs a baseflow table that contains field measured base flow water quality. An example of the baseflow water quality table is shown in Figure 32. The “Site”, “Organic”, “Totaln”, “PO4”, and “Totalp” field in the table stores the name, organic N, total N, PO₄, and total P of the base flow, respectively.

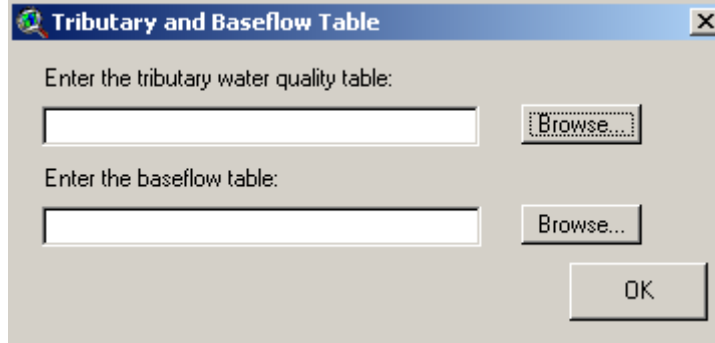


Figure 31. Dialog with Tributary and Baseflow inputs

<i>Site</i>	<i>Count</i>	<i>Organic</i>	<i>Total</i>	<i>Pc4</i>	<i>Total</i>
Deer Creek	10	0.4630	1.2090	18.5060	70.5880
Rock Creek	9	0.4678	0.6400	14.0700	72.7211
Rock Creek-Downstre	1	0.9200	2.3200	73.2100	212.8600
Wakarusa River	9	0.5344	1.3556	37.3722	110.3744

Figure 32. Baseflow sample table.

Once the two tables are specified, the Tributary Baseflow dialog (Figure 33) opens up with two dropdown list boxes and a text box. To calculate the flow rate of baseflow, select a tributary name from the dropdown list box on the left, and the corresponding baseflow tributary name from the left, enter the percentage of the reach's runoff flow rate that constitutes its baseflow. Click on the Add Baseflow Record button will add the baseflow tributary to the table.

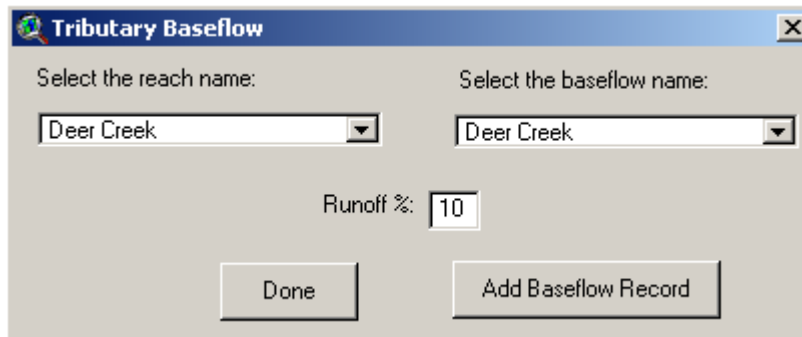



Figure 33. The Tributary Baseflow dialog.

4.6. Editing Tributary Table

The Edit Tributary Table tool gives a user the opportunity to edit the values within the tributary table based on tributary ID and the selected field. This tool can be accessed by clicking on the **Edit Tributary Parameters** menu item (Figure 34) or click its corresponding button, .

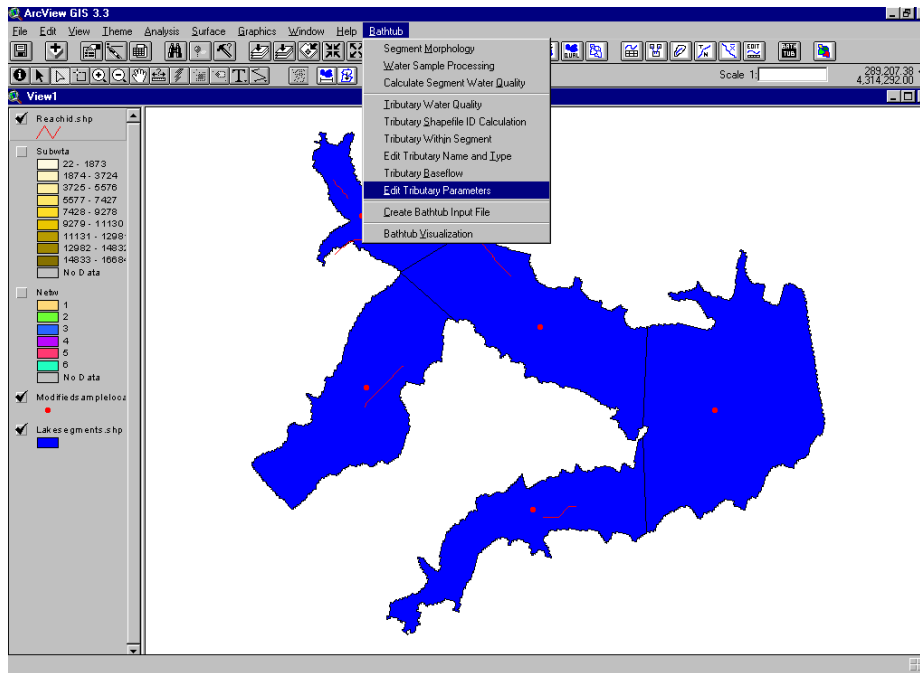


Figure 34. Interface with Edit Tributary Parameters menu item highlighted.

In the Tributary Table dialog (Figure 35), enter the tributary water quality table that has been created and updated in the previous chapters/sections. Upon clicking OK button, the Edit Tributary Table dialog will open. This dialog (Figure 36) requires three inputs, a tributary ID, chosen from the first dropdown list box, a Field in the table to edit, chosen from the second drop down list box, and a new value for the selected field. This process can be run multiple times until all necessary changes are made. Clicking on the Done button will close the dialog.

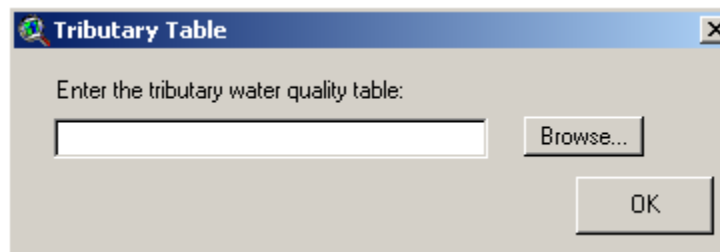


Figure 35. Tributary Table dialog.

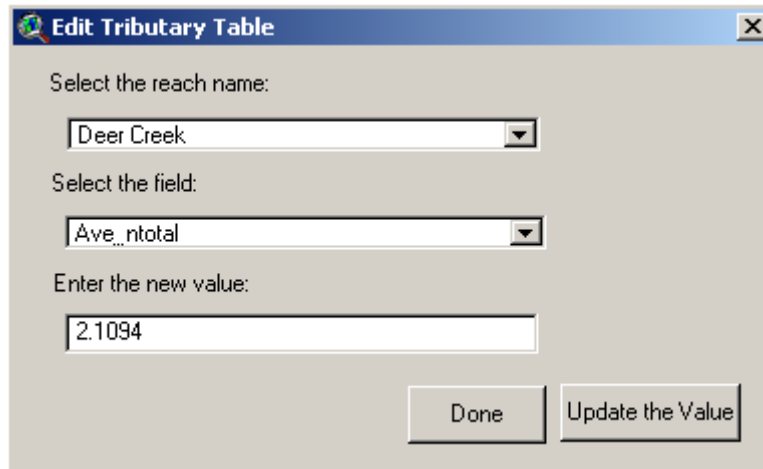



Figure 36. The Edit Tributary Table dialog.

5. GENERATING BATHTUB PROJECT FILE

When the calculation of segment and tributary parameters is accomplished, the next step is to generate the project file for BATHTUB. This step takes the segment morphology and segment water quality tables created in Chapter 3 and the tributary water quality table created and updated in Chapter 4 as inputs. It writes an output text file for BATHTUB. The tool can be accessed by selecting the **Create Bathtub Input File** menu item (Figure 37) or by clicking its corresponding button .

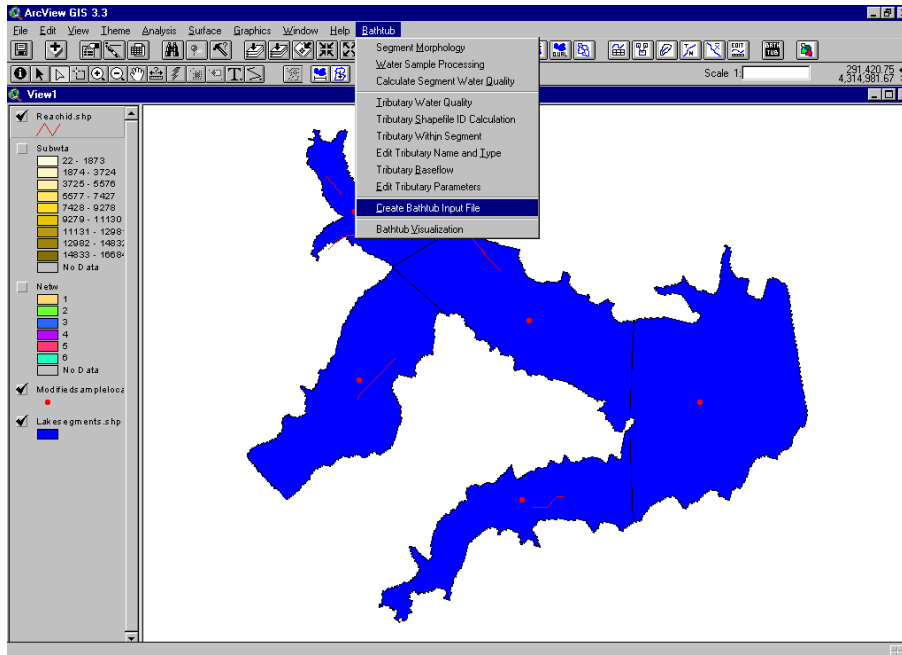


Figure 37. Interface with Create Bathtub Input File menu item highlighted.

The Create Bathtub Project File dialog will open and ask for several inputs (Figure 38). The first two textboxes ask for the segment morphology and segment water quality table. The third textbox asks for the tributary water quality table. The last one asks for the path and name of the output BATHTUB project file. The output file will, by default, have the *.btb extension, as this is the file extension that BATHTUB model accepts.

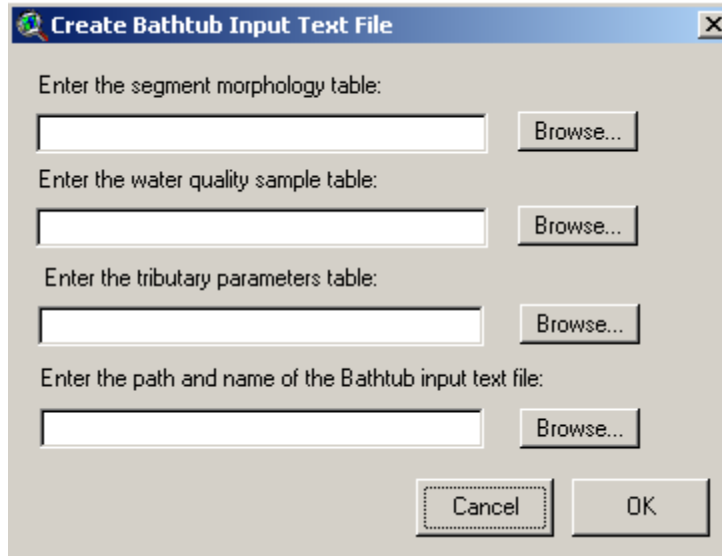


Figure 38. Dialog with Create Bathtub Input Text File inputs.

At this point, BATHTUB can be opened and the newly created *.btb file can be read. An example BATHTUB project file is shown in Figure 39.

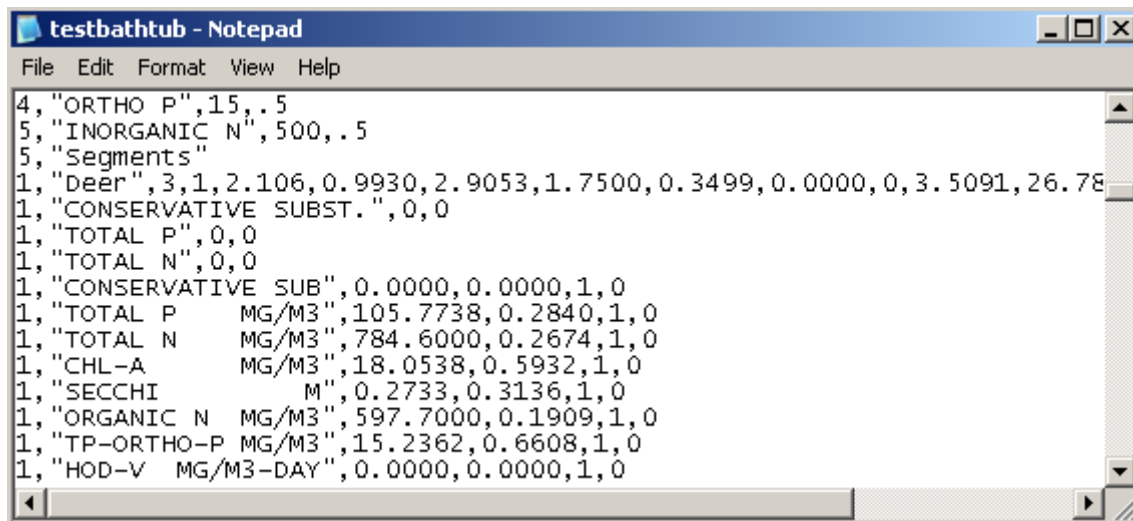



Figure 39. An example BATHTUB project file.

6. VISUALIZING BATHTUB OUTPUTS

After running a project file, the BATHTUB model will create an Excel workbook that contains several worksheets storing the modeling results for the segments. The last function that the BATHTUB extension provides is to visualize the profile output from BATHTUB runs. The Profile worksheet must be saved as a text file before it can be visualized in ArcView. To access the BATHTUB Visualization tool, select the **Bathtub Visualization** menu item (Figure 40) or click on the corresponding button . The Bathtub Profile dialog will open up asking for the path and name of the profile output text file from BATHTUB (Figure 41). The BATHTUB profile output file contains a header, segment number and name, and simulated segment water quality as shown in Figure 42.

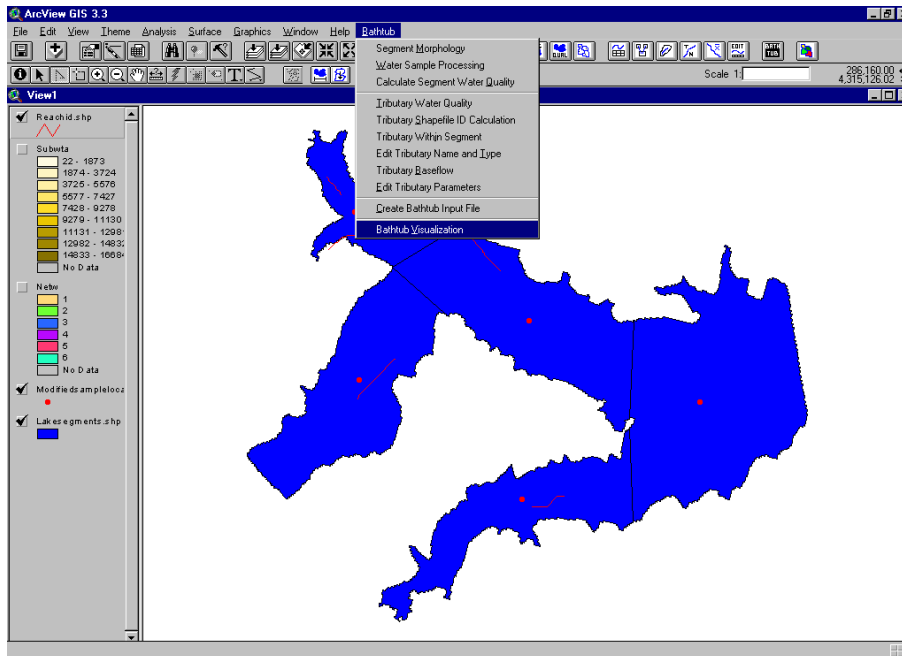


Figure 40. Interface with BATHTUB Visualization menu item highlighted.

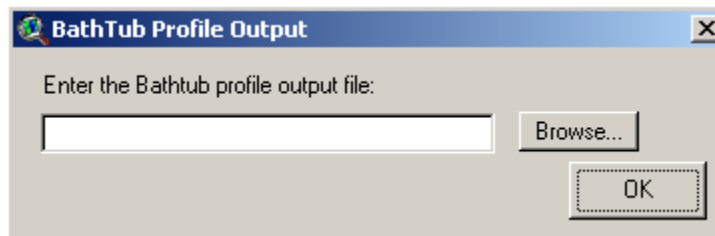


Figure 41. The BATHTUB Profile Output.


```

Segment  Name
1         upper wakarusa
2         deer creek
3         lower wakarusa
4         rock creek
5         main basin
Mean      Area-wtd Mean

PREDICTED CONCENTRATIONS:
Variable Segment-->    1      2      3      4      5
TOTAL P   MG/M3         79.8  91.3  58.2  61.2  40.9
TOTAL N   MG/M3        578.6 581.6 537.4 545.6 498.
C. NUTRIENT MG/M3       32.6  33.5  28.2  29.0  23.7
    
```

Figure 42. BATHTUB profile output text file.

Once the profile output file is specified, the Bathtub Profile Visualization dialog will open up and ask for the segment shapefile, the BATHTUB profile table to be created, the output variable type, and the water quality parameters to visualize (Figure 43).

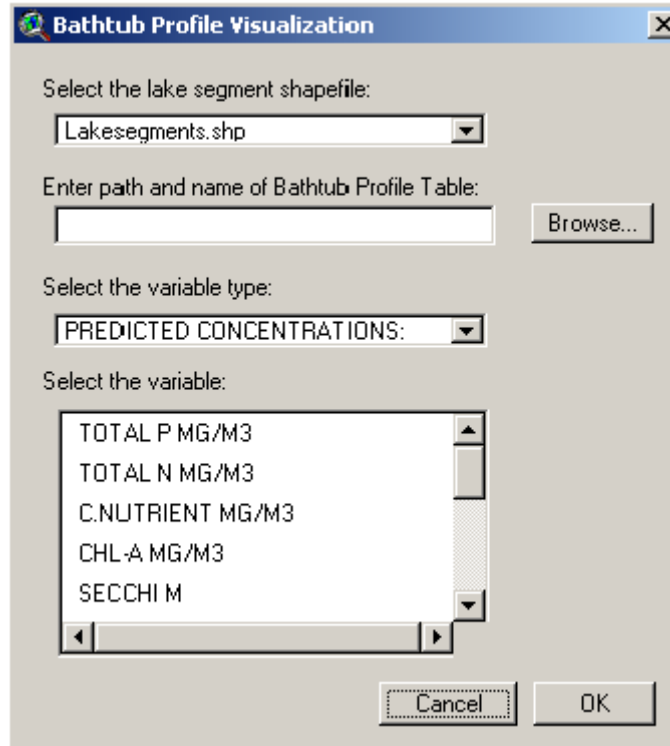


Figure 43. The BATHTUB Profile Visualization dialog.

Once the inputs are specified, a new table is created which holds the segment IDs and the different variables that were selected. Once the table has been created, it is joined with

the lake segment shapefile's attribute table. After joining the two tables, the lake segment shapefile's symbology is updated, showing the visualization of the first variable selected from the Bathtub Profile Visualization dialog, as shown in Figure 44.

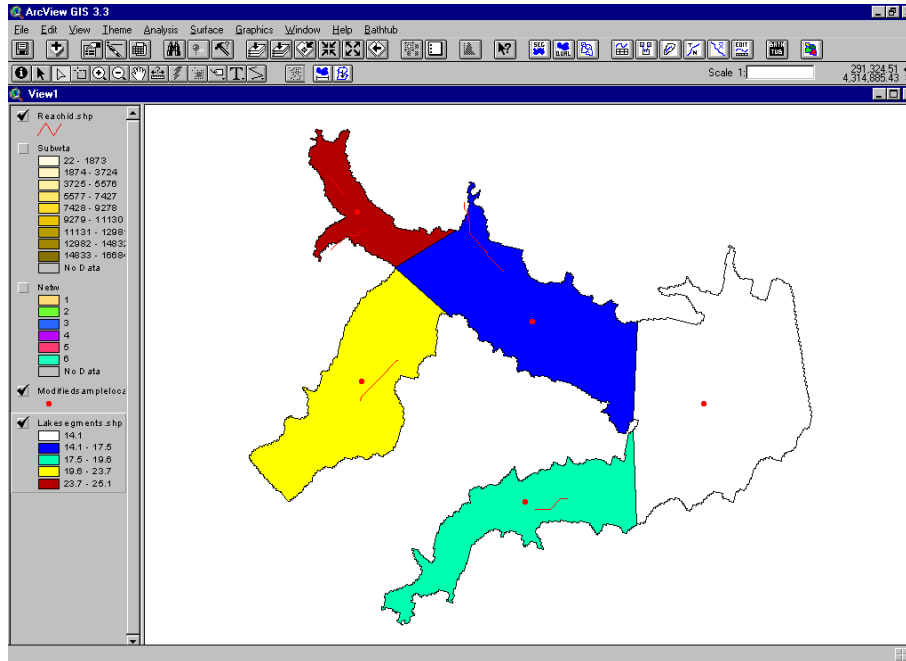


Figure 44. Visualization of simulated turbidity in BATHTUB profile output file.

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