



BASINS Case Study 1

Cottonwood Creek Watershed,
Idaho County, Idaho

Introduction

EPA's Office of Science and Technology was requested by the Idaho Division of Environmental Quality (IDEQ) to help develop a bacteria TMDL for Cottonwood Creek, Idaho using EPA's BASINS software. The technical goals of this project were to determine the source of the high bacteria concentrations, estimate bacteria loadings, and determine load reductions needed to meet State water quality criteria. Another key objective of this project was to produce a case study to demonstrate the use of BASINS in developing a TMDL. The technical goals of the study were met and the State was able to issue the draft TMDL in accordance with the project's schedule.

How to Use this Case Study

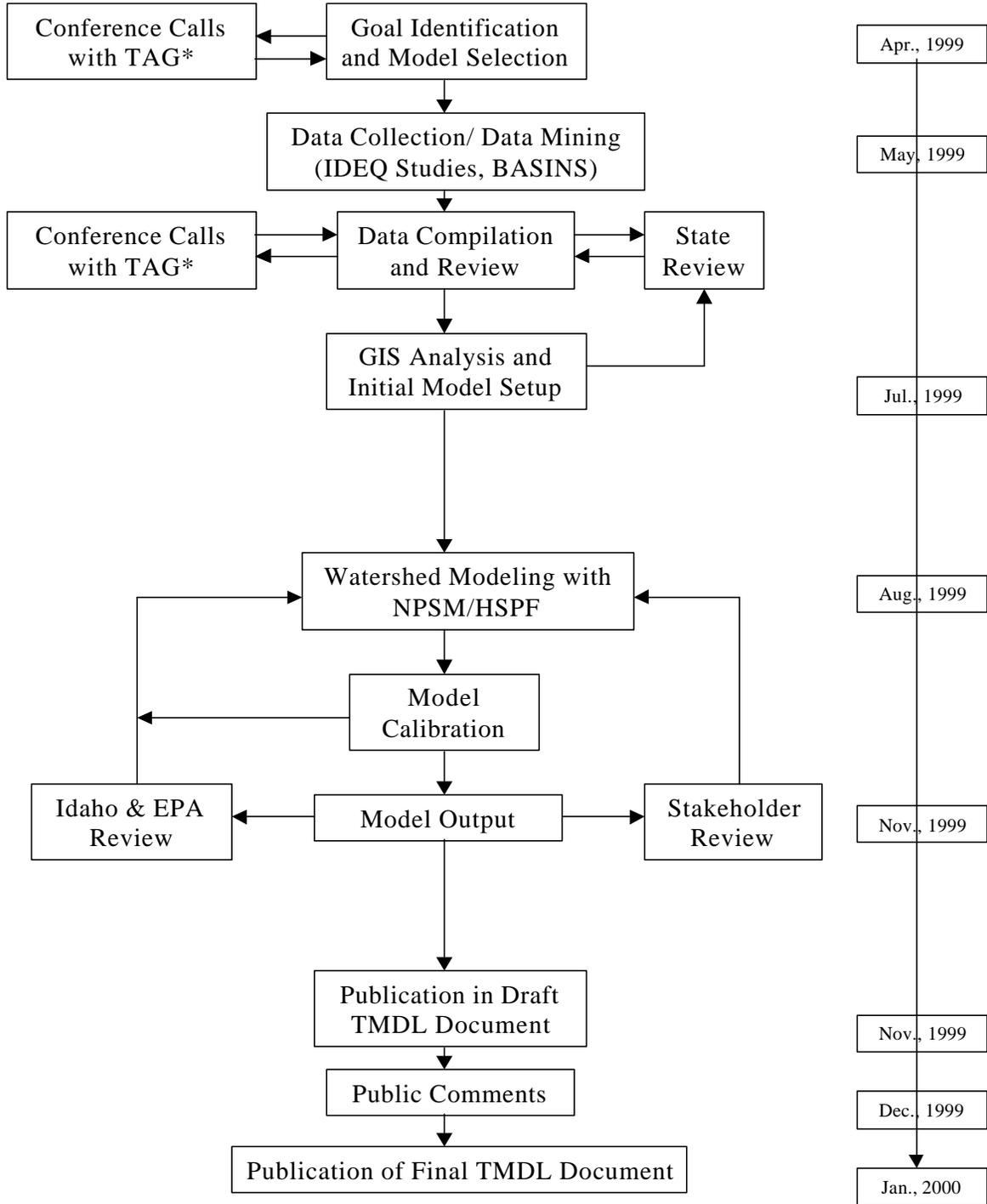
The file *Cottonwood_modeling_report.pdf*, included in the BAS-CS1.zip file delivered with this study, contains the complete report as submitted to the Idaho Department of Environmental Quality (IDEQ). The notes in the *Step-by-Step Guide* section of this study provide instructions on how to reconstruct, in your own BASINS and NPSM projects, the work products described throughout the modeling report. Unzip the BAS-CS1.zip file to a clean directory; make sure the Use Folder Names option is selected in WinZip when extracting the data in order to preserve the directory structure. The files, as extracted from the zip file will then be in the same order as in the File Index section of this study. The *Step-by-Step Guide* includes instructions on where files are to be placed in the BASINS directory structure, when required. Readers, then, can follow along with the steps taken during the course of the project by examining the available monitoring data; building the BASINS project and customizing it to local conditions; setting up and performing an initial NPSM watershed modeling run with default data sets; running the NPSM with the final hydrology calibration; examining the assumptions and calculations performed outside of BASINS for fecal coliform loading; running the model as calibrated for fecal coliform; and checking the output against the bacteria monitoring data.

Note: The *Step-by-Step Guide* part of this report was written explicitly for those watershed modelers who have had some exposure to BASINS in a BASINS training course, or through self-paced training with the User Manual tutorial. Users of the *Step-by-Step Guide* not yet familiar with BASINS are encouraged to use the user manual tutorial; the tutorial starts on page 4.3-3 of the user manual (how to create the BASINS tutorial project) and is found throughout the user manual as the last text box in each section.

Modeling and Public Participation Process

The modeling and public participation process is represented graphically in Figure 1, below.

Figure 1. Modeling and Public Participation Process: Cottonwood Creek Bacteria TMDL



* - Technical Advisory Group

This project included extensive stakeholder input and review. The TMDL development was a cooperative venture resulting from numerous discussions and reviews from federal, state, and tribal members, and local citizens. Two local Watershed Advisory groups were established from the stakeholders to review and advise on the development of the TMDL.

The first group, the Cottonwood Creek Watershed Advisory Group (WAG) was appointed by the IDEQ Administrator in August, 1997 to fulfill the State regulatory requirements for public participation, and to provide the needed community perspective on watershed management. Members of the Watershed Advisory Group were selected from nominations from the local community to represent specific stakeholders groups within the watershed (see below). The group met 12 times at the BLM office in Cottonwood, Idaho and all meetings were open to the public.

Cottonwood Creek Watershed Advisory Group (WAG)
Nez Perce Tribe Idaho County City of Cottonwood Livestock and Dairy Owners Recreation Business Agriculture Ag. Chemical Environmental Land Owners

The second group was the Cottonwood Creek Technical Advisory Group (TAG). The TAG dealt with the technical, regulatory and policy issues of the Cottonwood Creek TMDL and included representatives from the state and federal government, and the Nez Perce Tribe (see below).

During the course of this project, information was exchanged frequently with the IDEQ, as well as between EPA Headquarters and EPA's Region 10 Offices. The Cottonwood Creek Technical Advisory Group met via several conference calls to discuss data availability, modeling, and preliminary results. Memos and notes summarizing the meetings and telephone conferences were issued by the IDEQ.

**Cottonwood Creek Technical
Advisory Group (TAG)**

EPA Headquarters
EPA Region 10
EPA Region 10 Idaho Operations Office - Boise
Bureau of Land Management
Natural Resource Conservation Service
Soil Conservation Commission
Idaho Department of Environmental Quality
National Marine Fisheries Service
Nez Perce Tribe
Idaho Department of Lands
Idaho County Soil Water Conservation District

Preliminary results of the project were presented as a case study at the EPA Regional TMDL Coordinators Meeting held in Washington, D.C., and separately to a technical representative of EPA's Office of Wetlands, Oceans and Watersheds. Copies of draft and final documents were reviewed by EPA management, and by EPA's Region 10 Idaho Operations Office - Boise. An EPA environmental engineer traveled to Cottonwood, Idaho and met with the Technical Advisory Group and the IDEQ, to review the preliminary watershed modeling results. As a result of the meeting, a number of changes were made to the input parameters to more realistically represent local conditions and agricultural practices. The models were then re-run and a number of new scenarios were modeled based on suggestions from the TAG.

The report, *Fecal Coliform TMDL Modeling Report: Cottonwood Creek Watershed, Idaho County, Idaho* (file *cottonwood_modeling_report.pdf*), containing detailed information on the project was placed on file in the Idaho state docket and was made available for review by the public. A summary document discussing input parameters, model calibration, model results, and conclusions was also submitted to the State. This summary report was used as a component of the State's Cottonwood Creek watershed TMDL report, later published as a public review draft. The draft TMDL was available for public review and comment at several locations. Formal notification was made through several local and regional newspapers and copies were provided to each member of the various advisory groups. Written comments were accepted by the IDEQ. Two public meetings were held, one in Cottonwood and one in Lewiston, to summarize the findings. Following the public comment period, the comments were addressed and responses were provided in the appendix of the final TMDL document.

Step-by-Step Guide

The page numbers, below, refer to the original Fecal Coliform TMDL Modeling Report for Cottonwood Creek (*cottonwood_modeling_report.pdf*) and are adjoined by text describing steps you can take in a hands-on re-creation of the BASINS/NPSM projects used to perform the Cottonwood Creek fecal coliform TMDL. Note: you must have the BASINS 2.01 update installed in order to load and run the NPSM project files included in the zip file. Quality Assurance/Quality Control discussions (QA/QC notes) are also provided where decisions on whether or not to use a particular data set were made and/or where an original data set was modified to improve quality.

p.2&3 - Bacteria data from each of the seven monitoring stations in the Cottonwood Creek watershed can be viewed by opening the files in the Bacteria Data folder. The data can be read in a text editor or viewed in the NPSM Postprocessor: Open the NPSM Postprocessor and import the data using the USGS Flow Data button. The Postprocessor assumes the data is flow data since it uses the USGS format and cgi extension; the data is actually fecal coliform concentration in units of #/100ml. You can enter the water quality standard as a threshold value. If using the 30-day geometric mean standard, enter geometric mean for *Statistical Method* and 30 for *Step*; this re-plots the data as a running 30-day geometric mean.

QA/QC note: Bacteria measurements were collected by or for the State of Idaho and were reviewed by the Idaho Division Environmental Quality (IDEQ). Bacteria samples were collected as grab samples using sterilized 200 ml bottles from each of the seven water quality monitoring stations in the watershed. Standard laboratory methods were used for the bacteria analysis and all analyses were performed in certified laboratories using the *Membrane Filter Technique*.

Certified laboratories used in the water quality monitoring project included:

- Antatek Labs, Inc, Moscow, Idaho
- Analytical Sciences Laboratory, Moscow, Idaho
- AAA Superior Laboratory, Cheney, Washington
- Confluence Water Laboratory, Lewiston, Idaho

Six percent of the samples (ten of the bacteria samples taken between April and June, 1997) were split into duplicate samples and analyzed separately for quality assurance. The difference between split samples ranged from 50-160%, with an average difference of 84% (Gilmore, 1998).

Water quality observation data from BASINS were examined in this project. This data set contains actual water quality observations for a select combination of stations and parameters which are extracted from EPA's STORage and RETRIEVAL (STORET) database. In addition, a direct search of EPA's STORET databases found several dozen water analyses reported for Stockney and Upper Cottonwood Creeks taken between 1973 and 1985. However, the Cottonwood Wastewater Treatment Plant was redesigned in 1995-96 significantly reducing bacteria discharge to Upper Cottonwood Creek. Due to the limited nonpoint source loading data available during this time period, as well as due to the WWTP modifications, none of the early STORET data was

used in this project (USEPA, 1999B).

P. 3-5 - The Cottonwood WWTP flow and bacteria load data can be viewed in the *cot_bac.prj* - final bacteria calibration (baseline) file. If you have BASINS installed on a drive letter other than C:, you'll need to modify this file slightly prior to loading it into the NPSM. Open this file in a text editor with search capabilities (such as Wordpad), search for "C:" and replace the C drive letter with the drive letter to which you have BASINS installed. You'll have to do this twice, once for the *starter.def* file location, and again for the *cotton4.wdm* file location. To view or run this project on your computer, place the file in a new folder named *cotton* in the BASINS\modelout\cotton directory, make sure the *starter.def* file that comes with the BASINS system is in the BASINS\models\NPSM directory, and place the *cotton4.wdm*, *cotton4.inf*, and *cotton4.txt* files in the BASINS\data\met_data directory. Open the file in the NPSM, and click on the Point Source button, then the Loads button, select Cottonwood WWTP from the Discharger Name pull down list, and click the Edit Data button.

QA/QC note: The location of the Cottonwood WWTP was obtained from EPA's Industrial Facilities Discharge (IFD) database in BASINS, as opposed to the PCS coverage. The IFD database, contributed to by a number of organizations including federal, state, and interstate agencies, was designed and implemented in late 1970s to provide a comprehensive database of industrial and municipal point source surface water dischargers in the United States and includes the Permit Compliance System (PCS) (USEPA, 1998).

Discharge data for the Cottonwood WWTP was provided by the Cottonwood City Clerk. The record covered the period of discharge from November, 1996 to March, 1999. The raw WWTP data provided a running total from which a daily flow in millions of gallons per day (MGD) had been calculated by the City. A number of simple math errors were discovered in this data and corrected. The daily flow data was then entered into an Excel spreadsheet and converted from MGD to cubic feet per second and reformatted. The final data was provided to the IDEQ for review and then distributed to other Cottonwood TMDL workgroups that needed flow data (Cottonwood, 1999).

Only one other facility is permitted for discharge by EPA's NPDES program in the Cottonwood Creek watershed for discharge; The North Idaho Correctional Institution is permitted for a sewage system. However, the IDEQ reported that the facility discharges to Lawyers Creek, in an adjacent watershed. Since it is not a source of pollution to the Cottonwood Creek watershed, it was not considered further in this project (IDEQ, 1999A).

p. 6-11 (Section 3) - Data from each subsection is contained in or calculated from *append3.XLS*. This file is a beta version of the EPA fecal coliform spreadsheet with some modifications made specifically for this project. The final version of the spreadsheet will be made available on the BASINS web page and in Lotus format as well.

P.12 - You can recreate the Cottonwood BASINS project on your computer, by downloading and extracting the South Fork Clearwater Web Archive Data Files (*17060305_core.exe*, *17060305_dem.exe*, and *17060305_rf3.exe* from www.epa.gov/ost/basins/HUCS/17060305).

Project the data set according to the projection parameters listed on page 16 in order to match the projection of the local data sets.

P.12 - The local land use data is provided in the *landuse* folder of the Spatial Data directory (*cttnland.dbf*; *cttnland.sbn*, *cttnland.sbx*, *cttnland.shp*, and *cttnland.shx*). Add this to your Cottonwood BASINS project as a BASINS land use; The original land use code is *Minor1*; The original description field is *landuse*. You can add the legend created specifically for this project by loading the *cotlegnd.avl* file. To do so, double click on the *cttnland.shp* theme, click the load button, navigate to the *cotlegnd.avl* file location; click ok to load all classes and symbols, then click the Apply button and close the legend editor.

P.13 - The original Idaho DEQ watershed subdelineation is provided in the Delineated Watersheds folder in the Spatial Data directory as files: (*idsheds.dbf*; *idsheds.shp*, and *idsheds.shx*). The modified delineation which uses all seven monitoring stations as pour points is located in the same folder (files *rest2rf3.dbf*; *rest2rf3.sbn*, *rest2rf3.sbx*, *rest2rf3.shp*, and *rest2rf3.shx*). Both data sets can be imported as BASINS watersheds, however, you need to import the modified RF3 theme first (see next item). When importing the watersheds, select *Reach File, version 3*, then *Reach File, V3, rf3ct_rf*. Watershed delineation is discussed in more detail on page 23 of the modeling report.

Additional Spatial Data Coverages:

- The bacteria monitoring stations coverage (*idstations.dbf*, *idstations.shp*, and *idstations.shx*) is located in the Spatial Data directory and can be added as an *Other* theme. Coordinate information for the location of the bacteria sampling stations and gaging stations were provided by the IDEQ. Locations were derived from USGS 7 ½ minute topographic maps.
- The Nez Perce Reservation boundary files (*nezperce.dbf*, *nezperce.shp*, and *nezperce.shx*) are located in the Spatial Data directory and can be added as an *Other* theme.
- The Cottonwood WWTP location files (*ptctwwtp.dbf*, *ptctwwtp.shp*, and *ptctwwtp.shx*) are also located in the Spatial Data directory and can be added as an *Other* theme.

P. 13 - The modified RF3 coverage is located in the RF3 folder in the Spatial Data directory (files *rf3ct_rd.dbf*, *rf3ct_rd.sbn*, *rf3ct_rd.sbx*, *rf3ct_rd.shp*, and *rf3ct_rd.shx*). The original RF3 coverage was modified to union separate segments and include the *Level* field as required for watershed delineation with Pacific Northwest RF3 data (see page 7.1-9 in the BASINS User Manual). It contains only the RF3 segments relevant to the Cottonwood project (i.e. is clipped to the area of interest). Add this theme as a *BASINS Reach File, V3* theme.

p.13 - Calculations of the hydrologic function table (Ftable) values for each reach segment in the Cottonwood Creek watershed model are shown in the lotus spreadsheets in the *Ftables* directory. These calculations are described in more detail on page 22 of the modeling report.

P. 23-24 - The NPSM project file *cot_hyd.prj* contains the final hydrology calibration for the detailed Cottonwood Creek watershed model. Follow the directions given for the *cot_bac.prj* file in item **p.3-5**, on where to locate and how to modify (if necessary) the *cot_hyd.prj* file. In the

Output Manager, select the Reaches radio button, select the Lower Cottonwood Creek (009) subwatershed, and select the RO(1)(1) variable, in the RCHRES\HYDR module, for output. This variable is the total outflow from the Lower Cottonwood Creek at the flow gage station (in cfs) and is directly comparable to the data in the *stat7A90-98.cgi* file. You can reproduce *Figure 1. Hydrology Calibration at Lower Cottonwood Creek Gage Station* (on page 19) by plotting RO(1)(1) versus the *stat7A90-98.cgi* flow for the period 10/1/1996 to 5/30/1998. A default data set, created based on the Tualatin River site in the HSPFParm database, is also included (file *tualatn.def*). You can check the performance of the model using this default data set by saving the *cot_hydr.prj* file under a new name and opening that project, then loading the *tualatn.def* file as the new default data file.

QA/QC note: Analysis of the flow data by Jim Fitzgerald, EPA Region 10, concluded that high and low flows from the stations were being significantly over and under predicted, respectively. He did find a good correlation between discharge at the mouth of Lower Cottonwood Creek (Station 7) and the USGS gaging station at Lapwai Creek in a nearby watershed. Using this linear relationship, he generated a new set of estimated flow data for 1974 to 1998. This new data set representing only the flow at the mouth of Lower Cottonwood Creek was the basis for which NPSM was calibrated and modeled. Because of the uncertainty in flow data from the upper monitoring stations, they were not used in the analysis (Carol Fox, IDEQ; Jim Fitzgerald, USEPA, pers com., 1999).

It should also be noted that the BASINS - USGS gaging station database incorrectly lists a station on a tributary of the Upper Cottonwood Creek (USEPA, 1999A). USGS station # 13341000, named the *North Fork Clear Water River*, is not located in this watershed and no information concerning this station was used in this project.

P. 24-26 - The NPSM project file *cot_bac.prj* contains the final bacteria calibration for the detailed Cottonwood Creek watershed model. Again, to load this file on the NPSM follow the directions for changing the drive letter (if necessary) and place the file in the appropriate directory as described previously (item *p. 3-5*). You can reproduce *Figure 2. Fecal Coliform Calibration for Lower Cottonwood Creek* by comparing model output and measurement data for Lower Cottonwood Creek. In the Output Manager, select the DQAL variable (in RCHRES/GQUAL for the Lower Cottonwood Creek [009] subwatershed). Run the model and compare the DQAL output against the *stat7fc.cgi* bacteria concentration data (input it as a USGS file, flow parameter) in the NPSM Postprocessor. The *append3.XLS* file is the Excel spreadsheet used to calculate many of the numerous input parameters related to the bacteria calibration. The last sheet in this worksheet (PRJ Formatted Input) is how the MON-ACCUM (monthly accumulation rate) and MON-SQOLIM (monthly limiting storage) variables are transferred from the spreadsheet to the NPSM. This sheet is saved as a text file and the text file is opened in Wordpad. The entire contents of the text file are copied to the buffer. Then the prj file is opened in a text editor (Wordpad) and the buffer is copied to the appropriate location in the prj file.

P. 30 - You can reproduce the values in the *Manure Application, Grazing Cattle* column of *Table*

7. *Stream Loading by Source (Billions fecal coliform per year [Bfc/year])* by outputting SOQO for each subwatershed. In the Output Manager, select the SOQO variable (PERLND/PQUAL) for the All Pervious landuse for each subwatershed. After running the model, plot the variable, for a one year period, in the NPSM Postprocessor and check the area under the curve. Other values in Table 7 can be calculated, by hand or with a spreadsheet, from the data in the Point Sources Pollutant Information screen of the NPSM.

p. 31 - The percent reduction and *Load to Achieve WQ Std.* (or *Load Allocation*) were generated by iteratively modifying and running the uci file for the final bacteria calibration until the water quality standard was met for each reach segment. The multiplication factor values in the NETWORK block for POQUAL, (original values are the area of the land segment in acres) are modified in the *cttn47d.uci* by multiplying the original values by (1-% reduction). Place this file in the BASINS\modelout\cotton directory (make sure there is a *Reaches* subdirectory). If BASINS is loaded on a drive other than C:, open the file in a text editor and modify the file paths in the *FILES* block to reflect the correct drive letter. Run the file through HSPF in dos mode using the following command from the Start\Run menu: *C:\Basins\models\Npsm\XNPSM11x.exe C:\Basins\modelout\cotton\cttn47d.uci*. Check the output for each reach against the water quality standard applicable to that reach.

P. 32-33 - The control scenarios were designed more for purposes of diagnosing the loading problem as opposed to creating realistic potential controls. Once the effect of different source categories is understood, the stakeholders can decide on an effective control strategy - by proposing realistic controls that can be modeled to examine the actual impact in the model. The controls on wading cattle, septic systems, and the WWTP were simulated by applying a multiplier in the Point Source Editor, *Flow and Load Multiplier Screen*. Other scenarios (e.g. zero hog manure) were re-created by modifying the fecal coliform spreadsheet, and copying the results to the prj as described previously (item **p. 24-26**). Open and run the NPSM project files, corresponding with the scenarios listed in the File Index. Again, each project file will need to be modified if BASINS is loaded on a drive other than C:.

File Index

Bacteria Data (Fecal coliform sample results):

stat1fc.cgi - Stockney Creek;
stat2fc.cgi - Upper Cottonwood Creek;
stat3fc.cgi - Shebang Creek;
stat4fc.cgi - South Fork Cottonwood Creek;
stat5fc.cgi - Long Haul Creek;
stat6fc.cgi - Red Rock Creek; and
stat7fc.cgi - Lower Cottonwood Creek.

Control Scenarios (NPSM project files)

cotton48.prj - Scenario A;
cotton50.prj - Scenario B;
cotton53.prj - Scenario C;
cotton55.prj - Scenario D;
cotton57.prj - Scenario E; and
cotton58.prj - Scenario F.

Ftables (Hydrologic Function Tables)

Long_Haul.123;
Lower_Cottonwood.123;
Middle_Cottonwood.123;
Middle_Cottonwood_2.123;
Red_Rock.123;
Red_Rock_2.123;
S_Fork_Cottonwood.123;
S_Fork_Cottonwood_2.123;
Shebang.123;
Stockney.123;
Upper_Cottonwood.123;
Upper_Cottonwood_2.123; and
Upper_Cottonwood_3.123.

Spatial Data (Specific to Cottonwood Creek Watershed):

Delineated Watersheds

(Original watershed delineations provided by IDEQ)

idsheds.dbf;
idsheds.shp; and
idsheds.shx.

(Modified delineation corresponding with monitoring stations as pour points)

rest2rf3.dbf;
rest2rf3.sbn;
rest2rf3.sbx;
rest2rf3.shp; and
rest2rf3.shx.

Landuse

(Legend for local Cottonwood land use data)

cotlegnd.avl.

(Local Cottonwood land use data)

cttnland.dbf;

cttnland.sbn;

cttnland.sbx;

cttnland.shp; and

cttnland.shx.

Rf3 (Modified RF3 as required for subwatershed delineation)

rf3ct_rd.dbf;

rf3ct_rd.sbn;

rf3ct_rd.sbx;

rf3ct_rd.shp; and

rf3ct_rd.shx.

(Cottonwood monitoring stations)

idstations.dbf;

idstations.shp; and

idstations.shx.

(Nez Perce Reservation boundary)

nezperce.dbf;

nezperce.shp; and

nezperce.shx.

(Cottonwood WWTP)

ptctwwtp.dbf;

ptctwwtp.shp; and

ptctwwtp.shx.

Weather Data (Site Specific Cottonwood WDM Data; place in BASINS\data\met_data)

cotton4.inf;

cotton4.sta; and

cotton4.wdm.

(South Fork Clearwater Watershed Web Archive Data Files)

17060305_core.exe;

17060305_dem.exe; and

17060305_rf3.exe.

append3.XLS - fecal coliform spreadsheet (beta) with project specific modifications.

cot_bac.prj - final bacteria calibration (baseline).

cot_hyd.prj - final hydrology calibration with full reach network.

Cottonwood_modeling_report.pdf - *Fecal Coliform TMDL Modeling Report for Cottonwood Creek Watershed, Idaho County, Idaho*, as submitted to Idaho DEQ

cttn47d.uci - modified uci file used in dos-only run for final percent tributary load reductions.

stat7A90-98.cgi - adjusted flow data from Lower Cottonwood Creek gage station.

tualatn.def - default data file that matches the HSPFParm Tualatin River project.

References

Carol Fox, IDEQ; Jim Fitzgerald, USEPA, pers com., 1999. Regarding quality of flow data for seven monitoring stations in Cottonwood Creek watershed.

Cottonwood, 1999. Unpublished flow data from City of Cottonwood Wastewater Treatment Plant for the period of November, 1996 to March, 1999, Cottonwood, Idaho.

Gilmore, Shelly 1998. *Cottonwood Creek Monitoring Program, Final Report*, Resource Planning Unlimited, Moscow, Idaho.

IDEQ, 1999A. Idaho Division of Environmental Quality. *Cottonwood Creek TMDL*, Unpublished draft April 30, 1999. Compiled by IDEQ-LRO. Lewiston, ID.

USEPA, 1998. Meta Data for EPA/OW Industrial Facilities Database (IFD) for CONUS. On the web at: <http://www.epa.gov/ost/basins/metadata/ifd.htm>.

USEPA, 1999A. BASINS Version 2.0 - Region 10. January, 1999. EPA-823-C-98-012. USEPA, Office of Water, Washington, D.C.

USEPA, 1999B. STorage and RETrieval (STORET) database. Water Quality report for Cottonwood Creek watershed, Idaho. Washington, D.C.