A GIS Based

Watershed Analysis System

for Tillamook Bay, Oregon

by

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Dedicated to Mom and Dad

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ABSTRACT

The goal of this research is to develop a GIS based watershed scale water quality model of the Tillamook Bay watershed on the coast of Oregon that can be used as a decision support system. A method is developed using a Geographic Information Systems (GIS) platform, specifically Arc/Info and ArcView. A 100 foot grid digital elevation model is used to establish connectivity within the watershed. Raster maps of runoff and baseflow are determined from a raster map of annual precipitation. Non-point source loads of bacteria and sediment are determined for each grid cell as the product of discharge and expected mean concentration (EMC). EMC values are based on land use. These non-point loads are accumulated down to the bay segments. Point source loads from wastewater treatment plant effluent have been included in the model. Implementation of Best Management Practices (BMPs) result in load reductions on a per cell basis. These reductions are based on user input data related to BMP effectiveness and level of implementation. Predicted concentration grids are calculated based on accumulated loads and flows. Tools are available to determine: (1) loads, flows, and resultant concentrations at points of interest, (2) percent reduction of load to each bay segment as a result of BMP implementation, and (3) constituent concentration profiles along the length of a river. Predicted flows and concentrations reasonably match values reported in earlier studies. Model results indicate that the majority of the bacteria load comes from dairy lands, and sediment loads appear to be strongly linked to channel erosion processes, particularly in the lowland river reaches.

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1 INTRODUCTION

1.1 Background

The Environmental Protection Agency (EPA) established the National Estuary Program through the Federal Water Quality Act of 1987 to identify and protect significant estuaries in our nation. The Tillamook Bay National Estuary Project (TBNEP), nominated by Oregon's Governor Roberts and accepted into the program in 1994, is one of 28 estuaries included in the program.

The TBNEP is addressing several water quality and environmental problems in the watershed, and this study focuses on modeling the mass of constituents of concern being delivered to the bay, often referred to as the loading to the bay. The two constituents of interest are bacteria and sediment. The bacteria is represented by concentrations of fecal coliform (FC); sediment is represented by concentrations of total suspended solids (TSS). The TBNEP Environmental Characterization (TBNEP, 1998a) concluded that logging, dairy farming, and urbanization have contributed to increases in bacteria and sediment loads to the watershed and the bay, and that the increase in these loads have impacted habitat for many fish and shellfish species.

Bacteria contamination is the water quality parameter identified as the highest priority problem by the National Estuary Project. Bacterial concentrations historically have been high during the wet seasons, thus oyster growing is limited to specified areas of the bay, and harvesting is often closed due to high bacteria levels. Studies by the TBNEP indicate that sources of bacteria load include wastewater treatment plants, onsite septic systems, and dairy operations, as well as input from animals and other wildlife.

Five species of anadromous salmonids use the estuary and it's rivers during their life cycle. The basin has experienced loss of spawning and rearing habitat for these species as a result of increased sediment loading. Sedimentation has also changed the bay bathymetry, and thus the ecosystem and habitat for the creatures it supports. While forested lands are believed to be the primary source for sediment, approximately 15% of the total annual sediment load is believed to be related to agricultural lands (TBNEP, 1998a).

Best Management Practices (BMPs) exist to reduce bacteria and sediment loading in the watershed, and, many of them are being implemented in the basin. Dairy farms have installed additional manure storage, have adopted land application practices that reduce surface runoff contamination, and have installed structures to divert stormwater runoff away from manure storage areas. River bank stabilization, including installation of fencing and riparian vegetation, and the preservation of large woody debris in the channel, will reduce bank erosion and sediment loads in the watershed. With limited funding, the resource managers for the area desire a scientifically based tool to help focus implementation efforts. That desire is the impetus for this work.

1.2 Study Objective

The objective of this study is to develop a watershed analysis and decision support system for the watershed that will assist resource managers in allocating limited funding for the implementation of BMPs. This analysis and support system takes the form of a computer model developed in a Geographic Information Systems (GIS) framework, specifically the Arc/Info and ArcView platforms developed by ESRI. The study objective is comprised of seven tasks:

- **Construct a digital database of the region**. Use available 30 meter Digital Elevation Model (DEM) and the USGS Digital Line Graphs to delineate stream networks in the terrain. Compare digital data with existing aerial photos to validate accuracy.
- **Simulate hydrology over terrain surface.** Model water flow through individual cells based on elevation and flow characteristics. Compare existing precipitation data with stream discharge and develop a relationship between rainfall and runoff. Distinguish hydrology between surface runoff and baseflow components.
- **Calculate water mass balances.** Based on weighted flow accumulations and physical characteristics of five rivers and the receiving estuary, determine expected average water balances throughout the entire drainage area. Compare estimates with data from existing gauges.
- **Develop average pollutant concentrations for different land uses.** Based on existing data, literature values, and ongoing TBNEP monitoring, establish Event Mean Concentrations (EMCs) of bacteria and sediment for specific land uses and/or land use practices.

- **Estimate average pollutant loads.** Based on the product of spatially distributed EMCs and accumulated runoff in each grid cell, calculate average pollutant loads in each of five river basins. Estimate annual and seasonal loads, and if possible outline a technique to represent episodic storm runoff events.
- **Predict and compare pollutant values.** Calculate bacteria and sediment concentrations at various locations within the basin and compare them with sampled values at the same locations.
- **Estimate load reductions associated with BMPS.** Develop GIS coverages of relevant BMPs and assign load reductions based on available field data and/or literature values. Compare the overall effectiveness of various management plans based on estimated efficiencies and extent of BMP implementation.

1.3 Study Area

Tillamook Bay is a drowned river estuary which lies on the coast of Oregon about 60 miles west of Portland. The study area can be seen in Figure 1-1. The bay is fed by five rivers, the Miami, the Kilchis, the Wilson, the Trask, and the Tillamook, and their tributaries. The bay and its rivers are recognized as some of the Pacific Coast's most productive fishing spots for chinook, chum, coho, and steelhead (TBNEP, 1998a). Tillamook Bay is approximately 6.2 miles long and 2.1 miles wide, averages 6.6 feet deep and covers 8,400 acres. The bay experiences strong diurnal tides, exposing approximately half of the bay area as mudflats during low tide, and supports a very active shellfish harvesting industry. The watershed includes about 358,450 acres, with approximately 89% of the watershed covered by coniferous forests. The remaining lowland area is comprised of rich alluvial plains which support an active dairy industry that produces almost all of Oregon's cheese (TBNEP, 1998a). The area's mean annual precipitation ranges from about 80 inches per year in the lowlands to about 140 inches per year at higher elevations.

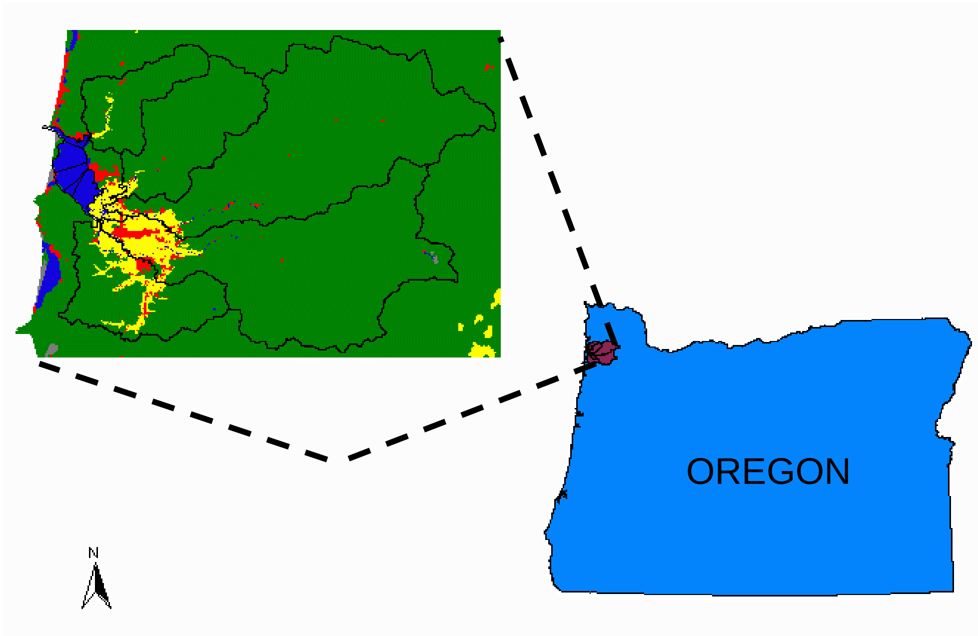


Figure 1-1. Tillamook Bay Study Area

1.4 Report Outline

This report is divided into 5 sections. This first section introduces the study, and the second section presents a review of related literature. The third section covers the methodology of model development and how the model is used, while the fourth section presents and discusses the model results and compares them to reported values from earlier studies. The fifth section presents conclusions of the study and recommendations for further model development that might be completed as more data becomes available. There are four appendices that include additional data. Appendix A presents various FORTRAN, Arc Macro Language (AML), and avenue script subroutines used in the study. Appendix B presents a users guide for the ArcView models developed as part of this study, while Appendix C presents a tutorial for model users. Appendix D contains the metadata for the GIS data layers created as part of this project.

2 LITERATURE REVIEW

Over the years, many models have been developed to help agencies assess and control the quality of our nation's water bodies. Water quality simulation models have been developed by government agencies, academic institutions, and consulting firms. Because end-of-pipe point sources are largely controlled and are highly regulated, more and more focus is being placed on non-point sources which make up a significant portion of pollution in natural waters. There are a large group of non-point source models that have been developed to address water quality concerns. These models are written in standard FORTRAN77 and are executable in the MS-DOS environment. Some of these models have been updated to include a Windows user interface. One of the potential drawbacks to using these models can be the need for very large input data sets. Conversely, spatial averaging can be assumed to decrease the amount of required input data at the potential expense of output accuracy. Some detail on these models is presented briefly.

Geographic Information Systems are becoming more useful in modeling water quality because they can incorporate spatially varying data. There are many instances where GIS have been incorporated into modeling efforts, and two basic ways that they have been used are: (1) as a method for deriving input for external models, and (2) as a stand-alone model. Since water quality is integrally related to water quantity, some hydrology models will also be mentioned in the review.

2.1 Non-point Source Models

Novotny (1995) provides a concise overview of many of these non-point source models. In discussing the fundamentals of modeling, Novotny stresses three key points: (1) use the simplest model that will satisfy the project objectives, (2) use a quality prediction model consistent with available data, and (3) only predict the quality parameters of interest and only over a suitable time scale.

2.1.1 *HSPF*

The Hydrologic Simulation Program –FORTRAN (HSPF) is a one dimensional stream network model representing the contribution of sediment, pesticides, and nutrients from agricultural areas and the resulting water quality conditions at the watershed scale (Novotny, 1995). The program was developed by EPA through the Athens Environmental Research Laboratory and can be down-loaded from the Internet at ftp://ftp.epa.gov/epa_ceam/wwwhtml/softwdos.htm.

HSPF considers surface runoff and interflow, as well as baseflow and links contributions from these components to an instream water quality model. The model also accounts for fate and transport of nutrients and pesticides including both simple relationships (constant concentration) and detailed soil process options (including leaching, sorption, and soil nutrient transformations), as well as instream processes such as dissolved oxygen transformations. The model includes three sediment types - sand, silt, and clay. Calibration requires sampling data for each of the sediment types.

The HSPF model runs in MS-DOS mode and is a continuous simulation model requiring continuous time series data input for weather conditions including precipitation, evapotranspiration, temperature, and solar intensity. For this reason the data requirements are quite extensive. The output is a time history of water quality and quantity in the watershed.

2.1.2 *CREAMS/GLEAMS*

CREAMS is the Chemicals, Runoff, and Erosion from Agricultural Management Systems model developed by the U.S. Department of Agriculture – Agriculture Research Service (USDA-ARS). This model is a field scale model that has submodels for the hydrology, erosion, and chemistry components (Novotny, 1995). The surface runoff component of the hydrology is estimated by the Soil Conservation Service (SCS) curve number method. The motivation for the development of CREAMS was a desire to assess agricultural best management practices for pollution control. CREAMS models only the surface runoff contribution; it does not address baseflow. Novotny (1995) notes that

CREAMS provides accurate representation of various soil processes. Management practices that can be modeled include aerial spraying or soil incorporation of pesticides, animal waste management, and tillage/terracing. GLEAMS is the Groundwater Loading Effects of Agricultural Management Systems model, also developed by USDA-ARS, and represents the vadose zone component of the CREAMS model, incorporating a vertical flux component for pesticides.

2.1.3 ANSWERS

ANSWERS is the Areal Nonpoint Source Watershed Environment Response Simulation and was developed by Beasley and Huggins of Purdue University (Novotny, 1995). ANSWERS utilizes the GIS raster data concept of dividing the surface into grid cells small enough so that parameters within the cell boundaries are uniform. Each discrete cell requires input data for precipitation, antecedent soil moisture, and soil and crop characteristcs. Depending on the grid size, this could be a sizable amount of input data. For each element, the model simulates the various hydrologic processes and sediment detachment/transport/deposition, routing the output for each cell downstream based on a user specified drainage network. Nutrients are simulated via correlations between chemical concentrations, sediment yield, and runoff volume.

2.1.4 AGNPS

The Agricultural Nonpoint Source (AGNPS) model is the result of efforts to modify CREAMS to simulate complex watersheds with varying soils, land use, and management and is supported by the USDA-ARS (Texas A&M Blackland Research Center, 1999). The emphasis of the model is on nutrients and sediment, and it allows for comparison of various control practices implemented in the watershed. As with ANSWERS, AGNPS uses a distributed approach dividing the watershed into grid cells with computations done at the cell level (Novotny, 1995). Model results for runoff, sediment, and nutrients are routed from cell to cell in the downstream direction to the watershed outlet. AGNPS uses the SCS curve number approach and unit hydrograph routing procedures to determine runoff. The Modified Universal Soil Loss Equation

(MUSLE) and relationships between chemical concentration, sediment yield, and runoff volume are applied to determine sediment and nutrient loadings. AGNPS does have the ability to handle point source inputs.

Data required for the model fall into two groups – watershed data and cell data. Watershed data consists of the watershed size, the number of grid cells in the watershed, and the storm intensity. Cell data consists of 21 different parameters, including physical information and land practice information. Because each cell must have data input for all required parameters, input files are often very large and time-consuming to assemble.

2.1.5 SWRRB

The Simulator for Water Resources in Rural Basins (SWRRB) operates on a daily time step, simulating weather, hydrology, crop growth, sedimentation, and nitrogen/phosphorous/pesticide movement (Novotny, 1995). This model is a modification of the CREAMS model to allow for application to large, complex basins, including channel processes and subsurface flow components. The SCS curve number technique and the MUSLE are used to calculate surface runoff and sediment yield, respectively. The sediment routing model accounts for deposition as well as degradation. The pollutant transport model is comprised of two sub-routines, one to address soluble contaminant and another to address contaminants attached to sediment. The pesticide component is a modification of the CREAMS pesticide model to include an application efficiency factor, as well as pesticide washoff and decay.

2.2 Deriving Input for External Models

2.2.1 BASINS

The BASINS model – Better Assessment Science Integrating Point and Nonpoint Sources – was originally released by the US EPA in September 1996 (US EPA, 1999). This system integrates a GIS with national watershed data and several environmental assessment and modeling tools into one program. BASINS allows for water quality assessment at selected stream sites or for an entire watershed. BASINS consists of five categories of integrated components:

- A variety of national databases
- Several built-in assessment tools for evaluating water quality and point source loadings
- Built-in utilities including data import, land use and DEM reclassification, watershed delineation, and management of water quality observation data
- Watershed and water quality models including a Non-Point Source Model linked to HSPF, TOXIROUTE, and QUAL2E
- Post processing output tools for interpreting model results.

All of these components are housed and integrated within the ArcView GIS environment. BASINS and its data sets can be downloaded over the Internet (US EPA, 1999). Spatially distributed data available includes land use/land cover, reach files, soils data, DEMs, and USGS hydrologic unit boundaries. Environmental monitoring data available includes water quality observation data, weather station sites, and USGS gaging stations. Point source data that is available includes industrial facility discharge sites, Superfund and RCRA sites, and toxic release inventory sites.

The program allows the user to select a watershed of interest, calculate non-point source loads in that watershed, and integrate that information into various assessment tools. The BASINS non-point source model (NPSM) is based on land use data and is linked to HSPF by a windows-based interface through ArcView. The output from NPSM can be entered into the TOXIROUTE or QUAL2E models which are called from the BASINS program, but run within their own interfaces. TOXIROUTE is a screening-level stream routing model that does simple dilution/decay calculations under mean conditions for the watershed of interest. QUAL2E is a one-dimensional, steady-state stream water quality and eutrophication model, allowing for fate and transport modeling for point and non-point source loadings. Output from either model can be post-processed back to ArcView for viewing or further assessment.

2.2.2 Input to AGNPS

The AGNPS model is a very popular model for analyzing non-point sources from agricultural land use practices. However, assembly of input files can be quite time-consuming, particularly in large watersheds with high spatial variability in input parameters. Several studies have used GIS to effectively and efficiently develop the majority of the input data.

A study of the Allerton watersheds in East Central Illinois integrated the AGNPS model with the Geographic Resources Analysis Support System (GRASS) GIS to assist in the management of runoff and erosion in these agricultural watersheds (Mitchell et al, 1993). This study used four GIS layers (watershed boundaries, field boundaries, DEM, and soils data) to derive all 22 required input parameters for the AGNPS model. The parameters were obtained using GRASS routines or by reclassifying one or more of the input data layers. Fifty storm events were monitored with half of the data sets used for parameter calibration. These calibrated parameters were used as input for the other 25 events to obtain runoff and sediment yield data which was used to evaluate the suitability of AGNPS for predicting runoff and sediment yield from these relatively small watersheds. Paired comparison of the validation events indicates that the GRASS-GIS link to AGNPS provides an acceptable simulation of runoff and sediment yield from the study watersheds. The GIS link was deemed to have significantly enhanced model effectiveness.

2.2.3 Input to HEC-HMS

The research group at the Center for Research in Water Resources at the University of Texas has developed an ArcView project to pre-process various digital spatial data sets to derive an input file for the Corps of Engineers Hydrologic Modeling System (HMS) developed by the Hydrologic Engineering Center. The HMS model provides several options for simulating precipitation-runoff processes. The HMS model recently added capabilities for continuous hydrograph simulation over long periods of time, and spatially distributed runoff computation using a grid-cell depiction of the watershed (US Army Corps of Engineers, Hydrologic Engineering Center, 1998). Sub-basins are identified and connected in a dendritic network, and computations are executed in an upstream-downstream sequence. Hydrographs can be examined at any point in the watershed, as well as at the outlet. Runoff can be computed using lumped parameters which are spatially averaged over a sub-basin or in a spatially distributed mode with rainfall being specified on a gridded basis. The model accounts for losses, provides several methods for runoff transformation as well as routing, and can account for diversions within the watershed.

2.2.4 SWAT

The Soil and Water Assessment Tool (SWAT) is another product of the USDA-ARS (Texas A&M Blackland Research Center, 1999). This model is a continuous time model that operates on a daily time step. The SWAT model is an outgrowth of the SWRRB model. SWAT allows a basin to be divided into hundreds of sub-watersheds and allows for analysis of long-term impacts of management (i.e., over many years) as well as timing of agricultural practices within the calendar year (i.e., crop rotations, irrigation or fertilizer application rates and timing) to maximize operations. The SWAT model includes commands to transfer water from any reach or reservoir to any other reach or reservoir in the basin. The user can specify flow diversions or apply water directly to a sub-basin for irrigation.

A GIS interface was developed to facilitate the use of digital spatial data. The SWAT interface was developed using the US Army Corps of Engineers Graphical Resources Analysis Support System (GRASS) and uses gridded DEM data, polygon coverages of soils and land cover, and point coverages of weather stations as basic input to the model. The interface software creates a sub-basin description combining soils and land cover data with the sub-basin coverage which is then queried to create the input files required by SWAT. The interface also allows for output data to be viewed and analyzed in ArcView as needed.

2.3 GIS Stand-Alone Models

Many National Estuary Project offices have developed stand-alone GIS models to help manage non-point source pollution in the watershed. Like the TBNEP, the Galveston Bay NEP, and the Corpus Christi Bay NEP are integrating GIS into their management efforts. The City of Austin, Texas has also developed a GIS model to assist in development of a water quality master plan.

Most studies using GIS to assess non-point source water quality issues have focused on sediment or nutrients. Very few GIS models have addressed bacterial contamination, a primary concern in the Tillamook Bay watershed.

2.3.1 Galveston Bay NEP

The Galveston Bay NEP developed a GIS model that helped to map geographic characteristics, analyze land use data, and complete non-point source load calculations (Rifai et al, 1993). The four basic data elements used included: (1) the area's USGS DEM, (2) digitized sub-watershed boundaries, (3) Soil Conservation Service (SCS) soil types data, and (4) land use data obtained from LANDSAT satellite imagery. A runoff model was developed in Arc/Info to calculate runoff for sub-watersheds using the SCS method. The SCS method uses the amount of precipitation and a Curve Number (CN) derived from soils data to determine depth of runoff. Loads were calculated in the GIS model based on runoff volume and typical concentration of water-quality constituents in runoff. Annual loads from sub-watersheds were summed to get the total annual load for the watershed.

2.3.2 Corpus Christi Bay NEP

The Corpus Christi Bay model incorporates point, non-point, and atmospheric pollutant loads into a receiving water body model and employs a grid to assign various properties to each grid cell (Quenzer et al, 1998). The watershed connectivity is based on the DEM, and loads are calculated as the product of flow and average concentration in runoff, referred to as EMCs, or Estimated Mean Concentration. Precipitation-runoff equations were based not only on average rainfall and discharge values, but also on the land use, and used a grid of average annual precipitation for the study area to calculate runoff; separation of baseflow was not considered in this study. The Corpus Christi study calculated loads to the bay for metals and nutrients. The study also quantified relative contribution from point, non-point, and atmospheric sources.

The bay was divided into segments, and salinity data was used to determine dispersion between segments. The predicted annual loads were used in a bay water quality model that accounts for dispersion, advection, and first order decay. The bay model predicted nutrients accurately, but under-predicted metals concentrations. This suggests that there is a source of metals to the bay that is not currently reflected in the model.

2.3.3 City of Austin

The City of Austin is using a non-point source pollution model that allows for computation of current pollution loads, computation of future loads based on increased urbanization, and incorporates the effects of best management practices (Dartiguenave, 1997). This model focuses on urban related water quality impacts. The DEM is used to delineate the stream network and sub-watersheds, and the two basic GIS data input elements for the model are precipitation and land use.

An average precipitation value is applied uniformly over the entire study area. The model considers surface runoff as well as baseflow in calculating water quality loads. Runoff and baseflow discharge coefficients (representing the fraction of precipitation that becomes discharge in one of the two forms) are a function of impervious cover which is related to land use. Discharges are calculated on a per cell basis and then accumulated in the downstream direction.

Loads are divided into a land component and an in-stream channel component. The land load is calculated based on average concentrations in runoff and baseflow. Runoff values in most cases are related to impervious cover. The instream channel load is based on the difference between predicted and observed load values and stream length and is related, again, to impervious cover. The effects of structural BMPs such as sand filters or sedimentation ponds are accounted for in this model.

2.4 Previous Studies in Tillamook Bay

There have been a number of studies conducted for the Tillamook Bay watershed to assess bacteria and sediment loadings. These studies have focused on using sampling data to determine relative ranking of watersheds based on contribution to total load, determine sources of bacteria and sediment loads, quantify those loads, and describe effects of those loads. None of the studies to date have addressed the potential quantitative effects of BMP implementation.

2.4.1 1982 Jackson and Glendening Report

The 1982 Fecal Source Summary Report (Jackson and Glendening, 1982) concluded:

- Most of the bacteria loading to the bay comes from the Wilson, Trask, and Tillamook River basins.
- Sewage treatment plants have the potential, when they malfunction, to contribute to the bacteria load.
- Dairy operations contribute to the bacteria load when it rains if manure is allowed to run into streams or if manure is inadvertently applied to the streams during application.
- A significant portion of bacterial contamination appears to come from barnyards adjacent to creeks.
- Cattle access to streams seems to be a significant contributor to bacteria load.
- Inadequate on-site sewage disposal systems contribute to the bacteria load when it rains
- Other sources, such as wildlife, recreations, forestry activities, and industry are not significant contributors to the bacteria load to the bay.
- Minimal bacteria contamination is occurring above the forest-ag interface of the watershed.
- The study quantified bacteria loads to the bay for 4 individual storms.

While this study was able to identify sources of bacteria load and, in some cases, the relative contribution to the load, it did not quantify contributions.

2.4.2 1997 Tillamook Bay Watershed Assessment – Draft Report

The 1997 Watershed Assessment conducted by the Oregon Department of Environmental Quality (ODEQ) focused on two sampling events during spring storms. The study concluded that while point sources contribute less than one percent of the sediment load for most of the year, the City of Tillamook and the Creamery treatment plants contribute a more substantial percent of the load to the Trask and Wilson Rivers respectively during the summer months (ODEQ, 1997). This study also identified that biosolids application and lumber yard activities warrant further investigation as possible significant contributors to both bacteria and sediment loads.

2.4.3 Tillamook Bay Environmental Characterization

The 1998 Environmental Characterization summarizes several different trend analyses that have been conducted to determine if bacteria concentrations have decreased over time, presumably in conjunction with the implementation of BMPs. These trend analyses indicate that reductions are being realized in the watershed (TBNEP, 1998a), however, they do not provide quantification of the reductions or association with particular BMPs.

While other reports and studies have focused on determining the sources of bacteria contamination, this report also presents information on the sources of sediment load in the watershed. The two principle sources of sediment are mass wasting, commonly referred to as landslides, and surface erosion (TBNEP, 1998a). Mass wasting is believed to represent a larger percentage of the sediment load. Rates of sediment production are not known and are difficult to establish, and any established rate would only apply to the site where it was established. A 1978 USDA study concluded that about 85 percent of the sediment produced in the watershed came from forested areas, while lowland areas contributed about 15 percent, mostly through streambank erosion.

2.4.4 E&S Environmental Chemistry, Inc. Water Quality Monitoring

During 1997 and 1998, E&S Environmental Chemistry, Inc. conducted monitoring for fecal coliform bacteria and total suspended solids along with other parameters to provide information needed to design a water quality monitoring program and to prepare the Comprehensive Conservation and Management Plan for the watershed (E&S Environmental Chemistry, Inc., 1998). The sampling program revealed that both bacteria and sediment concentrations show seasonal and episodic variability, with peak concentrations of bacteria occurring during fall and summer storms and peak concentrations of sediment occurring during events with very high flow rates, particularly in the Wilson and Trask rivers, the two largest drainage basins. The largest bacteria loads are from the Trask River, followed by the Wilson and then the Tillamook, while the largest sediment loads come from the Trask River, followed by the Wilson River (Sullivan et al, 1998b). While this study did not quantify water quality from different land uses, the storm sampling results suggest that the largest bacteria contributions occurred in areas associated with human habitation.

2.5 Summary

As this review of the literature has shown, there are many nonpoint source pollution models available. However, most of the models presently available focus on sediment yield and/or chemical constituents, such as nutrients or pesticides. By far, the largest concern for the TBNEP is bacterial contamination, although sediment is also a serious concern. None of the existing models seemed to be an ideal fit. For this reason, a stand-alone GIS model was developed. In addition, there were specific BMPs dealing with manure management that the TBNEP was interested in considering in the model. This study demonstrates:

- Methods for obtaining or creating the required data layers for such a modeling effort
- A spatially specific method of determining loads using a fine grid mesh
- A method for modeling surface runoff and baseflow based on linear regression of precipitation and measured discharge.
- An initial lumped parameter method for accounting for effects of dairy related BMPs.
- A method for quantification of load contribution from sub-watersheds and from different land uses
- A method for calculating predicted concentrations throughout the watershed and comparing those predicted concentration profiles with monitoring data.

3 METHODOLOGY

The water quality model developed for this project is based on a fundamental concept of water quality modeling and control, specifically, that pollutant load is equal to the product of concentration and flow (Thomann and Mueller, 1987). In order to study these loads and begin to address questions of control, the magnitude and location of contaminant loads must be determined. To this end, a model is developed in a GIS based platform. The power of GIS lies in their ability to effectively represent spatial distribution of a variety of system parameters.

This study considers mean annual flow conditions at steady state. Loads are derived from non-point sources in the contributing watersheds, and point sources from wastewater treatment. Other types of point sources can be included if necessary.

Because non-point source loads vary according to many factors affecting the quality of stormwater runoff, a Geographic Information System (GIS), designed to store and analyze spatially distributed data, is the platform for the loadings model; specifically, Arc/Info and ArcView were utilized for this effort. The land surface is divided into equally-sized cells by overlaying a 100 foot grid, and each cell is assigned a value for various parameters such as elevation, land use, and mean annual precipitation.

This system will serve as a tool to assist the TBNEP and local resource managers in developing effective management plans, including level of implementation of various Best Management Practices (BMPs), for the bay and its contributing watershed. The developed model allows for the synthesis of existing data to predict future-scenario constituent loads.

The ArcView project presented in this section calculates non-point and point source loadings for the Tillamook Bay National Estuary Project study area. Three project files were created as part of this study effort:

- (1) hydrology.apr – allows for the delineation of watersheds and associated stream networks.
- (2) bactimodel.apr - allows for determination of bacteria loads in the watershed
- (3) sedimodel.apr - allows for determination of sediment loads in the watershed.

The bactimodel and sedimodel project files include scripts for: (1) calculating surface runoff and baseflow on a per cell basis, (2) setting default values for surface runoff and baseflow water quality, (3) calculating loads in the five major watersheds as well as to the bay, and (4) accounting for reduction in loads realized from implementation of Best Management Practices (BMPs).

It is important to set or check the Analysis Properties (Extent and Cell size) prior to running any script. For consistency, both the extent and cell size are set to the same as the DEM or flow direction grid in use. It is also important to set the working directory when using the ArcView project files. The avenue scripts that are called in the model set a path name to save created data layers and tables; setting the working directory sets that path.

Throughout this section, reference is made to various Arc Macro Language (AML) or avenue scripts. Avenue is the language used to program in ArcView. All scripts used in this project can be found in Appendix A. Execution of many of the scripts requires user input that is obtained via dialog boxes; some boxes have default values that may be used. Example dialog boxes are presented for various sub-routines throughout this section. Reference is made to data layers provided by the TBNEP office on the TBNEP Geographic Information System CDROM (version 2, October 1998 – hereafter referred to as the TB CDROM), as well as data layers that were created as part of this study. All data layers are distinguished by **bold font**.

Avenue scripts may be executed in three different ways: (1) from an ArcView menu, (2) from a tool/button, or (3) directly from the script. In most cases, scripts are run from drop down menus. Running a script from a tool/button usually requires interaction with the mouse. The desired tool/button is activated, and then the mouse is used to interactively identify a location or area in the View. If a script is run directly from the script, the script is loaded as a new script, it is compiled, the applicable View is activated, and then the run button is selected.

3.1 Basics of Watershed Modeling in the GIS Environment

3.1.1 Map Projection

Geographic information systems allow engineers to work with spatially referenced data, i.e., a specific x,y coordinate system. In order for this locational reference to be linked to reality, it must be related to some standard established system of locating a point on the Earth's surface. The most commonly recognized system is the use of the geographic coordinates of latitude and longitude. Most engineering analysis is done using a cartesian coordinate system with orthogonal axes, typically referred to as the x-axis and y-axis. Translation from geographic coordinates to cartesian coordinates is accomplished through establishment of a map projection. The state of Oregon does have a state plane coordinate system with two zones, north and south, for the state (Snyder, 1987). While use of the north zone projection would be appropriate, neither of these projections was used for this study. The Oregon State Service Center for Geographic Information Systems (SSCGIS), through the Oregon GIS Group Project Leaders, has recently recommended the use of a single Oregon centered Lambert map projection as the standard map projection for the state (Oregon SSCGIS, 1998). In this way, data from different agencies can be viewed together using this one standardized projection without potential incompatibility problems. The specifics of the Oregon centered Lambert projection can be found in Table 3-1.

Table 3-1. Oregon Lambert Projection

Projection	Lambert
Datum	NAD 83
Spheroid	GRS 1980
Units	International Feet[1]
Parameters	
1st Standard Parallel	43 00 0.00
2nd Standard Parallel	45 30 0.00
Central Meridian	-120 30 0.00
Latitude of Projection Origin	41 45 0.00
False Easting (meters)	400,000.00
False Northing (meters)	0.00

(1) International foot = 0.3048 meters exactly; 1 meter = 3.28084 international feet; the units are specified as "3.28084" in a projection file (see Appendix A).

The Oregon SSCGIS has determined that with this projection, total area error for the entire state is 0.0045% (2,900 acres out of 64 million), and average length error for the entire state is 0.0176% (1.76 in 10,000). The TBNEP has adopted the Oregon Lambert project and this standard projection has been used for all data layers created as part of this project.

Because there are many different sources of data, there is the possibility that different sets of data may be obtained in different map projections, with different scales, and different coordinate systems. Geographic Information Systems, specifically Arc/Info and ArcView, allow different data sets to be viewed and used together as long as they have a common datum, map projection, and coordinate system. Arc/Info allows for conversion from one map projection to another with one easy command. Digital data sources that are presented in alternate map projections can be projected to the Oregon Lambert projection in Arc/Info using an Arc Macro Language (AML) file that specifies input and output projection parameters. Projection in Arc/Info is discussed later as it is used in the project. Recent developments in the ArcView software have made it fairly easy to project in ArcView also.

3.1.2 Hydrology Functions in ArcView

Raster based watershed modeling makes use of ArcView's 'Hydrology' extension which employs an eight-direction pour point model to analyze a digital elevation model (DEM). This pour point model determines the direction of flow for any cell by determining the direction of steepest descent between it and its eight adjacent neighbors. The slope is determined from the change in elevation divided by the distance between cells, determined between the centers of the cells in question. This function is called 'Flow Direction.' The 'Flow Accumulation' function queries the flow direction grid to identify those cells deemed to be upslope of the cell in question and creates a grid of accumulated flow to each cell by summing the weight for all cells that flow into each downslope cell. For a normal flow accumulation, no weight grid is specified, and the weight is assumed to be one. For a weighted flow accumulation, a weight grid is specified and the resultant grid at any point represents the sum of the weight values for all upstream cells. These two commands provide automated functions to trace the movement of water through a watershed.

3.1.3 Stream and Watershed Delineation

Once the flow direction and flow accumulation have been determined, stream networks can be identified by setting a threshold for the flow accumulation to define the beginning of a stream. Watersheds for any point can be determined by identifying all cells that flow into a particular cell of interest, i.e., which cells are upstream of any particular point. All of these function are automated within ArcView utilizing the 'Hydrology' extension.

3.2 Digital Elevation Model (DEM)

The DEM is the basic data element for constructing a model of the watershed hydrology. Analysis of the DEM allows for model representation of the stream network, as well as subbasins, within the watershed. This section describes work completed to build a digital database for use in the loading model presented in a later section. This database was created using data layers provided by the TBNEP which can be found on the TB CDROM (TBNEP, 1998b)or on the TBNEP web page at *http://osu.orst.edu/dept/tbaynep/nephome.html*.

3.2.1 Basic DEM

Digital Elevation Models are raster (or grid) representations of spatially distributed elevations of ground position that are distributed by the USGS. This study used a 7.5 minute (or 1:24,000 scale) DEM, also called a 30 meter (30m) DEM. The TBNEP already had a grid theme of the DEM for the study area that was in the Oregon Lambert projection. This file was provided as an export file – elev_g7.e00 which was imported using the Import 71 function of ArcView. This DEM grid has a cell size of 98.4252 feet (the equivalent of 30 meters). Since, it is much easier to work with a cell size of 100 ft, this DEM was resampled to a cell size of 100 ft. Resampling was done in

Arc/Info/Grid using the ‘setwindow’ and ‘setcell’ commands to produce a grid with 100 foot square cells.

The extent of this grid encompasses an area greater than the study area so it was reduced down to an extent closer to the extent of the watershed. This was accomplished through the use of a 2000 foot buffer around the **tillsub** coverage (which represents the study area watershed) from the TB CDROM (TBNEP, 1998b). A buffer of 2000 feet is used to ensure that all drainage for the study area is included and is created in Arc/Info using the ‘buffer’ command. The DEM grid is reduced to the extent of the study area in Arc/Info/Grid using three commands: (1) ‘mape’ - to set the map extent, (2) ‘setwindow,’ and (3) ‘setcell.’ The reduced grid was saved as **demarea**.

This version of the DEM has an elevation value of zero for the bay area and the ocean. To have a continuous land surface representation, the bay bathymetry data must be taken into account. This continuous surface allows for examination of flow paths from the land surface to different areas of the bay. In addition, as was discovered during this project, the ocean must have a value of 'no data' in order for the sub-watersheds along the coast to be delineated properly. The ‘no data’ value acts as an infinite sink and are hereafter referred to by the term “nodata.”

The coverage **B95pts** on the TB CDROM is a point coverage of measurements of depth to the bay floor that was used to incorporate the bay bathymetry (TBNEP, 1998b). This coverage was converted to a grid surface using the ‘Surface/Interpolate Grid’ function in ArcView. Because the bathymetry data only applies to the bay area, the grid surface was interpolated only to the extent of the bay (represented by the **shellmgt** coverage from the TB CDROM). The **B95pts** and **shellmgt** coverages from the TB CDROM are required to create the interpolated surface with the Analysis Extent set to "Same as Shellmgt" and the cell size to 100. IDW (for inverse distance weighting) was chosen as the interpolation method and depth as the z-value field. Default values were used for the other options in the ‘Interpolate Grid’ dialog box. There is a relatively new coverage available from the TBNEP homepage called **Bath95sh** that shows contours of the **B95pts** information. This coverage was used to check the accuracy of the interpolated surface, and from visual inspection, the match seemed to be reasonable.

This created grid covers a rectangular area to the extent of the **shellmgt** coverage, however, the bathymetry data is only needed in the area where the bay actually is located. Using the script "gridclip.ave" in ArcView, the interpolated surface was clipped specifically to the actual extent of the **shellmgt** polygon. The created clipped grid is a temporary grid, but is used later on, so it was saved as a permanent grid with the name **bathgrclip**, and is shown in Figure 3-1.

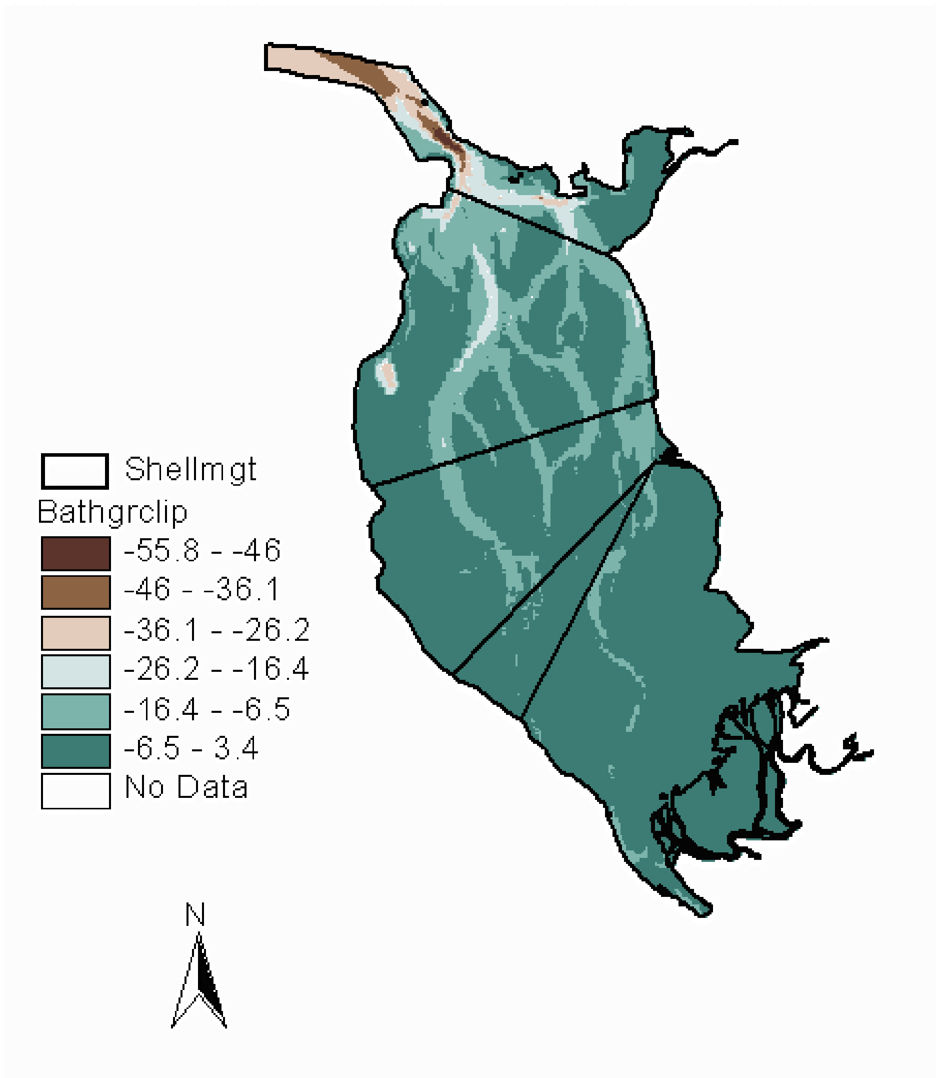


Figure 3-1. Clipped Grid of Interpolated Bathymetry Data Indicating Depth Below MSL

Using the avenue script “merge.ave” in ArcView, the clipped bathymetry grid was inserted into the larger **demarea** grid. As with all scripts, the working directory must be set before executing the script. In the merge operation, the new grid maintains the values of the primary grid for all cells that have a value and uses values of the secondary grid where the primary grid has a value of nodata. This has the effect of preserving the original DEM values everywhere except where the **bathgrclip** exists, and inserting the bathymetry grid data in those places. The script requires identification of the primary (**bathgrclip**) and secondary (**demarea**) grids, and then requests a merged grid name – this grid was named and saved as **bathdem**.

There are some values of nodata in the **bathdem** grid, but these are at the very edges of the DEM. In order for the watersheds that drain directly to the ocean to be delineated properly, the value for all of the grid cells in the ocean must be changed from zero to nodata. This was done in Arc/Info/ArcTools using the edit function. The **counties** coverage was used as a background image to indicate where the land stops and the ocean starts. The ‘sketch’ tools of the ArcTools set were used to edit the **bathdem** grid.

3.2.2 DEM Modifications

Before the hydrology extension can be employed, there were several more modifications made to the DEM. The **bathdem** grid is the result of modifications of the original DEM to insert the bathymetry data in the area of the bay and to change the elevation values of the ocean to nodata. Flow direction and flow accumulation grids were computed for the **bathdem** model, and streams were defined using the flow accumulation grid by selecting those grid cells with a flow accumulation greater than a specified threshhold. Because the lowland area is so flat and thus lacking much in the way of defining terrain, the model defined streams do not match the digitized streams very well as can be seen from Figure 3-2. In this figure, the digitized rivers are seen in purple and the delineated rivers are seen as blocks and long, thin rectangles. Because the modeled representation of streams does not match the actual stream network, the modeled flow must be artificially forced to accumulate in the actual streams. This process has been termed "burning in" the streams. In the burn in process, the elevation of the land that does not coincide with the streams is artificially raised by some height (for this study, a value of 2000 feet was used) while the elevation of the rest of the cells remains unaltered. To preserve the bay bathymetry data, the bay is also burned in along with the streams. The bay and streams are termed "waters of interest."

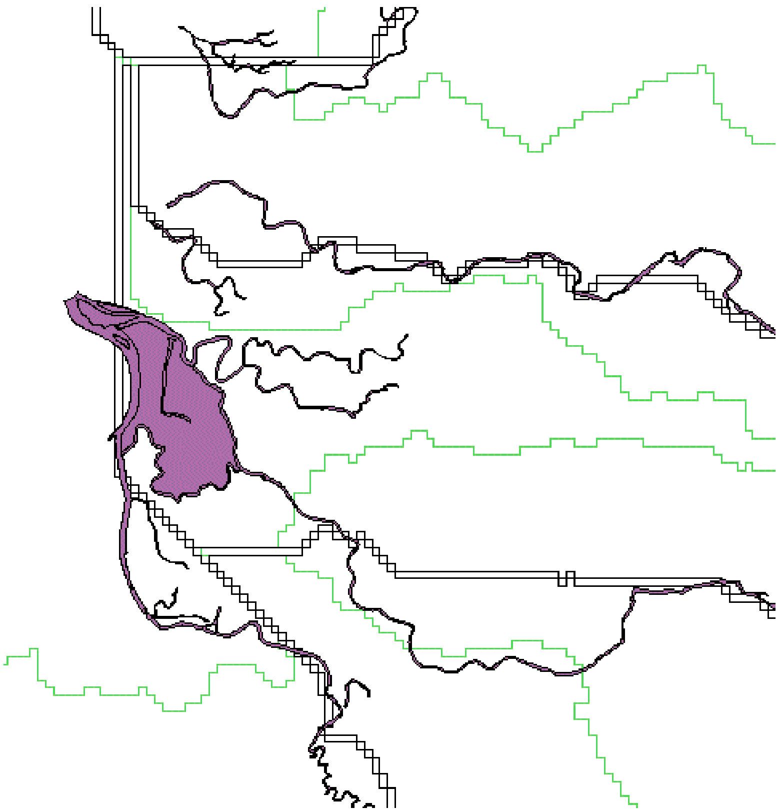


Figure 3-2. Delineated Rivers versus Lriver Coverage

3.2.3 Waters of Interest

In order to burn in the streams and bay, a raster representation is needed. This grid coverage must be continuous, i.e., have no breaks or gaps. The data available from the TB CDROM included three coverages that were used in the raster representation: **lriver** (polygon coverage of the five major rivers in the area), **lstreams** (line coverage of streams in the area), and **shellmgt** (polygon coverage of the bay) (TBNEP, 1998b). Each coverage was converted to a grid, and in Arc/Info/Grid, each cell value was set to either a value of 1 (for all cells with a cell value) or nodata using a condition statement. Then, the three grids were combined into one grid in Arc/Info/Grid using the ‘merge’ command and saved as **baywater1**. This grid was edited using Arc/Info ArcTools to make sure there were no gaps in the grid, particularly along the five main rivers. In addition to fixing gaps, extraneous discontinuous stream segments were deleted. These segments included those that were not along the main rivers or that did not drain to Tillamook Bay watershed, and thus are not of interest.

The next step was to actually burn the streams in. In ArcView using Map Calculator, the **baywater1** grid was multiplied by the **bathdem** grid. The resultant grid represents only the DEM elevation for the locations of the waters of interest and is renamed **dem** using ‘Theme/Properties.’ Using Map Calculator, the value of 2000 was added to the **bathdem** grid, the equivalent of raising the elevation by 2000 feet, and the resultant grid was renamed **demplus**. These two altered grids were then used to burn the streams into the dem using the script “merge.ave.” The **dem** was identified as the primary grid, and the **demplus** as the secondary grid. The “merge.ave” script maintains the original DEM elevation for all cells in the **dem** grid that do not contain a value of nodata, and the cell value of the **demplus** grid is written in the resultant grid for all **dem** grid cells that have a value of nodata. The resultant grid with the streams and bay burned in was saved as **burndem**.

3.2.4 Filling in False Sinks and Defining the Stream Network

Before further calculations can be done, potential data errors in the DEM must be corrected. In some cases, the DEM contains false sinks, i.e., one or more cells completely surrounded by cells of higher elevation. These false sinks effectively create a discontinuity in the modeled flow and are corrected using the Hydrology function command ‘Fill.’ The ‘Fill’ command alters the elevation of each sink so that it is equal to the elevation of its lowest neighbor. This command has been automated in ArcView in the Hydrologic Modeling extension but cannot process negative elevation values, so the **burndem** grid had to be altered once again before calculating the filled grid. The

burndem grid has negative numbers for the elevations in the bay segments where bathymetry data has supplemented the original **demarea** grid. To eliminate these negative numbers, all values of the **burndem** grid were increased by 100 using the 'Map/Calculator' function. The resultant grid was renamed in the View as **burndempos**.'

In ArcView with the Hydrologic Modeling extension active, the false sinks were filled in using the 'Hydro/Fill' command with the **burndempos** grid active. The resultant grid was named **bdemfill**. Using 'Hydro/Flow Direction,' a flow direction grid was created and, with the flow direction grid active, a flow accumulation grid was created using 'Hydro/Flow Accumulation.' The flow direction grid was named **flowdir**; the flow accumulation grid was named **flowacc**.

Initially, streams were delineated at a threshold of 1000 cells. This equates to a drainage area of 10 million sq ft or about 230 acres. This delineated stream network was compared to the **lriver** coverage to see if water was flowing where it should, i.e., in the rivers down to the bay. In a couple of places, this was not the case because of a short-circuit in the **baywater1** grid. Using ArcTools, these short-circuits were eliminated by changing appropriate cell values from 1 to nodata. Several iterations were required to get the delineated streams to match the rivers. Once the delineated streams matched the digitized streams, the **burndempos** grid was saved as the **burndem** grid. The **burndem** grid has the elevation plus 100 feet for the elevation of those cells coincident with the "waters of interest," while the other cells have an elevation equal to the original elevation plus 2100 feet. The final **burndem** grid was filled and saved as **bdemfill** which is used for further processing to develop a hydrology model of the watershed.

3.3 Hydrologic Model of Tillamook Bay Watershed

The **bdemfill** grid serves as the basic representation of terrain for the watershed. This model is used to determine stream flow paths and sub-watersheds and to model discharge and loadings to the watershed. The Center for Research in Water Resources at the University of Texas at Austin has developed an ArcView project file with a series of avenue scripts that automates the development of a hydrologic model. This project file was developed specifically to create an input file for the US Army Corps of Engineers

HEC-HMS model. Portions of this model pertaining to stream and watershed delineation have been transposed into the hydrology.apr project file for this project.

The hydrology.apr project file employs several pull down menus with items to accomplish various steps. The 'Delineation Tools' menu contains the majority of the steps that are employed and can be seen in Figure 3-3. Before delineating steams and sub-watersheds, one more alteration was made to the DEM.

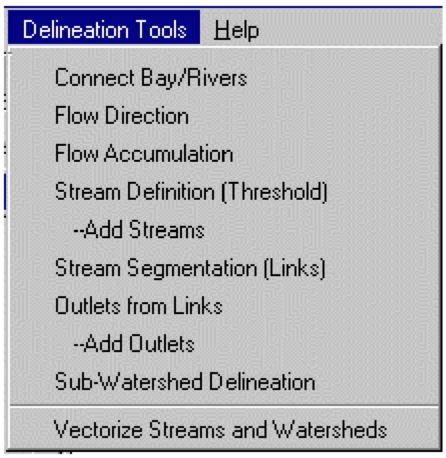


Figure 3-3. Delineation Tools Drop-down Menu

3.3.1 Connecting Bay Segments with the River Network

To examine flow and loadings to the bay, another modification was made to the DEM. Typical bay models divide the bay into finite segments. These finite segments are represented by the five segments of the bay represented by the **shellmgt** coverage from the TB CDROM (TBNEP, 1998b) – see Figure 3-4. These segments represent the management segments of Tillamook Bay for shellfish harvesting and are classified based on the approval to harvest shellfish. Each segment is classified as either conditionally approved, restricted, or prohibited.

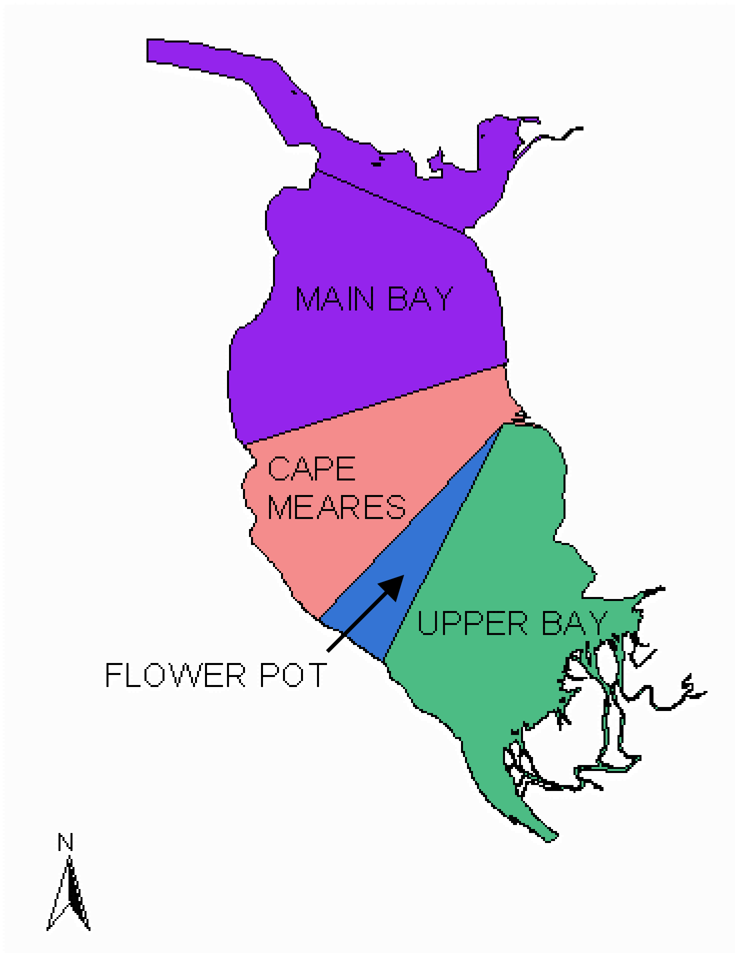


Figure 3-4. Segmentation of Tillamook Bay

The values of interest are the flows and loads going to each management segment individually. The **bdemfill** grid allows modeled flows and loads to be accumulated in the streams and rivers and then be routed from the most upstream management segment to the most downstream management segment and then to the ocean. In order to separate out contributions to the individual bay segments, the elevations of the bay segments are altered as follows.

The hydrology.apr project file contains a menu item called 'Connect Bay/Rivers' in the 'Delineation Tools' menu. This same menu item is available in the load model project files (bactimodel.apr and sedimodel.apr) under the ‘Discharge’ menu. This option runs the script “connectsink.ave” which drops the elevation of the bay segments below the elevation of the adjacent land surface. This script is a modified version of the “connect.ave” script written by Ferdinand Hellweger and utilized in the Corpus Christi Bay NEP study (Quenzer et al, 1998). The centroids of the bay segment polygons are dropped further and a nodata point is written to the centroid cell so the flow accumulates at the centroid.

The **shellmgt** coverage had to be edited to avoid problems with the “connectsink” script. The coverage was converted to a grid, and edited was using ArcTools/Grid Tools. Four edits were made to the grid version of the shellmgt coverage:

- Deleting the 'fingers' (representing tidal channels) at the south end that connect to the rivers
- Editing the eastern end of the flowerpot segment so that it extends the width of the bay (to avoid model short circuits)
- Deleting a few 'fingers' at the northeast end of the bay
- Extending the northern edge of the bay so that the centroid of the ‘main bay – prohibited’ segment fell within the bay polygon

After edits, the grid was converted back into a coverage and saved as **baymodel**.

The ‘Connect Bay/Rivers’ tool requires both a polygon and a polyline coverage of the modeled bay segments. A separate polyline coverage was created by converting the polygon coverage (**baymodel)** to a shapefile in ArcView, and then using the shapearc and build….lines commands in Arc/Info. This polyline coverage is called **bayarc**.

The ‘Connect Bay/Rivers’ tool requires that the filled version of the burned in DEM grid (**bdemfill**), the **baymodel** polygon coverage, and the **bayarc** arc coverage of the bay segments be available in the View. The ‘Connect Bay/Rivers’ option was chosen from the ‘Delineation Tools’ menu. The script prompts for input with a series of dialog boxes to specify the bay polygon, bay arc/line, and filled DEM themes. The temporary files that are created are not necessary and only take up valuable hard drive space, so they do not need to be saved.

Execution of this script also prompts for a name for the newly created modified DEM grid. The dialog box has a default name that can be used. If a script is run more than once in the same project run with the same working directory, the grid name must be somehow modified. ArcView does not overwrite previous files of the same name. If the name is not changed somehow (even adding a number to the name is sufficient), the script will not execute properly. Once a name has been specified, the new grid is saved to the working directory and added to the view. If the default name is used, the grid called **connectsink** is created and added to the View. The next step in the hydrology model is to delineate stream networks.

3.3.2 Modeling Stream Networks

In general, the remaining steps of the 'Delineation Tools' menu create temporary grids. The user specified names are merely for viewing purposes in the View window. If the project file is saved before closing, those temporary grids are saved as permanent grids, but with system derived names. To avoid loosing needed temporary grids, the project file should not be closed before either saving the project or saving the grids that are of continued interest or use. If the project is saved, the project file retains the names that the user specified for viewing purposes. Actual file names are ascertained by using the 'Theme/Properties' command.

The next step was to determine the flow direction and flow accumulation grids for the watershed based on the **connectsink** grid. Both of these options are accessed from the 'Delineation Tools' drop down menu. With the **connectsink** grid in the View, 'Flow Direction' was selected from the menu. The filled DEM grid was identified and a name specified for the output theme which was identified as the flowdirgrid, or flow direction grid, for the project run; see Figure 3-5.

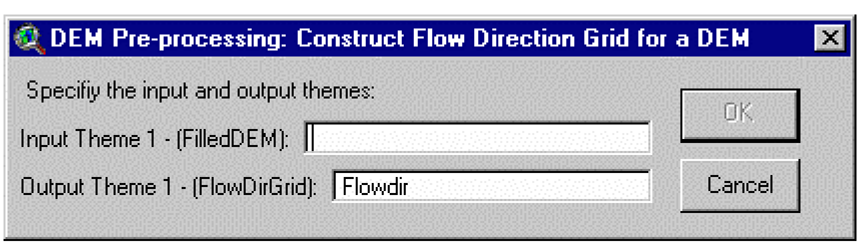


Figure 3-5. Dialog Box for Flow Direction Grid

The created grid is a temporary one, but is required for further processing, so it was saved as **flowdir**. Next, 'Flow Accumulation' was selected from the menu. The flow direction grid was identified and a name specified for the output theme which was identified as the flowaccgrid, or flow accumulation grid, for the project run. Again, the created grid is a temporary one, so it was saved as **flowacc**.

The flow accumulation grid was used to delineate streams by selecting 'Stream Definition (Threshold)' from the 'Delineation Tools' menu. A dialog box prompts for the input theme, which is the flowaccgrid, and a name for the output theme which is identified as the streamgrid for the project; see Figure 3-6. The grid created for this project was named **streamgrid**.

Figure 3-6. Dialog Box for Stream Definition

Next, the number of cells to initiate a stream was specified, designated the stream threshold (see Figure 3-7). This number represents the minimum number of cells that must accumulate to say that a cell is part of the stream network, with typical values ranging from 500 to 100,000, depending on the area being investigated. For this project a value of 1,000 cells seemed to match most of the streams and was appropriate for the purposes of delineating sub-watersheds.

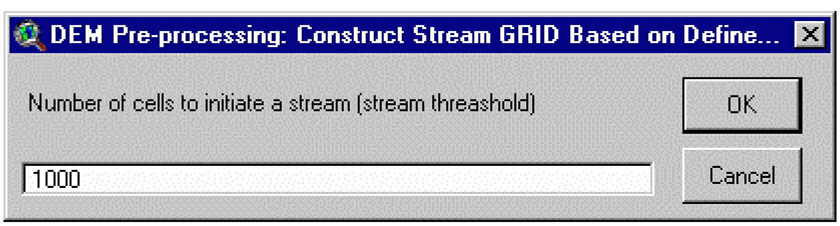


Figure 3-7. Dialog Box for Stream Threshold Definition

Execution of this menu option produced a grid with a value of 1 where a stream has been defined and nodata elsewhere. Once the stream network was identified, sub-watersheds were delineated.

3.3.3 Delineating Sub-watersheds in the Basin

Once a stream network was defined, stream network links and watershed outlets were determined. The 'Stream Segmentation (Links)' option was selected from the menu. A dialog box prompts for selection of a streamgrid (see Figure 3-8) –streamgrid rather than modified streamgrid was selected. This option creates a link grid which represents each unique segment of the stream network with a unique number.

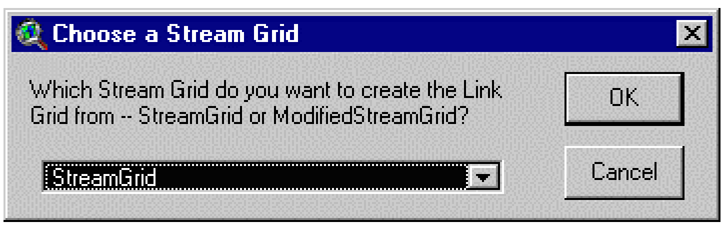
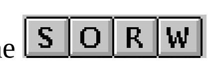


Figure 3-8. Dialog Box for Stream Grid Selection

Next, an outlet grid was created by selecting "Outlets from Links" from the menu. This command creates a grid that defines the points at the end of each link. As with other commands, dialog boxes prompt for input: a link grid (the link grid was used rather than the modified link grid), and a name for the output theme which was identified as the outlets grid for the project.

If this outlets grid were used for the rest of the project, many sub-watersheds would be created, one for each stream link. However, for this project, the objective was to delineate sub-watersheds that correspond with larger sections of the links network. So, additional outlet points were located by using the 'O' button from the 

buttons on the tool bar. The point coverage(s) that represents the desired sub-watershed outlet points were added to the View. The 'Add Outlets' tool, the 

button, was used to interactively identify each point in the coverage(s) of interest as an additional outlet point. These additional outlet points were checked to ensure that they coincided with the delineated streamgrid and were appropriately placed in regards to junction points. This procedure creates a shapefile called **Addasoutlets.shp**. Each selection is added to this shapefile. This process is somewhat time consuming, but necessary. Figure 3-9 shows an example of the identification of outlet points.

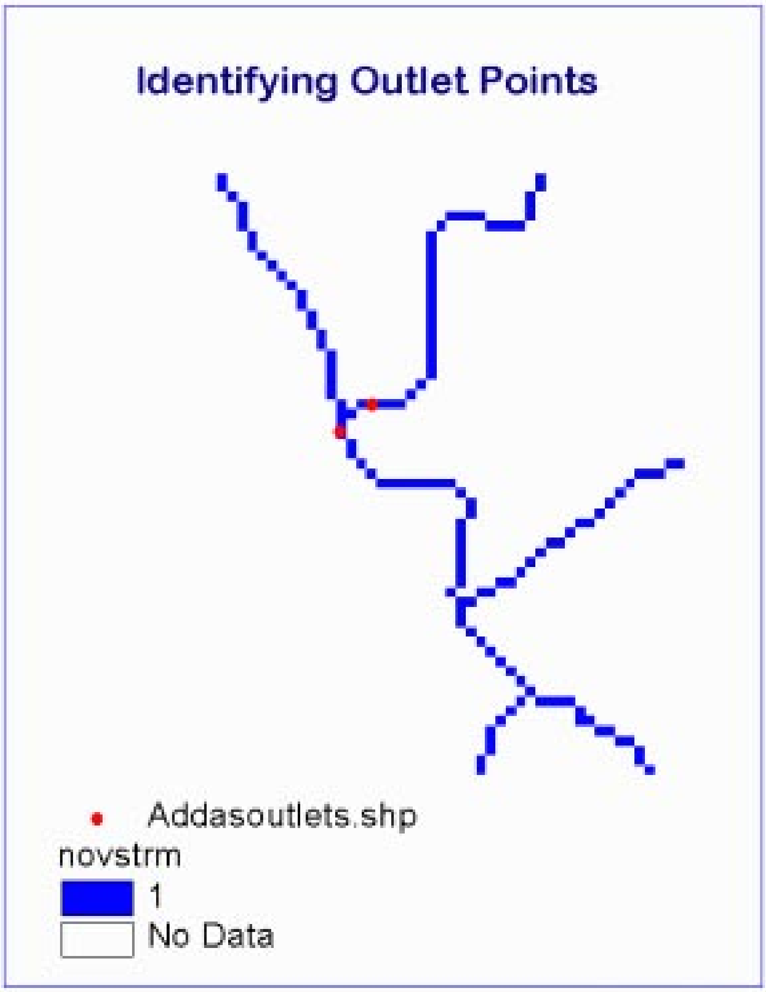


Figure 3-9. Identification of Outlet Points Using the 'Add Outlets' Tool

Once all outlet points were identified, the 'Add Outlets' option was selected from the 'Delineation Tools' menu with the steam grid rather than the modified stream grid selected for use in processing. Additional dialog boxes prompt for identification of other grids and names for the modified outlets grid and modified links grid. A final dialog box (as seen in Figure 3-10) prompts for selection of a set of outlet grids to use for processing. To delineate only the larger sub-watersheds that correspond to the specified points, only the selected outlets were used.

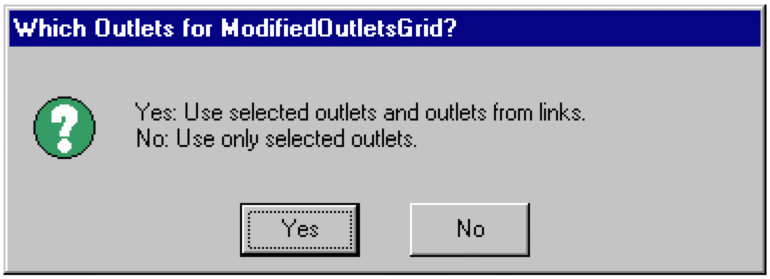


Figure 3-10. Dialog Box for Outlet Set Selection

The next item available on the drop down menu is 'Subwatershed Delineation.' This creates a grid representation with a unique value for each of the sub-watersheds using the flow direction grid, the stream links grid, and the modified outlets grid. The raster representation was converted into a vector coverage using the 'Vectorize Streams and Watersheds' menu option with the modified links grid.

Occasionally conversion of this data from raster to vector results in dangling polygons, which are small areas that have become separated from the rest of their sub-watershed during processing and have no stream segment associated with them. The 'Vectorize' menu item automatically dissolves these dangling polygons into the polygons that they should be associated with based on the grid code value.

For this project, two sets of sub-watershed delineations were performed. The first run was to delineate the watersheds of the five major rivers in the basin and is the primary delineation of interest for this work. The **mouth** point coverage (designating the locations of the river mouths) was used to add outlets for delineation. At the request of the TBNEP, an additional run was made to delineate sub-watersheds within the five river watersheds using the **mouth**, **mjrsubwspts**, and **fldplnwspts** point coverages. This second delineation was not actually used in this study, but is provided for future use. The grid representation of the five river basins is called **riverbasin**; the grid representation of the sub-watersheds is called **subwsheds**. The vector representation in both cases is a shapefile. The shapefile for the five river basins is called **rivbasin.shp**; the shapefile for the sub-watersheds is called **subbasin.shp**. Vector representations of the streams associated with each of these watersheds were also created and are called **river.shp** for the streams of the five basins and **subriver.shp** for the streams of the sub-watersheds. The grid representation, watershed polygon representation, and river arc representation for either set are all linked by a gridcode (for shapefiles) and value (for the grid) that is common to the subbasin. For instance, in the **river.shp** shapefile, each stream length has a grid code number that is associated with its. The **rivbasin.shp** polygon shapefile has a field that associates that same grid code with its corresponding basin as seen in Figure 3-11.

Attributes of Rivbasin.shp

Shape	Id	Gridcode	Area	Perimeter	Watershed
Polygon	1	2307	1021050000.000	233800.000	Miami River
Polygon	2	2308	1813200000.000	312800.000	Kilchis River
Polygon	3	2309	5376070000.000	606400.000	Wilson River
Polygon	4	2311	1697380000.000	315600.000	Tillamook River
Polygon	5	2310	4874800000.000	608600.000	Trask River

Figure 3-11. Attribute Table of River Basin Polygon Shapefile

The **mouth**, **mjrsubwspts**, and **fldplnwspts** coverages used in the second run represent river basins, major sub-watershed in the basin, and sub-watersheds in the flood plain area, respectively. The locations of the points in these three coverages were determined in conjunction with TBNEP staff members and represents outlet points of interest in the basin. The actual point coverages were created in ArcView using the 'View/New Theme' command.

This completes the development of the digital characterization and hydrology model of the watershed. The next major effort involves modeling the discharge in the basin.

3.4 Modeling Discharge in the Basin

There are very few rain gages or discharge gages in the Tillamook Bay basin that have long-term measurements. The Tillamook 1W raingage and the Wilson River discharge gages were selected for use in developing a mathematical relationship between rainfall and discharge because they do have a sufficiently long record set. To determine a relationship, data for both parameters must be known for the same location. Estimates of annual rainfall at the Wilson River gage were made based on daily rainfall data at the Tillamook 1W rain gage and a grid of long term average annual rainfall.

3.4.1 Precipitation Data

There are two types of precipitation information available. One is a grid of long term average annual precipitation obtained from the Oregon State University PRISM Project (Oregon State University, 1998) and based on data from 1961-1990. The other is a dataset of daily precipitation values obtained from the 1996 National Climatic Data Center (NCDC) 'ClimateData' CDROM (Hydrosphere Data Products, 1996).

3.4.1.1 Precipitation Grid Data

The precipitation grid was obtained from Oregon State University from their PRISM project. The data can be downloaded from the PRISM website at *http://www.ocs.orst.edu/prism/prism_products.html*.

The long term average annual precipitation grid for the entire state of Oregon was downloaded as an ascii file and imported to ArcView. This average grid is based on data from 1961 -1990. Grids of precipitation for areas smaller than a state, such as for a single county, were not available. This original imported precipitation grid is of long term average annual rainfall in mm/yr. As an aside, the grids that are currently available from the PRISM website (as of June 1998) are in units of mm/yr * 100. This imported grid was in geographic projection and was reprojected to the Oregon Lambert projection in Arc/Info using the projection file mentioned earlier called ‘orlamb’ (see Appendix A for file text).

The cell size of the original imported precipitation grid is 15,195 ft. To match the cell size of the DEM, the grid was resampled to a 100 foot cell size. In addition, because the precipitation data is only needed for the study area, the grid was reduced to the same extent as the DEM (**demarea**). These alterations were conducted in Arc/Info by setting the map extent and window to the **demarea** and setting the cell size to 100.

Since this grid has values in mm/yr, it was converted to inches/yr to work in English units. This was accomplished in ArcView using ‘Analysis/Map Calculator’ to divide the grid by 25.4 to convert from mm to inches. This grid was clipped to the actual extent of the **tillbuf2k** coverage using the “gridclip.ave” script and was saved as **precip**.

3.4.1.2 Daily Rainfall Gage Data

The other rainfall data set, daily rainfall data, was downloaded from the 1996 National Climatic Data Center CDROM (purchased by the Center for Research in Water Resources) for the following stations:

- Tillamook 1W (period of record: 1/48 to 12/95)
- Tillamook 12ESE (period of record: 1/50 to 12/51)
- Tillamook 13ENE (period of record: 1/70 to 12/78)
- Lee’s Camp (period of record: 1/50 to 12/51)
- Nehalem (period of record: 1/50 to 12/51)
- Cloverdale (period of record: 1/48 to 12/95)

This data can also be downloaded from the National Climatic Data Center website at *http://www.ncdc.noaa.gov*. As was discovered later, the Nehalem and Cloverdale gages, while in the surrounding area, are actually outside the Tillamook Bay watershed and were thus eliminated from further consideration for use in this study.

The data for Tillamook1W rain gage was selected for use in the analysis because it was within the watershed and had data for the entirety of the time span for the PRISM data (1961-1990). This rain gage is located at the radio station in downtown Tillamook. Because the PRISM rainfall grid is based on data from the years 1961-1990, only those years of data were used. Data cleanup was conducted to eliminate data values of 9999.0 and 9998.0 which represent data gaps. The data was deleted for non-existent days (i.e., 30 February), but leap year data (29 February) were maintained. All maintained values of 9999.0 and 9998.0 were replaced with a text zero to be able to distinguish missing data. Precipitation values were summed for each month to get a monthly total and monthly totals were summed to get an annual total. For each month, the number of days of missing data were determined and summed for the year. The measured annual value was scaled up by the fraction of missing days as shown in Equation 3-1:

$$SP = MP \times (1 + (MD / 365) \qquad \text{Equation 3-1}$$

where SP = scaled-up precipitation

MP = measured precipitation

MD = number of missing days

This value represents the corrected measured annual precipitation at the Tillamook1W station, listed as the 'Scaled-up Precip' value in Table 3-2, and was used in the precipitation-discharge analysis. To fully utilize this data, a point coverage of the locations of the gages is needed.

3.4.1.3 Point Coverage of Rain Gages

A point coverage of the locations of the rain gages was created to be able to locate the rain gages within the basin. While the Tillamook 1W gage was the only gage used for this project, all 6 gages were included in the point coverage for potential future use. The latitude and longitude coordinate data was presented in geographic degrees, minutes, & seconds. These values were converted to decimal degrees, carrying out the decimal potion to six places, to be used in the point coverage creation.

The rain gage point coverage was created in ArcView using the "gages.ave" avenue script and requires a table containing data describing the points. This table was created in ArcView and contains fields for "Gage_Name", "Gage_Num" , "Latitude, " and "Longitude." Execution of the script creates a shapefile that was converted to a point coverage and projected to the Oregon Lambert projection using the 'orlamb' projection file, found in Appendix A.

Table 3-2. Precipitation Data for Tillamook 1W Rain Gage

Year	Measured Precip (in/yr)	Missing Days	Scaled-up Precip (in/yr)
1961	102.38	6	104.06
1962	85.06	5	86.23
1963	88.85	4	89.82
1964	97.71	3	98.51
1965	76.36	5	77.41
1966	81.99	10	84.24
1967	80.87	16	84.41
1968	109.35	15	113.84
1969	80.03	38	88.36
1970	95.42	28	102.74
1971	117.44	29	126.77
1972	98.89	20	104.31
1973	94.89	27	101.91
1974	102.40	28	110.26
1975	105.89	25	113.14
1976	62.34	31	67.63
1977	90.01	29	97.16
1978	67.97	35	74.49
1979	81.41	40	90.33
1980	82.11	34	89.76
1981	88.56	22	93.90
1982	97.95	31	106.27
1983	104.72	19	110.17
1984	94.82	30	102.61
1985	61.21	18	64.23
1986	79.09	32	86.02
1987	71.88	21	76.02
1988	81.62	6	82.96
1989	76.36	4	77.20
1990	94.93	27	101.95

3.4.2 Discharge Data

Discharge data for the Wilson River and Trask River were downloaded from the USGS website *http://water.usgs.gov/* (USGS, 1999b) as a tab-delimited text file which was accessed in Excel. The data given is average daily discharge in cubic feet per second. The file also includes geographic coordinates of the gages and the drainage area in square miles.

3.4.2.1 Point Coverage of USGS Gage Stations

The coverage, **usgsgage**, was created in the same manner that the **raingage** coverage was created. Information on latitude, longitude, gage name, and gage number were obtained and a shapefile was created in geographic coordinates using the "gages.ave" script. The 'shapearc' and 'build' commands were used in Arc/Info to create a point coverage which was then projected to Oregon Lambert projection.

It is important that this coverage locating gages on the rivers actually coincides with the modeled streams that were delineated in the Hydrologic Model section. For this reason, the point locations were checked against the modeled stream grid. Points that did not actually lie on the stream grid were moved to the equivalent point on the stream grid, as was the case with the Trask River gage. This editing was accomplished in ArcView by converting the coverage to a shapefile and then dragging the point to the nearest location that coincides with the modeled stream grid. Once all points were corrected, the edits were saved and the shapefile was converted back to a coverage. The points may also be edited using ArcTools, but the author did not explore this option.

3.4.2.2 USGS Discharge Data

The Wilson River gage has data available for 1961 – 1990 (along with other years) to correspond with the rainfall data. The Trask River gage has data available for 1932 – 1954 and 1962 – 1971. Data from the Wilson River gage was used to develop the model, while data from the Trask River gage was used for validation.

For the project, it was desirable to be able to look at baseflow versus surface runoff. The baseflow was separated out using a fortran program "bflow3.exe" written by Dr. F. Olivera and presented in Appendix A. Information on this program can be found in Chapter 4, section 4.2.1.1 of Dr. Olivera's doctoral dissertation (Olivera et al, 1996). The program requires specification of an N value, representing peak flow duration. Several values, from 3 days to 8 days, were considered and a value of 5 days was chosen. Figure 3-12 graphically depicts baseflow separation.

The program calculates the baseflow that is then subtracted from the total flow at the gage to get the surface runoff, often referred to simply as runoff. Daily values in cubic feet per second (cfs) are summed over a year period and multiplied by 86,400 sec/day to get values of annual flow in cubic feet per year, broken out between runoff and baseflow. Annual data for the Wilson River for the years 1961 – 1990 can be found in Table 3-3.

Percent runoff and baseflow were determined in relation to precipitation volume which was determined as:

$$PV = \frac{PD(in)}{yr} \times \frac{1\,ft}{12in} \times DA(ft^2) \qquad \text{Equation 3-2}$$

where PV = precipitation volume (cubic feet/yr)

PD = precipitation depth (inches/yr)

DA = drainage area (square feet)

On the average, 53 percent of the total precipitation volume is converted into baseflow and 25 percent is converted into runoff. The remaining 22 percent is attributed to evapotranspiration and depression storage, and thus is not available for streamflow. Percent baseflow ranges from 44 to 66 percent, while percent runoff ranges from 17 to 36 percent. The variation is percent baseflow or runnoff from year to year is as much as 15 percent for some years.

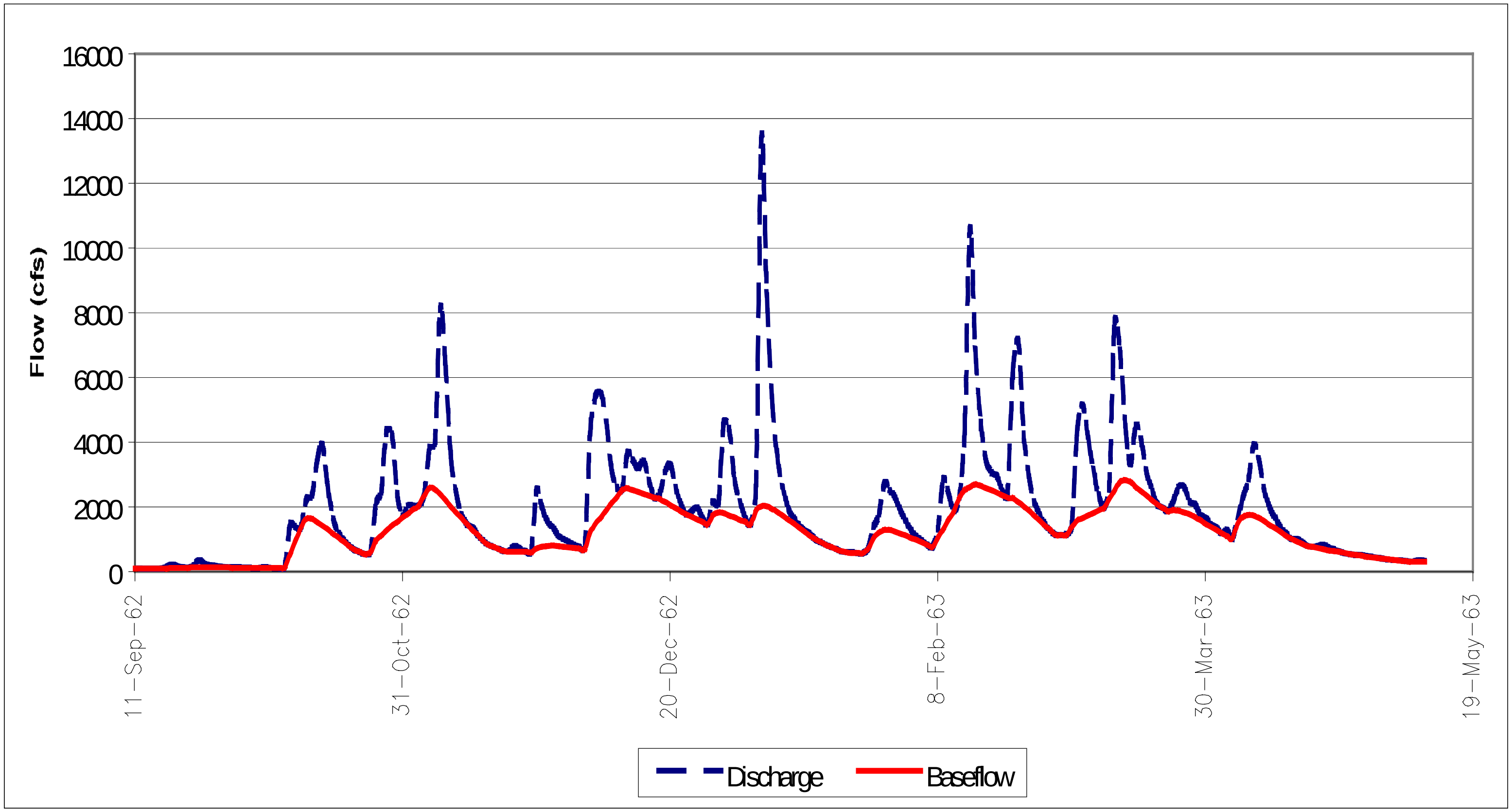


Figure 3-12. Example Baseflow Separation (Wilson River Data, N = 5 days)

Table 3-3. Wilson River Annual Discharge Data

Year	Runoff (Mcf/yr)	% Runoff	Baseflow (Mcf/yr)	% Baseflow	Precip Volume (Mcf/yr)
1961	13,488	27	31,027	61	50,593
1962	10,668	25	22,914	55	41,921
1963	8,982	21	22,753	52	43,670
1964	17,232	36	26,711	56	47,895
1965	7,873	21	19,174	51	37,633
1966	12,251	30	27,196	66	40,954
1967	10,621	26	22,842	56	41,041
1968	15,723	28	28,336	51	55,348
1969	7,941	18	24,393	57	42,960
1970	14,450	29	24,586	49	49,950
1971	15,308	25	33,441	54	61,633
1972	18,386	36	29,470	58	50,713
1973	10,903	22	25,943	52	49,546
1974	12,878	24	29,843	56	53,604
1975	16,989	31	29,938	54	55,008
1976	7,019	21	20,178	61	32,883
1977	13,391	28	23,643	50	47,238
1978	6,158	17	19,497	54	36,214
1979	8,347	19	19,392	44	43,917
1980	11,443	26	22,264	51	43,639
1981	11,349	25	24,362	53	45,651
1982	15,799	31	25,447	49	51,666
1983	11,984	22	27,399	51	53,563
1984	9,403	19	25,382	51	49,888
1985	4,799	15	16,801	54	31,227
1986	8,509	20	20,094	48	41,823
1987	9,706	26	17,551	47	36,957
1988	9,230	23	21,164	52	40,334
1989	10,109	27	20,309	54	37,531
1990	12,513	25	26,261	53	49,567
Average	**11,448**	**25**	**24,277**	**53**	**45,486**

3.4.3 The Precipitation/Discharge Relationship

In developing the precipitation-discharge relationship, variations in time are traded for variations in space. The objective is to create mean annual runoff and baseflow maps that are functions of precipitation which is spatially distributed from lower values near the coast to higher values in the mountain range. These discharge maps are created using precipitation-streamflow relationships developed from annual observed data for the period 1961-1990 at the Tillamook1W rain gage and the Wilson River discharge gage.

To develop a relationship between rainfall and discharge, annual rainfall at the Wilson River discharge gage for each year of interest must first be determined. This is accomplished by relating data at the Tillamook 1W rain gage to the ungaged location at the Wilson River USGS discharge gage through the use of a grid describing spatial variability of precipitation across the watershed.

In ArcView, the **raingage** point coverage and the **precip** grid (describing long term average annual rainfall across the basin) were added to a view. The inquiry button, , was used to query the **precip** grid at the Tillamook 1W rain gage location. This returned a value of long term average annual rainfall value of 87.13 inches. For each year (1961 to 1990), a ratio was calculated of the measured annual rainfall at the Tillamook 1W rain gage to the long term average annual rainfall value of 87.13 inches found from the grid. This ratio indicates how rainfall varies temporally and reflects wetter versus dryer years, as shown in column 2 of Table 3-4.

The next step is to determine an average precipitation grid that represents the average rainfall upstream of any given point. Because rainfall is "converted" into runoff by hitting the land surface and flowing downhill, the runoff at any point is influenced by what happens on the land surface that is upstream from the point. The derived average precipitation grid is based on the **precip** grid and the flow accumulation grid. In ArcView, a weighted flow accumulation was computed with the **precip** grid as the weight grid using the script “accpreci.ave.” The resulting grid is called **accprecip**.

Table 3-4. Precipitation and Discharge Data for the Wilson River Gage

Year	Ratio - Annual to Long Term Average Precipitation	Predicted Rainfall (in/yr)	Runoff (in/yr)	Baseflow (in/yr)	Total flow (in/yr)
1961	1.19	138	37	85	122
1962	0.99	114	29	63	92
1963	1.03	119	25	62	87
1964	1.13	131	47	73	120
1965	0.89	103	22	52	74
1966	0.97	112	33	74	108
1967	0.97	112	29	62	91
1968	1.31	151	43	77	120
1969	1.01	117	22	67	88
1970	1.18	136	39	67	107
1971	1.45	168	42	91	133
1972	1.20	138	50	80	131
1973	1.17	135	30	71	101
1974	1.27	146	35	82	117
1975	1.30	150	46	82	128
1976	0.78	90	19	55	74
1977	1.12	129	37	65	101
1978	0.85	99	17	53	70
1979	1.04	120	23	53	76
1980	1.03	119	31	61	92
1981	1.08	125	31	67	98
1982	1.22	141	43	69	113
1983	1.26	146	33	75	108
1984	1.18	136	26	69	95
1985	0.74	85	13	46	59
1986	0.99	114	23	55	78
1987	0.87	101	27	48	74
1988	0.95	110	25	58	83
1989	0.89	103	28	55	83
1990	1.17	135	34	72	106
Average	**1.07**	**124**	**31**	**66**	**98**

The average precipitation grid (**avgprecip**) was calculated in ArcView using the 'Map Calculator' as follows:

$$Avgprecip = \frac{precip + accprecip}{flowaccumulation + 1} \qquad \text{Equation 3-3}$$

This specific calculation, rather than merely dividing the accumulated precipitation by the flow accumulation value, is necessary because the flow accumulation does not count the cell being examined, only the cells upstream of it. For any points that were local elevation highs, this would result in division by zero, and thus a nodata value. Determining the average precipitation grid using Equation 3-3 avoids nodata values.

The **avgprecip** grid was also queried at the Wilson River gage location to find the average annual long term value – 118.30 in. The annual predicted rainfall at the Wilson River gage was determined by Equation 3-4 and can be found in column 3 of Table 3-4.

*P = 118.30 * R* Equation 3-4

where P = the estimated annual precipitation for a given year

R = ratio from column 2 of Table 3-4 *for a given year*

The annual baseflow and runoff values (in cubic feet per year) from Table 3-3 are converted to an equivalent depth of flow as follows:

$$DF = \frac{Q}{DA} \times \frac{12in}{ft} \qquad \text{Equation 3-5}$$

where DF = depth of flow (inches/year)

Q = discharge (cubic feet/year)

DA = drainage area (square feet)

The depth of flow values are found in columns 4 and 5 of Table 3-4. In Excel, plots of rainfall versus runoff and rainfall versus baseflow were made for the period of interest, 1961-1990, and can be seen in Figure 3-13 and Figure 3-14, respectively. Using linear regression, a line of best fit was determined for both cases.

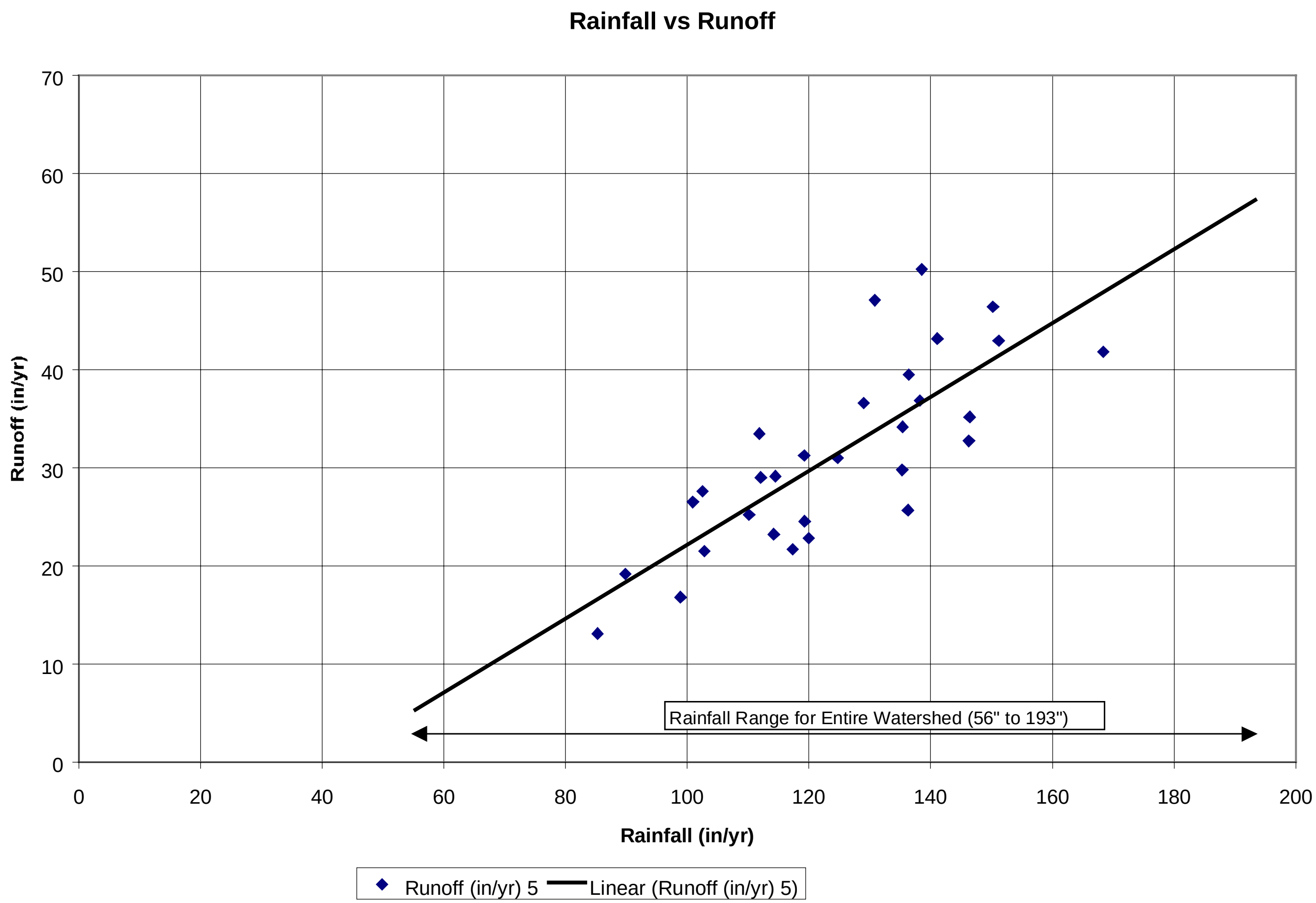


Figure 3-13. Graph of Annual Rainfall versus Annual Runoff For the Wilson River

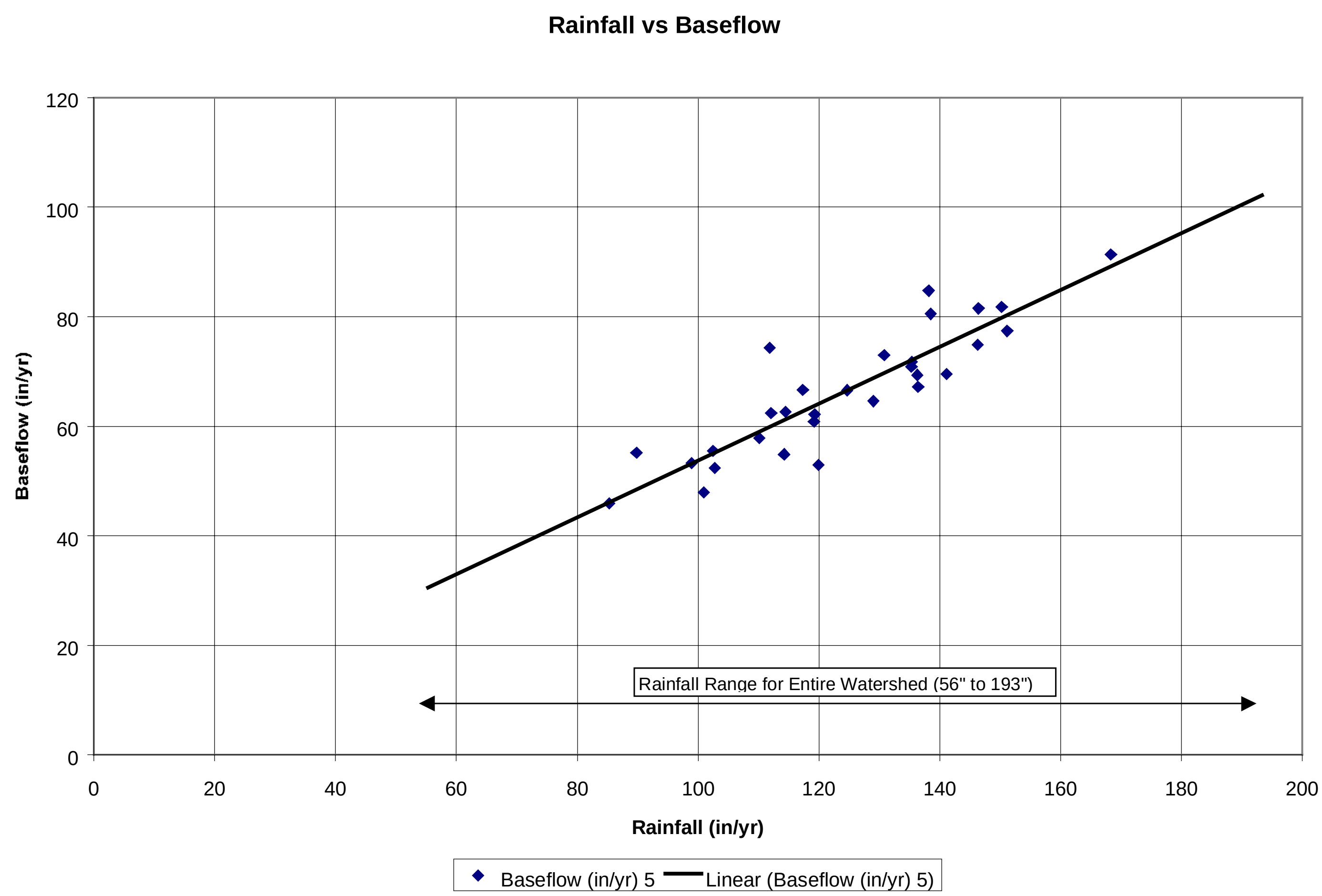


Figure 3-14. Graph of Annual Rainfall versus Annual Baseflow for the Wilson River

The equations relating rainfall to runoff and baseflow are shown below in Equations 3-6 and 3-7 and apply to rainfall in the range of 56 to 193 inches per year, the range of rainfall in the watershed determined from the **precip** grid. The regression statistics for the equations are presented in Table 3-5.

$$Q = 0.38P - 15.5 \quad \text{(Runoff)} \qquad \text{Equation 3-6}$$

$$Q = 0.52P + 1.9 \quad \text{(Baseflow)} \qquad \text{Equation 3-7}$$

where Q = *discharge (in/yr)*

P = *precipitation (in/yr)*

Table 3-5. Regression Statistics for the Precipitation-Discharge Equations

	Rainfall-Runoff	Rainfall-Baseflow
Slope	0.38	0.52
Intercept	-15.5	1.9
t Statistic (Slope)	6.8105	10.2382
t Statistic (Intercept)	-2.2282	0.2915
F ratio	46.3833	104.8215
R-squared value	0.6236	0.7892
Standard Error of Estimate	5.8579	5.3723

Except for the intercept of the rainfall-baseflow relationship, the coefficients are statistically significant. Because the intercept for the rainfall-baseflow is not significant, the intercept may actually be zero, indicating that extrapolation of the relationship outside the range of rainfall data over which the relationship was determined might be possible. The regressions statistics indicate that the intercept of the rainfall-runoff relationship is very probably not zero, thus extrapolation of the relationship outside of the rainfall range of the watershed would be inappropriate, as this would indicate negative runoff values at lower rainfall amounts. The relationship of rainfall to runoff at lower rainfall amounts will differ from the relationship derived here.

The relationships presented in Equation 3-6 and Equation 3-7 are independent of land use. The Soil Water and Assessment Tool (SWAT), a model developed by the US Department of Agriculture, was considered as a method to vary these relationships based on land use. The researchers at the Texas A&M Blackland Research Center conducted a

SWAT model run using information pertinent to the watershed. The initial results indicate that the predicted annual water yield per acre is about 40 percent lower than values reported for the watershed, thus this methodology was not pursued further.

3.4.4 Modeling Baseflow and Runoff

The spatial variability of baseflow and runoff are represented by creating grids of these two discharge components. The script "tillflow.ave" was written for this purpose and is automated in the bactimodel.apr project file. The project file includes a 'Discharge Analysis' drop down menu with a menu item called 'Flow Grids.' The analysis extent and cell size was set to "same as flow direction" prior to execution of this menu option. This script contains qualifiers for determination of baseflow and runoff for land uses designated as water where all precipitation is assumed to be converted to surface runoff. The script requires a grid representation of land use (the **lulccomposite** grid), a grid representation of precipitation (the **precip** grid), and a flow direction grid. These grids are identified through dialog boxes as shown in Figure 3-15. The script inserts the **precip** grid into Equations 3-6 and 3-7 and creates per cell grids of runoff and baseflow, respectively. The flow direction grid is used in an optional step to complete weighted flow accumulations of baseflow and runoff.

If a script is run more than once in the same project and same working directory, the names for the created grids must be changed to avoid attempting to overwrite an existing data set. ArcView cannot overwrite existing data sets, and the project run will crash. These per cell grids represent the average discharge for each grid cell. Once per cell grids are computed, an option is presented to compute weighted flow accumulations of the flow grids. If the weighted flow accumulations are not accomplished at the same time as the average discharge grids, they can be computed later from the 'Discharge' menu by selecting 'Accumulate Flows.' This script requires a flow direction grid and grids of average baseflow and runoff. The weighted flow accumulation represents the sum of average flow values upstream of a given point and accumulated flow grids are in units of cubic feet per year, as are the average flow grids.

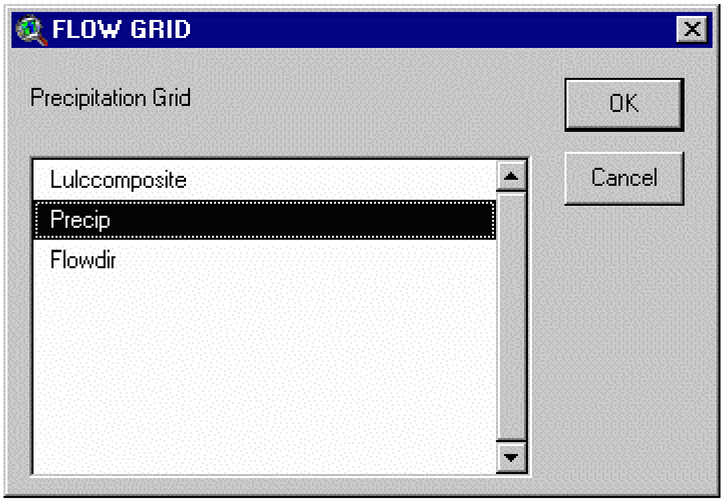


Figure 3-15. Dialog Box for Flow Grid Menu Item

Now that discharge has been modeled, the next step is to determine loads in the watershed.

3.5 Estimating Annual Loads

Loads of constituents delivered to the bay are the result of both point and non-point sources. Wastewater treatment plant (WWTP) discharge points are point sources. Loads from point sources are determined based on average effluent quality and quantity values. Storm related surface runoff makes up the majority of the load from non-point sources because pollutant concentrations are higher in storm runoff than in baseflow. Loads from non-point sources are determined based on EMC values. For the purposes of this report, EMC is defined as the expected mean concentration and represents the flow-weighted average concentration of a constituent in discharge. In this study, EMCs are differentiated between surface runoff and baseflow. While EMCs are not typically associated with the baseflow component of stream flow, the same terminology is used with baseflow EMCs representing average concentrations of constituents in the groundwater producing baseflow.

There are three typical ways of assigning EMC values: 1) based on land use/land cover information; 2) based on percent impervious cover; and 3) based on watershed type (Barrett, 1998). This project uses EMC values based on land use/land cover data.

The focus of this project is to determine load values of fecal coliform and sediment. There are two ArcView project files for determining loads. The bactimodel.apr file has scripts to calculate flows and loads of fecal coliform (often referred to as bacteria in this report), while the sediment.apr file has scripts to calculate loads of sediment. In general, this report describes steps in the bactimodel.apr project. When there are specific differences for the sediment.apr project, they are pointed out. Point source load determinations are discussed first.

3.5.1 Point Source Loads

There are 6 wastewater treatment plants in the Tillamook watershed. There is a point coverage of WWTP discharge locations available on the TB CDROM called **outfall**, but it is incomplete for two reasons. First, there are two discharge points that are missing, Bay City and the Port of Tillamook. Second, for the purposes of determining discharge data, the attribute table is missing information on annual discharge loads for fecal coliform and sediment.

The TBNEP office provided latitude and longitude location data for the two missing outfalls, and a point coverage for these outfalls was created in the same fashion as the rain gage and USGS gage location point coverages. This point coverage was used to edit the original **outfall** coverage to add the two new points; the edited coverage was saved as **outfalls**. Determination of annual loads is outlined below, and once these data were added to the **outfalls** attribute table, load grids representing annual loads from these point sources were created.

The annual loads were determined from monthly Discharge Monitoring Reports for the various WWTPs, provided by the TBNEP office. Sediment effluent quality is reported as the average daily effluent loading for the month in pounds of TSS per day, while bacteria effluent quality is reported as the average effluent bacteria concentration (in fecal coliform per 100 ml) for the month. Average values of effluent bacteria concentrations (found in column 3 of Table 3-6), daily sediment loads, and daily flows (in MGD) were determined as the mathematical average of the reported average values for each month for the period January 1997 to February 1998. Annual effluent flow in cubic feet per year for each plant was then determined by Equation 3-8 and can be found in column 2 of Table 3-6.

$$Q = q \times \frac{365d}{yr} \times \frac{cf}{7.481gal}$$ Equation 3-8

where Q = *average annual flow, in Mcf/yr*

q = *average daily flow over the period, in MGD*

Annual bacteria load, column 4 of Table 3-6, was determined as the product of average daily flow and average effluent concentration, from column 3, as follows:

$$L_b = q \times C \times \frac{10^6 gal}{MG} \times \frac{365d}{yr} \times \frac{1000ml}{L} \times \frac{1000L}{m^3} \times \frac{m^3}{35.3cf} \times \frac{cf}{7.481gal}$$

Equation 3-9

where L_b = *annual bacteria load, in fc/yr*

q = *average daily flow, in MGD*

C = *average effluent concentration, in fc/100ml*

Table 3-6. Average Wastewater Treatment Plant Effluent Data

Plant	Annual Flow	Average Bacteria Concentration	Annual Bacteria Load	Annual Sediment Load
	(Mcf/yr)	(fc/100ml)	($x10^7$ fc/yr)	(lbs SS/yr)
Bay City	15.28	26	11,340	8,225
Garibaldi	19.08	9	4,828	7,762
Pacific Campground	0.10	2	2,119	213
Port of Tillamook	30.50	10	8,315	18,029
Tillamook	87.67	45	111,390	103,323
Creamery	14.03	5	2,158	22,655

Annual sediment load, found in column 5 of Table 3-6, was determined from the average daily effluent sediment load as follows:

$$L_s = l_s \times \frac{365d}{yr}$$ Equation 3-10

where L_s *= annual sediment load, in lbs/yr*

l_s *= average daily sediment load, in lbs/day*

Flow data was not included in the attribute table for **outfalls** nor was it accounted for in the flow grids because the magnitude of flow from the outfalls is minimal (less than one percent of total flow in the basin) compared to the magnitude of the accumulated flows from baseflow and runoff. This is a conservative approach because the addition of flows from these plants serves as dilution, albeit a small dilution volume, at the point of discharge. Note that bacteria load is in units of 10^7 fc/year. The use of this unit expression was necessary to be able to create a grid of the load. For integer grids, all values must be less than 1,000,000. If average discharge values change, the attribute table can be edited to reflect current information. However, any value in the annual load fields must be less than 1,000,000.

Load grids for the point sources were created in the 'bactimodel' project file using 'NPS Analysis/Create Pt Src FC Grid' for fecal coliform, and 'NPS Analysis/Create Pt Src SS Grid' item in the 'sedimodel' project file for sediment. A dialog box prompts for input to identify the **outfalls** point coverage and the field to use for the fecal coliform load, as well as a name for the new grid. Remember the naming convention rule for multiple script runs – change the grid name or set the project to a new working directory. The resultant grid appears in the view as a solid color. The **outfalls** point coverage can be used as a guide to zoom in on one of the plant outfalls to see one grid cell that is a different color and represents the annual load for that plant. If this grid cell is queried using the  button, the value returned is the annual load value for that particular WWTP point source –units are 10^7 coliform/year for bacteria and pounds/year for sediment. This point source grid is used later in the load calculation. The next step is to determine non-point sources which are related to land use.

3.5.2 Land Use Data

EMC values for discharge in the basin are assigned based on land use. United States Geological Survey (USGS) Land Use and Land Cover (LULC) data describe vegetation, water, natural surface, and cultural features on the land surface. The USGS publishes these data sets and associated maps as part of its National Mapping Program. The LULC files use the Anderson Land Use classification system to differentiate different LULC types. This classification system uses nine main categories, which are then subdivided by a second digit to distinguish among subcategories of the main categories (US Geological Survey, 1999a). The LULC files for the Tillamook area include seven of the nine main categories.

- 1 = Built-up/Urban
- 2 = Agriculture
- 3 = Rangeland
- 4 = Forest
- 5 = Water
- 6 = Wetlands
- 7 = Barren

The LULC data for this study was obtained from the EPA FTP site *ftp://ftp.epa.gov:/pub/EPAGIRAS/wgiras*.

The files found at this site are based on the USGS 1:250,000 land use and land cover data sets. The EPA took USGS data in ASCII format and processed it with an Arc/Info AML script to create an Arc/Info compatible data set. Once at the ftp site, the file 'lva45122.e00.gz' was downloaded – this is the quad sheet that contains Tillamook County and is in Albers projection. The file was imported using the Import71 function of ArcView and then projected to Oregon Lambert in Arc/Info using the projection file, 'alblamb,' found in Appendix A. After projection, the 'build….poly' command was used to create the coverage.

This projected coverage has LULC information for the USGS quad containing Tillamook County and was clipped down to the study area by first converting the coverage to a grid in ArcView using 'Lucode' as the field for cell values. The grid was reduced to the extent of the study area in Arc/Info/Grid by setting the map extent and window to **tillbuf2k** and the cell size to 100. The final grid was saved as **lulcarea**.

The LULC data from the USGS is somewhat generalized. The TBNEP office provided a coverage called **lowpoly** (which can be downloaded from the TBNEP webpage) that has more detailed information on land use in the lowland areas based on digital ortho-quarter quad photos provided by the USDA. This coverage was used to augment the **lulcarea** land use grid, but has designations of LULC codes that are not currently part of the Anderson classification system. Therefore, two additional subcategories under the "built-up/urban" category were created for this project – rural residential (code 18) and rural industrial (code 19).

The **lowpoly** coverage has several fields in the attribute table that were used in determining how to augment the USGS land use coverage. The first is 'type' which generally equates to the Anderson classification, and the second is 'd-type' which describes development type and includes designations such as farm building, rural residential, and rural industrial. The third field of interest is acreage. Since the grid cell size for all grids is 100 feet, polygons that were selected to use in editing the **lulcarea** grid were generally limited to those that were greater than 1 acre, approximately equal to 4 grid cells.

The rural residential polygon acreage was handled a bit differently. Lands identified as rural residential (d-type = RR) are assumed not to be on an urban sewage collection system, and therefore would be likely to have a septic system. For this reason, rural residential land use was assumed to represent the potential fecal coliform load associated with failing septic systems. For rural residential land use, the polygons were limited to those greater than 3 acres. The 1982 Tillamook Bay Bacteria Study indicated that there were approximately 2900 homes on septic systems (Jackson and Glendening, 1982)). An assumption was made that there would be one septic system per acre of rural residential lands. The attribute table of the **lowpoly** coverage was exported as a '.dbf' file and opened in Excel to examine acreage of rural residential lands. Polygons with acreage greater than or equal to 3.0 were selected and assumed to have one septic system per acre of land. Any portion of an acre exceeding one half acre is equated to an additional septic system above the assumed one per acre. For example, a rural residential polygon with 3.2 acres would be assumed to include 3 septic systems, whereas a polygon with 3.8 acres would be assumed to include 4 septic systems. This methodology results in 2,854 septic systems in the watershed. Since the resulting number of septic systems using these assumptions is fairly close to the number reported, rural residential d-type polygons that were selected for use in augmenting land use information were limited to three acres.

In order to prepare the **lowpoly** coverage for use in augmenting the **lulcarea** grid, the attribute table was edited to add a field for a Landuse-Id which was populated based on either 'type' designation or 'd-type' designation or a combination of both. The query builder tool was used to select various records for a specific type and/or d-type. Once the records were selected, they were promoted to the top of the table for ease of entering the land use code. Land use determinations were made as follows:

- D-type = PO; there were 3 polygons with this designation that were listed as gravel pits. Gravel pits equates to Anderson Land Use Classification 75, for a type of barren land.
- D-type = FB and type = AG with no d-type classification; acreage >= 1.0; these polygons were assigned a land use id of 23, for confined animal feeding operations, to represent lands used for dairy activity. The polygons less than 1.0 acre were not assigned a value with the assumption that they retain the land use id of the **lulcarea** grid which in almost all cases is 21, cropland and pasture. The land use id of 23 is associated with all CAFO operations.
- D-type = RR; acreage >= 3.0; there is not an Anderson Land Use Classification specifically for rural residential. In order to be able to distinguish these polygons from urban lands, a new code (18) was assigned.
- D-type = RI; acreage >= 1.0; there is not a land use id for rural industrial either, so a new code (19) was assigned.
- Type = ST, SL, TC; acreage >= 1.0; these types are water bodies. They are assigned a land use id of 51 for streams and canals.
- D-type = UR; acreage >= 1.0; four records selected were also classified as type SL/ST. These four were left as land use id 51. Other records were assigned land use id 11 for urban residential.
- Type = LF; acreage >= 10.0; there were not many LF (lowland forest) polygons. Since the acreage of polygons in the lowlands is so small compared to the forest area, only those polygons greater than 10 acres were selected. These were assigned a land use id 43 for mixed forest land. All other LF polygons retain the land use code in the larger **lulcarea** grid.

- Type = NP; there was only one polygon with this designation for natural prairie. It was given a land use id 33 for mixed rangeland.

Once all of these land use codes were entered, the edits to the attribute table were saved.

In order to merge the more detailed land use information into the **lulcarea** grid, the **lowpoly** coverage was converted to a grid format. The grid version of the **lowpoly** coverage is merged into the **lulcarea** grid using the “merge.ave” script. The **lowpoly** grid is the primary grid, the **lulcarea** grid is the secondary grid, and the new grid was named **lulccomposite**.

After merging the two data sets, the resultant grid was visually examined in ArcView. There were two areas that should have been designated as CAFO (land use 23) that were designated as other agricultural lands. Examination of the attribute table for the **lowpoly** coverage revealed that there were two relatively large polygons with type designation as AG with a value of 0.0 for the acreage. From the size of the polygons, it was quite obvious that the acreage is greater than 1.0, and thus, both polygons should have been coded as land use 23. This was corrected in the **lowpoly** attribute table and the process of converting the coverage to a grid and merging it with the **lulcarea** grid was repeated. The **lulccomposite** grid was then converted back to a polygon in Arc/Info using the ‘gridpoly’ command and named **landuse**.

3.5.3 Linking EMCs to Land Use

In this study, EMCs were based on land use classification. Table 3-7 shows the EMC values assigned for baseflow and runoff and are based on professional judgment except where noted. These EMC values were gathered from various literature sources and data from various monitoring efforts. In both cases, water and wetlands were assumed to contribute no significant loads.

Table 3-7. EMC Values for Bacteria and Sediment

Grid Code	Land Use	Baseflow		Runoff	
		Bacteria	Sediment	Bacteria	Sediment
11-17	Urban/Built-up	100	5	10,000[1]	60[3]
18	Rural Residential	100	5	10,000[1]	60[3]
19	Rural Insudtrial	100	5	10,000[1]	150[3]
21,22,24	Various Ag Lands	100	5	1,500	100[3]
23	CAFO Dairy Land	1,000	5	30,000[4]	200[2]
30s	Rangeland	5	5	20	20
40s	Forest	5	5	20[2]	20[2]
50s	Water Bodies	0	0	0	0
60s	Wetlands	0	0	0	0
70s	Barren Lands	5	5	20	20

(1) Literature values
(2) Based on sampling data
(3) Based on the City of Portland's NPDES Stormwater sampling
(4) Calibrated within range (20K – 40K) of literature values

3.5.3.1 Bacteria EMC Values for Runoff

EMC values for bacteria load were represented by fecal coliform. While fecal coliform are not the only bacteria type of concern, this parameter is commonly used to indicate the presence of various pathogens that might be of concern.

The EPA's Report "Results of the Nationwide Urban Runoff Program (NURP), Volume I – Final Report" (US EPA, 1983) compiles the results of a program to characterize urban runoff. The NURP sampling program results indicate median fecal coliform concentrations range from 20 fc/100ml in cold weather to 281,000 fc/100ml in warm weather. The overall median value for warm weather was 21,000 fc/100ml, while the corresponding median value for cold weather was 1,000 fc/100ml. For an annual average, a value of 10,000 fc/100ml seems to be a reasonable value to expect for 'Urban/Built-up' land use. As much of the sampling under the NURP included urban commercial and industrial land use, an assumption has been made that runoff from 'Rural Industrial' land use may be characterized by the same value. In addition, no other data has been found to support a different value for that land use.

Since the ‘Rural Residential’ land use is assumed to be indicative of the pollutant load of failing septic systems, an average value associated with untreated domestic wastewater is appropriate. Metcalf & Eddy’s “Wasterwater Engineering: Treatment, Disposal, Reuse” lists concentrations of different microorganisms typically found in domestic wastewater (Metcalf & Eddy, 1991). A typical value for fecal coliform is 100,000 fc/100ml. Contamination in runoff from rural residential land use is assumed to result from a system failure. Taking into account some bacteria die-off in the septic tank and considering that any failure-related effluent is diluted by other ‘clean’ runoff on the property, the resultant EMC value for rural residential should be lower than untreated wastewater, therefore a value of 10,000 fc/100ml seems reasonable.

The database of sample results from the E&S Environmental Chemistry, Inc sampling efforts in 1997 and 1998 was queried for samples taken at forest/agricultural interface points representing runoff from forested lands before the influence of agricultural lands (E&S Environmental Chemistry, Inc., 1998). Those four sampling points are designated as “KIL-KRP,” “MIA-UPP,” “TRA-HAT,” and “WIL-KCB.” The average value for samples collected at these sites was 24 fc/100ml, thus a value of 20 fc/100ml is appropriate. An assumption was made that ‘Rangeland’ and ‘Barren Lands’ have similar characteristics. Even if this assumption is not quite accurate, it does not significantly alter the model results since these land use types make up a very small percentage of the land (both less than a tenth of a percent).

The CAFO dairy land use is indicative of the dairy operations in the watershed. Typical storm runoff quality from land supporting dairy operations ranges from 20,000 to 40,000 fc/100ml (Crane et al, 1983). Refinement of this number to the value seen in Table 3-7 can be found later in the section entitled “Deriving the CAFO land use EMC Value for Fecal Coliform.” The ‘Other AgLand’ category is assigned a value of 1,500 fc/100ml using professional judgment. Again, because this land use type makes up a very small percentage of the total land use (about half of a percent), its assigned value has minimal impact on the overall loads.

3.5.3.2 Sediment EMC Values for Runoff

Recently, sampling in the Tillamook Bay watershed was conducted at the bottom of a dairy pasture to determine sediment concentrations in runoff from dairy lands (Moore, 1999). Three samples taken show concentrations of 60, 130, and 320 mg/L. Based on this sampling, a value of 200 mg/L was chosen to be representative for sediment concentrations in runoff from CAFO dairy lands. Samples taken by E&S Environmental Chemistry, Inc at the forest/agricultural interface average about 20 mg/L for TSS (E&S Environmental Chemistry, Inc., 1998). This value was chosen to be indicative of forest, rangeland, and barren lands.

Sediment EMC values for urban, rural residential, rural industrial, and other agricultural lands were taken from the City of Portland's NPDES Stormwater Permit Application (City of Portland, 1993). Reported mean values were adopted for use in this project. The 'R2' station was used to represent quality of urban and rural residential land uses. Septic systems are not assumed to be an effective source of sediment, so sediment EMC values for rural residential lands are assumed to be the same as for other urban lands. The mean value for sampling at the 'R2' station was 57 mg/L, thus a value of 60 mg/L was assigned to urban and rural residential land uses. The 'I2' station representing light and general manufacturing was used to represent the rural industrial lands (land use code 19). The mean value for sampling at 'I2' was 142 mg/L, thus a value of 150 mg/L was used for this study to represent rural industrial lands. The 'OP1' station was used to represent other agricultural lands (land use codes 21, 22, and 24) with an EMC value of 100 mg/L.

3.5.3.3 Baseflow EMC Values

EMC values for both bacteria and sediment in baseflow were chosen based on best judgment. The literature search revealed no information to support selection of values.

3.5.3.4 Linking EMCs and Land Use

Once EMC values for baseflow and runoff were selected, they were associated with the land use through the attribute table of the **landuse** polygon coverage. The script "bacticoncvalue.ave" was written and added as a menu item in the bactimodel.apr ArcView project file. The corresponding script in the sedimodel.apr project file is named "sedimconcvalue.ave." From the 'NPS Analysis' menu, 'Set EMC defaults' is selected to set the EMC values. Several dialog boxes like the one seen in Figure 3-16 prompt for the following information: 1) the land use polygon coverage and 2) the field that designates the land use code (this field is grid code). As a note, the land use polygon coverage that is designated must be editable (i.e., do not use a coverage directly from a CD ROM).

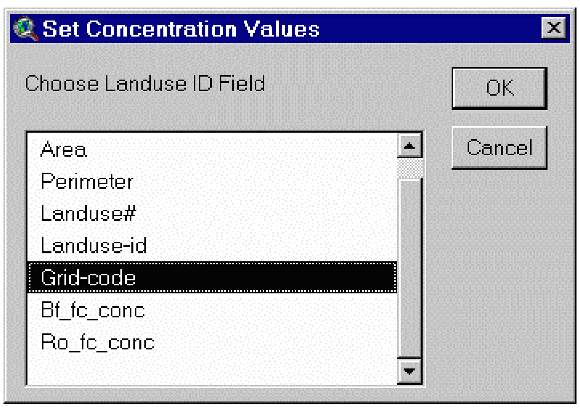


Figure 3-16. Dialog Box to Choose the Land Use Identifier Field

The script looks for fields named "Bf_fc_conc" (indicating fecal coliform concentration associated with baseflow) and "Ro_fc_conc" (indicating fecal coliform concentration associated with runoff). In a similar fashion, the sediment script looks for fields named "Bf_ss_conc" and "Ro_ss_conc." If these two fields are not found, they are added, and a dialog box is presented to input the EMC values for various land uses – see Figure 3-17.

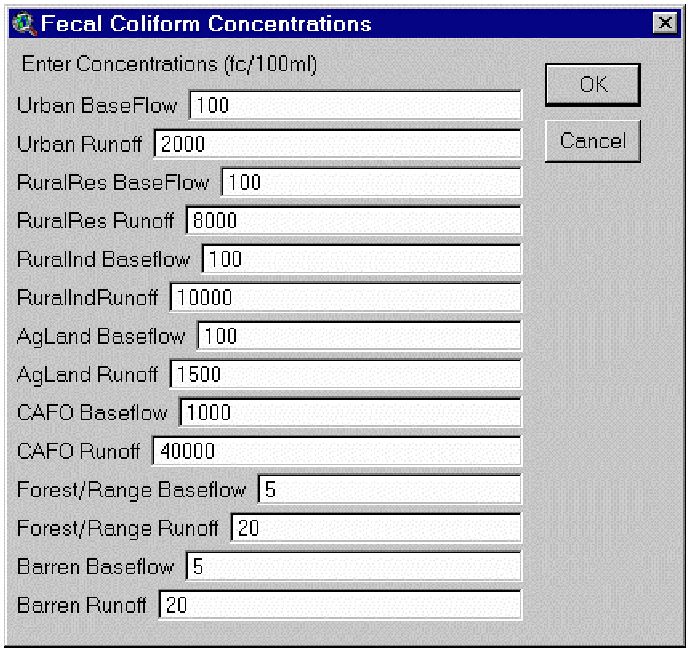


Figure 3-17. Input Dialog Box for Fecal Coliform EMC Values

There are default values already entered based on Table 3-7, however, one or all of the values may be changed based on additional or updated information. Note that changing the values in the dialog box will not change the default values, it will merely change the value that is used for the current run. Any changes to the default values should be documented to be able to relate EMC values to their associated created load grids and values. The default values may be permanently changed by editing the script itself. In addition, if the script is run multiple times, the previously assigned values in the **landuse** polygon coverage attribute table are over-written.

3.5.4 Non-point Source Loads

The next step is to create grids of the bacteria load associated with runoff and with baseflow. This has been automated in the 'NPS Analysis' menu by selecting 'Create Non Pt Src FC Grids.' The corresponding menu item in the sedimodel project file is 'Create Non Pt Src SS Grids.' A series of dialog boxes identifies the land use theme, the STP point source grid (**stpfcgrid**), average baseflow grid (**baseflowcf**), average runoff grid (**runoffcf**), and the flow direction grid. The baseflow concentration field (Bf_fc_conc) and the runoff concentration field (Ro_fc_conc) are identified next. This script creates two grids from the **landuse** coverage, one based on the baseflow concentration field and one based on the runoff concentration field – both of these grids are virtual grids and are not ever actually created even as temporary grids, so they are not actually ever seen. These two virtual grids are multiplied by the appropriate average flow grids with a conversion factor to get a resultant grid of average per cell load in units of fecal coliform per year and are named **bfbactigrid** (for baseflow) and **robactigrid** (for runoff).

Land related loads at any given grid cell location are calculated as follows:

$$L_{RL} = \sum_{i=1}^{x} \left[(Q_R)_i \times (C_{RL})_i \right]$$ Equation 3-11

$$L_{BL} = \sum_{i=1}^{x} \left[(Q_B)_i \times (C_{BL})_i \right]$$ Equation 3-12

$$L_L = L_{RL} + L_{BL}$$ Equation 3-13

where L_{RL} *= delivered pollutant load from land surface wash-off*

L_{BL} *= delivered pollutant load from baseflow*

Q_R *= average per cell surface runoff*

Q_B *= average per cell baseflow*

C_{RL} *= concentration of pollutant in surface runoff*

C_{RB} *= concentration of pollutant in baseflow*

L_L *= total delivered load from land related sources*

X = number of cells upstream of the location in question

The conversion factor for bacteria is:

$$\frac{ft^3}{yr} \times \frac{fc}{100ml} \times \frac{m^3}{35.3\,ft^3} \times \frac{1000L}{m^3} \times \frac{1000ml}{L} = 283\frac{fc}{yr}$$ Equation 3-14

The conversion factor for sediment is:

$$\frac{ft^3}{yr} \times \frac{mg}{L} \times \frac{1000L}{35.3\,ft^3} \times \frac{lbs}{0.4536kg} \times \frac{kg}{10^6\,mg} \times \frac{ton}{2000lbs} = 3.14 \times 10^{-8}\frac{tons}{yr}$$

Equation 3-15

Loads can be accumulated at this time, using the optional weighted flow accumulation step (described by Equations 3-11 and 3-12), or at a later time using the generic weighted flow accumulation item under the 'Misc Tools' menu. The delivered load at any given location is the sum of loads from baseflow and runoff as shown by Equation 3-13. The current load grids (**bfbactigrid** and **robactigrid**) do not take into account the effect of any Best Management Practices (BMPs). However, it may be useful to compare results before and after BMPs are accounted for, so it may be useful to accumulate these pre-BMP load grids. An accumulated grid for the baseflow load is required later on in the project file when effects of BMPs are accounted for, so it must be created at some time during the project run. There is an option in the BMP script to accumulate the baseflow load, so it can be created at either point in project execution. If loads are accumulated at this time, a dialog box prompts for a name for the accumulated grids. The default name for the accumulated runoff load is **raccbgrid**; the accumulated baseflow load is **baccbgrid**.

The sediment model has similar steps for creating load grids with an additional step for creating a supplemental sediment load. This additional sediment load is discussed later in the report.

As mentioned before, these developed load grids do not yet account for implementation of BMPs. The next section presents a methodology for incorporating reductions realized from BMP implementation.

3.6 Modeling Effects of Best Management Practices (BMPs)

Most of the BMPs being considered for implementation are non-located BMPs. This class of BMP includes such things as manure application methods and represents diffuse reductions applied to areas versus at a specific point. Located BMPs, such as wet ponds, are also being considered in the Tillamook watershed and represent reductions applied at a specific point in the watershed. The current model only incorporates effects of non-located BMPs. However, a tool was developed that allows for determination of the effect of a located BMP placed in the watershed.

Modeling the effects of BMPs presented the author with some challenges, specifically that of locational or spatial variability of effects. The specific CAFO locations are identified by a point coverage. While assumptions have been made about what land is associated with CAFO operations (through the land use coverage), there is not an effective way currently to associate a specific CAFO with specific parcels of land. Even if information is available to say which CAFOs are implementing a certain BMP, there is not an effective way available to associate a reduction on a specific parcel of land, so, the concept of spatial averages was used. The percent reduction associated with a specific BMP was multiplied by the percent of the CAFOs that have implemented that BMP, and the resultant effective reduction was applied to all CAFO dairy lands. An illustration of this concept of spatial averages is presented below in Figure 3-18. For example, if proper manure storage and handling results in a 25 percent reduction in bacteria concentration and 20 percent of the CAFOs have proper manure storage and handling, the effective reduction is 0.25 x 0.20 = 0.05, or a 5 percent reduction, which is applied over all the dairy land use areas (represented by land use code 23).

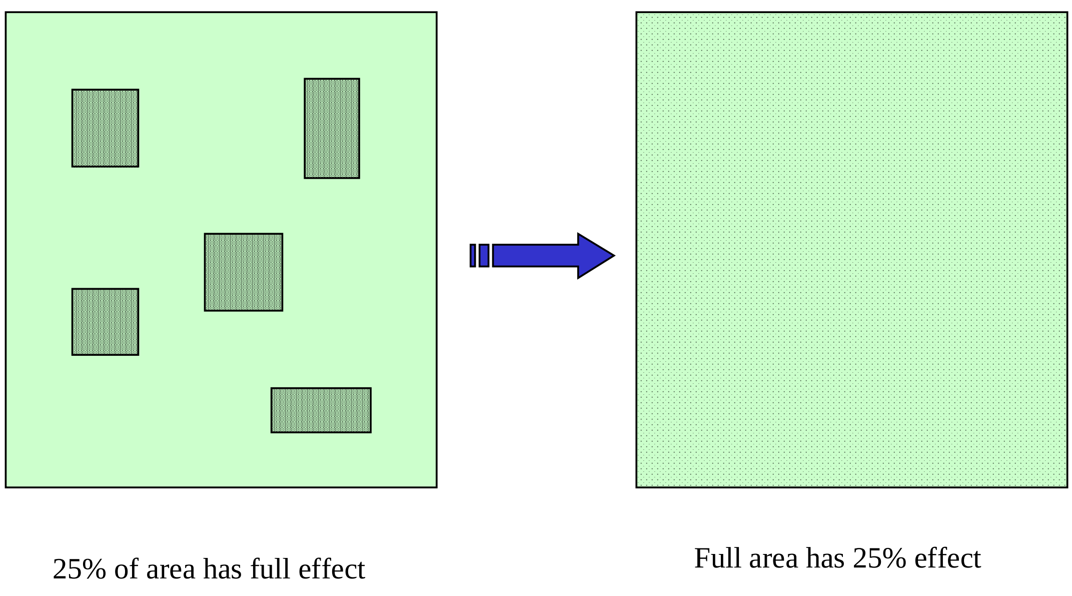


Figure 3-18. Spatial Averaging of Applied Management Practices

For multiple BMPs, the total effective reduction can be found as:

$$E_{tot} = [1 - ((1 - E_1) \times (1 - E_2) \times (1 - E_3))] \qquad \text{Equation 3-16}$$

where E_{tot} *= overall reduction*
E_1 *= the effective reduction from BMP1*
E_2 *= the effective reduction from BMP2*
E_3 *= the effective reduction from BMP3*

3.6.1 Non-located BMP Representation

There are currently three non-located BMPs that apply to CAFO dairy lands incorporated into the bactimodel project file. Non-located BMPs are similar to non-point sources and represent diffuse reductions that are applied over the entirety of the dairy lands. These non-located BMPs are: 1) Proper Manure Storage and Handling, 2) Proper Manure Application, and 3) Riparian Buffers/Fencing. The TBNEP office provided estimated percent reduction in loads associated with these BMPs (Nelson, 1998). Percent implementation was determined from data in the Tillamook Rural Clean Water Project Report, specifically, Table 2-1 (USDA, 1991). The number of farms implementing proper manure storage and handling was based on the minimum number of farms that had either adequate dry waste storage (BMP 2-a-1) or adequate liquid storage (BMP 2-a-1) or adequate roofing (BMP 2-a(2a)) or adequate guttering (BMP 2-a(2b)). The minimum number was chosen on the assumption that to meet the BMP all four of these factors had to be present. The number of farms implementing proper manure application was based on the number of farms deemed to have appropriate waste utilization (BMP 15-a). The number of farms implementing riparian buffers or fencing was based on the minimum number of farms that had either stream bank protection (BMP 10-a) or fencing (BMP 10-b). Again, the minimum number was chosen on the assumption that to meet the BMP both factors had to be present. There are currently 120 CAFOs in the Tillamook Bay watershed and Table 3-8 shows the compiled BMP information. Effective percent reduction for a particular BMP is determined as the product of the percent implemented and the percent reduction.

Table 3-8. Compiled Best Management Practice Information

BMP	BMP Designation[1]	Number of Farms	Farms with BMP Implemented	% Reduction	Effective % Reduction
Proper Manure Storage and Handling	2-a-1 (dry)	70	----		
	2-a-1 (liquid)	65	65/120 (0.54)	0.40	0.22
	2-a (2a)	77	----		
	2-a (2b)	80	----		
Proper Manure Application	15-a	67	67/120 (0.56)	0.60	0.34
Riparian Buffers or Fencing	10-a	7	----		
	10-b	6	6/120 (0.05)	0.25	0.01

(1) Taken from Table 2-1 of the *Tillamook Rural Clean Water Project* report (USDA, 1991)

In addition, there is a BMP reduction associated with the rural residential land use. As was indicated in the land use section of this report, the rural residential land use represents the presence of septic systems, and failing septic systems result in bacteria load. If a similar spatial average concept is used here, the percent of systems failing indicates the percent of load remaining for the rural residential land use. The impact of failing septic systems is incorporated into the model with the load from rural residential lands reduced based on the percent of systems deemed to be adequately sized and functioning properly.

3.6.2 Modeling Non-located BMP Reductions

The BMP effects are incorporated into the model through the “bmpeffect.ave” script which is accessed by the ‘NPS Analysis/BMP Effects’ menu item. The script for the bacteria model has the prefix ‘bacti’ while the script for the sediment model has the prefix ‘sedi’ in front of the script name. An assumption is made that these BMPs only affect load associated with surface runoff. At the start of the script run, a series of dialog boxes is presented to identify the land use grid (**lulccomposite**), the bacteria load associated with runoff (**robactigrid**), the bacteria load associated with baseflow (**bfbactigrid**), and the flow direction grid. Information about BMP implementation and effectiveness is entered via another dialog box as presented in Figure 3-19.

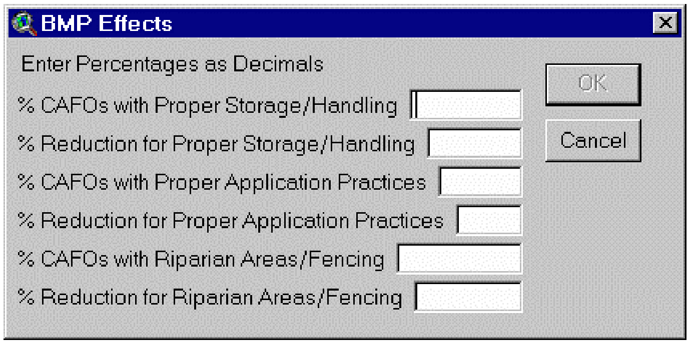


Figure 3-19. Dialog Box for Entering BMP Data

A dialog box also prompts for the percent of septic systems that are failing as shown in Figure 3-20.

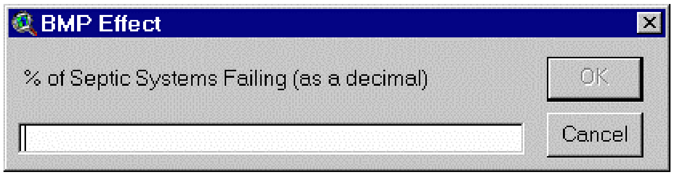


Figure 3-20. Dialog Box to Enter Septic System Failure Percentage

Next, an information box appears indicating the combined effective reduction associated with CAFO dairy land BMPs.

This script contains a condition statement that queries the land use grid, looking for grid cells with land use code 23 (for CAFO dairy lands) or 18 (for rural residential lands). If the land use grid value is 23 (for CAFO dairy lands), the value of the **robactigrid** is multiplied by the effective percent remaining for the CAFO BMPs and the result is written to the new grid. If the land use grid value is 18 (for rural residential), the value of the **robactigrid** is multiplied by the percent remaining due to failing septic systems and the result is written to the new grid. For all other cells, the value from **robactigrid** is written to the new grid indicating no reduction. After the **bmpbactiload** (the default name for the new grid) is computed, an optional flow accumulation can be computed for the new reduced runoff bacteria grid and saved with the default name **accbmpbacti**. If a flow accumulation of the bacteria grid associated with baseflow was not conducted earlier, it can be accomplished after the runoff accumulation.

The script to calculate reduced runoff load for sediment follows the same procedures as the bacteria script with a few minor differences. The only applicable BMP for sediment is assumed to be the Riparian Areas/Fencing BMP. The assumption is that manure related practices do not contribute significantly to the sediment load, therefore, those related BMPs do not significantly alter the load. In addition, septic systems were not considered to contribute significantly to sediment load, and rural residential lands are considered to contribute a load similar to other urban lands. For this reason, the septic system failure rate doesn't alter the resultant load.

3.6.3 Located BMP Tool

A button tool was also developed to determine the effects of a located BMP which represents 'concentrated' removal of load at a specific point (e.g., a detention pond) rather than diffuse removal over larger land areas. This tool is available in both the bacteria and sediment models. It is accessed by using the footprint button, , available when the View is active and requires that the BMP be interactively located using the mouse and cursor. Dialog boxes appear to designate the accumulated runoff and the accumulated load associated with runoff. For the sediment model, this tool also requires that the accumulated supplemental sediment load grid (discussed in the next section) be identified. The removal efficiency is input via a dialog box, and the model calculates the predicted concentration before and after implementation. This tool does not actually affect overall load calculations as the non-located BMP script does, it merely provides the ability to evaluate "what if…." scenarios.

3.7 Calibrating the Model

Bacteria model calibration was conducted by adjusting the runoff EMC value for the CAFO dairy land use within the range reported in the literature. The runoff EMC value for CAFO dairy lands was selected for calibration because it has the largest impact on loads and concentrations due to its magnitude and percent of land use relative to urban land uses (with the next largest EMC values). While this calibration did not allow for an exact match of reported values, it did allow for adjustment to approach those values.

Model runs for sediment concentrations and loads based solely on land use related contributions (using reasonable EMC values) predicted values much lower than those reported in previous studies, indicating that there are other sources of sediment not accounted for by land use. A supplemental sediment load grid was calculated in the sediment model in an effort to better approximate reported sediment concentrations.

3.7.1 Deriving the CAFO dairy land use EMC for Fecal Coliform

From the data derived in the bactimodel project file, it is apparent that the majority of the fecal coliform load is associated with the CAFO dairy land use. Figure 3-21 presents the relative contribution of bacteria load for each of the five major sub-basins. This bar graph clearly shows the dominance of CAFO dairy lands to the total bacteria load.

The EMC value for CAFO dairy land use used in this study was calibrated with the aim of matching the flow-weighted average concentration of fecal coliform measured during the periodic and storm monitoring program conducted by E&S Environmental Chemistry, Inc. (Sullivan et al, 1998a). This calibration does take into account the effect of assumed BMP implementation. ArcView's 'Summarize Zones' under the 'Analysis' menu was used to facilitate this effort and required that the land use grids be clipped to the extent of each of the five major river basins for processing.

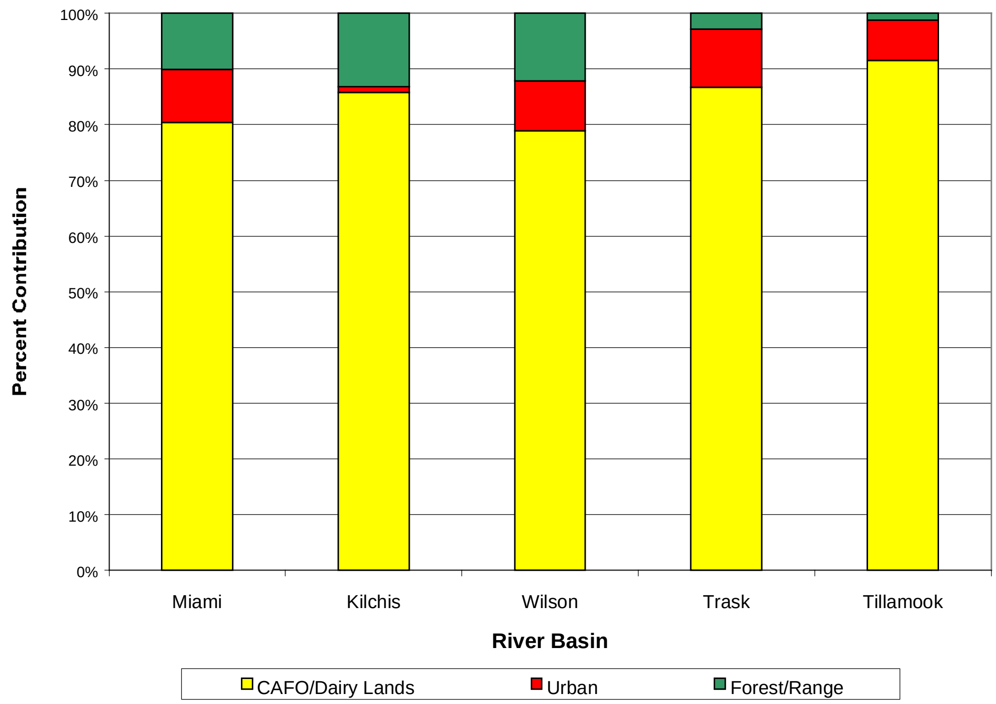


Figure 3-21. Bacteria Load Contribution by Land Use for the River Basins

The clipped grids were created using the "gridclip.ave" script with the shapefile of the modeled extent of each river basin as the clipping polygon. The shapefiles for each of the five river basins were created from the **rivbasin.shp** shapefile. The individual basin shapefiles were named **miami.shp**, **kilchis.shp**, **wilson.shp**, **trask.shp**, and **tillamook.shp**.

The grids that are created with the "gridclip.ave" script are temporary and were saved as **kilchislu**, **miamilu**, **tillamooklu**, **trasklu**, and **wilsonlu**. Each of these grids has the value from the **lulccomposite** grid within the extent of each river basin and a value of nodata elsewhere. These grids were used as the zone in the 'Summarize Zones' analysis to determine how much baseflow and runoff are associated with which land uses in each of the five basins. This data was used in the CAFO dairy land EMC calibration.

The summarize zones command calculates statistics such as minimum, maximum, mean, and sum for a chosen value grid. While all default statistics were calculated, the sum is the desired statistic, indicating the sum of baseflow or runoff for a particular land use within a basin. The 'Summarize Zones' command was executed for each river basin using first the **baseflowcf** grid, and then the **runoffcf** grid, as the variable to summarize, and the basin specific land use grid to designate 'zones.'

Baseflow and runoff were summarized for each of the five rivers, and the resultant table was exported to a .dbf file which was examined in Excel. The table for the Wilson River compiled data is shown in Table 3-9. This data was transferred to a worksheet with columns for land use, land type, baseflow, runoff, baseflow concentration, and runoff concentration.

Table 3-9. Compiled Flow Data for the Wilson River Basin from Summarize Zones Analysis

Land Use	Land Type	Wilson Runoff (Mcf/yr)	Wilson Baseflow (Mcf/yr)
11	Urban	15.3	38.1
12	Urban	2.2	5.4
13	Urban	0.5	1.3
16	Urban	2.1	5.0
18	Rural Res	39.2	99.8
19	Rural Ind	3.5	9.5
21	AgLand	15.8	40.5
23	CAFO	135.2	349.9
42	Forest	12,223.4	26,971.7
51	Water	76.4	0
62	Wetlands	0.3	0.7

Similar worksheets were created for each river basin, and formulas were set up to calculate load (the product of flow and concentration) for each component of flow, add the loads from the two components, sum loads for all land uses, and divide by total flow in the river basin to get a predicted concentration. Since the object of this effort is to calibrate the CAFO dairy land use EMC including the effects of BMPs, an excel workbook was setup to include the worksheets created for each of the five rivers and links to a new worksheet to detail the BMP reductions. The BMP reductions worksheet links model runoff concentration and model baseflow concentration based on land use to each of the basin worksheets that calculate predicted concentrations. This worksheet also back calculates an unaltered runoff concentration for the CAFO land use based on the reductions gained from BMP efforts. The comparison between the E&S Environmental Chemistry flow-weighted average values and the predicted values determined from this analysis are seen in Table 3-10.

Table 3-10. Comparison of Predicted and Reported Fecal Coliform Concentrations

Basin	Flow Weighted Average Conc (fc/100ml)[1]	Predicted Conc (fc/100ml)	% Diff
Miami	133	92	-31
Kilchis	38	73	91
Wilson	158	77	-52
Trask	169	302	79
Tillamook	523	622	19

(1) From *Water Quality Monitoring in the Tillamook Watershed* (Sullivan et al, 1998a)

In some cases, this scheme over-predicts average concentrations, in some cases there are under-predictions. Several different values for the CAFO dairy land bacteria EMC were evaluated, but the comparison presented in Table 3-10 seemed to present the best trade-off between over- and under-predictions. Analysis of observed data demonstrate quite a bit of variability, and given this variability, the comparison in Table 3-10 seems reasonable. This observed data variability is explored in more detail in the discussion of results presented later in this report. In general, the values are an order of magnitude within the E&S Environmental Chemistry values. From this analysis, the resultant runoff concentration associated with CAFO land use is 29,179 fc/100ml, and the default runoff value for CAFO land use has been set to 30,000 fc/100ml.

3.7.2 Deriving the Supplemental Sediment Load

The predicted sediment concentrations for the 5 river basins were determined, and in all cases, the predicted concentration based strictly on land use contribution was much lower than values reported by E&S Environmental Chemistry in recent sampling efforts (Sullivan et al, 1998a). It was also noted that the difference between reported and predicted values was much larger for the larger river basins. A plot was constructed showing land use derived concentrations and reported flow weighted average concentration versus drainage area for the 5 rivers and is presented in Figure 3-22. The predicted concentrations based solely on land use contribution appear to be entirely independent of drainage area, and the reported flow-weighted average seems to increase with increasing drainage area. From the graph in Figure 3-22, it seems that a large portion of the sediment load may be related to stream bank erosion rather than wash-off of sediment from the land surface. This larger erosion-related component of sediment is a result of larger drainage areas that tend to have greater streamflow, and thus more erosive power, especially during floods. While this study did not examine bank erosion in detail, an attempt was made to develop a supplemental load calculated for the modeled stream network grid cells to represent this bank erosion component of the sediment load. These stream grid cells are identified by querying the flow accumulation grid for those cells with a value greater than 1000, the threshold chosen to define a modeled stream segment. Using linear regression, a relationship was developed between the flow-weighted average reported values and the drainage area (represented as the flow accumulation value rather than in area units for this analysis) and is presented in Equation 3-17. The regression statistics for this equation are shown in Table 3-11.

$$C_E = (0.000379 \times FAC) + 2.8 \qquad \text{Equation 3-17}$$

where C_E = *concentration associated with erosion*

FAC = *flow accumulation value*

Table 3-11. Regression Statistics for the Supplemental Load Grid Equation

	Concentration-Flow Accumulation
Slope	0.000379
Intercept	2.80
Slope, t Stat	3.3747
Intercept, t Stat	0.0421
F ratio	11.3888
R-squared value	0.7915
Standard Error of Estimate	45.1431

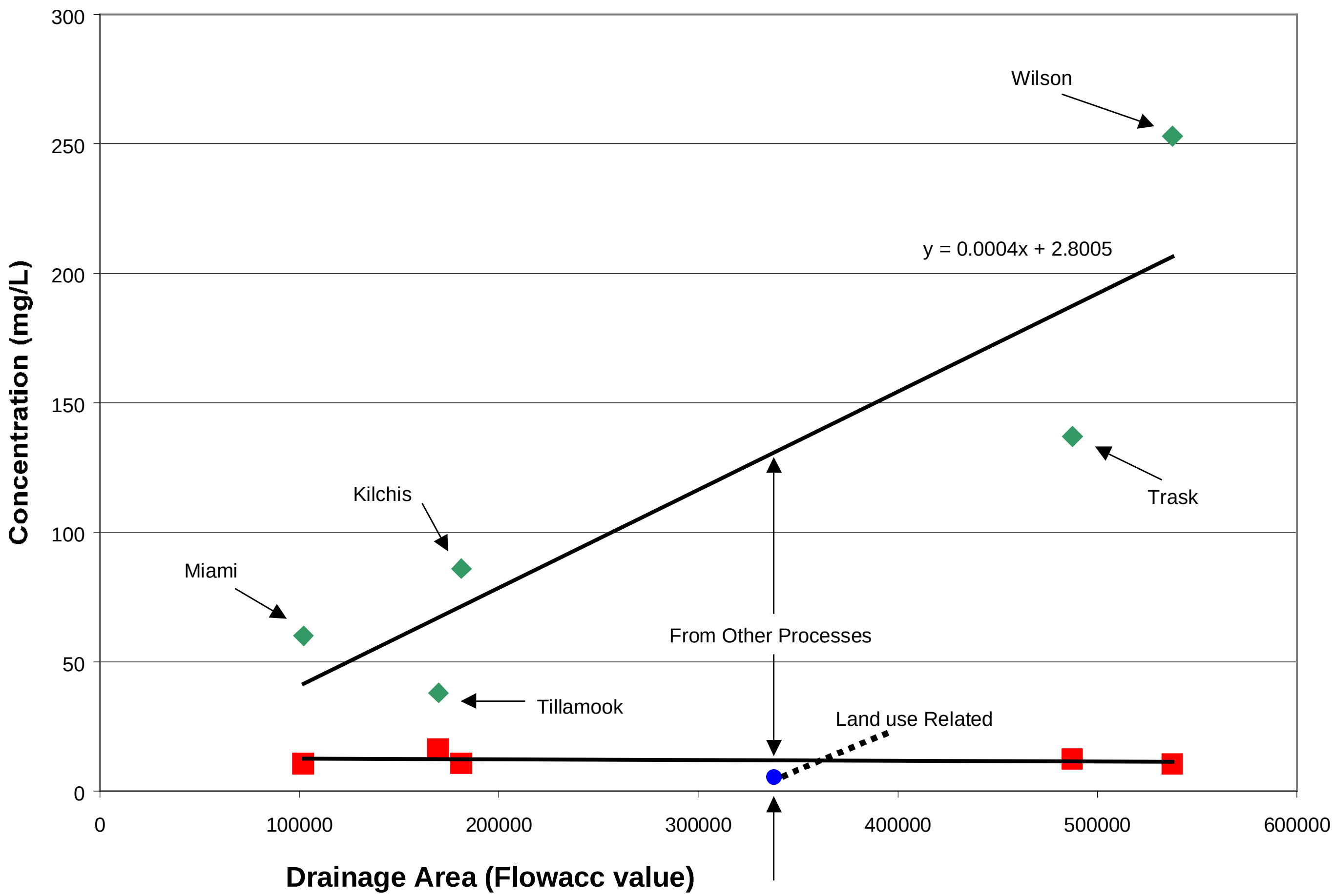


Figure 3-22. Sediment Load Contributions (expressed as concentration) Based on Drainage Area

The average concentration from land use (12.0 mg/L) was subtracted from the intercept value so as not to double count the land use contribution. The resulting equation (with the same variable definitions) for the supplemental concentration is:

$$C_E = (0.000379 \times FAC) - 9.2 \qquad \text{Equation 3-18}$$

This concentration represents an accumulated value rather than an average per cell value and is used to calculate the sediment load delivered at any point due to erosion. The avenue script "dasedigrid.ave" calculates a virtual concentration grid based on Equation 3-18, and the resultant accumulated supplemental sediment load grid is determined from Equation 3-19 presented below:

$$L_E = C_E \times \left[\sum_{i=1}^{x} (Q_R)_i + \sum_{i=1}^{x} (Q_B)_i \right] \qquad \text{Equation 3-19}$$

where L_E *= delivered sediment load from erosion*

C_E *= predicted sediment concentration based on Equation 3-18*

Q_R *= average per cell surface runoff*

Q_B *= average per cell baseflow*

X *= number of cells upstream of the location in question*

This supplemental load from erosion is added to the land related load to determine total sediment load at any point in the watershed as determined from Equation 3-20:

$$L = L_L + L_E \qquad \text{Equation 3-20}$$

where L *= total sediment load delivered*

L_L *= the land use related load based on Equations 3-13*

L_E *= the channel related load based on Equation 3-19*

Overall predicted concentration is determined by dividing the total load delivered by the total flow. This concludes the model development. The last section presents tools available for querying the model for predicted results.

3.8 Load, Flow, and Concentration Determinations

There are two menu items under the 'NPS Analysis' menu that allow for easy determination of values at points of interest. These two items are 'Pick Point Values' and

'Pick Bay Values.' In addition, there is a tool that allows for examination of how concentrations change along the length of a river.

3.8.1 Values at Points of Interest

The 'Pick Point Values' menu item allows for identification of a point coverage locating points where modeled resulting concentration values are of interest. The script in the bactimodel project file associated with this menu item is "pickbactisep.ave." The corresponding script in the sedimodel project file is "picksedisep.ave." These points of interest might be the mouths of rivers or a set of routine sampling locations. When this menu item is used, the following data must be identified: 1) the point coverage of interest (for this discussion the **mouth** point coverage is used), 2) accumulated bacteria load grids associated with both runoff and baseflow, and 3) accumulated runoff and baseflow discharge grids. The script creates a new table with the results of the queries and calculates a resultant baseflow and runoff concentration at the points of interest. For the accumulated bacteria grid associated with runoff, predictions before BMP effects are determined by choosing the **raccbgrid** grid (accumulated grid prior to applying BMPs) while predictions that account for reductions from BMPs are obtained by choosing the **accbmpbacti** grid. After identifying the required data sources, a dialog box prompts for a file name for the table that is created as a .dbf file – an example can be seen in Figure 3-23.

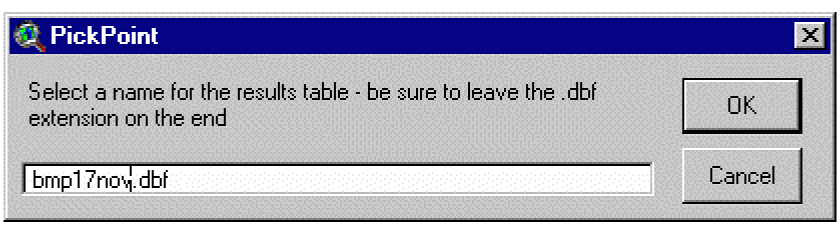


Figure 3-23. Dialog Box for Pick Point Values Menu Item

A field from the point coverage attribute table is selected to carry over to the results table as an identifier field. For the **mouth** point coverage, the 'watershed' field is selected. The bacteria results table for the **mouth** point coverage is presented in Table 3-12; the corresponding table for sediment is seen in Table 3-13.

Table 3-12. Example Results Table from 'Pick Point Values' Menu Item – Bacteria with BMPs taken into account

WATERSHED	RO_ACCFC ($x10^{12}$)	BF_ACCFC ($x10^{12}$)	ACCRO ($x10^9$)	ACCBF ($x10^9$)	RO_ CONC	BF_ CONC
Mouth of Wilson River	741	143	12.5	27.5	209	18
Mouth of Miami River	172	31	2.4	5.3	253	21
Mouth of Tillamook River	1,650	272	3.2	7.5	1,844	127
Mouth of Trask River	2,443	400	9.8	22.8	878	62
Mouth of Kilchis River	279	53	5.2	10.7	189	17

Table 3-13. Example Results Table from 'Pick Point Values' Menu Item - Sediment with BMPs taken into account

WATERSHED	RO_ ACCSED	BF_ ACCSED	ACCRO ($x10^9$)	ACCBF ($x10^9$)	RO_ CONC	BF_ CONC
Mouth of Wilson River	8,704	4,321	12.5	27.5	22	5
Mouth of Miami River	1,716	826	2.4	5.3	23	5
Mouth of Tillamook River	4,219	1,182	3.2	7.5	43	5
Mouth of Trask River	9,139	3,573	9.8	22.8	30	5
Mouth of Kilchis River	3,619	1,675	5.2	10.7	22	5

These values represent loads and concentrations after BMPs have been accounted for. The 'RO_ACCFC' and 'BF_ACCFC' columns represent the accumulated fecal coliform load associated with runoff and baseflow respectively, in units of fecal coliform per year. The 'ACCRO' and 'ACCBF' columns represent accumulated runoff and baseflow, respectively, in units of cubic feet per year. The columns labeled 'RO_CONC' and 'BF_CONC' represent the resultant predicted concentration associated with runoff and baseflow, respectively. The units for these two columns are fc/100ml. The sediment model has load units of tons/yr and concentration units of mg/L. The concentration values are calculated by dividing accumulated load by accumulated flow with an appropriate conversion factor.

The ‘Pick Bay Values’ menu item works a bit differently. The purpose of this menu item is to allow determination of accumulated loads or flow to each of the five bay shellfish harvesting management segments. This data could be subsequently fed to a bay model to predict bay concentrations. The script associated with this menu item is “pickbayvalue.ave.” The script requires the **baymodel** polygon coverage of the bay segments and a value grid of interest. Values of interest are picked at the centroid points for each of the segments. Recalling the DEM modification made to connect the bays and rivers, there is a nodata cell at the location of each centroid. For this reason, the accumulated value is determined as the sum of the grid cells directly above, below, left, and right of the centroid cell. These four grid cells contain the accumulation of the cells flowing to the nodata centroid cell. The value grids chosen for analysis should be accumulated grids, not average grids. As with the ‘Pick Point Values’ menu item, a new table is created to write the results of the query and summation. The ‘Pick Bay Values’ script requires the identification of two identifier fields. Two fields are used to be able to differentiate between the Main Bay segment where shellfish growing is prohibited from the Main Bay segment where shellfish growing is allowed on a conditional basis. Once the value grid of interest and the **baymodel** coverage have been identified, dialog boxes are presented to name the results table, select the two identifier fields, and name the field of interest (see Figure 3-24) to correspond with the value grid selected.

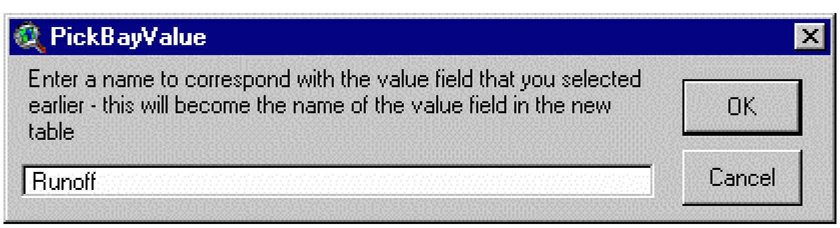


Figure 3-24. Input Box for Value of Interest Field - ’Pick Bay Values’ Item

The results of a query on the accumulated runoff grid can be seen in Table 3-14. The units of runoff are cubic feet per year, the same units as the **accrunoff** grid. The results of a query on the accumulated sediment load (before BMPs) can be seen in Table 3-15. The units for the 'RO_SEDIMEN' column are tons per year, the same units as the **raccsgrid** grid.

Table 3-14. Results for 'Pick Bay Values' Showing Accumulated Runoff

SEGMENT_NA	GROWING_MG	RUNOFF ($x10^6$)
Main Bay	Prohibited	2,970
Main Bay	Conditionally Approved	789
Cape Meares	Conditionally Approved	645
Flower Pot	Restricted	201
Upper Bay	Prohibited	31,886

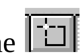
Table 3-15. Results for 'Pick Bay Values' Showing Accumulated Sediment

SEGMENT_NA	GROWING_MG	RO_SEDIMEN
Main Bay	Prohibited	1,984
Main Bay	Conditionally Approved	56
Cape Meares	Conditionally Approved	109
Flower Pot	Restricted	31
Upper Bay	Prohibited	27,071

3.8.2 Additional Point Location Coverages

Several additional point coverages were created from data supplied by E&S Environmental Chemistry, Inc. and were also used to query the grids for predicted concentrations. The location information from E&S was provided in an Access database (Tillamook.mdb) with Easting and Northing coordinates in a Universal Transverse Mercator (UTM) projection (E&S Environmental Chemistry, Inc., 1998). These point coverages were created in a different fashion than those for which geographic coordinates were given. The entire 'Site Information' table was exported from Access to Excel and converted to a comma-delimited text file appropriate for use in Arc/Info for generating a point coverage. The command sequence in Arc/Info for generating this point coverage, along with the projection file to convert from UTM to Oregon Lambert, is found in Appendix A. The created point coverage was named **eandspts.**

The projected coverage, **eandspts**, does not contain any station name information. Additional station information was added by editing the attribute table to add fields as needed. As with the **usgsgage** point coverage, it is very important that the location of these points coincides with the modeled stream grid. As necessary, the point coverage was edited to move points to coincide with the modeled stream network.

There are several points in this larger point file that are of particular interest. The first set contains the routine and forest/agricultural interface sampling points. A point coverage was created for this particular set by selecting the points of interest with the  button (remember to use the shift key to select more than one point) and converting the coverage to a shapefile. The set of points including the routine and forest/agricultural interface points was named **ensstormpts**. The shapefile was converted back to a coverage in Arc/Info using the 'shapearc' command followed by the 'build….points' command. With a point coverage, all of the attributes are automatically brought over to the coverage with the 'shapearc' command.

Two other point coverages were created in a similar fashion –

- **epariverpts** (created from the **wqsta** point coverage on the TB CDROM - for those EPA stations on the rivers that are sampled routinely)
- **tccasample** (created from the **eandspts** coverage - for the points where the Tillamook County Creamery Association samples routinely)

3.8.3 Concentration Profiles

It is often useful to be able to examine profiles of concentrations along the length of a stream segment. A set of tools (CRWR-Raster) were developed by Dr. Olivera at the CRWR, including a tool to create concentration profiles in ArcView. This tool is called a profiling tool and is accessible through both the bactimodel project file and the sedimodel project file. Since the concentration profile is desired, it is necessary to first create a predicted concentration grid for the entire watershed. Since monitoring data typically reflects total concentration at a point (versus concentration based on strictly runoff or baseflow), a grid that combines loads and flows from both runoff and baseflow is needed. Concentration grids are created using the 'NPS Analysis/Predicted Concentration Grid' menu item which invokes the "predconc.ave" script (with either 'bacti' or 'sedi' for a prefix as appropriate) and requires that the user identify accumulated and average load grids for both runoff and baseflow, as well as accumulated and average discharge grids for runoff and baseflow. The script performs the calculations outlined below:

$$RL = AccRL + AvgRL \qquad \text{Equation 3-21}$$

$$BL = AccBL + AvgBL \qquad \text{Equation 3-22}$$

$$RF = AccRF + AvgRF \qquad \text{Equation 3-23}$$

$$BF = AccBF + AvgBF \qquad \text{Equation 3-24}$$

$$Conc = \frac{RL + BL}{RF + BF} \qquad \text{Equation 3-25}$$

where *RL = load associated with runoff*

AccRL = accumulated runoff load

AvgRL = average per cell runoff load

BL = load associated with baseflow

AccBL = accumulated baseflow load

Avg BL = average per cell baseflow load

RF = runoff component of discharge

AccRF = accumulated runoff

AvgRF = average per cell runoff

BF = baseflow component of discharge

AccBF = accumulated baseflow

AvgBF = average per cell baseflow

Conc = predicted pollutant concentration

As was explained in the 'Precipitation/Discharge Relationship' section in the discussion regarding creation of the **avgprecip** grid, the accumulated and average grids are added to avoid grid cell values of nodata in the watershed. Since the flow accumulation function adds only the cells upstream of the point of interest, any local highs have a value of zero in the accumulated flow grid (in the denominator) and thus produce a nodata value in the predicted concentration grid. For fecal coliform load grids, the concentration grid values are in units of FC/100ml. For sediment load grids, the concentration grid values are in units of mg/L. Both scripts employ conversion factors developed from Equations 3-14 and 3-15 as appropriate.

The profile along a stretch was examined in the bactimodel project file using either the 'Misc Tools/Profiler' or 'Misc Tools/Profiler with Points' menu items. These two tools take a selected stream segment, divide that segment into a user specified number of evenly spaced sub-lengths, and then create a table showing the distance along the length and the concentration at each division point. The 'Profiler with Points' item also allows for identification of points of interest to determine concentrations in addition to the sub-length points. Both of these tools provide graphical depictions of concentration along the length of a segment beginning at the upper-most point of the segment and ending at the segment outlet and require a polyline representation of stream segments with one segment selected, a point coverage with at least one point selected and a grid (in this case of concentration). One of the rivers from the polyline coverage and the points of interest from the point coverage are selected using the  tool. All three themes must be active (use the shift key to select more than one theme), and the point coverage must be on top of the line coverage which must be on top of the grid in order for the script to execute properly. A dialog box appears showing the length of the selected segment and requests the number of divisions to be created. If the number of segments is large, a dialog box appears at the end of the run indicating that another program is required to view the output. Excel is an appropriate choice for this purpose.

An additional shapefile was created to represent the modeled lengths of the 5 main rivers and is called **profriv.shp**. This shapefile was created in the hydrology project file using the 'S' button of the 

button set. This button traces flow paths from user designated points down to associated outlet points. The downstream oulet point of the Miami and Kilchis rivers in this shapefile coincide with the centroid of the bay segments that they flow into. The downstream point of the Tillamook and Trask Rivers coincides with the point at which their respective modeled stream paths converge. The downstream point of the Wilson River coincides with the point at which its modeled stream path converges with the flow from the Tillamook/Trask Rivers, just inside the modeled Upper Bay segment.

The Wilson River bacteria concentration profile was created in the bactimodel project, by selecting the Wilson River length from the **profriv.shp** shapefile, points of interest along the Wilson River from the **eandspts** point coverage, and the predicted bacteria concentration grid. The results, when viewed in Excel, are shown in Figure 3-25.

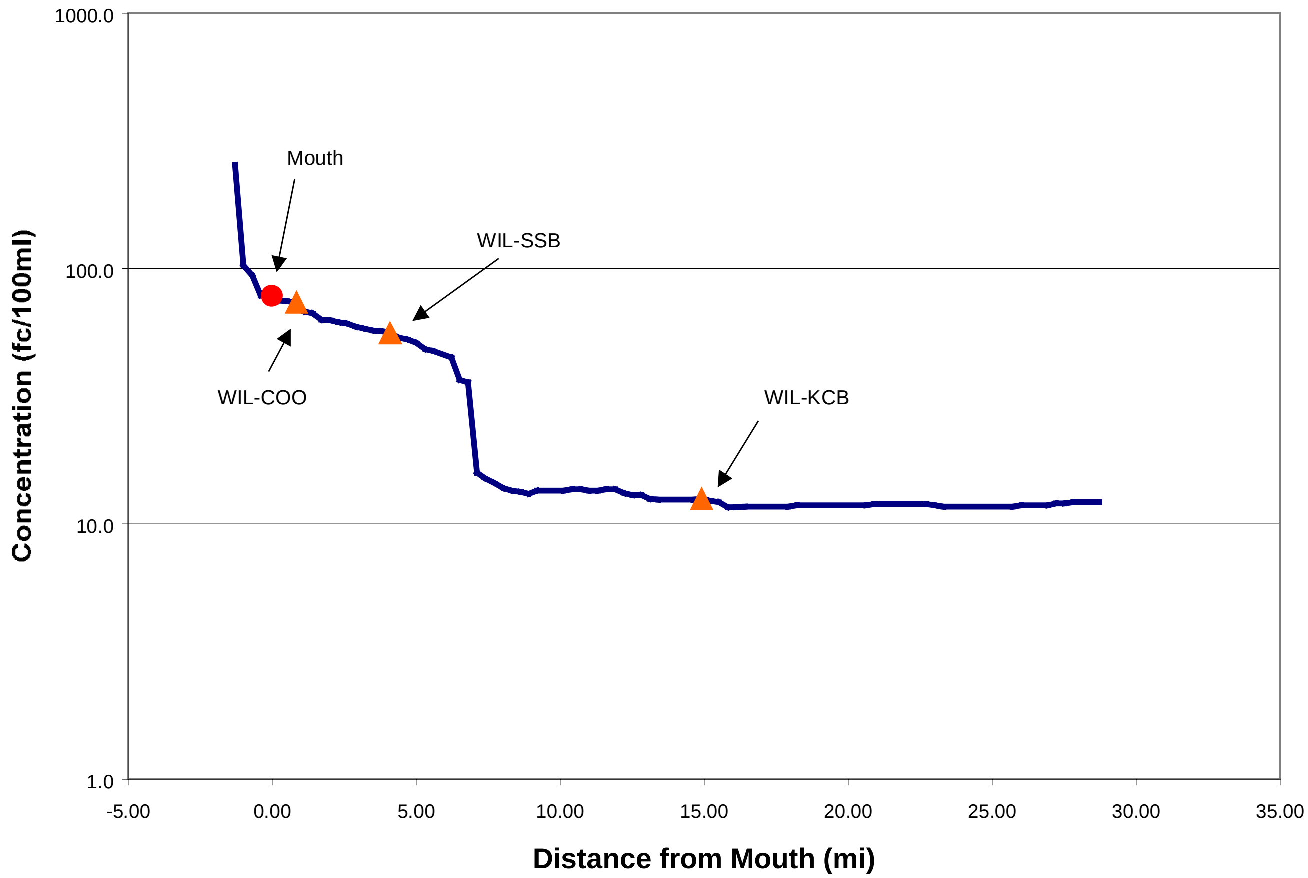


Figure 3-25. Wilson River Example of Concentration Profile with E&S Sampling Points Indicated

4 RESULTS AND DISCUSSION

4.1 Terrain Analysis - Drainage Areas and Watershed Boundaries

One way to assess the accuracy of the hydrology model is to compare the modeled drainage areas with reported drainage areas. Overall, it appears that the model defines the major river basins and the gaged basins quite well. Modeled drainage areas in square miles for the five major river basins as well as the delineated sub-basins are found in Table 4-1. This table also includes modeled drainage areas for the two USGS discharge gages found on the Wilson and Trask Rivers. Estimates of drainage areas have been reported in the Tillamook Bay Drainage Agricultural Non-Point Source Pollution Abatement Plan (Pederson, 1981) and the 1998 Tillamook Bay Environmental Characterization report (TBNEP, 1998a). The values in the 1998 study report produce the best match with the modeled drainage areas. The USGS has reported the drainage areas for the Wilson and Trask river discharge gages as 161.0 sq mi and 145.0 sq mi respectively (USGS, 1999b). A bar chart comparing the model values with the reported drainage area estimates by the USDA as found in the Non-Point Source Pollution Abatement Plan, as well as estimates reported in the Environmental Characterization report, is presented in Figure 4-1. The gaged areas are compared with USGS reported drainage areas.

Using either set of reported drainage area values, the only difference that exceeds 10 percent is the Kilchis River when compared to the 1981 Pollution Abatement Plan values. Differences in the actual location of the outlet points used to determine drainage areas in the studies versus in the model might account for these relatively small differences.

Table 4-1. Drainage Area of Modeled Subwatersheds

WATERSHED	Area (mi^2)
Miami River	36.6
Kilchis River	65.0
Wilson River	192.8
Tillamook River	60.9
Trask River	174.9
Upper Main Stem Miami	17.3
North Fork - Kilchis	16.0
North Fork - Wilson	27.0
South Fork - Kilchis	10.3
Devil's Lake Fk - Wilson	26.4
Mouth of Miami	19.3
Upper Main Stem Kilchis	13.0
South Fork - Wilson	15.9
Little S Fork - Kilchis	11.9
Vermilyea Slough	0.4
Stasek Slough	0.5
Mouth of Kilchis	13.9
Little N Fork - Wilson	19.8
Hall Slough	1.0
Dougherty Slough	1.4
Upper Main Stem - Wilson	92.9
N Fork of N Fork - Trask	12.7
Hoquarten Slough	2.8
Mouth of Wilson	10.8
McKenzie Creek	4.1
Chance Road	1.3
Upper Main Stem - Trask	13.4
Mouth of Trask	6.8
Anderson Creek	1.7
Mill Creek	4.8
Gold Creek	6.7
Mouth of Tillamook	15.8
North Fork - Trask	36.7
Mid Fork of N Fork - Trask	31.8
Bewley Creek	5.8
Fawcett Creek	6.3
Upper Main Stem - Tillamook	2.4
Middle Main Stem - Tillamook	28.8
South Fork Trask	23.3
E Fork of S Fork - Trask	29.0
Wilson River at USGS Gage	157.3
Trask River at USGS Gage	146.4

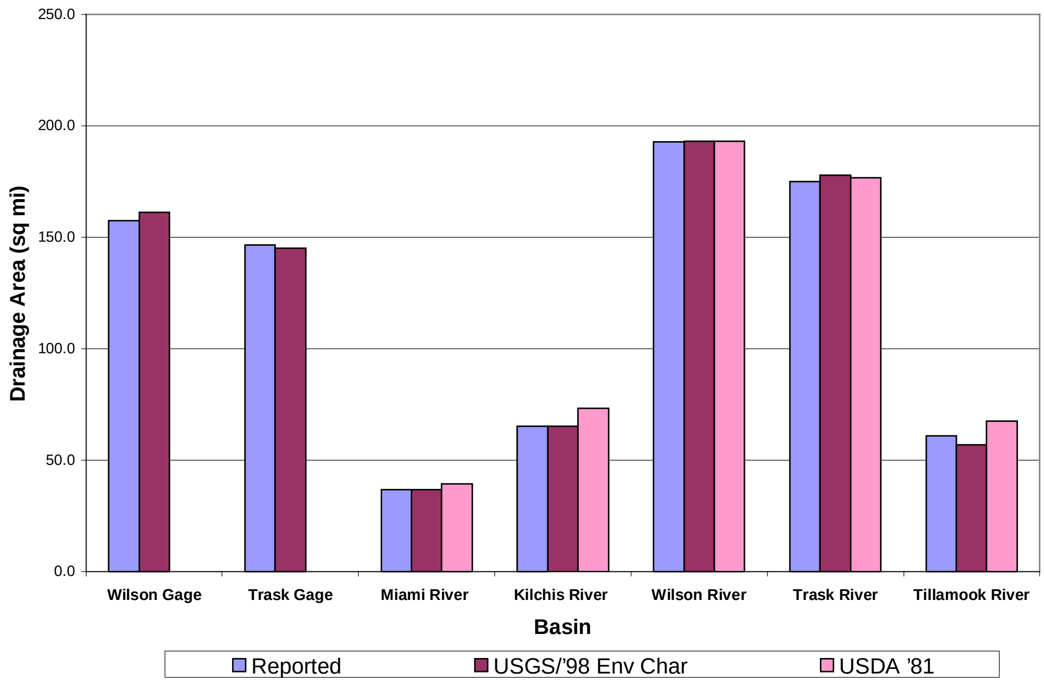


Figure 4-1. Comparison of Drainage Areas (square miles)

Visual comparison of modeled and digitized basin boundaries indicates that the model provides a good match. The boundaries for the five river basins are compared to the digitized boundaries provided by the TBNEP in Figure 4-2. The heavy yellow line represents the digitized drainage basins, and watersheds are identified by river name. There appears to be one discrepancy between the Tillamook and Trask River basins. There is a portion of the modeled Tillamook basin (in green) that the digitized coverage attributes to the Trask River (in brown). This discrepancy has been discussed with the TBNEP office, and the conclusion was that the digitized coverage is not correct. If this area is closely examined, the stream network supports the model-delineated boundaries. Other than this discrepancy, the match looks quite good.

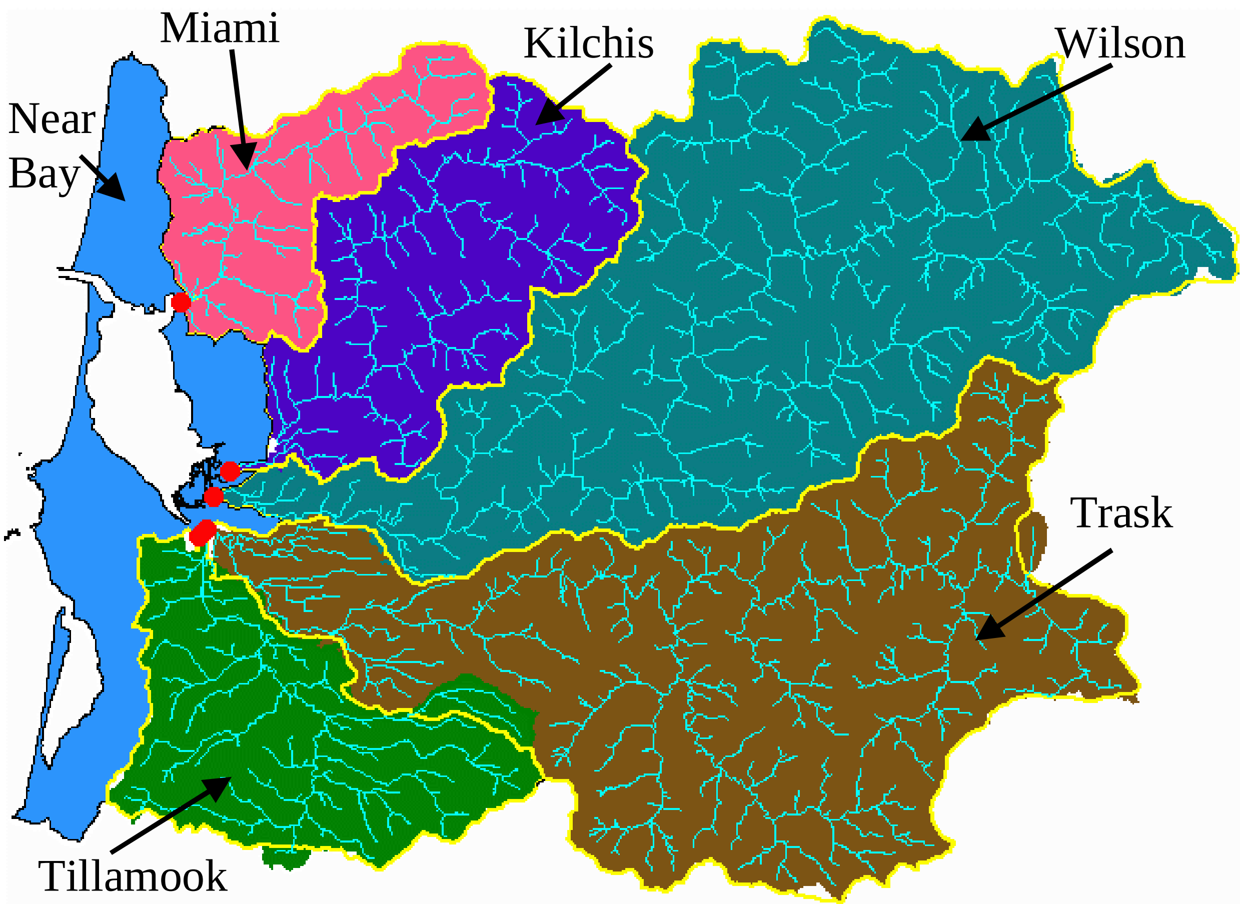


Figure 4-2. Delineation of River Basins

4.2 Discharge in the Basin

Based on the river discharge, annual water yield, and flow contribution information, the model accurately defines discharge in the watershed. Discussion of model results for each these three characteristics, along with a determination of the bay residence time, are presented in this section.

4.2.1 River Discharge

An assessment of the precipitation-discharge relationship necessitated a comparison of recorded data with the modeled prediction of discharge. The relationships developed earlier in the report are validated using data from the Trask River gage, as well as the Wilson River gage. As a reminder, the data for the Trask River gage was not used in developing the rainfall discharge relationships. For the time period that was evaluated, the Trask River has measured discharge data available for the years 1962 – 1971. The comparison of Wilson River data covers the years 1961 to 1990.

In order to determine the predicted flows at the Trask River gage, an estimate of rainfall was needed. The rainfall for each year of interest was determined in the same fashion as the estimate of rainfall at the Wilson River gage. The PRISM data was queried at the Trask River gage location and multiplied by the ratio of the annual to long term average determined for the Tillamook1W rain gage for each year, 1962 – 1971. The annual estimated rainfall was used to calculate predicted annual runoff and baseflow depth of flow in inches per year for the Trask River based on Equations 3-6 and 3-7. The measured daily runoff and baseflow values were summed for each year to get the measured annual discharge at the gage. The measured depths of flow for both runoff and baseflow were calculated as follows:

$$DF(in/yr) = \frac{Q(ft^3/yr)}{DA(ft^2)} \times \frac{12in}{ft} \qquad \text{Equation 4-1}$$

where DF = depth of flow

Q = measured discharge (runoff or baseflow)

DA = drainage area

The Trask River predicted depth of flow was plotted against the measured depth of flow and can be seen in Figure 4-3. The pink line on the graph represents a perfect one to one match of predicted versus observed values.

Similarly, the estimated rainfall at the Wilson River gage was used to determine predicted annual depth of flow based on Equations 3-6 and 3-7, and the measured discharge was used to determine the equivalent depth of flow based on the drainage area using Equation 4-1. Again, the predicted depth of flow was plotted against the measured depth of flow and can be seen in Figure 4-4. Both figures indicate that the model prediction is a good estimate of observed flow.

The model currently uses two mathematical relationships between discharge and precipitation, one for baseflow and one for surface runoff. These relationships are applied basin wide and are independent of land use. Discussions with TBNEP staff indicate that these relationships may vary by major sub-watershed and possibly by tributary catchment; however, the graphs of predicted versus observed depth of flow indicate that the modeled discharge represents the actual discharge fairly well. Additionally, the degree of error in modeling the Trask River is not appreciably different from that in the Wilson River despite the fact that data from the Trask River were not used in the developing the precipitation-discharge relationships.

The model can be modified to reflect variations in the precipitation-discharge relationship based on variations in soil type, land use, or other appropriate parameter on a cell-by-cell basis and provide a better reflection of actual conditions. Condition statements can be programmed to vary these discharge-precipitation relationships spatially across the watershed. The Soil Water Assessment Tool (SWAT), from the Blackland Research Center in Temple, TX, was considered for use in an attempt to vary discharge-precipitation relationships dependent on land use such that runoff per unit area for dairy lands could be different than forest lands. Initial results seemed to underestimate water yield when compared to reported data, and since the current relationships seem to provide a reasonable description of discharge in the watershed, this methodology was not pursued further.

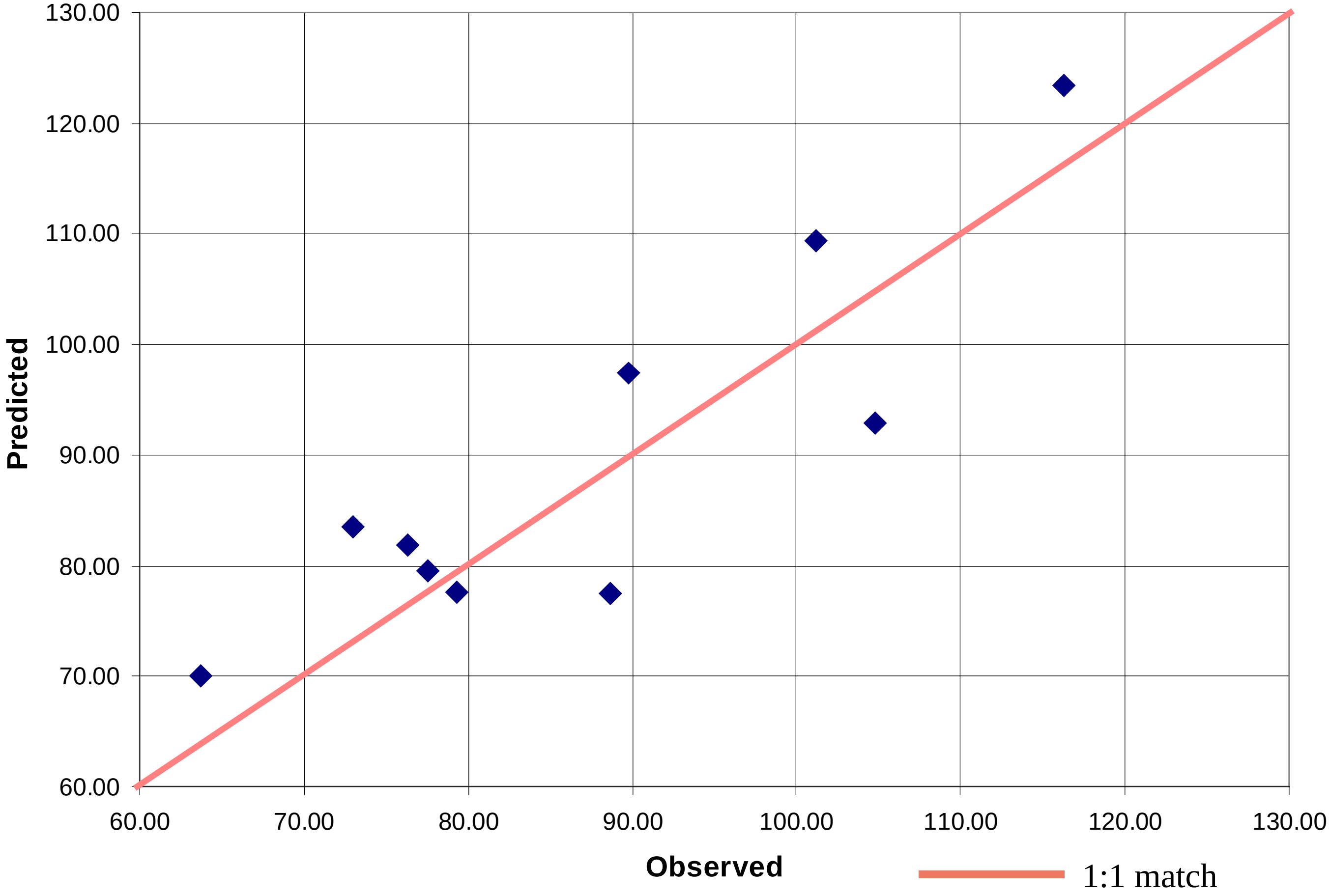


Figure 4-3. Predicted versus Observed Depth of Flow (in/yr) for the Trask River (1962 - 1971)

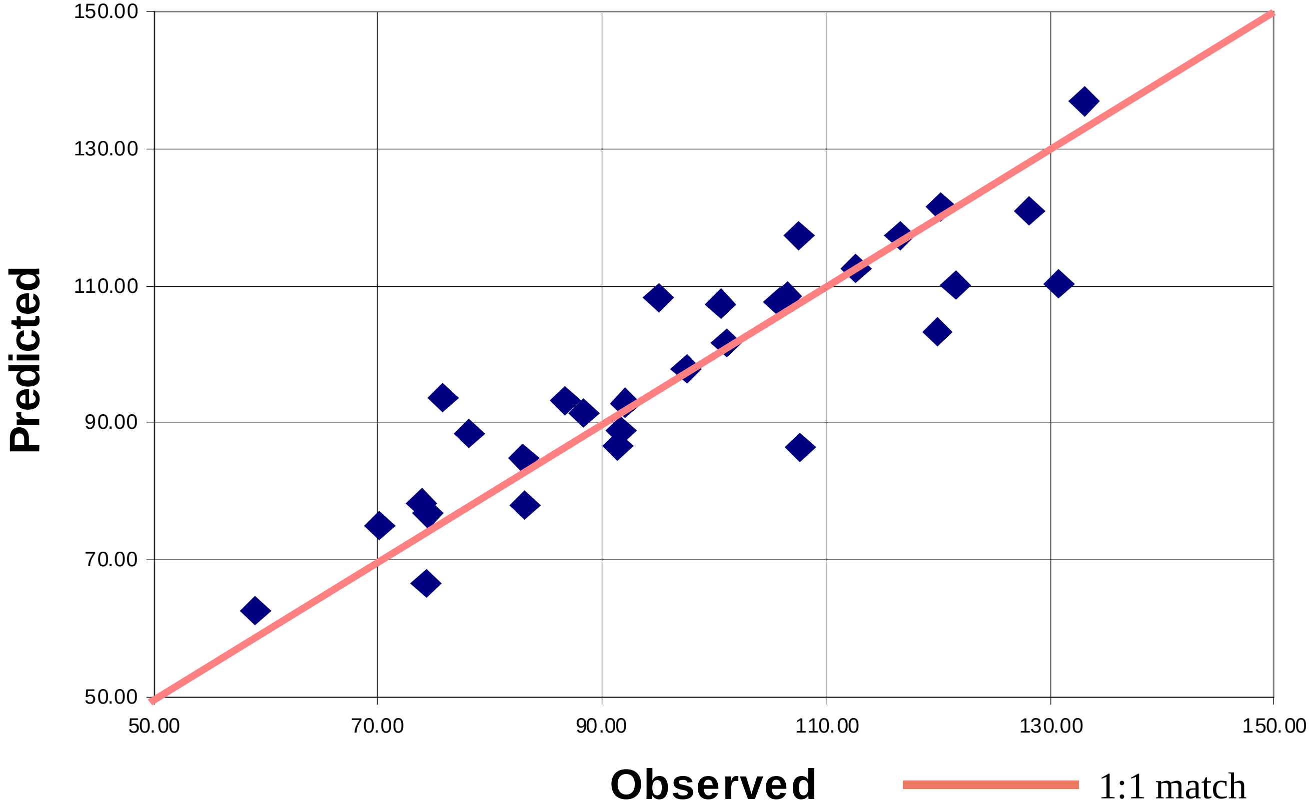


Figure 4-4. Predicted versus Observed Depth of Flow (in/yr) for the Wilson River (1961 - 1990)

4.2.2 Annual Water Yield

The mean annual water yield for the basin is reported as 2,628,296 acre-feet of water (Jackson & Glendening, 1982). The 'Pick Bay Values' tool was used to determine the model predicted annual baseflow and runoff to each of the five bay segments and the results are shown in Table 4-2. The total sum of these flows equates to about 2.6 million acre-feet. This is within 1.5 percent of the previous estimate.

Table 4-2. Annual Flows to Tillamook Bay based on Model Representation

Segment Name	Growing Management	Baseflow (1000 acre-ft/yr)	Runoff (1000 acre-ft/yr)	Total Flow (1000 acre-ft/yr)
Main Bay	Prohibited	138	68	206
Main Bay	Conditionally Approved	5	18	23
Cape Meares	Conditionally Approved	8	15	22
Flower Pot	Restricted	3	5	8
Upper Bay	Prohibited	1,598	732	2,330
Total Flow to Bay		1,752	838	2,590

Jackson and Glendening (1982) also reported annual average water yield for each of the five river basins. A comparison between these values and the modeled values can be seen in Figure 4-5. In all cases, modeled water yield is within 10% of the reported value.

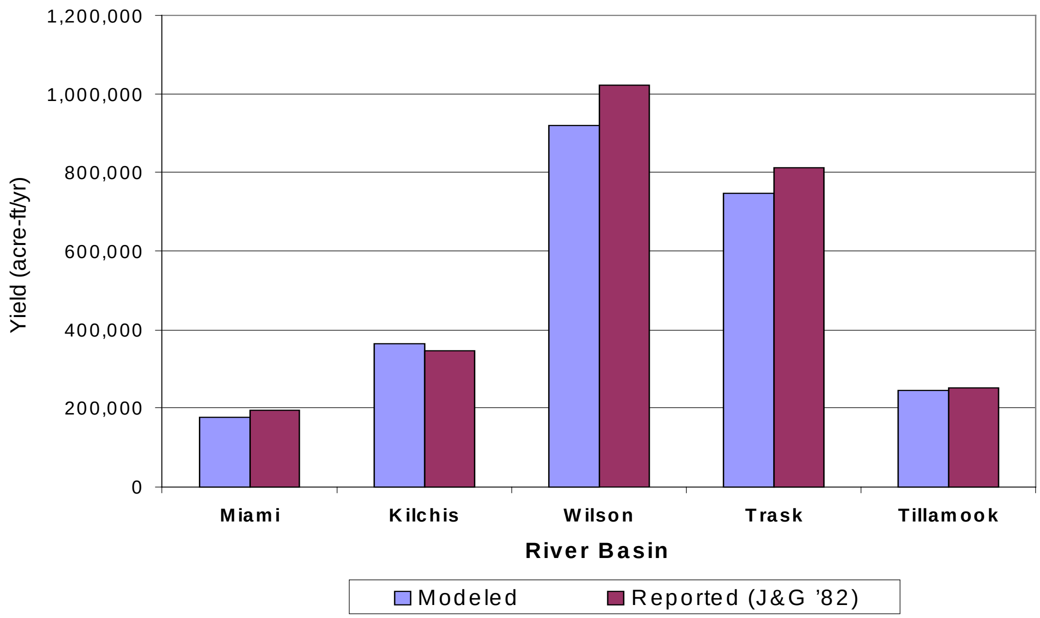


Figure 4-5. Annual Basin Water Yield - Modeled versus Reported

4.2.3 Flow Contribution

Jackson and Glendening (1982) reported that the Wilson, Trask, and Kilchis rivers contribute about 80 percent of the total water yield. Total runoff and baseflow values for the five rivers were obtained using the 'Pick Point Values' tool with the **mouths** point coverage. If the balance of the total flow is attributed to the lands directly adjacent to the bay (sometimes referred to as the 'Near Bay'), the apportionment of flows is as shown in Figure 4-6.

Analyzing the values in Figure 4-6, the model predicts that the Kilchis, Trask, and Wilson contribute 79 percent of the total flow, a one percent difference from the reported value. In addition, the percent contribution from each watershed matches the values reported by Jackson and Glendening (1982) within three percent.

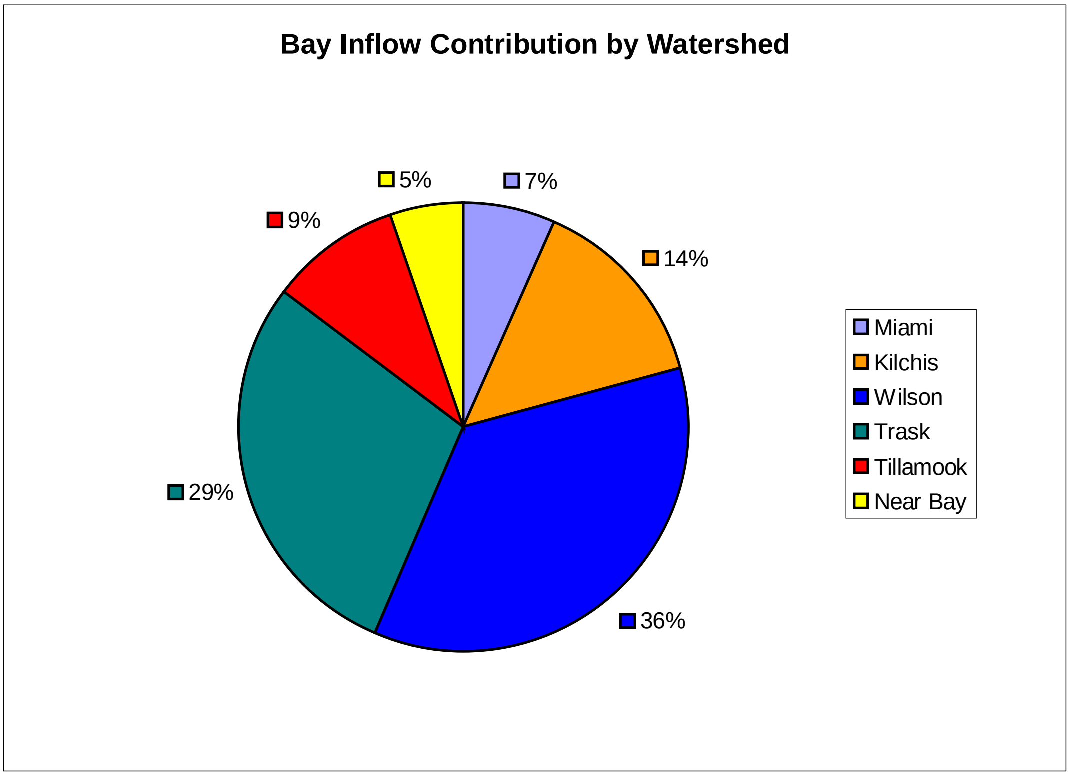


Figure 4-6. Flow Contribution by Watershed based on Model Representation

Data in Table 4-3 reflect the flow contribution measured in acre-feet/year by land use for each of the major river basins. Figure 4-7 presents a graphical depiction of this breakout. Overall, forest land use contributes more than 90 percent of the flow in the basin. Forest land use accounts for nearly all of the flow generated in the Wilson, Kilchis, and Miami basins.

Table 4-3. Flow contribution by Land Use for the River Basins (acre-ft/yr)

Land Use	Miami	Kilchis	Wilson	Trask	Tillamook
Urban/Rural	781	884	5,092	13,534	7,684
Agricultural	3,440	5,119	12,430	42,458	33,382
Forest	171,460	358,231	899,797	689,336	203,015
Water	366	626	1,775	2,560	1,331

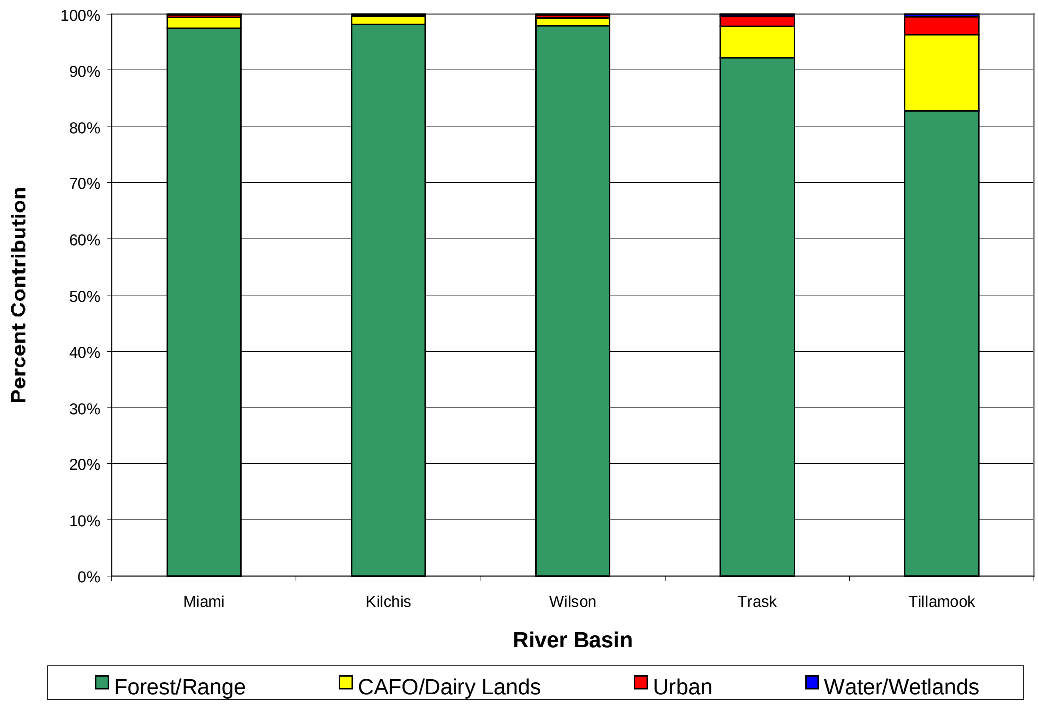


Figure 4-7. Percent Flow Contribution by Land Use in the River Basins

4.2.4 Bay Residence Time

Bay residence times were calculated using the grid representation of the bathymetry and a mean tide level of 4 feet. The **bathdem** grid was clipped to the extent of the **baymodel** coverage. In ArcView, using the Map Calculator, the clipped grid was subtracted from the mean tide level of 4 feet. This did produce some negative values since some of the bay is exposed at mean tide. These negative values were set to zero using the Map Query to select all cells with a value greater than zero. The 'zonal sum' command was used in Arc/Info with the bay segments as the zones to sum the depth values for the land under water for each segment. Volume was determined by:

$$Vol_{seg} = \sum z(ft) \times 10{,}000\, ft^2 \qquad \text{Equation 4-2}$$

$$Vol_{Bay} = \sum Vol_{seg} \qquad \text{Equation 4-3}$$

where z = depth in each grid cell for a particular segment and

$\sum z$ *= the value obtained from the zonal sum command*

The total bay volume of 51 thousand acre-feet was divided by the total annual flow to the bay to determine an average residence time of 7 days for the bay.

4.3 Load Analysis

Since computed loads are related to land use through the use of EMC values, this analysis begins with an examination of the modeled land use distribution. Then, predicted concentrations along the length of the rivers are presented along with a summary of average flows, concentrations, and loads for each of the major river basins.

4.3.1 Land Use in the Basin

The Tillamook Bay Environmental Characterization Report (TBNEP, 1998a) indicates that land use distribution is approximately 89% forest, 6.5% agricultural lands, 1.5% urban or rural development, and 3% water. The **lulccomposite** grid was used to determine the land use distribution for the model. Since this grid extends out past the actual extent of the watershed, it was clipped to the extent of **tillbuf2k** coverage. The land use distribution is determined from the clipped grid’s attribute table and is shown in Figure 4-8.

The 'Urban/Rural' category includes all urban land uses along with rural residential and rural industrial. 'Agriculture' encompasses all agriculturally related land uses including CAFO dairy lands. The 'Forest' category also includes range lands and barren lands, while the 'Water' category accounts for rivers, streams, and wetlands. As the figure shows, the model’s land use distribution matches the reported breakout quite well. The urban land use is overstated, possibly reflecting the inclusion of some lands that the model classifies as rural residential or rural industrial that aren’t reflected in the value reported by the Environmental Characterization Report (TBNEP, 1998a). Additionally, the distribution of land use for the five river basins is presented by percent of total and actual acreage in Table 4-4 and is shown graphically in Figure 4-9.

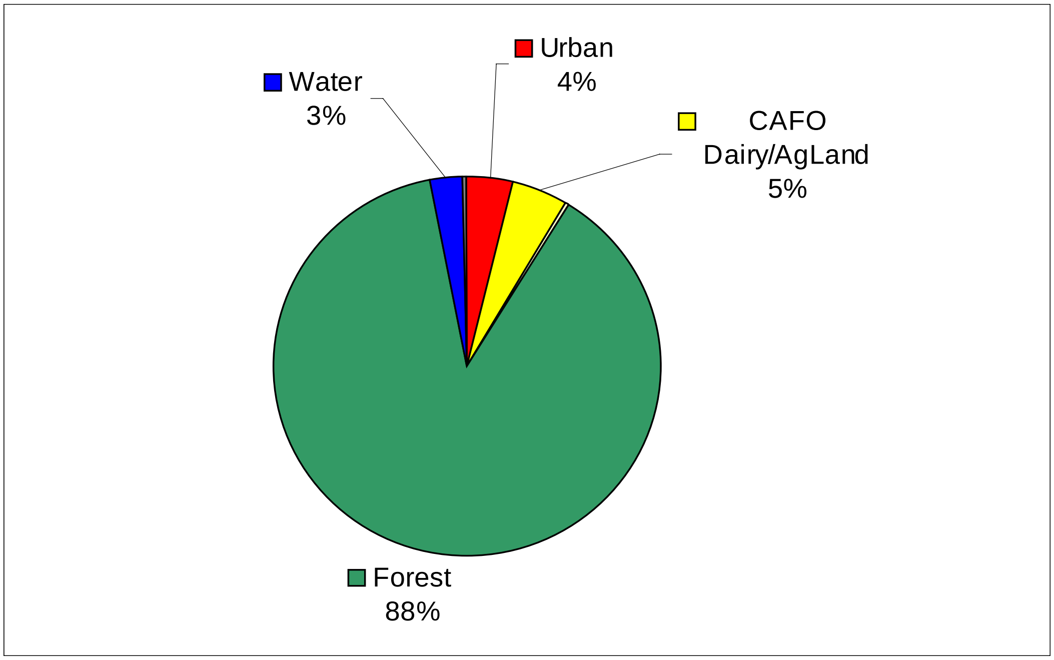


Figure 4-8. Land Use Distribution for the Tillamook Bay Watershed

Table 4-4. Land Use in the River Basins based on Model Representation

	Miami		Kilchis		Wilson		Trask		Tillamook	
Land Use	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres
Urban/Rural	0.5	119	0.3	121	0.7	860	2.2	2,408	3.5	1,366
Ag/Dairy	2.4	568	1.8	737	1.7	2,159	6.7	7,529	15.2	5,909
Forest	96.9	22,707	97.8	40,699	97.4	120,184	90.8	101,647	80.9	31,527
Water	0.2	47	0.2	70	0.2	222	0.3	329	0.4	165

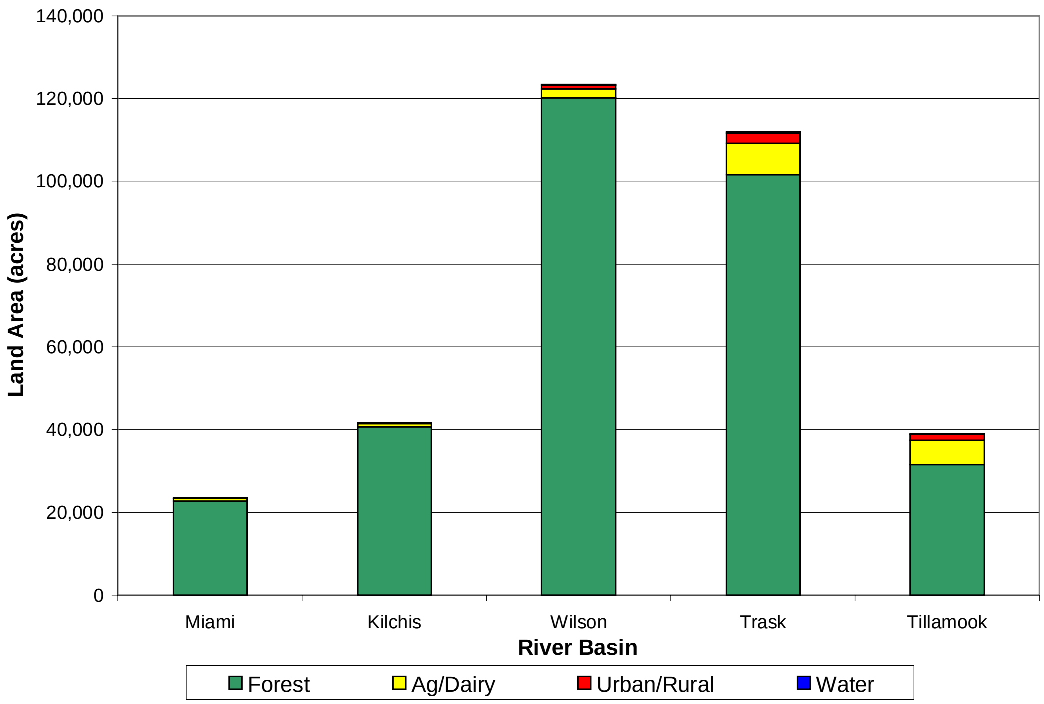


Figure 4-9. Cumulative Land Use Acreage in each River Basin

In addition to presenting the differences in drainage area for the five basins, this figure also demonstrates that a greater percent of the dairy activity is located in the Trask and Tillamook basins resulting in higher concentrations and loads.

A 1997 watershed assessment by the Oregon Department of Environmental Quality (ODEQ) identified two possible sources of pollutant loads that may warrant further investigation: (1) the land application of biosolids and (2) lumber yard activity (ODEQ, 1997). Monitoring data for runoff from areas supporting these two activities should be used either to help establish a better EMC value for rural industrial lands or to establish sub-categories within the rural industrial land use along with associated pollutant concentrations.

4.3.2 Concentration Profiles and Load Summary

The concentration profiles presented in this section represent the model predicted concentration from the headwaters of a river to the mouth and then on towards the bay. They were created in the ArcView project using the 'Misc Tools/Profiler with Points' menu item. In order to compare the predicted value at points where sampling has occurred, a frequency analysis of the monitoring data was conducted. This section presents the frequency analysis of monitoring data, a general explanation of the profile figures, followed by the river profiles and a load summary. Bacteria results are presented first, followed by sediment results.

4.3.2.1 Frequency Analysis of Monitoring Data

The data used for comparison was collected by E&S Environmental Chemistry during 1997 and the early part of 1998 and consisted of dry weather sampling as well as storm sampling (E&S Environmental Chemistry, Inc., 1998). Samples were collected at numerous sites in the watershed and in the bay, including five sites near the river mouths and four sites at the forest/agricultural land use interface. Only points with a minimum of eight samples were used in the frequency analysis and in the comparison with model results.

A frequency analysis was conducted to determine the median value of sample data and the spread of sampling results. The analysis used standard statistical methods. Data for an individual monitoring station were ordered and ranked from the highest value to the lowest value. The cumulative probability was calculated as:

$$P = 1 - \frac{R}{n+1}$$ Equation 4-4

where P = *cumulative probability*

R = *data point rank (R=1 for the highest value)*

n = *number of data points*

The cumulative probability of a data point value represents the probability that a random sample will be less than that value.

The median is the value with a cumulative probability of 0.5, or the 50^{th} percentile value. The data spread is represented by the 10^{th}, 25^{th}, 75^{th}, and 90^{th} percentile values. Figure 4-10 presents the layout and identification of points and values that are presented in subsequent figures showing the concentration profiles. The median value is denoted by a blue diamond symbol. The data spread, indicating the other percentile values is denoted with a box and whisker plot. The model concentration is denoted with an orange triangle symbol.

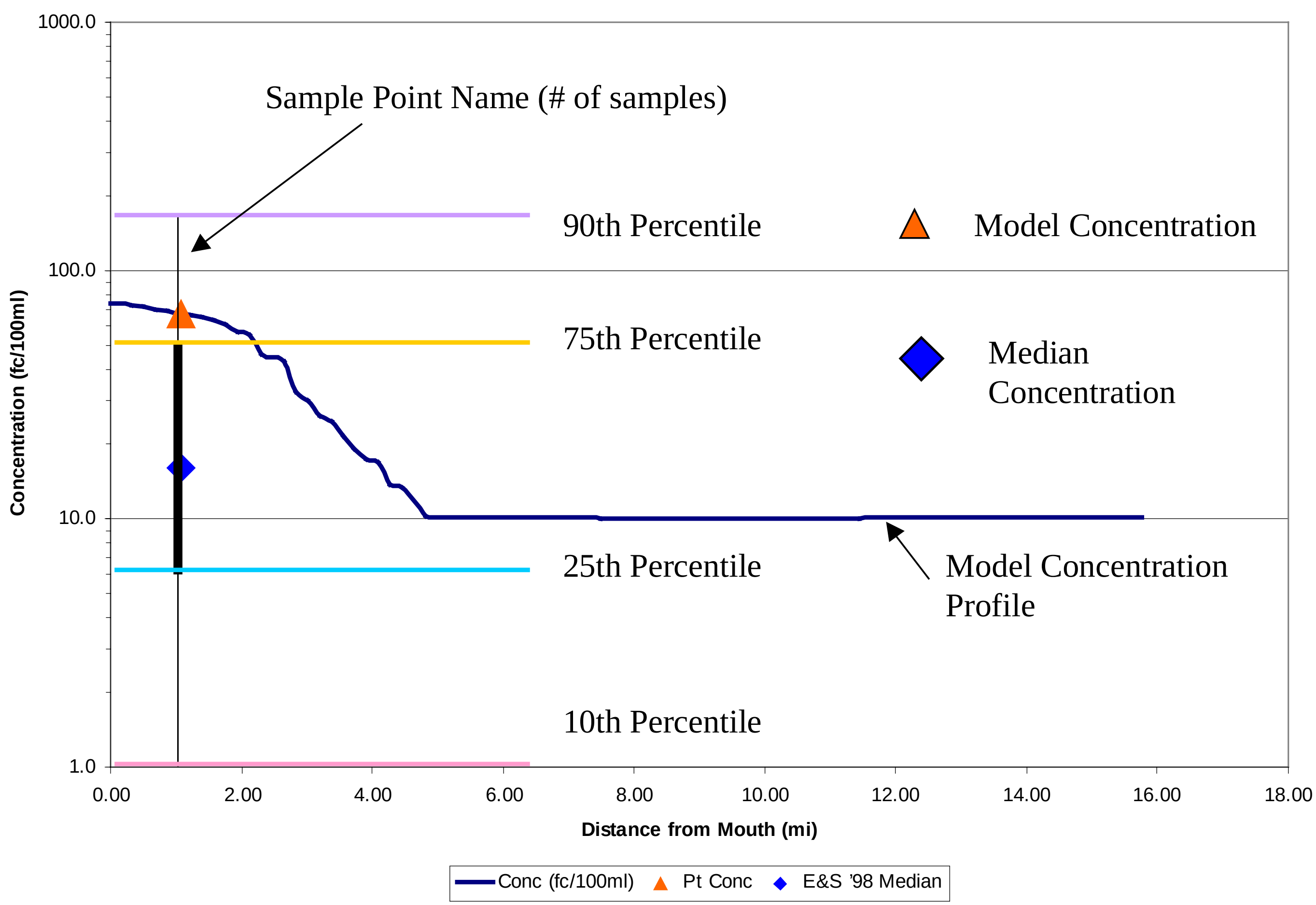


Figure 4-10. General Concentration Profile Diagram

4.3.2.2 Bacteria Concentration Profiles and Load Summary

The model predicted concentration profiles can be found at the end of this section and are presented for:

- Miami River - Figure 4-11
- Kilchis River - Figure 4-12
- Wilson River - Figure 4-13
- Trask River - Figure 4-14
- Tillamook River - Figure 4-15

Figure 4-11 (profile for the Miami River) and Figure 4-13 (profile for the Wilson River) both demonstrate the confluence of the main river with a tributary whose basin is comprised of lands with higher EMC values (for urban or agricultural lands versus forested lands) than the area upstream of the tributary's entry. This tributary entry is indicated by a sharp jump in the concentration profile. The Kilchis River profile, presented in Figure 4-12, demonstrates a constant relatively low concentration in the upper half of the river, reflecting the single forest land use in the upper half of the basin. Contrasting the Trask River profile with the Tillamook River profile demonstrates the impact of differences in land use distribution. The Tillamook River profile, presented in Figure 4-15, has a relatively flat concentration profile, indicative of a basin with different land uses distributed throughout the entire basin. Figure 4-14, the Trask River profile, shows a gradual increase in concentrations along the length of the river downstream of the point where land use changes from a single land use (mainly forest) to the influence of multiple land uses.

In all cases, the model values fall within the data spread indicating a reasonable representation of concentrations in the rivers. In most cases, the predicted values fall between the 25th and 75th percentile values. The agreement between predicted and observed median values seems to be excellent for the Tillamook River, and quite good for the Trask. For all cases except for the Tillamook River, there is a fairly distinct river location downstream of which the bacteria concentration increases fairly rapidly. This point coincides with the forest/agricultural interface and reflects the large increase in bacteria load from the CAFO dairy lands. This is not evident on the Tillamook River because CAFO dairy lands are distributed throughout its entire drainage area.

A comparison of profiles for all five rivers can be seen in Figure 4-16. Modeled bacteria concentrations in the Tillamook River are the highest of all the rivers, which supports conclusions previously reported by Sullivan et al (1998a). Figure 4-17 presents a model load summary, reflecting average annual flow, concentration, and load for all five rivers. The Tillamook River has the highest concentration with a fairly low flow, while the Trask River concentration is about half the value of the Tillamook but has more than double the annual flow. The Wilson River contributes the highest flow, but has a very low concentration, reflecting a very low percentage of CAFO dairy land use in that basin. When looking at predicted load values, which are a product of flow and concentration, the Trask River has the highest loading reflecting a moderate concentration but high flow. The Tillamook River has the next highest load, due largely to its high concentration, followed by the Wilson, the Kilchis, and the Miami.

The dairy lands have the highest runoff bacteria concentration of any land use; consequently, this land use has the highest relative contribution to the bacteria loading on a per cell basis. Considering load as the product of flow and concentration, the higher flows originate from higher elevations which get more rain, and those areas of higher elevation are largely comprised of forested lands with a very low runoff concentration for bacteria. Even though these areas have a larger flow, the load contribution is small compared to the dairy lands.

Data presented earlier in Figure 4-9, shows that the Trask River has the largest total acreage of agricultural lands, which are mostly dairy lands, even though the Tillamook River has a higher percentage of its lands dedicated to agricultural use. That larger overall acreage explains the higher loading in the Trask River, and the high percentage of agricultural lands in the Tillamook watershed result in the higher concentrations measured in that basin.

The water associated with forested land is very clean and serves to effectively dilute concentrations downstream since the bacteria concentration in runoff from forested lands is 20 fc/100ml compared to 30,000 fc/100ml for dairy lands. Overall, forest land use contributes more than 90 percent of the total flow in the basin. When comparing the water-yield associated with forested land use for the Trask River versus the Tillamook River, the reason for the higher concentrations in the Tillamook River becomes quite apparent. While the Trask River has a higher overall loading, it has more that three times the 'dilution' water from forested land compared to the Tillamook River.

The current model over-predicts the concentration for the Kilchis, Trask, and Tillamook, while it under-predicts concentrations in the Wilson and Miami. A comparison of the reported concentrations from the 1998 sampling effort by E&S Environmental Chemistry (presented as the flow weighted average) and the model predicted concentrations are shown in Table 4-5. Additional sampling to better define EMC values may help to minimize these discrepancies. The predicted annual bacteria loads from each of the five rivers, the near bay area, and point sources, along with the percent contribution to total load are shown in Table 4-6. The near bay area contribution is calculated as the difference between the total predicted load and the sum of the loads from the rivers and point sources. This table demonstrates that the contribution from point sources is nearly negligible.

Table 4-5. Comparison of Reported Bacteria Concentrations with Modeled Bacteria Concentrations

Basin	Flow Weighted Average (fc/100ml)[1]	Predicted (fc/100ml)
Miami	133	94
Kilchis	38	74
Wilson	158	78
Trask	169	308
Tillamook	523	635

(1) From *Water Quality Monitoring in the Tillamook Watershed* (Sullivan et al, 1998a)

Table 4-6. Annual Loads and Percent of Total for Source Areas

Source Area	Annual Load ($x10^{12}$ fc/yr)	Reported Load ($x10^{12}$ fc/yr)[1]	Modeled Percent of Total
Miami River	203.1	339	2.77
Kilchis River	331.7	238	4.52
Wilson River	883.2	2,065	12.04
Trask River	2,843.3	3,189	38.76
Tillamook River	1,921.2	1,623	26.19
Near Bay	1,153.4	--------	15.72
Point Sources	1.4	--------	0.02
Total to Bay	7,337.3	7,454	100

(1) From *Results of Storm Sampling in theTillamook Bay Watershed* (Sullivan et al, 1998b)

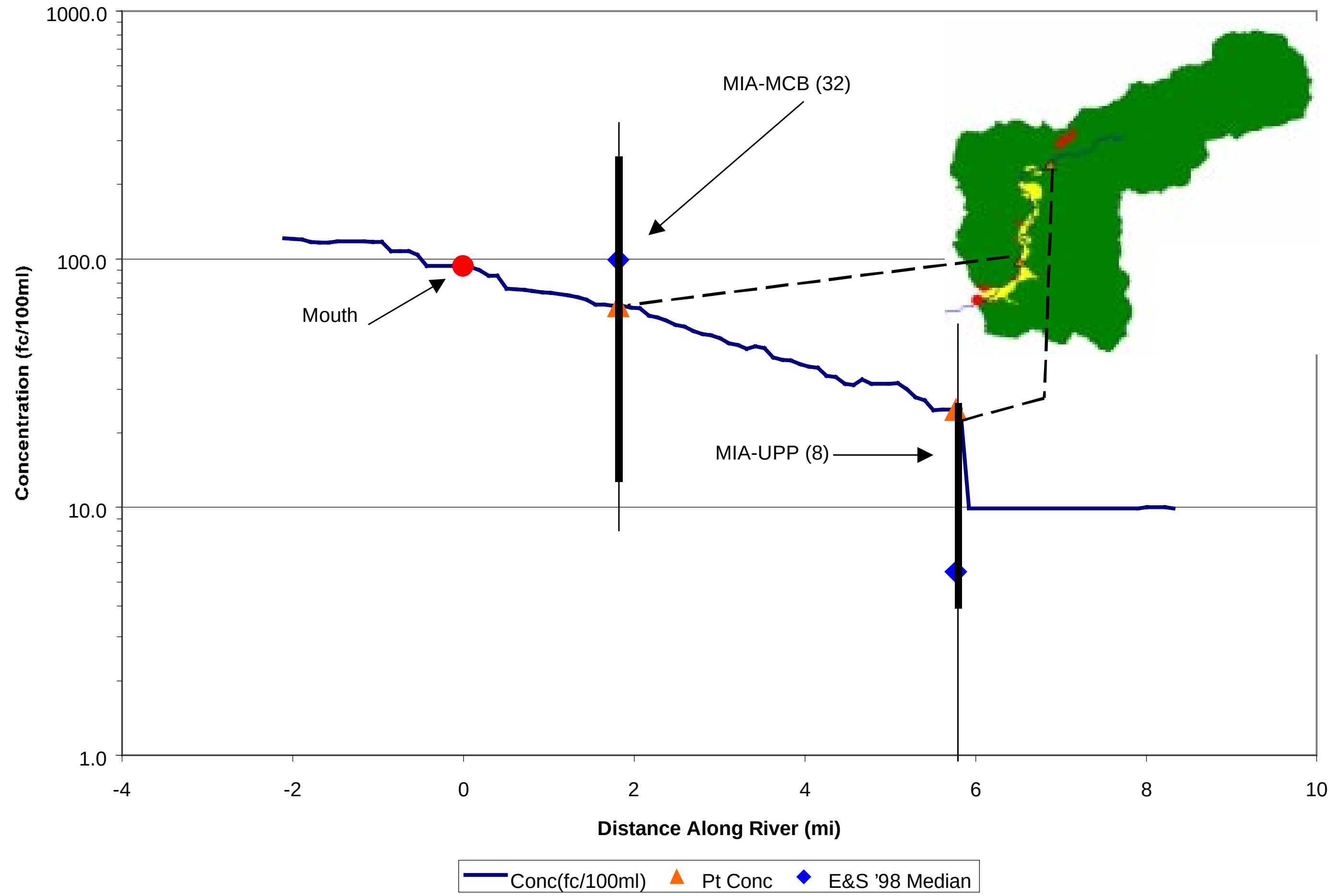


Figure 4-11. Miami River Bacteria Concentration Profile Compared to Monitoring Data

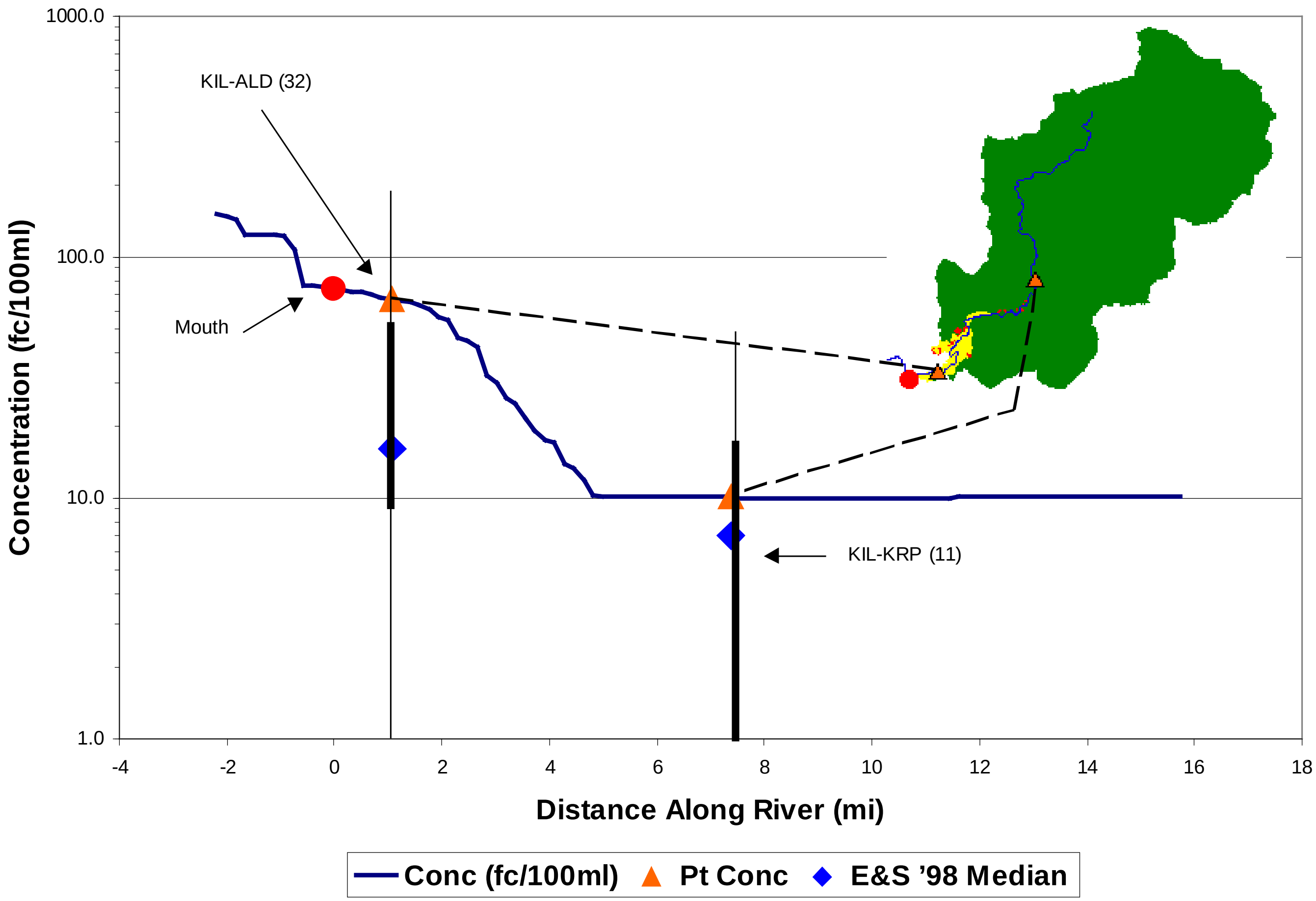


Figure 4-12. Kilchis River Bacteria Concentration Profile Compared to Monitoring Data

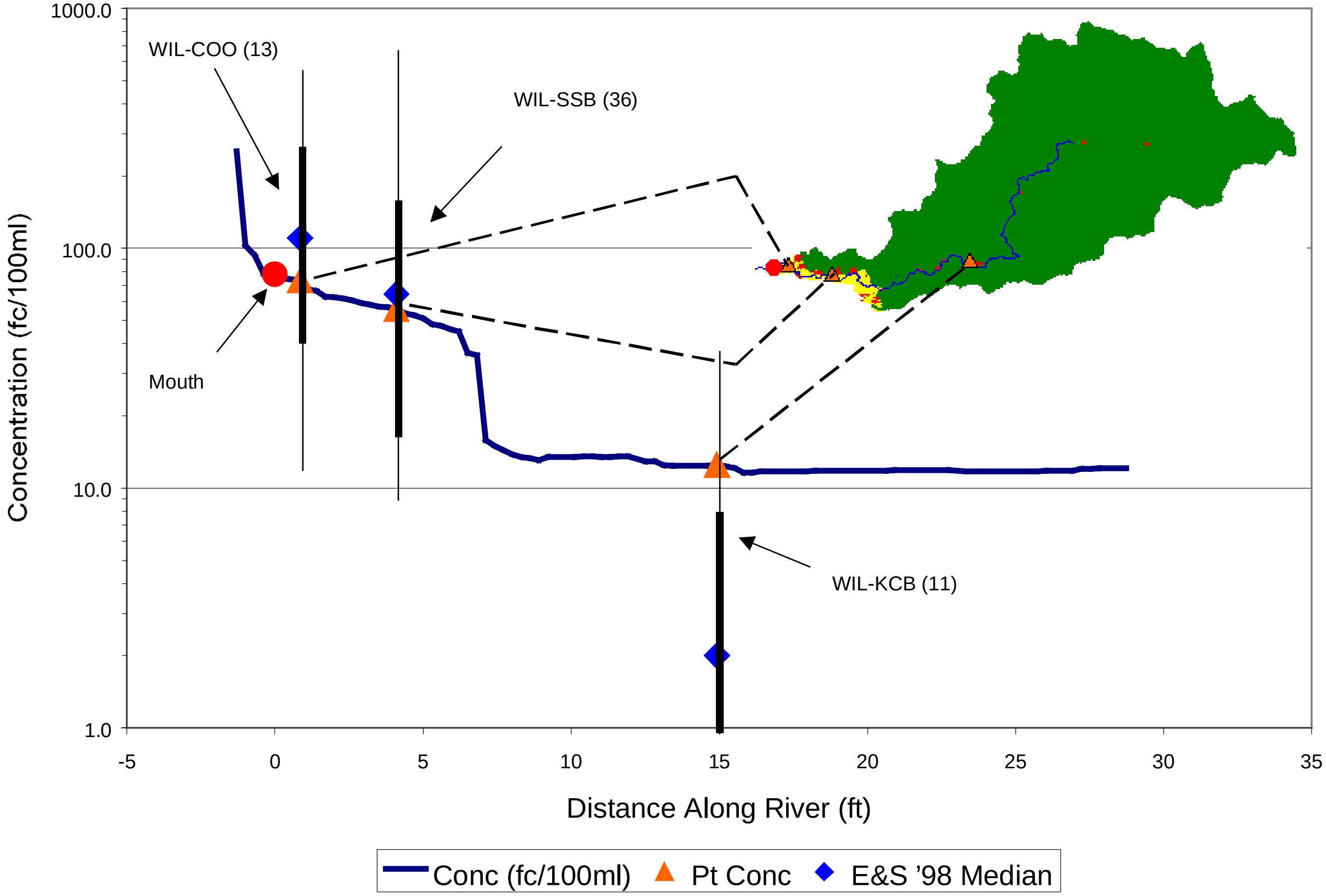


Figure 4-13. Wilson River Bacteria Concentration Profile Compared to Monitoring Data

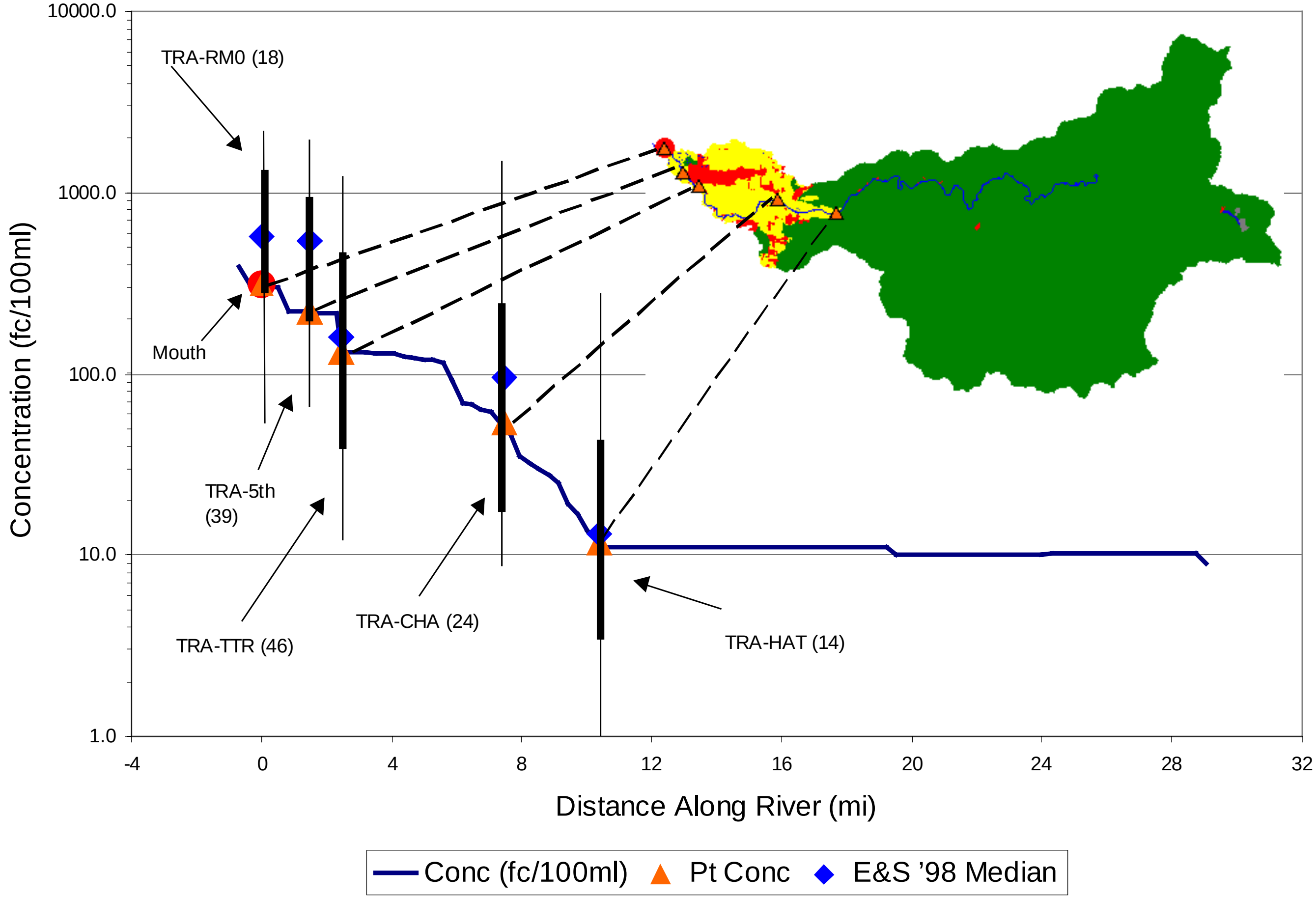


Figure 4-14. Trask River Bacteria Concentration Profile Compared to Monitoring Data

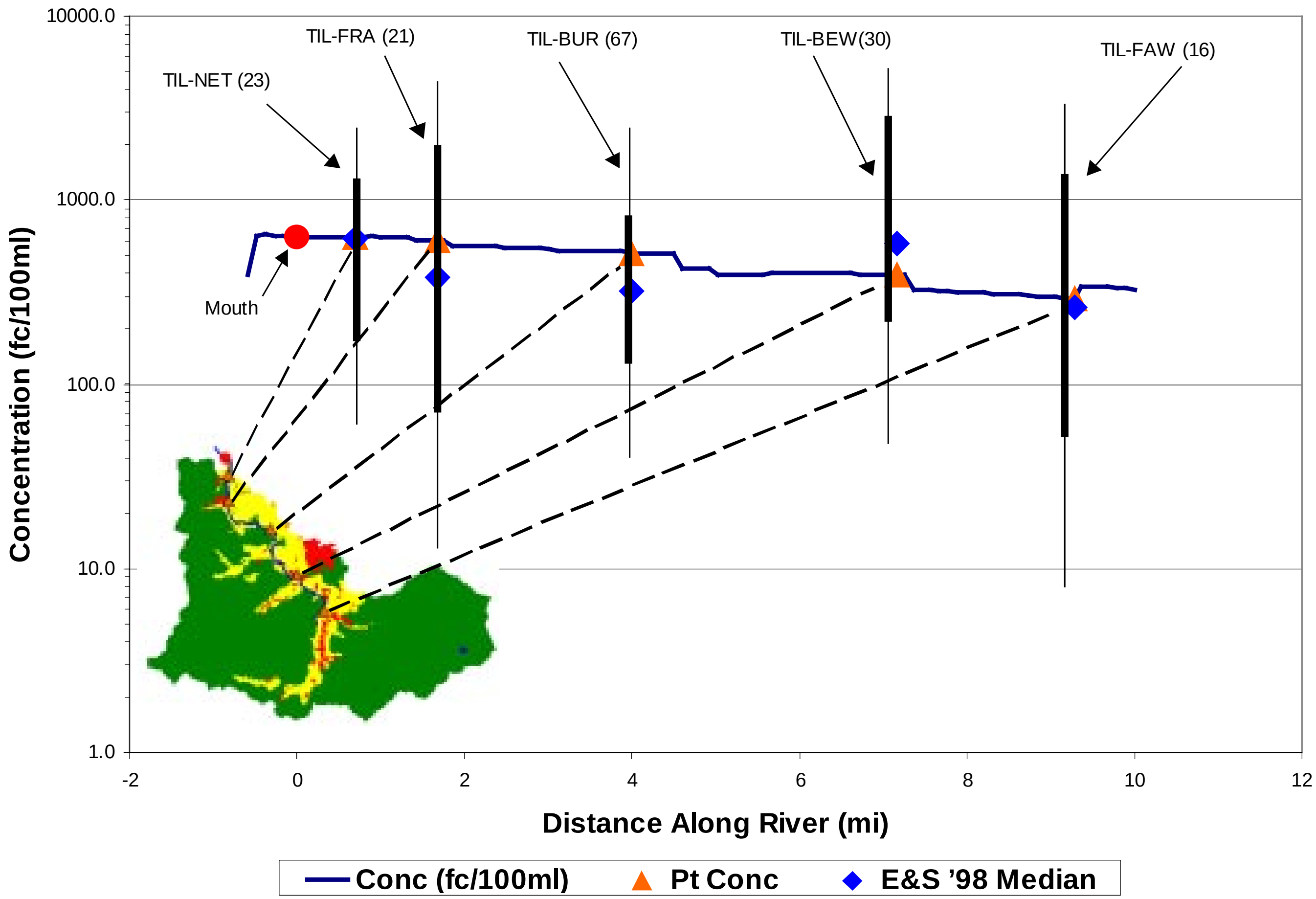


Figure 4-15. Tillamook River Bacteria Concentration Profile Compared to Monitoring Data

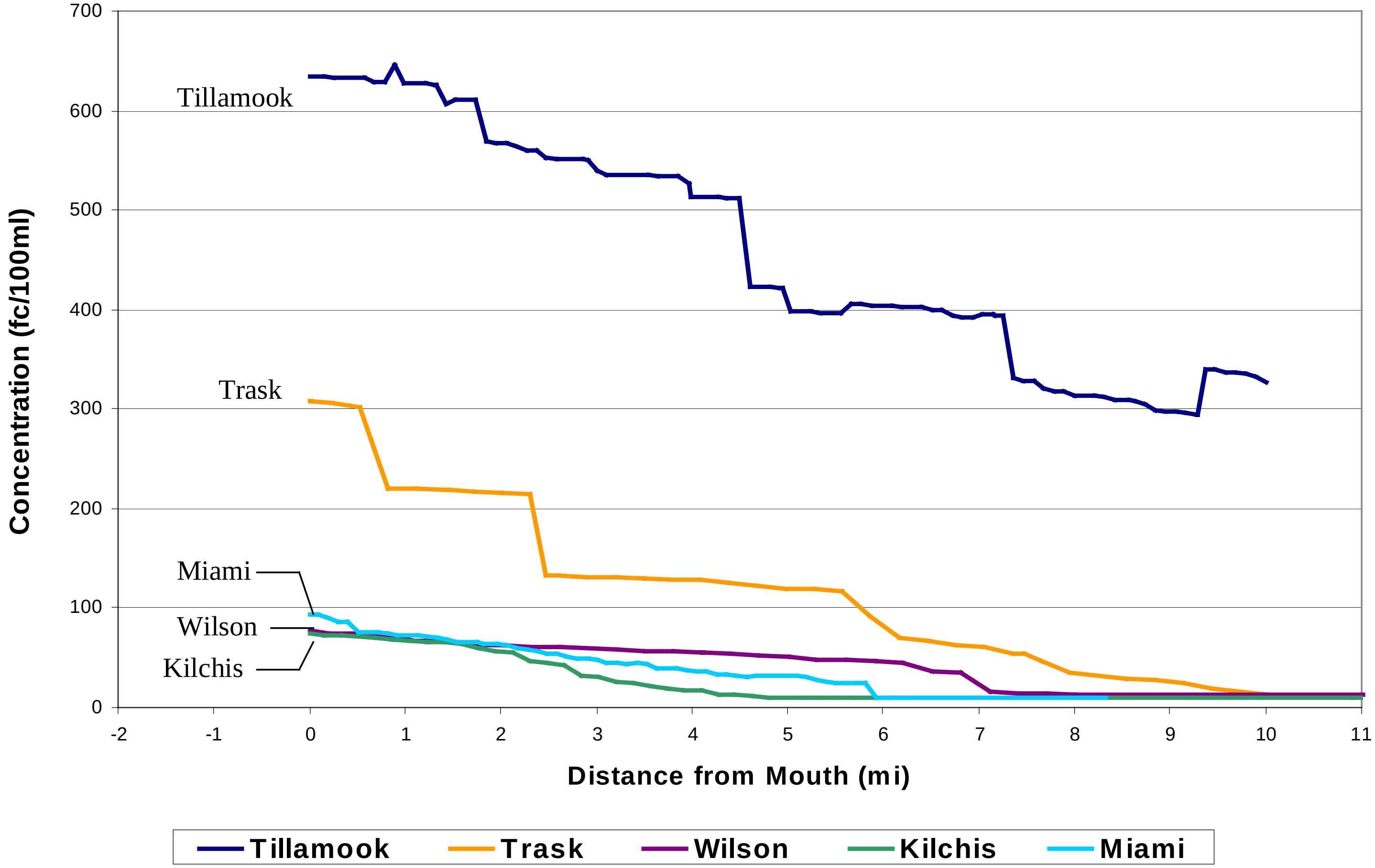


Figure 4-16. Comparison of Bacteria Concentration Profiles for the Five Rivers in the Watershed

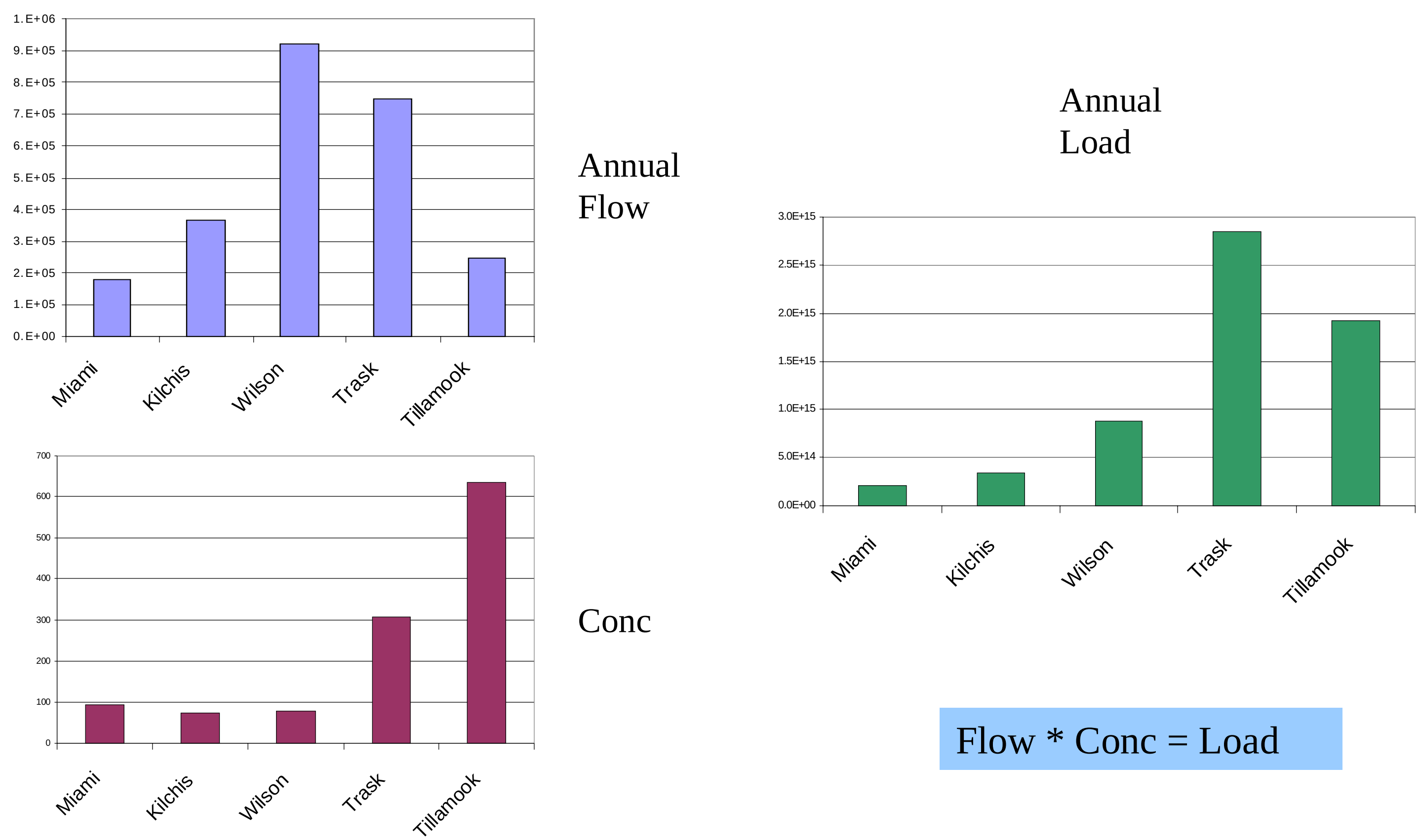


Figure 4-17. Bacteria Load Summary for the Watershed

4.3.2.3 Sediment Concentration Profiles and Load Summary

The model predicted concentration profiles can be found at the end of this section and are presented for:

- Miami River - Figure 4-18
- Kilchis River - Figure 4-19
- Wilson River - Figure 4-20
- Trask River - Figure 4-21
- Tillamook River - Figure 4-22

The sediment concentration profiles include comparison with the flow-weighted average value and the mean value for sample results as well as with the median value. While the median value represents the 50th percentile value, the mean represents the arithmetic average of all measured values. For these sampling data sets, the mean is always greater than the median, reflecting a few relatively high concentrations measured during high flow periods, as demonstrated in the Miami River profile in Figure 4-18. The flow weighted average value is even higher than the mean as it weights the higher concentrations associated with higher flows with a greater weight value based on that higher flow. The flow weighted average value is below the predicted value for the Tillamook River as shown in Figure 4-22, but above the predicted value for the Wilson River profile found at Figure 4-20. This difference is related to the method used to develop the supplemental load grid, which was calculated in an attempt to match reported sediment concentrations more closely. As shown in Figure 3-22, the regression line lies above the Tillamook reported value resulting in an under-prediction of channel contribution and the overall sediment concentration. The reverse is true of the Wilson River, where the predicted value exceeds the reported value.

The slope of the rise in concentration is fairly constant along the length of the rivers (with the exception of some small jumps related to additional load from tributaries) as revealed in the Trask River profile (Figure 4-21). The Kilchis River profile, as presented in Figure 4-19, follows this same trend. This constant slope of the sediment concentration along the length is in contrast to the slope of the bacteria concentration profiles which generally show two areas of differing slope, one for the upper watershed representing input from forest land use only and a second slope representing additional input from other land uses with larger EMC values. The constant slope of the sediment profiles is influenced by the supplemental channel load which has a constant incremental sediment value. The contrast of bacteria profiles, which generally have two areas of differing slope, is influenced by the fact that the difference in EMC values between land uses is much greater for bacteria than for sediment.

Generally, the model values fall within the data spread. In most cases, the modeled concentrations tended toward the upper end of the data spread. This is likely related to the supplemental load that was added for the contribution from sources other than land use. This supplemental load was calculated based on the flow-weighted average values for each river reported by E&S Environmental Chemistry (Sullivan et al, 1998a). These flow-weighted averages may have been influenced by a few samples taken during very high flows which can carry a larger amount of sediment. This may explain why the model predicted values match the flow weighted average or mean values more closely than the median values.

A sediment profile comparison for the five rivers can be seen in Figure 4-23. The Wilson River has the highest concentrations followed by the Trask River. This suggests that sediment concentrations are related to drainage area and channel processes. The load summary presented in Figure 4-24 also supports the conclusion that sediment loads are related to drainage area. Not only do the larger drainage areas have larger sediment concentrations, but they also have large annual flows. Consequently, the Wilson River, which has the largest drainage area, has the highest flows, concentration, and loads. The current model concentrations in the Miami, Kilchis, and Wilson match fairly well as can be seen from Table 4-7, however, the predicted concentrations for the Trask and the Tillamook are a bit high.

Table 4-7. Comparison of Reported Sediment Concentrations with Modeled Sediment Concentrations

Basin	Flow Weighted Average (mg/L)[1]	Predicted (mg/L)
Miami	60	59
Kilchis	86	89
Wilson	253	225
Trask	137	208
Tillamook	38	90

(1) From *Water Quality Monitoring in the Tillamook Watershed* (Sullivan et al, 1998a)

The supplemental load representing bank erosion is determined for the entire modeled stream network. This modeled stream network includes stream segments down to the bay segment centroids. The segment lengths from the river mouths to the bay centroids represent modeled flow paths, but do not necessarily represent actual stream lengths, so the accumulated supplemental loads at the five river mouths represent the entire bank erosion contribution to the bay sediment load. Annual loads, showing contribution from land use and channel processes along with total predicted load, compared with reported values are shown in Table 4-8. The model predicted values match within 20 percent, with the exception of the Tillamook River.

Table 4-8. Comparison of Annual Modeled Sediment Loads with Reported Sediment Loads

Source Area	Land Related Load (tons/yr)	Channel Related Load (tons/yr)	Total Load (tons/yr)	Reported Load (tons/yr)[1]
Miami	2,542	11,533	14,075	16,500
Kilchis	5,294	38,884	44,178	53,900
Wilson	13,025	267,700	280,724	345,400
Trask	12,712	198,401	211,114	203,500
Tillamook	5,401	24,682	30,083	11,000
Near Bay	2,158	None	2,158	-------
Point Sources	None	None	80	-------
Total Bay Load	41,132	541,200	582,412	630,300

(1)From *Results of Storm Sampling in theTillamook Bay Watershed* (Sullivan et al, 1998b)

A comparison of model values with sampling data at the forest-agriculture interface, as well as the primary monitoring points (near the river mouths), reveals some differences in sediment delivery between watersheds. Sampling data collected by E&S Environmental Chemistry was analyzed to determine the flow-weighted average sediment concentration of samples collected during six different storms and is presented along with model predicted values at the same locations in Table 4-9 (E&S Environmental Chemistry, Inc., 1998).

Table 4-9. Comparison of Sediment Sampling Data with Predicted Data Within the Watershed

Monitoring Point	Location	Flow Weighted Average (mg/L)	Predicted (mg/L)	Percent Difference
MIA-UPP	Forest-Ag	22	38	73
KIL-KRP	Forest-Ag	34	61	79
TRA-HAT	Forest-Ag	50	182	264
WIL-KCB	Forest-Ag	172	180	5
MIA-MCB	Near Mouth	44	50	14
KIL-ALD	Near Mouth	57	89	56
TRA-TTR	Near Mouth	150	196	31
WIL-SSB	Near Mouth	240	220	-8

The sampling data at the forest-agriculture interface indicates that there is some factor related to sediment delivery in the Wilson River basin that is significantly different than in the other basins as the average concentration is much higher than concentrations in the other three basins. Comparison of values for both points on the Wilson River reveal a close match, supporting the assumption of constant incremental sediment input along the channel that was made in developing the supplemental channel load for the model. Table 4-9 shows that there is a smaller difference between measured and predicted values for sediment load at the river mouths than at the forest-agriculture interface. Since the model assumes a constant rate of channel contribution, the lowland channels must be contributing sediment at a higher rate than the channels within the forested areas. The relatively higher sediment load derived in the lowlands is especially pronounced for the Trask River (50 mg/L at the forest-agriculture interface versus 150 mg/L at the primary monitoring site).

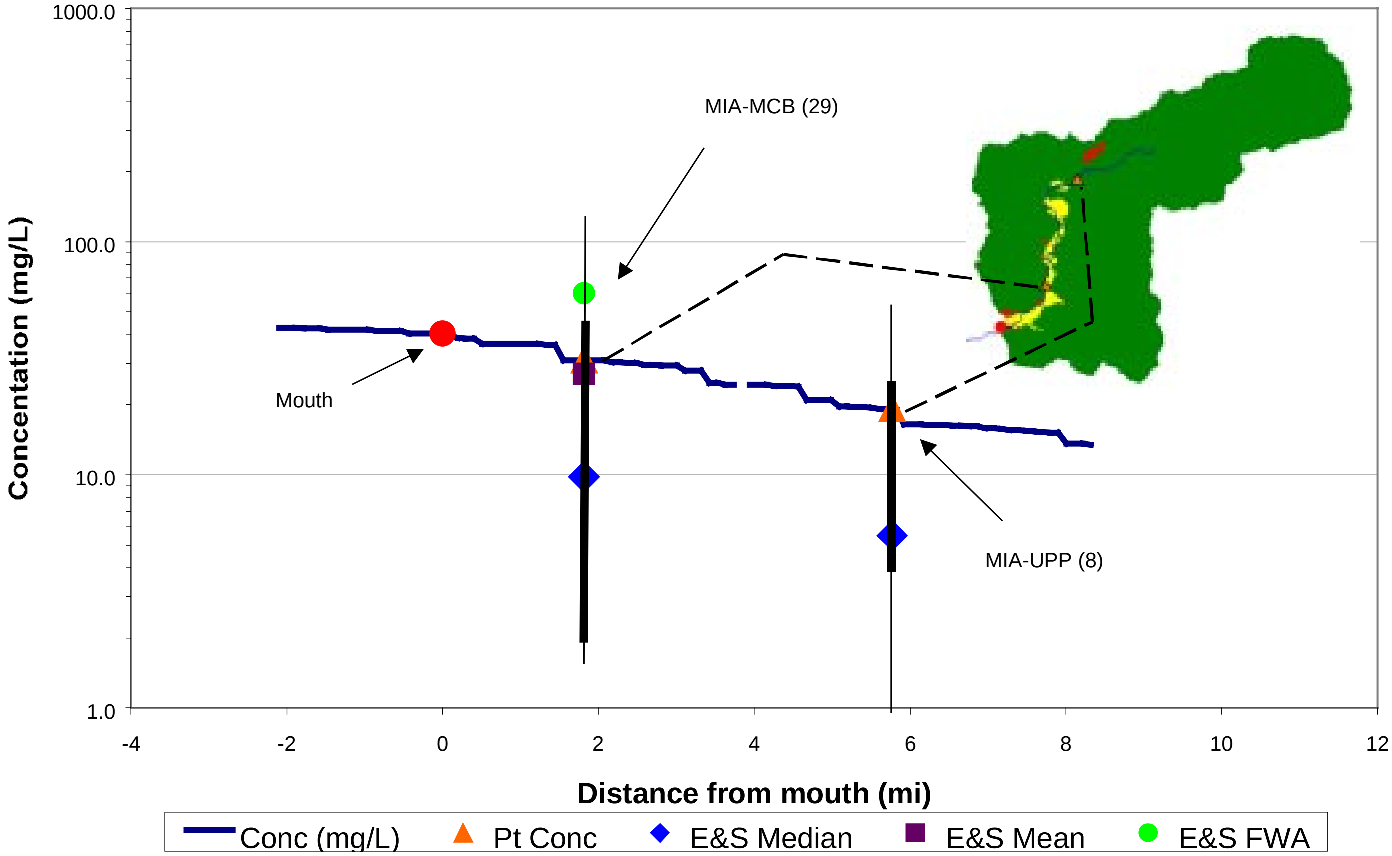


Figure 4-18. Miami River Sediment Concentration Profile Compared to Monitoring Data

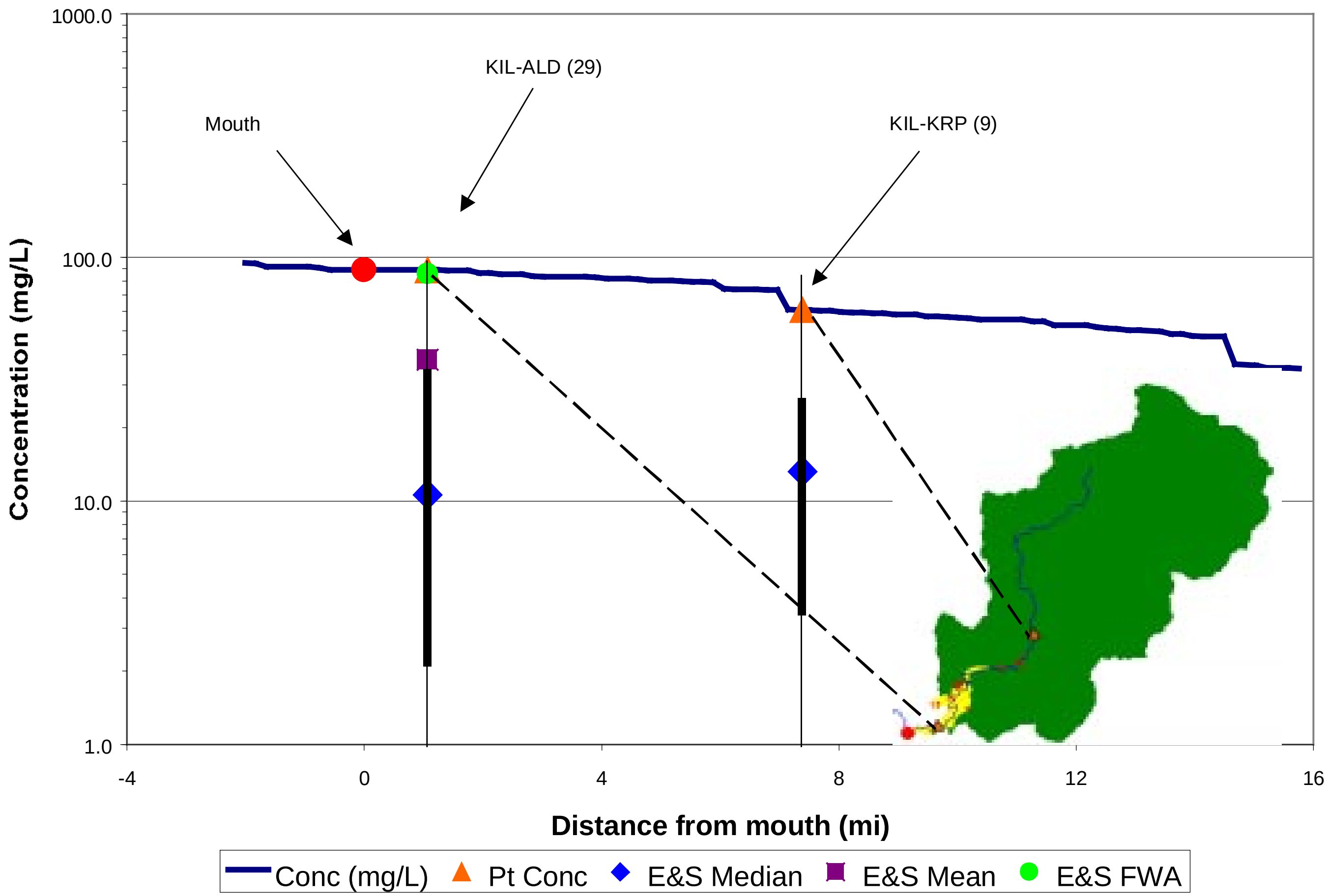


Figure 4-19. Kilchis River Sediment Concentration Profile Compared to Monitoring Data

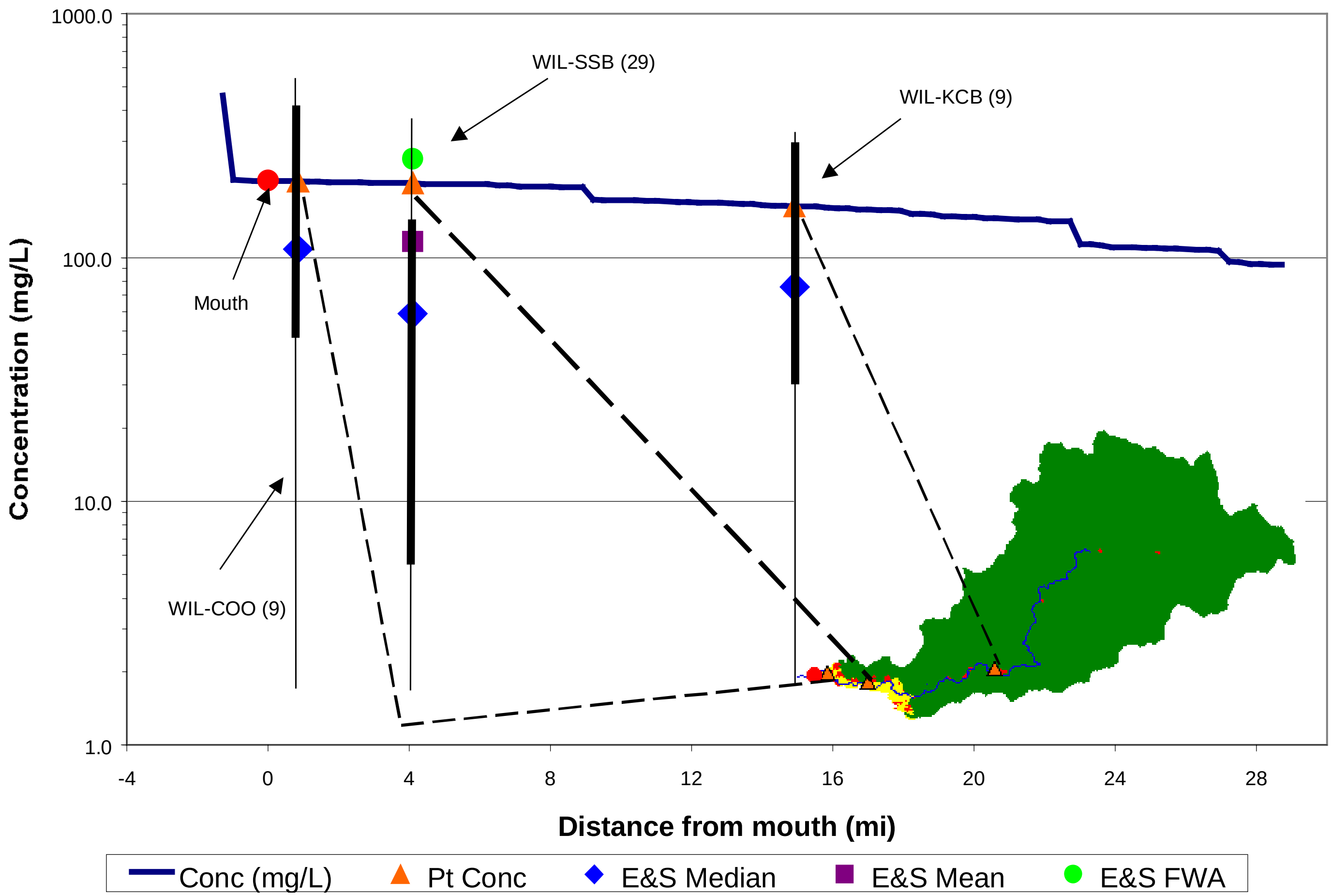


Figure 4-20. Wilson River Sediment Concentration Profile Compared to Monitoring Data

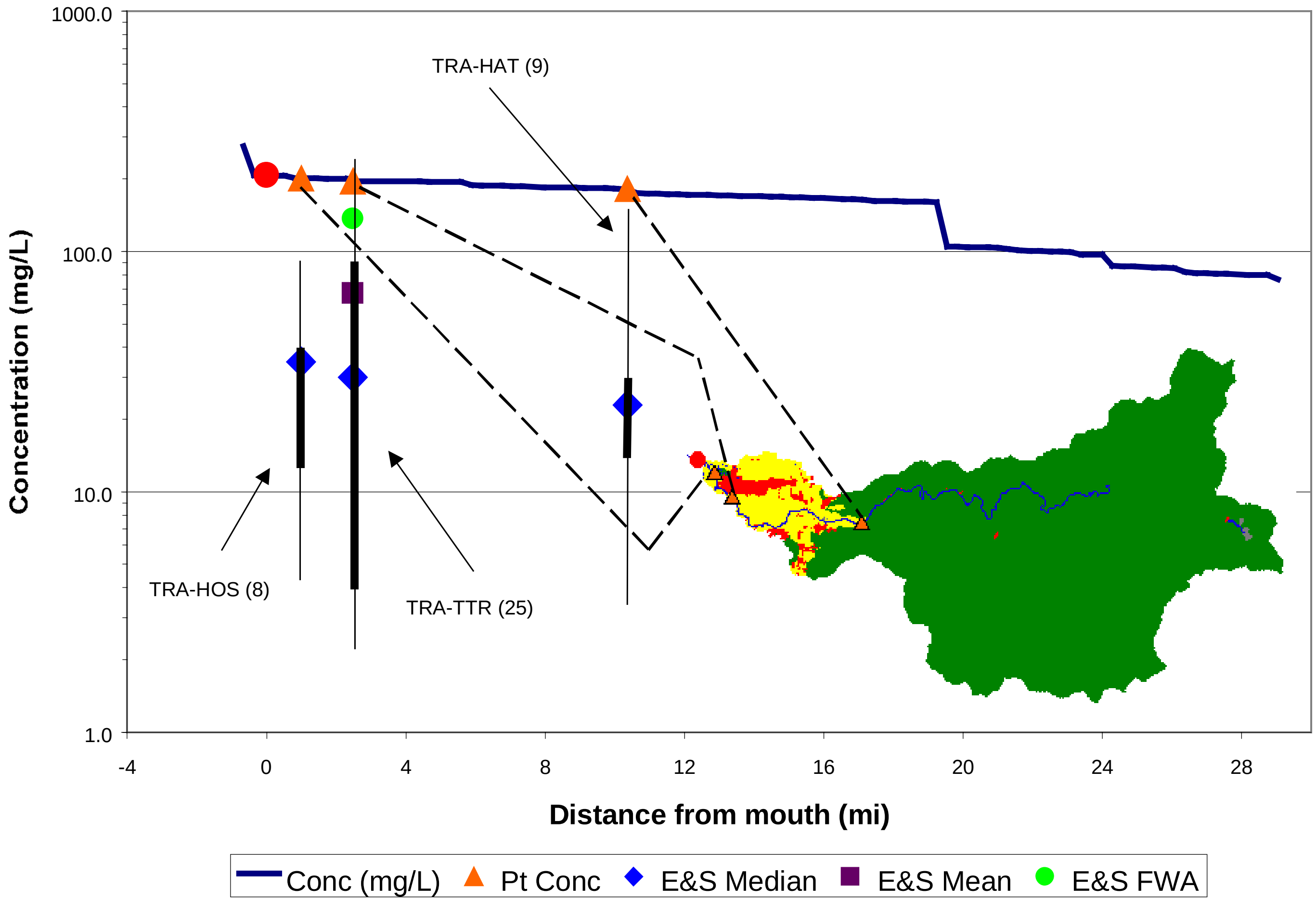


Figure 4-21. Trask River Sediment Concentration Profile Compared to Monitoring Data

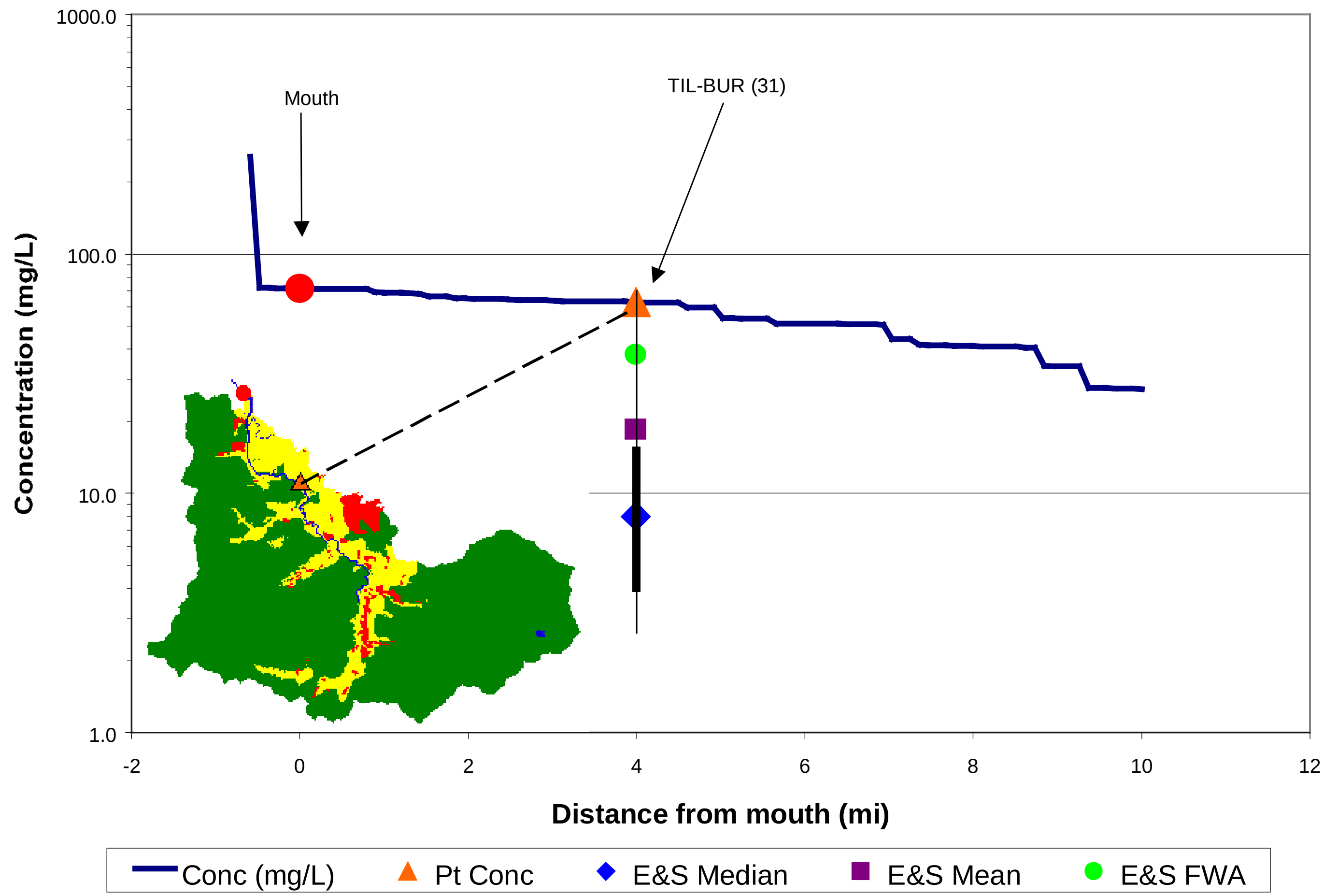


Figure 4-22. Tillamook River Sediment Concentration Profile Compared to Monitoring Data

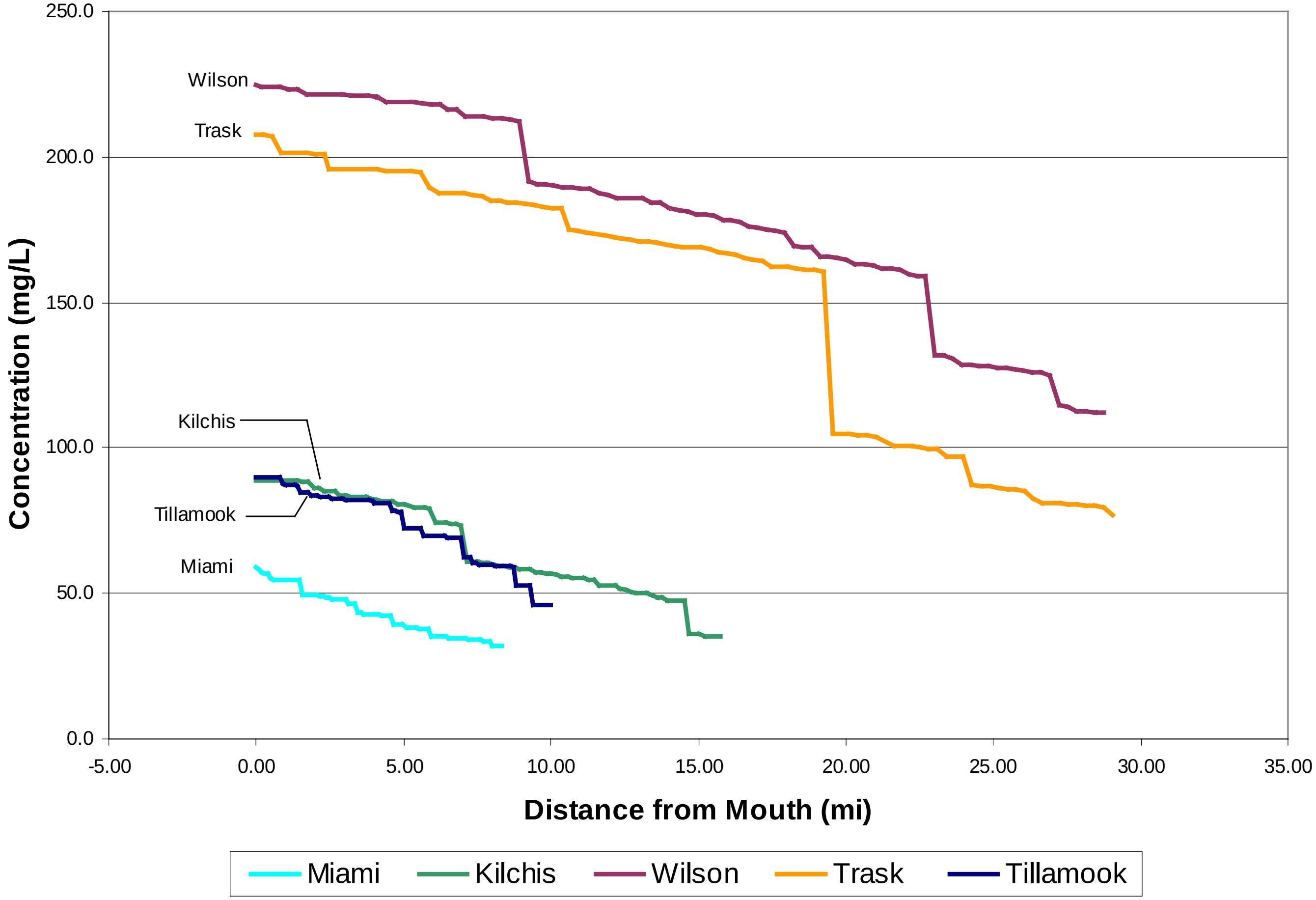


Figure 4-23. Comparison of Sediment Concentration Profiles for the Five Rivers in the Watershed

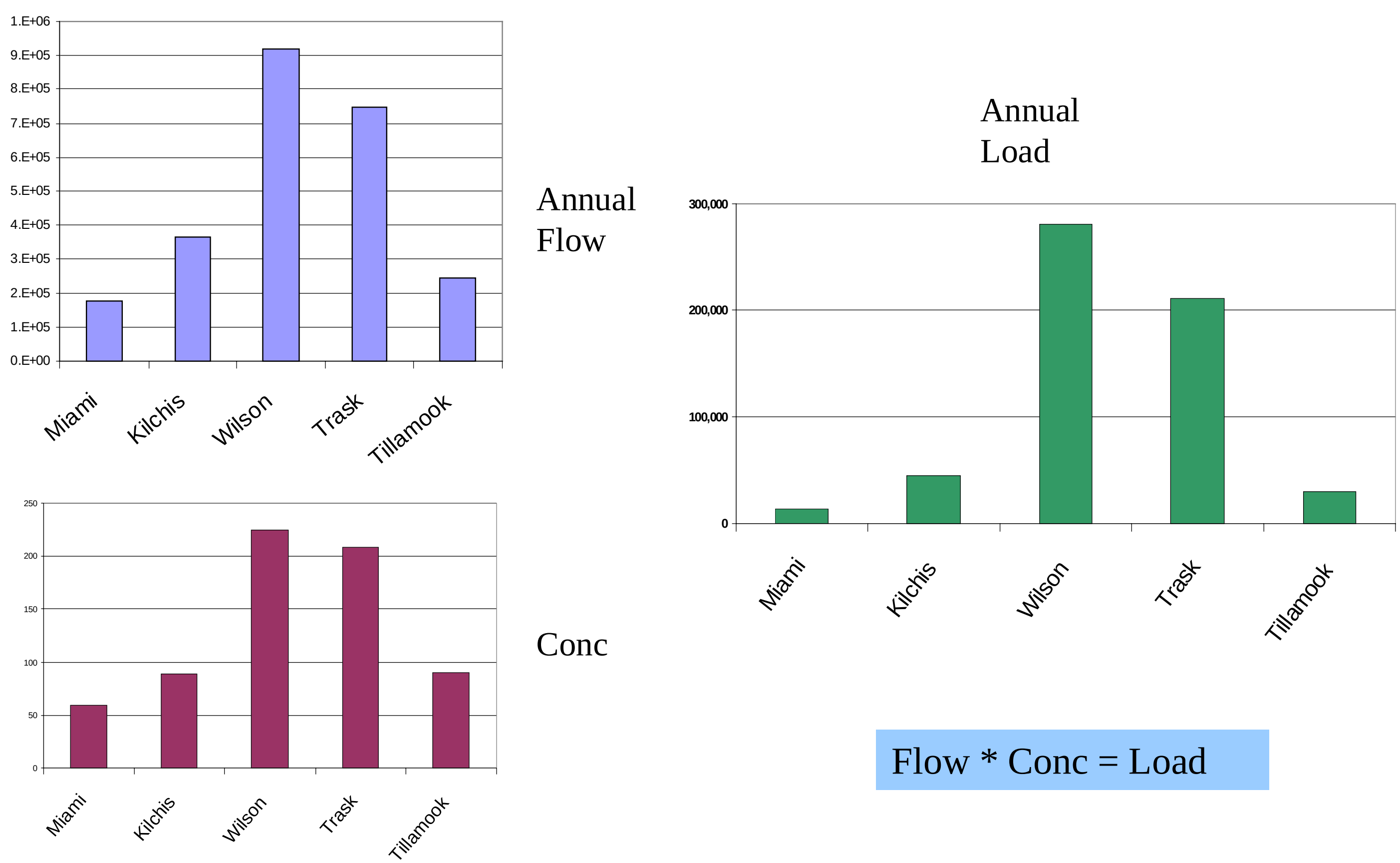


Figure 4-24. Sediment Load Summary for the Watershed

4.3.3 Point Source Loads

Point sources do contribute to the load in the watershed, albeit not significantly. Point sources make up less that a half a percent of the total load contribution for both bacteria and sediment – see Table 4-6 and Table 4-8, respectively, presented earlier. This statement assumes that the plants are operating correctly and supports findings in a previous study by Jackson and Glendening (1982).

4.3.4 Impact of BMP Implementation

The model demonstrates that the implementation of BMPs does result in reduced bacteria concentrations in the watershed, as well as reduced loads to the bay. Based on assumptions regarding BMP effectiveness and current level of implementation, Figure 4-25 shows a comparison between the concentrations predicted at the mouth of the five basins based on three scenarios: (1) prior to implementing any BMPs, (2) the current level of BMP implementation, and (3) full implementation of the model BMPs. The current level of implementation provides a 40 to 45 percent reduction in coliform concentrations in the rivers and a 43 percent reduction in total bacteria load to the bay compared to levels prior to BMP implementation. Full implementation, compared to levels prior to BMP implementation, provides a 66 to 72 percent reduction in concentration levels in the rivers, along with a 70 percent reduction in total load to the bay. In considering the impact of increasing the level of implementation of modeled BMPs, an additional 47 percent reduction to total bay loads can be realized by raising the implementation effort from current levels to full implementation.

The bacteria concentrations in the Tillamook and Trask rivers are still rather high, even after BMP implementation, but this model does not include all of the BMP possibilities. Once all of the BMPs are incorporated into the model, further reductions should be reflected in the model results.

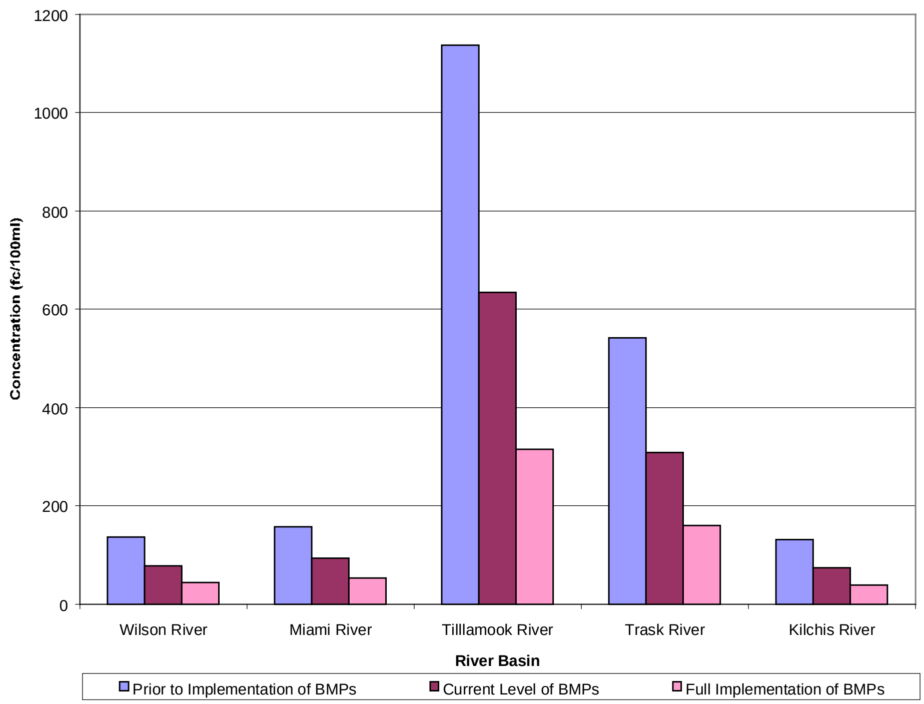


Figure 4-25. Comparison of Bacteria Concentrations (in fc/100ml) Based on Different Levels of BMP Implementation

5 CONCLUSIONS

This study demonstrates that GIS is an effective platform for modeling water quantity and quality in the Tillamook Bay watershed and for developing a decision support system for resource managers. Loadings from the basin sub-watersheds are segregated and attributed to various land uses, and effects of various Best Management Practices (BMPs), which reduce pollutant loads, are described.

5.1 Water Balances

Spatially varying discharge maps were created using precipitation-discharge relationships developed from observed annual data at the Tillamook1W rain gage and the Wilson River discharge gage. On the average, 25 percent of rainfall is converted into surface runoff, 53 percent becomes baseflow, and evapotranspiration accounts for the remaining 22 percent. Total flow at the USGS discharge gages on the Wilson and Trask Rivers were matched reasonably well, and flow contribution from the various watersheds were also accurately reproduced. The contribution to total flow was quantified for various land uses within each river basin, as well as within the watershed as a whole. Discharge from forested land accounts for the vast majority (greater than 90 percent) of flow generated in the basin. An average bay residence time of seven days was determined based on bay volume and average discharge from the contributing watershed.

5.2 Average Pollutant Concentrations for Different Land Uses

Average concentrations of pollutants in surface runoff and baseflow were assigned to different areas of the watershed based on the land use. The values selected for these average concentrations were based on literature values, limited sampling data, and professional judgment. The bacteria concentration in runoff for the dairy lands was calibrated to a value of 30,000 fc/100ml in an effort to match average reported concentrations in the five river basins. In some cases the model prediction is high, in some cases low relative to recent sampling results. The model has also shown that, while there is a component of the sediment load based on land use, there are other factors such as channel processes that contribute significantly to the load. This channel contribution was accounted for through the use of a supplemental sediment load. This supplemental load was calculated based on a derived relationship between reported average sediment concentrations and drainage area.

5.3 Average Pollutant Loads

There are two sources to pollutant loads to the bay. Point sources are those that deliver a 'concentrated' load at a specific point in the watershed and include the area wastewater treatment plants. Non-point sources are a result on wash-off of pollutants from the land surface and are related to the land use.

5.3.1 Bacteria Loading

Non-point sources account for nearly all of the bacteria load to the bay, with point sources contributing less than one percent of the total annual bacteria load. Model results indicate that the largest bacteria loading comes from the Trask River (2,843 x 10^{12} fc/yr), followed by the Tillamook River (1,921 x 10^{12} fc/yr). Loading contributions from the Wilson (203 x 10^{12} fc/yr), Kilchis (332 x 10^{12} fc/yr), and Miami (203 x 10^{12} fc/yr) are significantly lower than contributions from the other two subbasins. The Near Bay, which is about one-third to one-half dairy land use, also contributes 1153 x 10^{12} fc/yr, or about 15 percent of the total to the bay.

The finding that the Trask River contributes the largest loading is in agreement with recent sampling efforts (Sullivan et al, 1998a); however, that sampling indicates that the Wilson River, rather than the Tillamook River, has the second highest bacteria loading. This difference results from the lower modeled concentration in the Wilson River compared to that measured by E&S Environmental Chemistry. The lower modeled concentration is reflected in a lower predicted annual load. Additional sampling to better define EMC values may help to resolve this difference. In addition, there are other industrial activities in the lowland areas, such as the application of biosolids and lumber yard operations, that are not currently reflected in the model, yet may contribute to bacteria loads in the lowlands. Despite the fact that the Trask River contributes the largest load, it does not have the highest fecal coliform concentrations. These occur in the Tillamook River because the Tillamook basin has the highest percentage of dairy lands of the five river basins.

5.3.2 Sediment Loading

Non-point sources account for nearly all of the sediment load to the bay, with point sources contributing less than one percent of the total annual sediment load. Study results indicate that modeling sediment load based only on washoff from the land surface is not entirely appropriate since it does not appear to be the dominant factor in sediment loading in the watershed. Model concentrations were severely under-predicted if runoff concentrations alone are used in the analysis. The flow-weighted average sediment concentrations determined for each of the five rivers indicate a positive correlation with drainage area. These larger drainage areas have higher flows which might explain this correlation with higher sediment concentrations. In addition to having a higher sediment carrying capacity, higher flows have more energy and cause more channel erosion. Both of these factors would result in concentration variations that are associated with the size of the drainage area. Additional studies in the area of sediment loading should address the sediment carrying capacity of the rivers and tributaries and channel bank erosion as a sediment source.

Previous reports have concluded that forested areas account for about 85 percent of the sediment produced in the watershed, and that this portion is largely derived from logging roads and land slides (TBNEP, 1998a). However, sampling data shows relatively low sediment concentrations at the interface between forest lands and agricultural land use areas when compared to concentrations near the river mouths, as demonstrated by the Trask River data. If large sediment loads are being delivered in the uplands, sampling data indicates that they are not necessarily moving downstream toward the river mouths. This suggests that a large component of the sediment load is derived in the lower reaches, probably from channel erosion. This large erosion related component might be a result of different soils in the lower reaches or may reflect the impact from cow access to the rivers and resultant destablilization of banks. This suggests that riparian buffers and fencing could reduce the channel component of the sediment load. As with bacteria loads, there are other industrial activities in the lowland areas, such as the application of biosolids and lumber yard operations, that are not currently reflected in the model, yet may contribute to higher sediment concentrations in the lower river reaches.

5.4 Analysis of Predicted Pollutant Values

The comparison of model results with sampling data shows that the variation in concentration along the length of the five major rivers falls within the statistical spread of the observed data, providing reasonable correlation with measured concentrations. Bacteria concentrations at the designated river mouth location were over-predicted in the Kilchis, Trask, and Tillamook Rivers, but under-predicted in the Miami and Wilson Rivers. The modeled sediment concentrations generally fall toward the higher end of the data spread. This is likely because the land use related load was supplemented by a channel related load that was based on flow-weighted average sediment concentrations. These flow weighted average values may have been unduly influenced by a few samples collected during very high flows that would have had very high sediment concentrations.

5.5 Estimate Load Reductions Associated with BMPs

The model predicts that the current level of BMP implementation caused an approximate 40 percent reduction in concentrations of bacteria in the five major rivers. If the BMPs represented in the model were fully implemented, i.e., at 100 percent, the concentrations in the rivers would be reduced by an approximate additional 45 percent. Even though the model has shown that sediment load is largely related to drainage area and channel processes, BMP impacts on sediment loads from land surface washoff were calculated for the riparian buffer/fencing BMP since it is assumed that this is the only BMP considered in the model that is related to sediment load. Riparian buffers will act as filters for sediment wash-off and fencing will prevent cows from trampling the banks and reducing bank stability.

There are other BMPs that are being implemented in the watershed that are not yet incorporated into the model. These can be incorporated into the model as data on effectiveness and level of implementation become available. In particular, efforts should be made to reflect the effects of management practices that affect sediment load, such as erosion control techniques and the presence of large woody debris that slows discharge flows.

5.6 Additional Data Needs

The developed model fulfills its purpose as a management tool for the decision-makers and stakeholders in the Tillamook Bay watershed, but it does have some limitations. First, the model focuses on mean annual calculations assuming steady state conditions, and it separately account for the contributions from baseflow and runoff. Secondly, the average pollutant concentrations used were based largely on the literature. While these average concentrations are related to land use type, the land uses specified are somewhat generalized. In addition, literature values do not necessarily reflect the site-specific conditions in this watershed. However, the relative contribution of constituents seems to be reasonably depicted. Finally, the reductions realized from implementation of BMPs are based on professional judgment and may not represent actual reductions.

Additional data may allow for model modification to better reflect actual conditions in the watershed. There are two areas where additional data would be useful: (1) more specificity in land use and discharge concentration data and (2) better data to support reductions realized from the implementation of BMPs.

5.6.1 Land Use and Discharge Concentration Data

Land use specific monitoring to better establish concentration values for bacteria contamination in discharge could provide significant improvements to load modeling. As was discussed previously, the land use-concentration link does not adequately address the issue of sediment discharge.

The incorporation of additional data from aerial photographs allows for more detailed spatial description in the lowland areas. The spatial resolution could be increased depending on the availability of data to differentiate between land uses. No attempt was made in this study to incorporate the herd size of various dairy operations. If land parcels associated with dairy operations can be associated with a particular dairy operation permit, those parcels could be attributed with a concentration that might reflect herd size. For example, if monitoring data can establish a relationship between the bacteria concentration for surface runoff and a range of herd size, the land parcels can be attributed with the herd size associated with those lands and conditional statements used in the avenue script to assign a concentration based on animal density or number.

Consideration should be given to accounting for bacteria load contribution from land application of biosolids and from lumber yard/logging industrial activities if data on runoff quality becomes available. The 1997 Watershed Assessment (ODEQ, 1997) identified these two activities as possible significant contributors to loads. While neither of these activities is accounted for specifically, both of them might be considered sub-categories of the rural industrial land use classification and could be modeled as such. In addition, the watershed assessment (ODEQ, 1997) identified the Anderson creek storm sewer system as a point source. If indeed this is a point source, consideration should be given to adding this to the existing outfalls point coverage.

The model setup assumes that failing septic systems are the sole source of bacteria load for rural residential lands. If septic systems are functioning properly (representing the implementation of a best management practice), the model assumes that there is no load contribution, and this is likely not an accurate representation. Consideration should be given to trying to develop a method to calculate two loads associated with rural residential lands - one that might be similar to other urban residential lands and one that would be associated with failing septic systems. If septic systems can be spatially located within the watershed, they could be modeled as point source inputs, similar to the wastewater treatment plants.

5.6.2 BMP representation

The model represents three BMPs associated with the dairy industry and the impact of failing septic systems. There are other dairy related BMPs being implemented in the basin that could be incorporated into the model. The current modeled level of implementation is based on a 1991 report and may need to be updated. In addition, the reduction associated with these three BMPs is based on professional judgment. Additional work could be done to obtain more accurate values for reductions realized from all BMPs of interest.

Additionally, the model currently uses the concept of spatial averaging to apply reductions based on BMP reduction and effectiveness. This average is applied to the entire watershed. An additional level of detail could be employed to apply these spatial averages on a river basin basis. If data becomes available to be able to differentiate level of implementation and land use/land management information on an individual farm basis, this information could be incorporated into the BMP reduction scripts and reflected in the model. As with load estimates, if CAFO dairy land parcels can be associated with a particular CAFO permit and detailed information regarding level of BMP implementation is known, the reduction for BMP implementation can be made at the farm scale.

The model does include sediment reduction based on the use of riparian buffers and/or fencing; however, based on the conclusion that land use accounts for a very small portion of the sediment load, this reduction is not significant. Even at full implementation of this BMP, sediment concentrations are only reduced by about one percent. However, the reduction from this BMP is applied only to the wash-off component of the sediment load, when in fact, it will also affect the supplemental channel load, particularly the use of fencing to prevent cow access to the streams which can result in bank destabilization and additional channel erosion. Once the sources of the sediment loads are better understood, they can be represented more accurately. In addition, attention should be given to determining BMPs that effectively reduce sediment load, and then incorporating those into the model. Since there is strong suggestion that the majority of the sediment load may be related to channel erosion, BMPs that mitigate this should be included in the model. These BMPs would include efforts in the way of bank stabilization and restoration of large woody debris to decrease velocities in the channels.

5.7 Summary

This study and model do provide an effective, scientifically based management tool despite the limitations of the model and the need for more data. The current model calculates loads based on mean annual values. Loads from individual watersheds were quantified, and the effects of various BMP implementation strategies were examined to help focus those efforts. This tool allows managers to quantify load contribution, not only on a sub-watershed basis, but also on a land use basis within sub-watersheds.

The decision support system developed in this project is merely a starting point. It is intended to be a living model. It provides a framework for developing a more detailed tool to be used by managers and stakeholders in the Tillamook Bay watershed. As monitoring and data collection continues, the model can be updated to allow for more specificity and detail in the analysis. This model refinement will not happen overnight, but as more data becomes available, it can be used to provide more focused guidance for resource managers.

APPENDIX A

SCRIPTS/PROGRAMS AND PROCEDURES

Projection Files

- Orlamb
- Alblamb
- Utmlamb

Arc/Info command sequence for Point Coverage creation

Bflow3.exe

Avenue Scripts

- Accflow.ave
- Accpreci.ave
- Bactibayreduction.ave
- Bactibmpeffect.ave
- Bacticoncvalue.ave
- Bactigrid.ave
- Bactilocatedbmp.ave
- Bactipredconc.ave
- Bathdem.ave
- Burndem.ave
- Connectsink.ave
- Dasedigrid.ave
- Gages.ave
- Gridclip.ave
- Merge.ave
- Pickbactisep.ave
- Pickbayvalue.ave
- Picksedisep.ave
- Profiler.ave
- Profilerwithpoints.ave
- Ptsrcfcgrid.ave
- Ptsrcssgrid.ave
- Sedibayreduction.ave
- Sedibmpeffect.ave
- Sediconcvalue.ave
- Sedigrid.ave
- Sedilocatedbmp.ave
- Sedipredconc.ave
- Tillflow.ave
- Wtfac.ave

‘Orlamb’ AML projection file –

```
input
projection geographic
datum NAD83
units dd
parameters
output
projection lambert
datum NAD83
units 3.2808400000
spheroid GRS1980
parameters
43 0 0.000
45 30 0.000
-120 30 0.000
41 45 0.000
400000.00000
0.00000
end
```

‘Alblamb’ AML projection file –

```
input
projection albers conical
equal area
datum NAD83
units meters
spheroid GRS1980
parameters
29.500
45.500
-96.000
23.000
0.000
0.000
output
projection lambert
datum NAD83
units 3.2808400000
spheroid GRS1980
parameters
43 0 0.000
45 30 0.000
-120 30 0.000
41 45 0.000
400000.000
0.000
end
```

‘Utmlamb’ AML projection file –

```
input
projection UTM
datum NAD27
units meters
zone 10
parameters
output
projection lambert
datum NAD83
units 3.2808400000
spheroid GRS1980
parameters
43 0 0.000
45 30 0.000
-120 30 0.000
41 45 0.000
400000.00000
0.00000
end
```

Arc/Info command sequence for creating the **eandspts** coverage:

Arc: *generate sampinfo*
Generate: *input siteinfo.fil*
Generate: *points*
Generate: *quit*
Arc: *build sampinfo points*
Arc: *addxy sampinfo*
Arc: *project cover sampinfo eandspts utmlamb*
Arc: *build eandspts points*

Bflow3.exe – Fortran Program Code for Baseflow Separation

```
c
*****************************************************************
c Author: Francisco Olivera
c CRWR - University of Texas at Austin
c Date: February 5, 1996
c
c Purpose: Given a flow time series, the program
generates base flow
c and direct runoff time series.
c
c Given the plot of the flow time series, the base flow is
c obtained by pivoting a straight line on a point and
c connecting it with the lowest part of the flow curve. The
c length of the straight line is defined by the user.
c
c Input: (1) Length of the straight line (in time steps).
c (2) Flow time series
c
c
*****************************************************************
c Declaring parameters
    parameter (NMax=5000)
c Declaring variables
    Real Flow(NMax), BaseFlow(NMax), MinSlope,
Slope(NMax)
    Integer L, N
c Open input files for reading
    open(unit=10, file='flow.in', status='old')
c Open output file for writing
    open(unit=30, file='baseflow.out', status='unknown')
c Reading input file
    read(10,*) L
    do 101 i=1,NMax
    read(10,*,end=901) Flow(i)
    N=i
    101 continue
    901 continue
c Generating the base flow
    BaseFlow(1)=Flow(1)
    i=1
    501 continue
    MinSlope=1000000
    Do 102 j=1,L
    If (i+j.LE.N) then
    Slope(j)=(Flow(i+j)-BaseFlow(i))/j
    If (Slope(j).LT.MinSlope) then
    MinSlope=Slope(j)
    End if
    End if
    102 continue
    BaseFlow(i+1)=BaseFlow(i)+MinSlope
    i=i+1
    If (i-N) 501,502,502
    502 continue
c Echo the output to the screen
    do 104 i=1,N
    write(*,*) i,Flow(i),BaseFlow(i)
    104 continue
c Writing the Flow and the BaseFlow
    do 105 i=1,N
    write(30,*) i,Flow(i),BaseFlow(i)
    105 continue
    end
```

Script: accflow.ave

```
'
'---------------------------------
'--- Creation information ---
'---------------------------------
'
'Name: wfacgrid.ave
'Version: 1.0
'Date: 02/17/97
'Author: Ferdi Hellweger
'       Center for Research in Water Resources
'       The University of Texas at Austin
'       ferdi@crwr.utexas.edu
'
'Modified: 02/28/97
'         Ann Quenzer
'         Center for Research in Water Resources
'         The University of Texas at Austin
'         quenzer@mail.utexas.edu
'         1) changed the conversions to reflect project
'         2) changed the message box descriptions to
'                    reflect the script
'         3) computes an integer grid
'         4) added purpose and description
'
' Modified 6/23/98 by Patrice Melancon
(pmelancon@mail.utexas.edu)
'          1)  Edited the purpose and script to reflect
accumulation of flow
'          2)  No conversion factor in this; only accumulates flow
values
'          New Name:  accflow.ave
'-------------------------------
'--- Purpose/Description ---
'-------------------------------
'
'Computes a weighted flow accumulation using the connectsink flow
'direction grid and the runoff and baseflow grids.  The
'result produces a grid that gives the accumulated flow (of all upstream
cells) at any given point in
'cf/yr assuming that the flow grids are in cf/yr.
'Requires a flow direction grid, the average runoff grid, and average
baseflow grid.
'
'----------------------------------
'--- Get view and themes -----
'----------------------------------
'
theview = av.getactivedoc
thethemes = theview.getthemes
if (thethemes.count = 0) then
   msgbox.error("No themes found", "AccFlow")
   exit
end
if (thethemes.count = 1) then
   msgbox.error("Only one theme found", "AccFlow")
   exit
end
thegthemes = list.make
for each thetheme in thethemes
   if (thetheme.getclass.getclassname = "gtheme") then
      thegthemes.add(thetheme)
   end
end
if (thegthemes.count = 0) then
   msgbox.error("No grid themes found", "Accflow")
   exit
```

```
end
if (thethemes.count = 1) then
   msgbox.error("Only one grid theme found", "Accflow")
   exit
end
fdrtheme = msgbox.listasstring(thegthemes, "Flow direction
theme", "AccFlow")
if (fdrtheme = nil) then
   exit
end
flrtheme = msgbox.listasstring(thegthemes, "Runoff Grid",
"AccFlow")
if (flrtheme = nil) then
   exit
end
'
flbtheme = msgbox.listasstring(thegthemes, "Baseflow Grid",
"AccFlow")
if (flbtheme = nil) then
   exit
end
'
'------------------
'--- Calculate ---
'------------------
'
fdrgrid = fdrtheme.getgrid
flrgrid = flrtheme.getgrid
flbgrid = flbtheme.getgrid
'
ae = theView.GetExtension(AnalysisEnvironment)
ae.setcellsize(#ANALYSISENV_VALUE,fdrgrid.getcellsize)
ae.setextent(#ANALYSISENV_VALUE,fdrgrid.getextent)
'
rfacgrid = (fdrgrid.flowaccumulation(flrgrid))
raccname = msgbox.input("Give the accumulated runoff grid a
name","AccFlow","accrunoff")
rfacfilename = FN.merge(av.getproject.getworkdir.asstring,raccname)
rfacgrid.savedataset(rfacfilename)
rfacgtheme = gtheme.make(rfacgrid)
theview.addtheme(rfacgtheme)
rfacgtheme.setvisible(false)
'
bfacgrid = (fdrgrid.flowaccumulation(flbgrid))
baccname = msgbox.input("Give the accumulated baseflow grid a
name","AccFlow","accbflow")
bfacfilename = FN.merge(av.getproject.getworkdir.asstring,baccname)
bfacgrid.savedataset(bfacfilename)
bfacgtheme = gtheme.make(bfacgrid)
theview.addtheme(bfacgtheme)
bfacgtheme.setvisible(false)
'
'final message to user
'
message = "Accumulated flow grids calculated."
msgbox.info(message,"AccFlow")
'
'------------
'--- End ----
'------------
'
```

Script: accpreci.ave

```
'---------------------------------
'--- Creation information ---
'---------------------------------
'
'Name: wfacgrid.ave
'Version: 1.0
'Date: 02/17/97
'Author: Ferdi Hellweger
'       Center for Research in Water Resources
'       The University of Texas at Austin
'       ferdi@crwr.utexas.edu
'
'Modified: 02/28/97
'        Ann Quenzer
'        Center for Research in Water Resources
'        The University of Texas at Austin
'        quenzer@mail.utexas.edu
'        1) changed the conversions to reflect project
'        2) changed the message box descriptions to
'                       reflect the script
'        3) computes an integer grid
'        4) added purpose and description
'
' Modified 3/9/98 by Patrice Melancon
(pmelancon@mail.utexas.edu)
'         1)  Edited the purpose and script to reflect
accumulation of rainfall
'         2)  No conversion factor in this; only accumulates
precip values
'         3New Name:  accpreci.ave
'--------------------------------
'--- Purpose/Description ---
'-------------------------------
'
'Computes the weighted flow accumulation using the flow
'direction grid and the precipitation grid.  The
'resulting grid produces a grid (precipload) with the
'total accumulated precipitation at any given point in in/yr*cells
'
'-------------------------------
'--- Get view and themes---
'-------------------------------
'
theview = av.getactivedoc
'
thethemes = theview.getthemes
if (thethemes.count = 0) then
   msgbox.error("No themes found", "WFAC GRID")
   exit
end
if (thethemes.count = 1) then
   msgbox.error("Only one theme found", "WFAC GRID")
   exit
end
thegthemes = list.make
for each thetheme in thethemes
   if (thetheme.getclass.getclassname = "gtheme") then
      thegthemes.add(thetheme)
   end
end
if (thegthemes.count = 0) then
   msgbox.error("No grid themes found", "WFAC GRID")
   exit
end
if (thethemes.count = 1) then
   msgbox.error("Only grid one theme found", "WFAC GRID")
```

```
    exit
end
fdrtheme = msgbox.listasstring(thegthemes, "Flow direction
theme", "WFAC GRID")
if (fdrtheme = nil) then
    exit
end
ldtheme = msgbox.listasstring(thegthemes, "Precip Grid",
"WFAC GRID")
if (ldtheme = nil) then
    exit
end
’
’------------------
’--- Calculate ---
’------------------
’
fdrgrid = fdrtheme.getgrid
ldgrid = ldtheme.getgrid
’
cellsize = number.makenull
dummmy = grid.getanalysiscellsize(cellsize)
extent = rect.makenull
dummy = grid.getanalysisextent(extent)
’
facgrid = (fdrgrid.flowaccumulation(ldgrid))
facfilename = av.getproject.makefilename("facgrid", "")
facgrid.savedataset("accprecip".asfilename)
facgtheme = gtheme.make(facgrid)
theview.addtheme(facgtheme)
facgtheme.setvisible(true)
’
’final message to user
’
message = "Accumulated precip grid calculated."
msgbox.info(message,"WFAC GRID")
’
’------------
’--- End ----
’------------
’
```

Script: bactibayreduction.ave

```
'---------------------------------
'--- Creation information ---
'---------------------------------
'
'Name: pickload.ave
'Version: 1.0
'Date: 02/11/97
'Author: Ferdi Hellweger
'	Center for Research in Water Resources
'	The University of Texas at Austin
'	ferdi@crwr.utexas.edu
'
'Modified by:  Patrice A. Melancon
(pmelancon@mail.utexas.edu)
'	Date:  7/20/98
'	Center for Research in Water Resources, University of
Texas at Austin
'	New Name:  pickbayvalue.ave
'	Fixed the script so that it works in ArcView; added in
option to select a value grid; added in option to select the
polygon theme to then get the centroids on. Set the new field to
'Acc Flow' for now; could be changed for other variables.
'
'Modified by:  Patrice A. Melancon
'	Date:  29 Oct 98
'	Modified so that the attribute table of the polygon theme
is not altered.  A new .dbf file and table are created, and all
values are written to the new table and .dbf file.
'	New name:  pickbayvalue.ave
'
'Modified by:  Patrice A. Melancon
'	Date:  9 Feb 99
'	Modified to be able to predict % load reduction for each segment
of the bay.
'	New name:  bactibayreduction.ave
'
'-------------------------------
'--- Purpose/Description ---
'-------------------------------
'
'This program picks up the accumulated value for each polygon in the
modeled bay segments coverage (baymodel)
'from whatever grid you tell it to.  The grid that you specify should be
an accumulated grid (ie, flow accumulation
'has been calculated already) based on the flow direction from the
connectsink modified DEM
'grid with the cellvalue request. A new table and .dbf file are created
and the value is written to a field
'that the user specifies.  The script will ask for two identifiers since
there are two segments named 'main bay.'  The user should
'identify the segment name as the primary identifier and the growing
management as the secondary identifier.
'This script only queries one grid at a time, so if you are interested in
more than one grid, you
'will need to run this script multiple times.
'
'------------------
'--- Get view ---
'------------------
'
theview = av.getactivedoc
vgraphics = theview.getgraphics
'
'---------------------
'--- Get themes ---
'---------------------
```

```
'
thethemes = theview.getthemes
if (thethemes.count = 0) then
    msgbox.error("No themes found", "Bay Reduction")
    exit
end
'get the grid themes
thegthemes = list.make
for each thetheme in thethemes
  if(thetheme.getclass.getclassname = "gtheme") then
    thegthemes.add(thetheme)
  end
end
if (thegthemes.count = 0) then
  msgbox.error("No grid themes found","Bay Reduction")
  exit
end
'get the coverage themes
thefthemes = list.make
for each thetheme in thethemes
  if(thetheme.getclass.getclassname = "ftheme") then
    thefthemes.add(thetheme)
  end
end
if (thefthemes.count = 0) then
  msgbox.error("No coverage themes found","Bay Reduction")
  exit
end
'
'Get the pre bmp accumulated load grid associated with runoff
'
pregtheme = msgbox.listasstring(thegthemes,"Pre-BMP Acc
Runoff Load","Bay Reduction")
if (pregtheme = nil) then
  exit
end
'
'Get the post bmp accumulated load grid associated with runoff
'
postgtheme = msgbox.listasstring(thegthemes,"Post-BMP Acc Runoff
Load","Bay Reduction")
if (postgtheme = nil) then
  exit
end
'
'get the accumulated load grid associated with baseflow
'
basegtheme = msgbox.listasstring(thegthemes,"Acc Baseflow
Load","Bay Reduction")
if (basegtheme = nil) then
  exit
end
'
'Pick the polygon coverage that you want the values for
'
baytheme = msgbox.listasstring(thefthemes,"Bay Polygon Theme","Bay
Reduction")
if (baytheme = nil) then
  exit
end
'
'------------------------
'--- Set up themes ---
'------------------------
'
'grid theme
'
pregrid = pregtheme.getgrid
```

```
postgrid = postgtheme.getgrid
basegrid = basegtheme.getgrid
’
thecellsize = pregrid.getcellsize
’
’polygon theme
’
bayftab = baytheme.getftab
if (bayftab = nil) then
   msgbox.error("Can’t open polygon theme","Bay Reduction")
   exit
end
’
bayshapef = bayftab.findfield("shape")
if (bayshapef = nil) then
   msgbox.error("Can’t find ’shape’ field in polygon
theme","Bay Reduction")
   exit
end
’
’Create a new table and .dbf file and then populate it with
appropriate information
’
polytablename=msgbox.input("Select a name for the results
table - be sure to leave the .dbf extension on the end","Bay
Reduction","*.dbf")
if (polytablename.right(4).ucase = ".DBF") then
  polytblfilename =
FN.merge(av.getproject.getworkdir.asstring,polytablename)
else
  polytablename = polytablename.merge(".dbf")
  polytblfilename =
FN.merge(av.getproject.getworkdir.asstring,polytablename)
end
’
theVtab = Vtab.MakeNew(polytblfilename,dbase)
’
’get two identifier fields from the point coverage attribute table
’
ident1f = msgbox.choice(bayftab.getfields,"Pick the field that you want
to carry over as the primary identifier field","Bay Reduction")
newident1f = ident1f.clone
ident2f = msgbox.choice(bayftab.getfields,"Pick the field that you want
to carry over as the secondary identifier field","Bay Reduction")
newident2f = ident2f.clone
’
’Create fields for the table
’Select a field name for the value you are interested in
’
valueinterest = msgbox.input("Enter a name to correspond with the
value field that you selected earlier - this will become the name of the
value field in the new table","Bay Reduction","Reduction")
valuef = field.make(valueinterest, #FIELD_FLOAT, 10, 0)
theVtab.addfields({newident1f,newident2f,valuef})
’
’------------------
’--- Calculate ---
’------------------
’
’Note that due to instabilities in the flowaccumulation algorithm
’at sinks the accumulated value can not be simply picked of the grid at
the
’centroid (the sink).  The accumulated value is the integral of the grid
’values of the 8 cells surrounding the centroid.
’
’--- Initial set up ---
’
’--- Loop ---
```

```
'
for each bayrec in bayftab
    '
    'get the identifier for the polygon
    '
    ident1v = bayftab.returnvalue(ident1f,bayrec)
    ident2v = bayftab.returnvalue(ident2f,bayrec)
    '
    'get centroid
    '
    bayshape = bayftab.returnvalue(bayshapef, bayrec)
    cenbay = bayshape.returncenter
    cenx = cenbay.getx
    ceny = cenbay.gety
    '
    'plot centroid
    '
    cengs = graphicshape.make(cenbay)
    vgraphics.add(cengs)
    '
    'check if centroid is in polygon
    '
    inside = cenbay.iscontainedin(bayshape)
    if (not inside) then
        msgbox.error("Polygon centroid not inside polygon",
"Bay Reduction")
    end
    '
    'get values for 8 cells around centroid
    '
    pickx = cenx + (0 * thecellsize)
    picky = ceny + (1 * thecellsize)
    pickp = point.make(pickx, picky)
    prev1 = pregrid.cellvalue(pickp,Prj.MakeNull)
    postv1 = postgrid.cellvalue(pickp,Prj.MakeNull)
    basev1 = basegrid.cellvalue(pickp,Prj.MakeNull)
    '
    pickx = cenx + (1 * thecellsize)
    picky = ceny + (0 * thecellsize)
    pickp = point.make(pickx, picky)
    prev2 = pregrid.cellvalue(pickp,Prj.MakeNull)
    postv2 = postgrid.cellvalue(pickp,Prj.MakeNull)
    basev2 = basegrid.cellvalue(pickp,Prj.MakeNull)
    '
    pickx = cenx + (-1 * thecellsize)
    picky = ceny + (0 * thecellsize)
    pickp = point.make(pickx, picky)
    prev3 = pregrid.cellvalue(pickp,Prj.MakeNull)
    postv3 = postgrid.cellvalue(pickp,Prj.MakeNull)
    basev3 = basegrid.cellvalue(pickp,Prj.MakeNull)
    '
    pickx = cenx + (0 * thecellsize)
    picky = ceny + (-1 * thecellsize)
    pickp = point.make(pickx, picky)
    prev4 = pregrid.cellvalue(pickp,Prj.MakeNull)
    postv4 = postgrid.cellvalue(pickp,Prj.MakeNull)
    basev4 = basegrid.cellvalue(pickp,Prj.MakeNull)
    '
    'add up all 4 values for the total value
    '
    prevaluev = prev1 + prev2 + prev3 + prev4
    postvaluev = postv1 + postv2 + postv3 + postv4
    basevaluev = basev1 + basev2 + basev3 + basev4
    '
    'calculate the total pre and post loads
    '
    totalpre = prevaluev + basevaluev
    totalpost = postvaluev + basevaluev
```

```
    '
    'calculate the percent reduction
    '
    valuev = (totalpre - totalpost)/totalpre*100
    '
    'Add a record to the new table and write percent reduction
value to new record
    '
    therec = theVtab.addrecord
    theVtab.setvalue(newident1f,therec,ident1v)
    theVtab.setvalue(newident2f,therec,ident2v)
    theVtab.setvalue(valuef,therec,valuev)
    '
end
'
'make the new table non editable
'
theVtab.seteditable(false)
'
baytable = Table.Make(theVtab)
baytable.setname(polytablename)
baytable.GetWin.Open
'
'final message to user
'
message = "Reduction to bay segments calculated"
msgbox.info(message,"Bay Reduction")
'
'-------------
'--- End ----
'-------------
'
```

Script: bactibmpeffect.ave

```
'-------------------------------------
'---------Creation Info-------------
'-------------------------------------
'
'Name:  bactibmpeffect.ave
'Version:  1.0
'Date:  8 Sep 98
'Author: Patrice Melancon
'       Center for Research in Water Resources
'       The University of Texas at Austin
'       pmelancon@mail.utexas.edu
'
'------------------------------------
'------Purpose/Description-------
'------------------------------------
'
'This script calculates a new runoff bacti grid to account for the effects of BMPs on CAFO lands.
'This script does not affect the baseflow bacti grid since it is assumed that BMPs don't affect baseflow.
'This scripts requires a landuse grid, a grid of runoff FC load and baseflow FC load, and a flow direction grid.
'A MultiInput box will get information on BMP implementation and associated reductions.
'An effective reduction for CAFO BMPs is calculated.
'A grid is created to represent the remaining load - the landuse grid is queried
'and for all CAFO land the load remaining is calculated by the runoff load * the percent
'remaining (which is represented by 1 - effective reduction) and is written to the result grid;
'for rural residential land, the load remaining is calculated by the runoff load * percent of
'septic systems failing and is written to the result grid; for all other lands, the original
'runoff load is written to the result grid (representing no reduction).
'Optionally, flow accumulation is done on the resultant runoff load grid to get a new accumulated runoff grid.
'Another option allows the user to flow accumulate the baseflow bacti load grid if that was not done in the
'previous step.
'
'There are number of lines that are commented out dealing with more BMPs and gradations of proper manure application.
'These lines have been left in for potential future use.
'
'-----------------
'--- Get view ---
'-----------------
'
theview = av.getactivedoc
'
'-------------------
'--- Get theme ---
'-------------------
'
thethemes = theview.getthemes
if (thethemes.count = 0) then
   msgbox.error("No themes found", "BMP Effect")
   exit
end
'
thegthemes = list.make
for each thetheme in thethemes
   if (thetheme.getclass.getclassname = "gtheme") then
```

```
      thegthemes.add(thetheme)
    end
end
'
if (thegthemes.count = 0) then
   msgbox.error("No grid themes found","BMP Effect")
   exit
end
'
'get the landuse grid
'
lusetheme = msgbox.listasstring(thegthemes,"Landuse
Grid","BMP Effect")
if (lusetheme = nil) then
   exit
end
lusegrid = lusetheme.getgrid
'
'get the runoff FC load per cell grid
'
rofctheme = msgbox.listasstring(thegthemes,"Runoff FC Load
Grid","BMP Effect")
if (rofctheme = nil) then
   exit
end
rofcgrid = rofctheme.getgrid
'
'get the baseflow FC load per cell grid
'
bffctheme = msgbox.listasstring(thegthemes,"Baseflow FC
Load Grid","BMP Effect")
if (bffctheme = nil) then
   exit
end
bffcgrid = bffctheme.getgrid
'
'get the flow direction grid
'
fdrtheme = msgbox.listasstring(thegthemes,"Flow Direction
Grid","BMP Effect")
if (fdrtheme = nil) then
   exit
end
fdrgrid = fdrtheme.getgrid
'
'Set the analysis properties
'
ae = theView.GetExtension(AnalysisEnvironment)
ae.setcellsize(#ANALYSISENV_VALUE,fdrgrid.getcellsize)
ae.setextent(#ANALYSISENV_VALUE,fdrgrid.getextent)
'
'Set up the BMP effectiveness parameters
'
BMPlabels = list.make
BMPdefaults = list.make
effectlist = list.make
'BMPlabels = {"% CAFOs with Adequate Storage","% Reduction for
Adequate Storage","% CAFOs with Proper Manure Handling","%
Reduction for Proper Handling","% CAFOs with Grade A
Application","% Reduction for Grade A Application","% CAFOs with
Grade C Application","% Reduction for Grade C Application","%
CAFOs with Grade F Application","% Reduction for Grade F
Application","% CAFOs with Riparian Areas/Fencing","% Reduction
for Riparian Areas/Fencing"}
'BMPdefaults = {"","","","","","","","","","","",""}
BMPlabels = {"% CAFOs with Proper Storage/Handling","%
Reduction for Proper Storage/Handling","% CAFOs with Proper
Application Practices","% Reduction for Proper Application
```

```
Practices","% CAFOs with Riparian Areas/Fencing","%
Reduction for Riparian Areas/Fencing"}
BMPdefaults = {"","","","","",""}
effectlist = MsgBox.MultiInput("Enter Percentages as
Decimals","BMP Effects",BMPlabels,BMPdefaults)
'ASapplied = effectlist.get(0).asnumber
'ASred = effectlist.get(1).asnumber
'PMHapplied = effectlist.get(2).asnumber
'PMHred = effectlist.get(3).asnumber
'GrAapplied = effectlist.get(4).asnumber
'GrAred = effectlist.get(5).asnumber
'GrCapplied = effectlist.get(6).asnumber
'GrCred = effectlist.get(7).asnumber
'GrFapplied = effectlist.get(8).asnumber
'GrFred = effectlist.get(9).asnumber
'Ripapplied = effectlist.get(10).asnumber
'Ripred = effectlist.get(11).asnumber
'
ASPHapplied = effectlist.get(0).asnumber
ASPHred = effectlist.get(1).asnumber
PAapplied = effectlist.get(2).asnumber
PAred = effectlist.get(3).asnumber
Ripapplied = effectlist.get(4).asnumber
Ripred = effectlist.get(5).asnumber
'
'Set up the Septic System effect parameters
'
Septiceff = MsgBox.Input("% of Septic Systems Failing (as a
decimal)","BMP Effect","")
Septicrem = Septiceff.asnumber
'
'Determine the total BMP effectiveness and corresponding
percent remaining
'
'ASeff= ASapplied*ASred
'PMHeff = PMHapplied*PMHred
'Appeff = (GrAapplied*GrAred) + (GrCapplied*GrCred) +
(GrFapplied*GrFred)
'Ripeff = Ripapplied*Ripred
'BMPeff = (1 - ((1-ASeff)*(1-PMHeff)*(1-Appeff)*(1-Ripeff)))
'BMPrem = (1 - BMPeff)
'effmsg = "The % remaining is"++BMPrem.asstring
'msgbox.info(effmsg,"BMP Effect")
'
ASPHeff= ASPHapplied*ASPHred
PAeff = PAapplied*PAred
Ripeff = Ripapplied*Ripred
BMPeff = (1 - ((1-ASPHeff)*(1-PAeff)*(1-Ripeff)))
BMPrem = (1 - BMPeff)
effmsg = "The CAFO dairy land BMPs
remove"++BMPeff.asstring++"percent of the bacteria load."
msgbox.info(effmsg,"BMP Effect")

'Calculate the resultant runoff bactigrid accounting for BMPs
'Note - the BMP reduction is only applied to CAFO land use lands; the
effect of failing septic systems is applied to rural residential lands
'
newrofcload = ((lusegrid =
23.asgrid).con((BMPrem.asgrid*rofcgrid),(lusegrid =
18.asgrid).con((Septicrem.asgrid*rofcgrid),rofcgrid)))
newroname = msgbox.input("Name the new resultant runoff bacti
grid","BMP Effect","bmpbactiload")
newrofcfilename =
FN.merge(av.getproject.getworkdir.asstring,newroname)
newrofcload.savedataset(newrofcfilename)
newrotheme = gtheme.make(newrofcload)
theview.addtheme(newrotheme)
newrotheme.setvisible(false)
```

```
'
'Check to see if the user wants to do Flow Accumulations
'
accum = MsgBox.yesno("Do you wish to conduct flow
accumulation on the new runoff load grid now?","BMP
Effect",true)
if (accum) then
  newaccgrid = (fdrgrid.flowaccumulation(newrofcload))
  newaccname = msgbox.input("Name the new accumulated
runoff bacti grid","BMP Effect","accbmpbacti")
  newaccbfilename =
FN.merge(av.getproject.getworkdir.asstring,newaccname)
  newaccgrid.savedataset(newaccbfilename)
  newaccbtheme = gtheme.make(newaccgrid)
  theview.addtheme(newaccbtheme)
  newaccbtheme.setvisible(false)
  '
  'check, if the user did not already run flow accumulation on
the baseflow bacti grid, would they like to do it now
  '
  accum2 = msgbox.yesno("If you did not already flow
accumulate the bacti grid for baseflow, do you wish to do that
now?","BMP Effect",true)
  if (accum2) then
    baccbgrid = (fdrgrid.flowaccumulation(bffcgrid))
    baccbname = msgbox.input("Name the accumulated bacti
grid associated with baseflow","Bacti Load","baccbgrid")
    baccbfilename =
FN.merge(av.getproject.getworkdir.asstring,baccbname)
    baccbgrid.savedataset(baccbfilename)
    baccbtheme = gtheme.make(baccbgrid)
    theview.addtheme(baccbtheme)
    baccbtheme.setvisible(false)
    '
    'final message to user
    '
    message = "Reduced accumulated runoff bacti grid calculated."
    msgbox.info(message,"BMP effect")
  else
    '
    'final message to user
    '
    message = "Reduced accumulated runoff bacti grid calculated."
    msgbox.info(message,"BMP effect")
  end
else
  '
  'final message to user
  '
  message = "Reduced average per cell runoff bacti grid calculated."
  msgbox.info(message,"BMP Effect")
end
'
'-------------------------
'--------End-------------
'-------------------------
```

Script: bacticoncvalue.ave

```
'-------------------------
'----Creation info-----
'-------------------------
'
'Name:  bacticoncvalue.ave
'Date:  17 Jul 98
'Author:  Patrice A. Melancon
'         Center for Research in Water Resources
'         The University of Texas at Austin
'         pmelancon@mail.utexas.edu
'
'------------------------------------------
'--------Purpose/Description---------
'------------------------------------------
'
'This script was written to change/set default runoff and
baseflow concentration parameters based on land use.
'It requires a landuse coverage.  The landuse coverage attribute
table is edited to add appropriate fields and
'then populate them based on landuse code.  This script only
covers values for bacteria.  Any commands for dealing
'with sediment have been commented out.
'
' get the view
'
theview = av.getactivedoc
'
'get the themes
'
thethemes = theview.getthemes
if (thethemes.count = 0) then
  msgbox.error("no themes found", "Set Concentration Values")
  exit
end
thefthemes = list.make
for each thetheme in thethemes
  if (thetheme.getclass.getclassname = "ftheme") then
    thefthemes.add(thetheme)
  end
end
if (thefthemes.count = 0) then
  msgbox.error("No coverage themes found", "Set Concentration
Values")
  exit
end
'
'Pick the landuse theme that contains and EMC field
'
atheme = msgbox.listasstring(thefthemes, "Landuse Theme", "Set
Concentration Values")
if (atheme = nil) then
  exit
end
'
'adding fields for EMC values
'
concFTab = atheme.getFTab
if (concFTab = nil) then
  msgbox.error("Can't open the landuse theme","Set Concentration
Values")
  exit
end
'
bfbactif = concFTab.findfield("Bf_fc_conc")
if (bfbactif = nil) then
```

```
  addfield = msgbox.yesno("Can’t find ’Baseflow FC Conc’
field in the attribute table.  Add it?","Set Concentration
Values",true)
  if (addfield) then
    concFTab.SetEditable(true)
    bfbactif = field.make("Bf_fc_conc",#FIELD_FLOAT,10,1)
    concFTab.AddFields({bfbactif})
    concFTab.seteditable(false)
  else
    exit
  end
end
robactif = concFTab.findfield("Ro_fc_conc")
if (robactif = nil) then
  addfield = msgbox.yesno("Can’t find ’Runoff FC Conc’ field
in attribute table.  Add it?","Set Concentration Values",true)
  if (addfield) then
    concFTab.SetEditable(true)
    robactif = field.make("Ro_fc_conc",#FIELD_FLOAT,10,1)
    concFTab.AddFields({robactif})
    concFTab.seteditable(false)
  else
    exit
  end
end
’
’-----------------------------------------
’-----Set Runoff Concentrations----
’-----------------------------------------
’
’make the attribute table editable
concFTab.seteditable(true)
’
’find the grid-code field
’
lufields = concFTab.getfields
lusef = msgbox.listasstring(lufields,"Choose Landuse ID Field","Set
Concentration Values")
if (lusef = nil) then
  msgbox.error("You need to have a Landuse ID field.","Set
Concentration Values")
  exit
end
’
’Set the various concentration parameters.
conclabels = list.make
concdefaults = list.make
conclist = list.make
bactiz = 0
’
’Start by setting Fecal Coliform concentrations
’
bactilabels = {"Urban BaseFlow","Urban Runoff","RuralRes
BaseFlow","RuralRes Runoff","RuralInd
Baseflow","RuralIndRunoff","AgLand Baseflow","AgLand
Runoff","CAFO Baseflow","CAFO Runoff","Forest/Range
Baseflow","Forest/Range Runoff","Barren Baseflow","Barren Runoff"}
bactidefaults =
{"100","10000","100","10000","100","10000","100","1500","1000","3
0000","5","20","5","20"}
bactilist = MsgBox.MultiInput("Enter Concentrations
(fc/100ml)","Fecal Coliform Concentrations",bactilabels,bactidefaults)
bfbactiur = bactilist.get(0).AsNumber
robactiur = bactilist.get(1).AsNumber
bfbactirr = bactilist.get(2).AsNumber
robactirr = bactilist.get(3).AsNumber
bfbactiri = bactilist.get(4).AsNumber
robactiri = bactilist.get(5).AsNumber
```

```
bfbactiag = bactilist.get(6).AsNumber
robactiag = bactilist.get(7).AsNumber
bfbacticafo = bactilist.get(8).AsNumber
robacticafo = bactilist.get(9).AsNumber
bfbactifor = bactilist.get(10).AsNumber
robactifor = bactilist.get(11).AsNumber
bfbactibar = bactilist.get(12).AsNumber
robactibar = bactilist.get(13).AsNumber
'
'Go through each record and depending on the land use code,
assign a concentration
'For Landuse = 0 ('nodata' areas) and water and wetlands, value
assigned is zero.
for each rec in concFTab
'get the value for the land use from the 'grid-code' field.
  lusev = concFTab.ReturnValue(lusef, rec)
  if (lusev = 0) then
    bfbactiv = bactiz
    robactiv = bactiz
  elseif ((lusev >10) and (lusev <18)) then
    bfbactiv = bfbactiur
    robactiv = robactiur
  elseif (lusev = 18) then
    bfbactiv = bfbactirr
    robactiv = robactirr
  elseif (lusev = 19) then
    bfbactiv = bfbactiri
    robactiv = robactiri
  elseif ((lusev >20) and (lusev <25) and (lusev <> 23)) then
    bfbactiv = bfbactiag
    robactiv = robactiag
  elseif (lusev =23) then
    bfbactiv = bfbacticafo
    robactiv = robacticafo
  elseif ((lusev >30) and (lusev <44)) then
    bfbactiv = bfbactifor
    robactiv = robactifor
  elseif ((lusev >50) and (lusev <63)) then
    bfbactiv = bactiz
    robactiv = bactiz
  else
    bfbactiv = bfbactibar
    robactiv = robactibar
  end
  concFTab.setvalue(bfbactif,rec,bfbactiv)
  concFTab.setvalue(robactif,rec,robactiv)
end
'
concFTab.SetEditable(false)
'
concTable = Table.Make(concFTab)
concTable.GetWin.Open
'
message = "Bacti Concentration Values Assigned Based on Land Use."
MsgBox.info(message,"Set Concentration Values")
'
'---------------
'---End-------
'---------------
```

Script: bactigrid.ave

```
'---------------------------------
'--- Creation information ---
'---------------------------------
'
'Name: concgrid.ave
'Version: 1.0
'Date: 02/17/97
'Author: Ferdi Hellweger
'       Center for Research in Water Resources
'       The University of Texas at Austin
'       ferdi@crwr.utexas.edu
'
'Modified: 02/28/97
'        Ann Quenzer
'        Center for Research in Water Resources
'        The University of Texas at Austin
'        quenzer@mail.utexas.edu
'        1) changed the message box description to reflect the
script
'        2) added purpose and description
'        3) changed pathname for the data file to be saved
'        4) took out error message of only one theme found
'
'Modified:  6/29/98
'         Patrice Melancon
'         Center for Research in Water Resources
'         pmelancon@mail.utexas.edu
'         1)  Changed the purpose to reflect a grid of bacteria
'         New name:  bactigrid.ave
'
'Modified:  8/15/98
'         Patrice Melancon
'         1)  Added the Point Source load
'
'--------------------------------
'--- Purpose/Description ---
'--------------------------------
'
'This script requires a landuse coverage, the grid for the STP point
source FC load, the avg baseflow grid, the avg runoff grid,
'(both in cf/yr) and a flow direction grid.  Concentration grids are
computed for the land surface using the landuse coverage
'which has the EMC values for baseflow and runoff in the attribute
table.
'The resultant grids are multiplied by the avg baseflow and runoff flow
grids (in cf/yr)
'with an appropriate conversion (1/100*1000*1000/35.3 = 283) factor
to give load grids in fc/yr.  STP point source FC load
'grid (in 1x10^7 FC/yr) is multiplied by 10000000 and added to the
runoff load grid.  Percell grids are called bfbactigrid
'and robactigrid.  An optional weighted flowaccumulation is calculated
on each (runoff and baseflow) load grid - the user has
'the option to skip doing a weighted FAC.  The resulting grids are called
raccbgrid and baccbgrid and are in fc/yr.
'
'----------------
'--Get view ---
'----------------
'
theview = av.getactivedoc
'
'--------------------
'--- Get theme ---
'--------------------
'
thethemes = theview.getthemes
```

```
if (thethemes.count = 0) then
   msgbox.error("No themes found", "Bacti Load")
   exit
end
thefthemes = list.make
for each thetheme in thethemes
   if (thetheme.getclass.getclassname = "ftheme") then
      thefthemes.add(thetheme)
   end
end
thegthemes = list.make
for each thetheme in thethemes
   if (thetheme.getclass.getclassname = "gtheme") then
      thegthemes.add(thetheme)
   end
end
if (thefthemes.count = 0) then
   msgbox.error("No feature themes found", "Bacti Load")
   exit
end
if (thegthemes.count = 0) then
   msgbox.error("No grid themes found","Bacti Load")
   exit
end
’
’get the landuse theme
’
theptheme = msgbox.listasstring(thefthemes, "Landuse
Theme", "Bacti Load")
if (theptheme = nil) then
   exit
end
thepftab = theptheme.getftab
thepshapef = thepftab.findfield("shape")
thepshape = thepftab.returnvalue(thepshapef, 0)
if (not (thepshape.getclass.getclassname = "polygon")) then
   msgbox.error("Landuse Theme needs to be a polygon theme", "Bacti
Load")
   exit
end
’
’get the STP Point source grid
’
stpgtheme = msgbox.listasstring(thegthemes, "STP Point Source
Grid","Bacti Load")
if (stpgtheme = nil) then
   exit
end
’
’get the baseflow grid theme
’
thebftheme = msgbox.listasstring(thegthemes, "Avg BaseFlow Grid (in
cf/yr)","Bacti Load")
if (thebftheme = nil) then
   exit
end
’
’get the runoff grid theme
’
therotheme = msgbox.listasstring(thegthemes, "Avg Runoff Flow Grid
(in cf/yr)","Bacti Load")
if (therotheme = nil) then
   exit
end
’
’get the flow direction theme
’
```

```
fdrtheme = msgbox.listasstring(thegthemes,"Flow Direction
Grid","Bacti Load")
if (fdrtheme = nil) then
   exit
end
’
’-----------------
’--- Get field ---
’-----------------
’
thepfields = thepftab.getfields
thebfcfield = msgbox.listasstring(thepfields, "Choose Baseflow
Bacti concentration field", "Bacti Load")
if (thebfcfield = nil) then
   exit
end
therocfield = msgbox.listasstring(thepfields, "Choose Runoff
Bacti concentration field", "Bacti Load")
if (therocfield = nil) then
   exit
end
’
’-------------------
’--- Calculate ---
’-------------------
’
’get the flow grids and get the cell size and extent
’
bflowgrid = thebftheme.getgrid
rflowgrid = therotheme.getgrid
’
cellsize = bflowgrid.getcellsize
extent = bflowgrid.getextent
’
bfconcgrid = grid.makefromftab(thepftab, prj.makenull, thebfcfield,
{cellsize, extent})
’bfconcfilename =
FN.merge(av.getproject.getworkdir.asstring,"bfconcgrid")
’bfconcgrid.savedataset(bfconcfilename)
’
roconcgrid = grid.makefromftab(thepftab, prj.makenull, therocfield,
{cellsize, extent})
’roconcfilename =
FN.merge(av.getproject.getworkdir.asstring,"roconcgrid")
’roconcgrid.savedataset(roconcfilename)
’
’calculate the load as flow * concentration with conversion to fc/yr
’
bloadgrid = bfconcgrid * bflowgrid * 283.asgrid
bloadname = msgbox.input("Name the average bacti grid associated
with baseflow","Bacti Load","bfbactigrid")
bloadfilename =
FN.merge(av.getproject.getworkdir.asstring,bloadname)
bloadgrid.savedataset(bloadfilename)
’
rloadgrid1 = roconcgrid * rflowgrid * 283.asgrid
’
’
stpgrid = stpgtheme.getgrid
’
rloadgrid = (rloadgrid1 + (stpgrid * 10000000.AsGrid))
rloadname = msgbox.input("Name the average bacti grid associated
with runoff","Bacti Load","robactigrid")
rloadfilename = FN.merge(av.getproject.getworkdir.asstring,rloadname)
rloadgrid.savedataset(rloadfilename)
’
’Check if the user wants to do flow accumulations right now
’
```

```
accum = MsgBox.yesno("Do you wish to conduct flow
accumulations on the load grids now?","Bacti Load",true)
if (accum) then
  ’
  ’do a weighted flow accumulation on the each of runoff load
and baseflow load
  ’
  ’
  ’get the flow direction grid
  ’
  fdrgrid = fdrtheme.getgrid
  raccbgrid = (fdrgrid.flowaccumulation(rloadgrid))
  raccbname = msgbox.input("Name the accumulated bacti grid
associated with runoff","Bacti Load","raccbgrid")
  raccbfilename =
FN.merge(av.getproject.getworkdir.asstring,raccbname)
  raccbgrid.savedataset(raccbfilename)
  raccbtheme = gtheme.make(raccbgrid)
  theview.addtheme(raccbtheme)
  raccbtheme.setvisible(false)
  ’
  baccbgrid = (fdrgrid.flowaccumulation(bloadgrid))
  baccbname = msgbox.input("Name the accumulated bacti
grid associated with baseflow","Bacti Load","baccbgrid")
  baccbfilename =
FN.merge(av.getproject.getworkdir.asstring,baccbname)
  baccbgrid.savedataset(baccbfilename)
  baccbtheme = gtheme.make(baccbgrid)
  theview.addtheme(baccbtheme)
  baccbtheme.setvisible(false)
  ’
  rbactitheme = gtheme.make(rloadgrid)
  theview.addtheme(rbactitheme)
  rbactitheme.setvisible(false)
  ’
  bbactitheme = gtheme.make(bloadgrid)
  theview.addtheme(bbactitheme)
  bbactitheme.setvisible(false)
  ’
  ’final message to user
  ’
  message = "Accumulated and Per Cell FC load grids calculated."
  msgbox.info(message,"Bacti Load")
else
  rbactitheme = gtheme.make(rloadgrid)
  theview.addtheme(rbactitheme)
  rbactitheme.setvisible(false)
  ’
  bbactitheme = gtheme.make(bloadgrid)
  theview.addtheme(bbactitheme)
  bbactitheme.setvisible(false)
  ’
  ’final message to user
  ’
  message = "Average per cell FC load grids calculated."
  msgbox.info(message,"Bacti Load")
end
’
’-------------
’--- End ---
’-------------
’
```

Script: bactilocatedbmp.ave

```
'
'---------------------------------
'--- Creation information ---
'---------------------------------
'
'Name: bactilocatedbmp.ave
'Version: 1.0
'Date: 01/28/99
'Author: Patrice A. Melancon
'       Center for Research in Water Resources
'       The University of Texas at Austin
'       pmelancon@mail.utexas.edu
'
'---------------------------------------------------
'-------Purpose/Description---------------------
'---------------------------------------------------
'
''This script calculates the effect of a located BMP.  Script
allows a user to identify one located point BMP
'interactively on the display.  The user identifies accumulated
runoff load as well as the accumulated runoff flow.
'The user also identifies the removal efficiency of the located
BMP.
'The script will return the concentration at the point before and
after the implementation of the located BMP.
'
' get the view
'
theview = av.getactivedoc
thedisplay = theview.getdisplay
'
'get the themes
'
thethemes = theview.getthemes
if (thethemes.count = 0) then
  msgbox.error("No Themes Found", "Located BMPs")
  exit
end
'
thegthemes = list.make
for each thetheme in thethemes
  if (thetheme.getclass.getclassname = "gtheme") then
    thegthemes.add(thetheme)
  end
end
if (thegthemes.count = 0) then
  msgbox.error("No grid themes found", "Located BMPs")
  exit
end
'
pnt = thedisplay.returnuserpoint
pntx = pnt.getx
pnty = pnt.gety
userPoint = Point.MakeNull
userPoint = Point.Make(pntx,pnty)
'
'if(thegthemes.count > 1) then
'  msgbox.error("You must have only one grid theme active","Located
BMPs")
'  exit
'end
'
lrgtheme = msgbox.listasstring(thegthemes, "Accumulated Runoff Bacti
Load","Located BMPs")
if (lrgtheme = nil) then
  exit
```

```
end
'
flrgtheme = msgbox.listasstring(thegthemes, "Accumulated
Runoff (cf/yr)","Located BMPs")
if (flrgtheme = nil) then
  exit
end
'
lrgrid = lrgtheme.getgrid
flrgrid = flrgtheme.getgrid
'
'
'pick off the value of the load from the grid
'
load = lrgrid.cellvalue(userPoint,Prj.MakeNull)
flow = flrgrid.cellvalue(userPoint,Prj.MakeNull)
'
'calculate the concentration before removal
'
conc = (load/flow) * (35.3/(1000*1000)*100)
'
'have the user identify the removal efficiency of the located
BMP
'
BMPeffect = msgbox.input("Enter the removal efficiency of
this BMP (as a decimal)","Located BMPs","")
'
loadremv = load * BMPeffect.asnumber
loadremn = load - loadremv
'
'calculate the concentration after removal
'
newconc = (loadremn/flow) * (35.3/(1000*1000)*100)
'
msgbox.report("The concentration at the point before implementing the
BMP is"++conc.asstring++"fc/100ml"+"."+NL+
"The concentration after implmenting the BMP
is"++newconc.asstring++"fc/100ml"+".","Located BMPs")
'
'------------
'--- End ---
'------------
'
```

Script: bactipredconc.ave

```
'
'--------------------------------
'--- Creation information ---
'--------------------------------
'
'Name: bactipredconc.ave
'Version: 1.0
'Author: Patrice A. Melancon
'       Center for Research in Water Resources
'       The University of Texas at Austin
'       pmelancon@mail.utexas.edu
'       Date:  6 Oct 98
'
'-------------------------------
'--- Purpose/Description ---
'-------------------------------
'
'This program calculates a predicted concentration grid for bacteria.  This grid is for total flow (ie, accounts for baseflow and
'runoff).  This script requires accumulated and average grids for bacteria loads (in FC/yr) and flows (in cf/yr) associated with
'both baseflow and runoff.
'This program adds the accumulated grids to the average grids, then adds baseflow grids to runoff grids to get total grids.  Next, the
'program divides the total load grid by the total flow grid with an appropriate conversion factor to get a grid
'of resulting concentration expressed as FC/100ml.
'The conversion factor is FC/yr*yr/cf*35.3cf/1000L*L/1000ml*100
'This script that deals with bacteria is called bactipredconc.ave.
'
'------------------
'--- Get view ---
'------------------
'
theview = av.getactivedoc
'vgraphics = theview.getgraphics
'
'--------------------
'--- Get themes ---
'--------------------
'
thethemes = theview.getthemes
if (thethemes.count = 0) then
   msgbox.error("No active themes found", "Concentration Grid")
   exit
end
'
thegthemes = list.make
for each thetheme in thethemes
  if(thetheme.getclass.getclassname = "gtheme") then
   thegthemes.add(thetheme)
  end
end
if (thegthemes.count = 0) then
  msgbox.error("No grid themes found","Concentration Grid")
  exit
end
'
'get all of the runoff related grids
'
lrgtheme = msgbox.listasstring(thegthemes, "Accumulated Runoff Bacti Load","Concentration Grid")
```

```
if (lrgtheme = nil) then
  exit
end
alrgtheme = msgbox.listasstring(thegthemes, "Average Runoff
Bacti Load","Concentration Grid")
if (alrgtheme = nil) then
  exit
end
flrgtheme = msgbox.listasstring(thegthemes, "Accumulated
Runoff (cf/yr)","Concentration Grid")
if (flrgtheme = nil) then
  exit
end
aflrgtheme = msgbox.listasstring(thegthemes, "Average
Runoff (cf/yr)","Concentration Grid")
if (aflrgtheme = nil) then
  exit
end
’
’get all the baseflow related grids
’
lbgtheme = msgbox.listasstring(thegthemes, "Accumulated
Baseflow Bacti Load","Concentration Grid")
if (lbgtheme = nil) then
  exit
end
albgtheme = msgbox.listasstring(thegthemes, "Average
Baseflow Bacti Load","Concentration Grid")
if (albgtheme = nil) then
  exit
end
flbgtheme = msgbox.listasstring(thegthemes, "Accumulated
Baseflow (cf/yr)","Concentration Grid")
if (flbgtheme = nil) then
  exit
end
aflbgtheme = msgbox.listasstring(thegthemes, "Average Baseflow
(cf/yr)","Concentration Grid")
if (aflbgtheme = nil) then
  exit
end
’
’-----------------------
’--- Set up themes ---
’-----------------------
’
’grid themes
’
lrgrid = lrgtheme.getgrid
flrgrid = flrgtheme.getgrid
alrgrid = alrgtheme.getgrid
aflrgrid = aflrgtheme.getgrid
’
lbgrid = lbgtheme.getgrid
flbgrid = flbgtheme.getgrid
albgrid = albgtheme.getgrid
aflbgrid = aflbgtheme.getgrid
’
thecellsize = lrgrid.getcellsize
theextent = lrgrid.getextent
’
load = lrgrid + alrgrid + lbgrid + albgrid
flow = flrgrid + aflrgrid + flbgrid + aflbgrid
concgrid = (load/flow) * ((35.3/(1000*1000)*100).asgrid)
’
concname = msgbox.input("Give the resultant grid a
name","Concentration Grid","")
concfilename = FN.merge(av.getproject.getworkdir.asstring,concname)
```

```
concgrid.savedataset(concfilename)
concgtheme = gtheme.make(concgrid)
theview.addtheme(concgtheme)
concgtheme.setvisible(false)
'
message = "Predicted Concentration Grid Calculated"
msgbox.info(message,"Concentration Grid")
'
'------------
'--- End ---
'-------------
'
```

Script: bathdem.ave

```
’
ViewName = "StudyArea"
aGridName = "Bathgrclip2"
bGridName = "dem100"
’****************************************
TheView = av.Getproject.FindDoc(ViewName)
’
aTheme = TheView.FindTheme(aGridName)
aGrid = aTheme.GetGrid
’
bTheme = TheView.FindTheme(bGridName)
bGrid = bTheme.GetGrid
’
listGrid = {bGrid}
’
outGrid = aGrid.Merge(listGrid)
’
outGrid.SaveDataSet("z:\melancon\tbnepdem\bathdem2".AsFi
leName)
’
outTheme = GTheme.Make(outGrid)
’
TheView.AddTheme(outTheme)
```

Script: burndem.ave

```
’
’---------------------------------
’-----Creation Information----
’---------------------------------
’
’Name:  burndem.ave
’Author:  Patrice A. Melancon
’
ViewName = "Tillamook"
aGridName = "demstrm"
bGridName = "demplus"
’****************************************
TheView = av.Getproject.FindDoc(ViewName)

aTheme = TheView.FindTheme(aGridName)
aGrid = aTheme.GetGrid

bTheme = TheView.FindTheme(bGridName)
bGrid = bTheme.GetGrid

listGrid = {bGrid}

outGrid = aGrid.Merge(listGrid)

outGrid.SaveDataSet("z:\melancon\tbnepdem\burndem".AsFileName)

outTheme = GTheme.Make(outGrid)

TheView.AddTheme(outTheme)
```

Script: connectsink.ave

```
'
'----------------------------------
'--- Creation information ---
'----------------------------------
'
'Name: connect.ave
'Version: 1.0
'Date: 02/13/97
'Author: Ferdi Hellweger
'       Center for Research in Water Resources
'       The University of Texas at Austin
'       ferdi@crwr.utexas.edu
'
'Modified:  8/23/98, Patrice Melancon
'         pmelancon@mail.utexas.edu
'         Center for Research in Water Resources, U Texas
'         1)  Added a step to create a nodata sink at centroids.
'         2)  Also added msgboxes to pick the various themes.
'              New name:  connectsink.ave
'
'----------------------------------
'--- Purpose/Description ---
'----------------------------------
'
'This program modifies an elevation grid based on a polygon
grid.
'It digs sinks for the polygons and puts a value of nodata in the
grid
'at the centroid locations so the flowaccumulation will
'accumulate at the polygon centroids.  Use the pickload
program
'to pick of loads.
'
'------------------
'--- Get view ---
'------------------
'
theview = av.getactivedoc
vgraphics = theview.getgraphics
'
'---------------------
'--- Get themes ---
'---------------------
'
thethemes = theview.getthemes
if (thethemes.count = 0) then
  msgbox.error("No themes found", "CONNECT")
  exit
end
thefthemes = list.make
for each thetheme in thethemes
  if (thetheme.getclass.getclassname = "ftheme") then
    thefthemes.add(thetheme)
  end
end
if (thefthemes.count = 0) then
  msgbox.error("No coverage themes found", "CONNECT")
  exit
end
'
thegthemes = list.make
for each thetheme in thethemes
  if (thetheme.getclass.getclassname = "gtheme") then
    thegthemes.add(thetheme)
  end
end
```

```
if (thegthemes.count = 0) then
  msgbox.error("No grid themes found", "CONNECT")
  exit
end
'
'Pick the bay polygon coverage
'
baytheme = msgbox.listasstring(thefthemes, "Bay Polygon
Theme", "CONNECT")
if (baytheme = nil) then
  exit
end
'
'Pick the bay line coverage
'
linetheme = msgbox.listasstring(thefthemes, "Bay Arc/Line
Theme","CONNECT")
if (linetheme = nil) then
  exit
end
'
demtheme = msgbox.listasstring(thegthemes, "Filled DEM
Theme","CONNECT")
if (demtheme = nil) then
  exit
end
'
'--------------------
'--- Get input ---
'--------------------
'
keeptemp = msgbox.yesno("Keep temporary data sets?",
"CONNECT", false)
'
'-------------------------
'--- Set up themes ---
'-------------------------
'
'grid theme
'
demgrid = demtheme.getgrid
'
demextent = demgrid.getextent
demcellsize = demgrid.getcellsize
'
'polygon theme
'
pftab = baytheme.getftab
if (pftab = nil) then
   msgbox.error("Can't open polygon theme","CONNECT")
   exit
end
'
pshapef = pftab.findfield("shape")
if (pshapef = nil) then
   msgbox.error("Can't find 'shape' field in polygon
theme","CONNECT")
   exit
end
'
'line theme
'
lftab = linetheme.getftab
if (lftab = nil) then
   msgbox.error("Can't open line theme","CONNECT")
   exit
end
'
```

```
'--------------------
'--- Calculate ---
'--------------------
'
'--- Initial set up ---
'
'setwindow
grid.setanalysisextent(#GRID_ENVTYPE_VALUE,
demextent)
'
'setcell
'
grid.setanalysiscellsize(#GRID_ENVTYPE_VALUE,
demcellsize)
'
'centroid grid
'
cpfilename = av.getproject.makefilename("cenp", "shp")
cpftab = ftab.makenew(cpfilename, point)
cpshapef = cpftab.findfield("shape")
cpfields = list.make
cpgridvalf = field.make("gridval", #FIELD_DECIMAL, 16, 4)
cpfields.add(cpgridvalf)
cpftab.addfields(cpfields)
cpftab.seteditable(true)
for each prec in pftab
    pshape = pftab.returnvalue(pshapef, prec)
    cenp = pshape.returncenter
    cengs = graphicshape.make(cenp)
    vgraphics.add(cengs)
    inside = cenp.iscontainedin(pshape)
    if (not inside) then
        msgbox.error("Polygon centroid not inside polygon",
"CONNECT")
    end
    theoutrec = cpftab.addrecord
    cpftab.setvalue(cpshapef, theoutrec, cenp)
    cpftab.setvalue(cpgridvalf, theoutrec, 1)
end
cpftab.seteditable(false)
cengrid = grid.makefromftab(cpftab, prj.makenull, nil, nil)
if (keeptemp) then
    cenfilename = av.getproject.makefilename("cengrid", "")
    cengrid.savedataset("cen".asfilename)
    cengtheme = gtheme.make(cengrid)
    theview.addtheme(cengtheme)
    cengtheme.setvisible(true)
end
'
'boundary grid
'
bndgrid = grid.makefromftab(lftab, prj.makenull, nil, nil)
if (keeptemp) then
    bndfilename = av.getproject.makefilename("bndgrid", "")
    bndgrid.savedataset("bnd".asfilename)
    bndgtheme = gtheme.make(bndgrid)
    theview.addtheme(bndgtheme)
    bndgtheme.setvisible(true)
end
'
'polygon grid
'
polygrid = grid.makefromftab(pftab, prj.makenull, nil, nil)
if (keeptemp) then
    polyfilename = av.getproject.makefilename("polygrid", "")
    polygrid.savedataset("poly".asfilename)
    polygtheme = gtheme.make(polygrid)
    theview.addtheme(polygtheme)
```

```
    polygtheme.setvisible(true)
end
'
'drop grid
'
dropgrid = (polygrid.isnull).con(0.asgrid,
(bndgrid.isnull).con(1.asgrid, 0.asgrid))
if (keeptemp) then
    dropfilename = av.getproject.makefilename("dropgrid", "")
    dropgrid.savedataset("drop".asfilename)
    dropgtheme = gtheme.make(dropgrid)
    theview.addtheme(dropgtheme)
    dropgtheme.setvisible(true)
end
'
'cost grid
'
costgrid = (dropgrid = 1.asgrid).con(1.asgrid, 1000000.asgrid)
if (keeptemp) then
    costfilename = av.getproject.makefilename("costgrid", "")
    costgrid.savedataset("cost".asfilename)
    costgtheme = gtheme.make(costgrid)
    theview.addtheme(costgtheme)
    costgtheme.setvisible(true)
end
'
'dist grid
'
distgrid = cengrid.costdistance(costgrid, nil, nil, nil)
if (keeptemp) then
    distfilename = av.getproject.makefilename("distgrid", "")
    distgrid.savedataset("dist".asfilename)
    distgtheme = gtheme.make(distgrid)
    theview.addtheme(distgtheme)
    distgtheme.setvisible(true)
end
'
'modification parameters
'
tmpgrid = (distgrid < 1000000.asgrid).con(distgrid, 0.asgrid)
maxdist = tmpgrid.getstatistics.get(1)
sinkelev = (-100 - (maxdist * 0.1))
'
'modified elevation grid
'
megrid = (dropgrid = 0.asgrid).con(demgrid, (sinkelev.asgrid +
(0.1.asgrid * distgrid)))
centrgrid = (cengrid.isnull).con(1.asgrid, 0.asgrid)
sinkgrid = megrid/centrgrid
sinkname = msgbox.input("Name the connected DEM
grid","CONNECT","connectsink")
sinkfilename = FN.merge(av.getproject.getworkdir.asstring,sinkname)
sinkgrid.savedataset(sinkfilename)
megtheme = gtheme.make(sinkgrid)
theview.addtheme(megtheme)
megtheme.setvisible(false)
'
'final message to user
'
message = "Grid connected and sinks created"
msgbox.info(message,"CONNECT")
'
'-------------
'--- End ---
'-------------
'
```

Script: dasedigrid.ave

```
'
'----------------------------------
'--- Creation information ---
'----------------------------------
'
'Name: dasedigrid.ave
'Version: 1.0
'Date: 01/29/99
'Author: Patrice Melancon
'       Center for Research in Water Resources
'       The University of Texas at Austin
'       pmelancon@mail.utexas.edu
'
'----------------------------------------------------
'-------Purpose/Description-----------------
'----------------------------------------------------
'
'This script allows for accounting for a supplemental
concentration effect associated with drainage related processes
'such as channel processes.  The supplemental concentration is
calculated based on the flow accumulation grid.
'A virtual grid (units mg/L) is created which is then multiplied
by the sum of the accumulated runoff (accrunoff) and
accumulated
'baseflow (accbflow) to get an associated accumulated load
grid (called chaccsgrid).  This accumulated load grid will
'be added to runoff load and baseflow load in the script which
calculates the predicted concentration grid.
'
'The appropriate conversion
(mg/L*cf/yr*1000L/35.31cf*#/.4536kg*kg/10^6mg*ton/2000
# = 3.14*10^-8) factor gives load
'grids in tons/yr.
'
'Requires:  flow accumulation grid, accumulated baseflow and runoff
grids
'
'-------------------
'--- Get view ---
'-------------------
'
theview = av.getactivedoc
'
'--------------------
'--- Get theme ---
'--------------------
'
thethemes = theview.getthemes
if (thethemes.count = 0) then
   msgbox.error("No themes found", "Sediment Load")
   exit
end
thegthemes = list.make
for each thetheme in thethemes
   if (thetheme.getclass.getclassname = "gtheme") then
      thegthemes.add(thetheme)
   end
end
if (thegthemes.count = 0) then
   msgbox.error("No grid themes found","Sediment Load")
   exit
end
'
'get the baseflow grid theme
'
```

```
accbftheme = msgbox.listasstring(thegthemes, "Accum
BaseFlow Grid (in cf/yr)","Supplemental SS Load")
if (accbftheme = nil) then
   exit
end
'
'get the runoff grid theme
'
accrotheme = msgbox.listasstring(thegthemes, "Accum Runoff
Flow Grid (in cf/yr)","Supplemental SS Load")
if (accrotheme = nil) then
   exit
end
'
'get the flow accumulation grid theme
'
factheme = msgbox.listasstring(thegthemes, "Flow
Accumulation","Supplemental SS Load")
if (factheme = nil) then
   exit
end
'
'get the three grids
'
accbf = accbftheme.getgrid
accro = accrotheme.getgrid
fac = factheme.getgrid
'
'set the analysis properties
'
ae = theView.GetExtension(AnalysisEnvironment)
ae.setcellsize(#ANALYSISENV_VALUE,fac.getcellsize)
ae.setextent(#ANALYSISENV_VALUE,fac.getextent)
'
'calculate the virtual grid representing the supplemental concentration
'
supconcgrid = ((fac > 1000.asgrid).con(((0.000379.asgrid * fac) -
9.2.asgrid),0.asgrid))
'
'calculate the accumulated supplemental load grid
'
chloadgrid = (supconcgrid * (accbf + accro)) * 0.0000000314.asgrid
'
chloadname = msgbox.input("Name the accumulated sediment grid
associated with drainage area related processes","Supplemental SS
Load","chaccsgrid")
chloadfilename =
FN.merge(av.getproject.getworkdir.asstring,chloadname)
chloadgrid.savedataset(chloadfilename)
'
chloadgtheme = gtheme.make(chloadgrid)
theview.addtheme(chloadgtheme)
chloadgtheme.setvisible(false)
'
'end message to the user
'
message = "The accumulated supplemental load has been calculated."
msgbox.info(message,"Supplemental SS Load")
'
'------------------------
'---------End-----------
'------------------------
```

Script: gages.ave

```
'-------------------------------------------------------------------
'-------------------------------------------------------------------
' Name: swbp.definegages
' Headline:
' Self:
' Returns:
' Description: Create a point shape file from locations specified
' in a table.
'
' Topics:
' Search Keys:
' Requires:
' History:
' Modified by: P. Melancon (pmelancon@mail.utexas.edu) on
23 Mar 98
'   Added a second id field and edited the length of fields.
'-------------------------------------------------------------------
'-------------------------------------------------------------------
theProject=av.GetProject
theView=av.GetActiveDoc
theDocs=theProject.GetDocs
tabList=List.Make
for each d in theDocs
  if (d.Is(Table)) then
    tabList.Add(d.getname)
  end
end
'--- IDENTIFY INPUT TABLE
intablename=msgbox.choiceasstring(tabList,"Choose table
with Lat/Lon Values","Table")
if (intablename=nil) then
  exit
end
intable=theproject.finddoc(intablename)
invtab=intable.getvtab
infields=invtab.getfields
'--- IDENTIFY INPUT FIELDS
latfield=msgbox.choiceasstring(inFields,"Choose the latitude
field.","Latitude")
if (latfield=nil) then
  exit
end
lonfield=msgbox.choiceasstring(inFields,"Choose the longitude
field.","Longitude")
if (lonfield=nil) then
  exit
end
idfield=msgbox.choiceasstring(inFields,"Choose Gage Number
field.","Gage_Num")
if (idfield=nil) then
  exit
end
id2field=msgbox.choiceasstring(inFields,"Choose Gage Name
field.","Gage_Name")
if (idfield=nil) then
  exit
end
'
'--- READ AND PROCESS DATA
'
OutFileName=FileDialog.Put("".asfilename,"*.shp","Output Shape
File" )
if(OutFileName=Nil)then
  exit
end
OutFileName.SetExtension("shp")
```

```
OutFTab=FTab.MakeNew(OutFileName,point)
outTheme=Ftheme.make(outftab)
'
'CREATE FIELDS FOR THE NEW POINT TABLE
'
outFields=List.Make
outFields.Add(Field.Make("Gage-Num",#field_decimal,16,0))
outFields.Add(Field.Make("Gage_Name",#field_char,20,4))
outFields.Add(Field.Make("Latitude",#field_decimal,16,6))
outFields.Add(Field.Make("Longitude",#field_decimal,16,6))
outFieldsc=outFields.DeepClone
outftab.addfields(outFieldsc)
theView.addtheme(outTheme)
if(outFtab.CanEdit)then
  outFtab.SetEditable(true)
else
  msgbox.info("Can't edit the output theme.","Error")
  exit
end
'
'IDENTIFY FIELDS FOR WRITING
'
shpField=outFtab.findfield("shape")
oidfield=outftab.findfield("Gage-Num")
oid2field=outftab.findfield("Gage_Name")
olatfield=outftab.findfield("Latitude")
olonfield=outftab.findfield("Longitude")
for each rec in invtab
  id=invtab.returnvalue(idfield,rec)
  id2=invtab.returnvalue(id2field,rec)
  lat=invtab.returnvalue(latfield,rec)
  lon=invtab.returnvalue(lonfield,rec)
  newrec=outFtab.AddRecord
  pt=point.make(lon,lat)

  outFtab.Setvalue(shpField,newrec,pt)
  outftab.setvalue(oidfield,newrec,id)
  outftab.setvalue(oid2field,newrec,id2)
  outftab.setvalue(olatfield,newrec,lat)
  outftab.setvalue(olonfield,newrec,lon)
  end

outftab.seteditable(false)
```

Script: gridclip.ave

```
'*****************************************
' Name: swbp.extract
' Headline:
' Self:
' Returns:
' Description: This program clip a grid Theme
' based on selected polygons in a polygon
' coverage.
'
' Topics:
' Search Keys:
' Requires:
' History: Modified from hydro.ExtByPly
'*****************************************
theView = av.getactivedoc
theThemes = theView.getthemes
if (nil = theThemes) then exit end
if (theThemes.count < 2) then
  msgbox.error("At least 2 themes must be in the
View","Error")
  exit
end
polythemes=list.make
gridthemes=list.make
for each t in thethemes
   if (t.getclass.getclassname = "GTheme") then
      gridthemes.add(t)
   elseif (t.getftab.findfield("shape").gettype=#field_shapepoly)
then
      polythemes.add(t)
   end
end
GridTheme=Msgbox.choiceasstring(gridthemes,"Choose Grid to be
clipped?","Clip Grid")
if (gridTheme = NIL) then exit end
clipTheme=Msgbox.Choiceasstring(polythemes,"Which polygon theme
is the clipping theme?","Clip Grid")
if (clipTheme = NIL) then exit end
'--- build a polygon which is the union of all selected polygons
'--- if no polygons are selected, then select all polygons in the
'--- clipTheme
clipftab=cliptheme.getftab
shapefield=clipftab.findfield("Shape")
clipselection = clipftab.getselection

if (clipselection.count=0) then
  clipftab.getselection.setall
  clipftab.updateselection
end

rec1=clipftab.getselection.getnextset(-1)
totalshape=clipftab.returnvalue(shapefield,rec1)
for each rec in clipftab.getselection
   totalshape=totalshape.returnunion(clipftab.returnvalue(shapefield,
rec))
end

theclipshape = totalshape
sourceGrid=GridTheme.GetGrid
'--set the extent before extracting
ae = theView.GetExtension(AnalysisEnvironment)
ae.SetExtent(#ANALYSISENV_VALUE,theclipshape.ReturnExtent)
ae.Activate
CutGrid=SourceGrid.ExtractByPolygon(theclipshape,prj.makeNull,Fals
e)
cutFN=av.GetProject.GetWorkDir.MakeTmp(GridTheme.GetName,"")
```

```
CutGrid.ReName(cutFN)
outGTheme=GTheme.Make(CutGrid)
outGTheme.SetName(cutFN.getBaseName)
theView.AddTheme(outGTheme)
outGTheme.SetVisible(true)
```

Script: merge.ave

```
’---------------------------------------------
’--------Creation Information---------
’---------------------------------------------
’Name:  merge.ave
’Date:  Spring 98
’Version:  1.0
’Author:  Patrice A. Melancon
’         Center for Research in Water Resources
’         The University of Texas at Austin
’         pmelancon@mail.utexas.edu
’
’----------------------------------------------
’----------Purpose/Description--------
’----------------------------------------------
’
’Merges two grids together, primary into secondary.
’Modified from script written by Dr. Olivera described in
’GIS Class Sp 97, Urubamba Exercise
’
’****************************************
’--------------------
’--Get View------
’--------------------
’
theview = av.getactivedoc
’
’-------------------------
’---Get themes--------
’-------------------------
’
thethemes = theview.getthemes
if (thethemes.count = 0) then
   msgbox.error("No themes found", "Merge Grids")
   exit
end
thegthemes = list.make
for each thetheme in thethemes
   if (thetheme.getclass.getclassname = "gtheme") then
      thegthemes.add(thetheme)
   end
end
if (thegthemes.count = 0) then
   msgbox.error("No grid themes found", "Merge Grids")
   exit
end
’Pick the primary grid - values in this grid will be maintained in the final
grid.
atheme = msgbox.listasstring(thegthemes, "Primary grid", "Merge
Grids")
if (atheme = nil) then
   exit
end
’Get the grid from the selected primary grid.
agrid = atheme.getgrid
’Pick the secondary grid - primary grid will be merged into this grid.
btheme = msgbox.listasstring(thegthemes, "Secondary grid", "Merge
Grids")
if (btheme = nil) then
   exit
end
’Get the grid from the selected secondary grid.
bgrid = btheme.getgrid
’
listGrid = {bGrid}
’Perform the merge operation.
outGrid = aGrid.Merge(listGrid)
```

```
outname = msgbox.input("Give the merged grid a
name","Merge Grids","")
mergefilename =
FN.merge(av.getproject.getworkdir.asstring,outname)
'Save the merged grid - need to specify where to save the grid.
outGrid.SaveDataSet(mergefilename)
outTheme = gtheme.make(outGrid)
TheView.AddTheme(outTheme)
'
'final message to user
message = "Grids have been merged."
msgbox.info(message, "Merge Grids")
'------------
'---end------
'------------
'
```

Script: pickbactisep.ave

```
'
'---------------------------------
'--- Creation information ---
'--------------------------------
'
'Name: pickload.ave
'Version: 1.0
'Date: 02/11/97
'Author: Ferdi Hellweger
'       Center for Research in Water Resources
'       The University of Texas at Austin
'       ferdi@crwr.utexas.edu
'
'Modified by:  Patrice A. Melancon,
pmelancon@mail.utexas.edu
'   Date:  16 Jul 98
'   Modified to use with a point coverage; picks one value per
point from grid.
'   New Name:  pickbactipoint.ave
'
'Modified by:  Patrice A. Melancon
'   Date:  26 Jul 98
'   Modified to allow for baseflow and runoff concentrations to
be calculated at a point.
'   New name:  pickbactisep.ave
'
'Modified by:  Patrice A. Melancon
'   Date:  29 Oct 98
'   Modified so that the attribute table of the point theme is not
altered.  A new .dfb file and table are created, and
'     all picked values are written to the new table and .dbf file.
'
'--------------------------------
'--- Purpose/Description ---
'--------------------------------
'
'This program requires a point coverage, the accum bacti grids for both
runoff and baseflow and the accum flow grids for both
'runoff and baseflow.  This program will calculate the predicted
baseflow concentration and runoff concentration at a point by
'picking the bacti load value (in fc/yr) from a load grid for each point in
a point coverage and then picking the corresponding
'accumulated flow (in cf/yr).  A new table and .dbf file are created and
these two values are written to fields that have been
'created in the new VTab.  The concentration at the point is calculated
as load/flow with appropriate conversions
'and is written to another added field.  This is done for both baseflow
and runoff (storm flow).  The point coverage attribute table is
'not affected or edited in any way.  All results are written to a new .dbf
that the user names.
'
'-------------------
'--- Get view ---
'-------------------
'
theview = av.getactivedoc
'vgraphics = theview.getgraphics
'
'----------------------
'--- Get themes ---
'----------------------
'
thethemes = theview.getthemes
if (thethemes.count = 0) then
   msgbox.error("No active themes found", "PickPoint")
   exit
```

```
end
'
thefthemes = list.make
for each thetheme in thethemes
  if (thetheme.getclass.getclassname = "ftheme") then
    thefthemes.add(thetheme)
  end
end
if (thefthemes.count = 0) then
  msgbox.error("No coverage themes found","PickPoint")
  exit
end
thegthemes = list.make
for each thetheme in thethemes
  if(thetheme.getclass.getclassname = "gtheme") then
    thegthemes.add(thetheme)
  end
end
if (thegthemes.count = 0) then
  msgbox.error("No grid themes found","PickPoint")
  exit
end
'
'pick the point coverage
'
theptheme = msgbox.listasstring(thefthemes, "Point
Coverage","PickPoint")
if (theptheme = nil) then
  exit
end
'
'pick the accumulated load grids
'
lrgtheme = msgbox.listasstring(thegthemes, "Runoff Accumulated Bacti
Load","PickPoint")
if (lrgtheme = nil) then
  exit
end
'
lbgtheme = msgbox.listasstring(thegthemes, "Baseflow Accumulated
Bacti Load","PickPoint")
if (lbgtheme = nil) then
  exit
end
'
'pick the accumulated flow grids
'
flrgtheme = msgbox.listasstring(thegthemes, "Accumulated Runoff
Flow (cf/yr)","PickPoint")
if (flrgtheme = nil) then
  exit
end
'
flbgtheme = msgbox.listasstring(thegthemes, "Accumulated Baseflow
(cf/yr)","PickPoint")
if (flbgtheme = nil) then
  exit
end
'
'-------------------------
'--- Set up themes ---
'-------------------------
'
'grid themes
'
lrgrid = lrgtheme.getgrid
lbgrid = lbgtheme.getgrid
```

```
flrgrid = flrgtheme.getgrid
flbgrid = flbgtheme.getgrid
’
thecellsize = lrgrid.getcellsize
’
’polygon theme
’
pftab = theptheme.getftab
if (pftab = nil) then
   msgbox.error("Can’t open coverage","PickPoint")
   exit
end
’
’Create a new table and populate it with appropriate
information
’
pnttablename=msgbox.input("Select a name for the results
table - be sure to leave the .dbf extension on the
end","PickPoint","*.dbf")
if (pnttablename.right(4).ucase = ".DBF") then
  pnttblfilename =
FN.merge(av.getproject.getworkdir.asstring,pnttablename)
else
  pnttablename = pnttablename.merge(".dbf")
  pnttblfilename =
FN.merge(av.getproject.getworkdir.asstring,pnttablename)
end
’
theVtab = Vtab.MakeNew(pnttblfilename,dbase)
’
’get the identifier field from the point coverage attribute table
’
identf = msgbox.choice(pftab.getfields,"Pick the field that you
want to carry over as the identifier field","PickPoint")
newidentf = identf.clone
’
’Create fields for the table
’
rbactif = field.make("Ro_accfc", #FIELD_FLOAT, 30, 0)
bbactif = field.make("Bf_accfc", #FIELD_FLOAT, 30, 0)
raccflowf = field.make("Accro", #FIELD_FLOAT, 20, 0)
baccflowf = field.make("Accbf", #FIELD_FLOAT, 20, 0)
rconcf = field.make("Ro_conc", #FIELD_FLOAT, 10, 0)
bconcf = field.make("Bf_conc", #FIELD_FLOAT, 10, 0)
’
’add the fields to the table
’
theVtab.Addfields({newidentf,rbactif,bbactif,raccflowf,baccflowf,rconc
f,bconcf})
’
’--------------------
’--- Calculate ---
’--------------------
’
’--- Initial set up ---
’
ptshape = pftab.findfield("shape")
if (ptshape = nil) then
  msgbox.error("Can’t find ’shape’ field in point theme.","PickPoint")
  exit
end
’
’--- Loop to get values for each record---
’
for each prec in pftab
  shapev = pftab.returnvalue(ptshape,prec)
  identv = pftab.returnvalue(identf,prec)
  valuerb = lrgrid.cellvalue(shapev,Prj.MakeNull)
```

```
  valuebb = lbgrid.cellvalue(shapev,Prj.MakeNull)
  valuerf = flrgrid.cellvalue(shapev,Prj.MakeNull)
  valuebf = flbgrid.cellvalue(shapev,Prj.MakeNull)
  therec = theVtab.addrecord
  theVtab.setvalue(newidentf,therec,identv)
  theVtab.setvalue(rbactif,therec,valuerb)
  theVtab.setvalue(bbactif,therec,valuebb)
  theVtab.setvalue(raccflowf,therec,valuerf)
  theVtab.setvalue(baccflowf,therec,valuebf)
end
'
'calculate the concentration
'
'pftab.seteditable(true)
for each therec in theVtab
  loadrv = theVtab.returnvalue(rbactif,therec)
  flowrv = theVtab.returnvalue(raccflowf,therec)
  concrv = (loadrv/flowrv) * (35.3/(1000*1000)*100)
  loadbv = theVtab.returnvalue(bbactif,therec)
  flowbv = theVtab.returnvalue(baccflowf,therec)
  concbv = (loadbv/flowbv) * (35.3/(1000*1000)*100)
  theVtab.setvalue(rconcf,therec,concrv)
  theVtab.setvalue(bconcf,therec,concbv)
end
'
'make the new table non editable
'
theVtab.seteditable(false)
'
bactiTable = Table.Make(theVtab)
bactiTable.setname(pnttablename)
bactiTable.GetWin.Open
'
'final message to user
'
message = "Concentrations Calculated"
msgbox.info(message,"PickPoint")
'
'-------------
'--- End ---
'-------------
'
```

Script: pickbayvalue.ave

```
'
'-----------------------------------
'--- Creation information ---
'-----------------------------------
'
'Name: pickload.ave
'Version: 1.0
'Date: 02/11/97
'Author: Ferdi Hellweger
'        Center for Research in Water Resources
'        The University of Texas at Austin
'        ferdi@crwr.utexas.edu
'
'Modified on 7/20/98 by Patrice A. Melancon
(pmelancon@mail.utexas.edu)
'        Center for Research in Water Resources, University of
Texas at Austin
'        Fixed the script so that it works in ArcView; added in
option to select a value grid;
'        added in option to select the polygon theme to then get
the centroids on.
'        Set the new field to 'Acc Flow' for now; could be
changed for other variables.
'        New Name:  pickbayvalue.ave
'
'Modified by:  Patrice A. Melancon
'        Date:  29 Oct 98
'        Modified so that the attribute table of the polygon theme
is not altered.  A new .dbf file and table are
'              created, and all values are written to the new table
and .dbf file.
'
'-----------------------------------
'--- Purpose/Description ---
'-----------------------------------
'
'This program picks up the accumulated value for each polygon in the
modeled bay segments coverage (baymodel)
'from whatever grid you tell it to.  The grid that you specify should be
an accumulated grid (ie, flow accumulation
'has been calculated already) based on the flow direction from the
connectsink modified DEM
'grid with the cellvalue request. A new table and .dbf file are created
and the value is written to a field
'that the user specifies.  The script will ask for two identifiers since
there are two segments named 'main bay.'  The user should
'identify the segment name as the primary identifier and the growing
management as the secondary identifier.
'This script only queries one grid at a time, so if you are interested in
more than one grid, you
'will need to run this script multiple times.
'
'------------------
'--- Get view ---
'------------------
'
theview = av.getactivedoc
vgraphics = theview.getgraphics
'
'---------------------
'--- Get themes ---
'---------------------
'
thethemes = theview.getthemes
if (thethemes.count = 0) then
  msgbox.error("No themes found", "PICKLOAD")
```

```
    exit
end
’get the grid themes
thegthemes = list.make
for each thetheme in thethemes
  if(thetheme.getclass.getclassname = "gtheme") then
    thegthemes.add(thetheme)
  end
end
if (thegthemes.count = 0) then
  msgbox.error("No grid themes found","PICKLOAD")
  exit
end
’get the coverage themes
thefthemes = list.make
for each thetheme in thethemes
  if(thetheme.getclass.getclassname = "ftheme") then
    thefthemes.add(thetheme)
  end
end
if (thefthemes.count = 0) then
  msgbox.error("No coverage themes found","PickBayValue")
  exit
end
’
’Pick the grid that has acc values based on the connectfdr
’
valuegtheme = msgbox.listasstring(thegthemes,"Value
Grid","PickBayValue")
if (valuegtheme = nil) then
  exit
end
’
’Pick the polygon coverage that you want the values for
’
baytheme = msgbox.listasstring(thefthemes,"Bay Polygon
Theme","PickBayValue")
if (baytheme = nil) then
  exit
end
’
’-------------------------
’--- Set up themes ---
’-------------------------
’
’grid theme
’
thevgrid = valuegtheme.getgrid
’
thecellsize = thevgrid.getcellsize
’
’polygon theme
’
bayftab = baytheme.getftab
if (bayftab = nil) then
    msgbox.error("Can’t open polygon theme","PickBayValue")
    exit
end
’
bayshapef = bayftab.findfield("shape")
if (bayshapef = nil) then
    msgbox.error("Can’t find ’shape’ field in polygon
theme","PickBayValue")
    exit
end
’
’Create a new table and .dbf file and then populate it with appropriate
information
```

```
'
polytablename=msgbox.input("Select a name for the results
table - be sure to leave the .dbf extension on the
end","PickBayValue","*.dbf")
if (polytablename.right(4).ucase = ".DBF") then
  polytblfilename =
FN.merge(av.getproject.getworkdir.asstring,polytablename)
else
  polytablename = polytablename.merge(".dbf")
  polytblfilename =
FN.merge(av.getproject.getworkdir.asstring,polytablename)
end
'
theVtab = Vtab.MakeNew(polytblfilename,dbase)
'
'get two identifier fields from the point coverage attribute table
'
ident1f = msgbox.choice(bayftab.getfields,"Pick the field that
you want to carry over as the primary identifier
field","PickBayValue")
newident1f = ident1f.clone
ident2f = msgbox.choice(bayftab.getfields,"Pick the field that
you want to carry over as the secondary identifier
field","PickBayValue")
newident2f = ident2f.clone
'
'Create fields for the table
'
'Select a field name for the value you are interested in
'
valueinterest = msgbox.input("Enter a name to correspond
with the value field that you selected earlier - this will become
the name of the value field in the new
table","PickBayValue","")
valuef = field.make(valueinterest, #FIELD_FLOAT, 30, 0)
theVtab.addfields({newident1f,newident2f,valuef})
'
'--------------------
'--- Calculate ---
'--------------------
'
'Note that due to instabilities in the flowaccumulation algorithm
'at sinks the accumulated value can not be simply picked of the grid at
the
'centroid (the sink).  The accumulated value is the integral of the grid
'values of the cells directly above, below, to the left, and to the right of
the centroid.  This assumes that the
'flow is directly to the centroid and not around the perimeter of
'the box.  Observations support this assumption.  The flow direction
'grid could be used to check and/or modify the algorithm.
'
'--- Initial set up ---
'
'--- Loop ---
'
for each bayrec in bayftab
   '
   'get the identifier for the polygon
   '
   ident1v = bayftab.returnvalue(ident1f,bayrec)
   ident2v = bayftab.returnvalue(ident2f,bayrec)
   '
   'get centroid
   '
   bayshape = bayftab.returnvalue(bayshapef, bayrec)
   cenbay = bayshape.returncenter
   cenx = cenbay.getx
   ceny = cenbay.gety
```

```
    '
    'plot centroid
    '
    cengs = graphicshape.make(cenbay)
    vgraphics.add(cengs)
    '
    'check if centroid is in polygon
    '
    inside = cenbay.iscontainedin(bayshape)
    if (not inside) then
      msgbox.error("Polygon centroid not inside polygon",
"PickBayValue")
    end
    '
    'get values for 4 cells around centroid
    '
    pickx = cenx + (0 * thecellsize)
    picky = ceny + (1 * thecellsize)
    pickp = point.make(pickx, picky)
    v1 = thevgrid.cellvalue(pickp,Prj.MakeNull)
    '
    pickx = cenx + (1 * thecellsize)
    picky = ceny + (0 * thecellsize)
    pickp = point.make(pickx, picky)
    v2 = thevgrid.cellvalue(pickp,Prj.MakeNull)
    '
    pickx = cenx + (-1 * thecellsize)
    picky = ceny + (0 * thecellsize)
    pickp = point.make(pickx, picky)
    v3 = thevgrid.cellvalue(pickp,Prj.MakeNull)
    '
    pickx = cenx + (0 * thecellsize)
    picky = ceny + (-1 * thecellsize)
    pickp = point.make(pickx, picky)
    v4 = thevgrid.cellvalue(pickp,Prj.MakeNull)
    '
    'add up all 4 values for the total value
    '
    valuev = v1 + v2 + v3 + v4
    '
    'Add a record to the new table and write acc value to new record
    '
    therec = theVtab.addrecord
    theVtab.setvalue(newident1f,therec,ident1v)
    theVtab.setvalue(newident2f,therec,ident2v)
    theVtab.setvalue(valuef,therec,valuev)
    '
end
'
'make the new table non editable
'
theVtab.seteditable(false)
'
baytable = Table.Make(theVtab)
baytable.setname(polytablename)
baytable.GetWin.Open
'
'final message to user
'
message = "Accumulated value picked"
msgbox.info(message,"PickBayValue")
'
'-------------
'--- End ---
'-------------
'
```

Script: picksedisep.ave

```
'
'----------------------------
'--- Creation information ---
'----------------------------
'
'Name: pickload.ave
'Version: 1.0
'Date: 02/11/97
'Author: Ferdi Hellweger
'       Center for Research in Water Resources
'       The University of Texas at Austin
'       ferdi@crwr.utexas.edu
'
'Modified by:  Patrice A. Melancon,
pmelancon@mail.utexas.edu
'   Date:  16 Jul 98
'   1)  Modified to use with a point coverage; picks one value
per point from grid.
'   Renamed:  pickbactipoint.ave
'
'Modified by:  Patrice A. Melancon
'   Date:  26 Jul 98
'   1)  Modified to allow for baseflow and runoff
concentrations to be calculated at a point.
'   New name:  pickbactisep.ave
'
'Modified by:  Patrice A. Melancon
'   Date:  29 Oct 98
'   1)  Modified so that the attribute table of the point theme is
not altered.  A new .dfb file and table
'   are created, and all picked values are written to the new
table and .dbf file.
'
'Modified by:  Patrice A. Melancon
'   Date:  29 Dec 98
'   1)  Modified to account for sediment loads versus bacti loads.
'   New name:  picksedisep.ave
'
'Modified by:  Patrice A. Melancon
'   Date:  31 Jan 99
'   1)  Modified to account for channel/drainage area processes
contribution to sediment concentration
'
'---------------------------
'--- Purpose/Description ---
'---------------------------
'
'This program requires a point coverage, the accum sediment grids for
both runoff and baseflow and the accum flow grids for both
'runoff and baseflow.  Program also requires the accum supplemental
sediment grid from channel/drainage area related processes.
'This program will calculate the predicted baseflow concentration and
runoff concentration at a point by
'picking the sediment load value (in tons/yr) from a load grid for each
point in a point coverage and then picking the corresponding
'accumulated flow (in cf/yr).  Program also picks off the value from the
accum supplemental sediment grid.
'A new table and .dbf file are created and these results values are written
to fields that have been
'created in the new VTab.  The concentration at the point is calculated
as load/flow with appropriate conversions
'and is written to another added field.  Calculates runoff related
concentration, baseflow related concentration, supplemental
'load related concentration, and overall concentration.
```

```
'The conversion factor is
tons/yr*yr/cf*35.1cf/1000L*2000#/ton*0.4536kg/#*10^6mg/k
g = 32033232.
'This is done for both baseflow and runoff (storm flow).  The
point coverage attribute table is
'not affected or edited in any way.  All results are written to a
new .dbf that the user names.
'
'----------------
'--- Get view ---
'----------------
'
theview = av.getactivedoc
'vgraphics = theview.getgraphics
'
'------------------
'--- Get themes ---
'------------------
'
thethemes = theview.getthemes
if (thethemes.count = 0) then
    msgbox.error("No active themes found", "PickPoint")
    exit
end
'
thefthemes = list.make
for each thetheme in thethemes
  if (thetheme.getclass.getclassname = "ftheme") then
    thefthemes.add(thetheme)
  end
end
if (thefthemes.count = 0) then
  msgbox.error("No coverage themes found","PickPoint")
  exit
end
thegthemes = list.make
for each thetheme in thethemes
  if(thetheme.getclass.getclassname = "gtheme") then
    thegthemes.add(thetheme)
  end
end
if (thegthemes.count = 0) then
  msgbox.error("No grid themes found","PickPoint")
  exit
end
'
'pick the point coverage
'
theptheme = msgbox.listasstring(thefthemes, "Point
Coverage","PickPoint")
if (theptheme = nil) then
  exit
end
'
'pick the accumulated load grids
'
lrgtheme = msgbox.listasstring(thegthemes, "Runoff Accumulated
Sediment Load","PickPoint")
if (lrgtheme = nil) then
  exit
end
'
lbgtheme = msgbox.listasstring(thegthemes, "Baseflow Accumulated
Sediment Load","PickPoint")
if (lbgtheme = nil) then
  exit
end
'
```

```
chgtheme = msgbox.listasstring(thegthemes, "Supplemental
Accumulated Sediment Load","PickPoint")
if (chgtheme = nil) then
  exit
end
'
'pick the accumulated flow grids
'
flrgtheme = msgbox.listasstring(thegthemes, "Accumulated
Runoff Flow (cf/yr)","PickPoint")
if (flrgtheme = nil) then
  exit
end
'
flbgtheme = msgbox.listasstring(thegthemes, "Accumulated
Baseflow (cf/yr)","PickPoint")
if (flbgtheme = nil) then
  exit
end
'
'---------------------
'--- Set up themes ---
'---------------------
'
'grid themes
'
lrgrid = lrgtheme.getgrid
lbgrid = lbgtheme.getgrid
chgrid = chgtheme.getgrid
flrgrid = flrgtheme.getgrid
flbgrid = flbgtheme.getgrid
'
thecellsize = lrgrid.getcellsize
'
'polygon theme
'
pftab = theptheme.getftab
if (pftab = nil) then
   msgbox.error("Can't open coverage","PickPoint")
   exit
end
'
'Create a new table and populate it with appropriate information
'
pnttablename=msgbox.input("Select a name for the results table - be
sure to leave the .dbf extension on the end","PickPoint","*.dbf")
if (pnttablename.right(4).ucase = ".DBF") then
  pnttblfilename =
FN.merge(av.getproject.getworkdir.asstring,pnttablename)
else
  pnttablename = pnttablename.merge(".dbf")
  pnttblfilename =
FN.merge(av.getproject.getworkdir.asstring,pnttablename)
end
'
theVtab = Vtab.MakeNew(pnttblfilename,dbase)
'
'get the identifier field from the point coverage attribute table
'
identf = msgbox.choice(pftab.getfields,"Pick the field that you want to
carry over as the identifier field","PickPoint")
newidentf = identf.clone
'
'Create fields for the table
'
rsedif = field.make("Ro_accsed", #FIELD_FLOAT, 30, 0)
bsedif = field.make("Bf_accsed", #FIELD_FLOAT, 30, 0)
chsedif = field.make("Ch_accsed", #FIELD_FLOAT, 30, 0)
```

```
ttlsedif = field.make("Total_accsed", #FIELD_FLOAT, 30, 0)
raccflowf = field.make("Accroflow", #FIELD_FLOAT, 20, 0)
baccflowf = field.make("Accbflow", #FIELD_FLOAT, 20, 0)
taccflowf = field.make("Acctotalflow", #FIELD_FLOAT, 20,
0)
rconcf = field.make("Ro_conc", #FIELD_FLOAT, 10, 0)
bconcf = field.make("Bf_conc", #FIELD_FLOAT, 10, 0)
chconcf = field.make("Ch_conc", #FIELD_FLOAT, 10, 0)
ttlconcf = field.make("Overall_conc", #FIELD_FLOAT, 10, 0)
’
’add the fields to the table
’
theVtab.Addfields({newidentf,rsedif,bsedif,chsedif,ttlsedif,rac
cflowf,baccflowf,taccflowf,rconcf,bconcf,chconcf,ttlconcf})
’
’-----------------
’--- Calculate ---
’-----------------
’
’--- Initial set up ---
’
ptshape = pftab.findfield("shape")
if (ptshape = nil) then
  msgbox.error("Can’t find ’shape’ field in point
theme.","PickPoint")
  exit
end
’
’--- Loop to get values for each record---
’
for each prec in pftab
  shapev = pftab.returnvalue(ptshape,prec)
  identv = pftab.returnvalue(identf,prec)
  valuers = lrgrid.cellvalue(shapev,Prj.MakeNull)
  valuebs = lbgrid.cellvalue(shapev,Prj.MakeNull)
  valuechs = chgrid.cellvalue(shapev,Prj.MakeNull)
  valuettls = valuers + valuebs + valuechs
  valuerf = flrgrid.cellvalue(shapev,Prj.MakeNull)
  valuebf = flbgrid.cellvalue(shapev,Prj.MakeNull)
  valuettlf = valuerf + valuebf
  therec = theVtab.addrecord
  theVtab.setvalue(newidentf,therec,identv)
  theVtab.setvalue(rsedif,therec,valuers)
  theVtab.setvalue(bsedif,therec,valuebs)
  theVtab.setvalue(chsedif,therec,valuechs)
  theVtab.setvalue(ttlsedif,therec,valuettls)
  theVtab.setvalue(raccflowf,therec,valuerf)
  theVtab.setvalue(baccflowf,therec,valuebf)
  theVtab.setvalue(taccflowf,therec,valuettlf)
end
’
’calculate the concentration
’
’pftab.seteditable(true)
for each therec in theVtab
  loadrv = theVtab.returnvalue(rsedif,therec)
  flowrv = theVtab.returnvalue(raccflowf,therec)
  concrv = (loadrv/flowrv) * 32033232
  loadbv = theVtab.returnvalue(bsedif,therec)
  flowbv = theVtab.returnvalue(baccflowf,therec)
  concbv = (loadbv/flowbv) * 32033232
  loadch = theVtab.returnvalue(chsedif,therec)
  flowttl = theVtab.returnvalue(taccflowf,therec)
  concchv = (loadch/flowttl) * 32033232
  loadttl = theVtab.returnvalue(ttlsedif,therec)
  concttlv = (loadttl/flowttl) * 32033232
  theVtab.setvalue(rconcf,therec,concrv)
  theVtab.setvalue(bconcf,therec,concbv)
```

```
  theVtab.setvalue(chconcf,therec,concchv)
  theVtab.setvalue(ttlconcf,therec,concttlv)
end
’
’make the new table non editable
’
theVtab.seteditable(false)
’
bactiTable = Table.Make(theVtab)
bactiTable.setname(pnttablename)
bactiTable.GetWin.Open
’
’final message to user
’
message = "Point Concentrations Calculated"
msgbox.info(message,"PickPoint")
’
’-----------
’--- End ---
’-----------
’
```

Script: profiler.ave

```
'
'ArcView 3.0a Avenue Script: Profiler Ver 1.0
'
'Use to create chart profiles of line features (streams, roads, trails, etc.) using a line theme
'and an elevation grid theme.
'
'Requires Spatial Analyst Extension.
'
'Requires two active themes, The first a line theme and the second a grid theme of elevations.
'
'Requires lines to be selected. In general, selected lines should be connected for results
'to be realistic. There is no programmatic check to ensure selected lines are connected. In general, selected lines
'should not contain multiple branching for results to be realistic. That is, each node should connect no more than
'two _selected_ line segments.
'
'Merges selected lines then finds interval points along the merged line at equal intervals.  User is queried for how
'many divisions of merged line.
'
'Queries active grid theme cells for elevation values at interval points.
'
'Outputs a dbf file of distances starting at the lowest interval point and includes all interval points
'and corresponding z values.
'
'Outputs a line graph (profile) of distance from origin vs. z values if no more
'than about 100 interval points are produced. Use a more robust graphing package to graph larger outputs.
'
'Bill Eichenlaub
'bill_eichenlaub@nps.gov
'
'Date: 5/18/98
'
'Francisco Olivera
'folivera@mail.utexas.edu
'
'Date: 9/15/98
'
'Modified by:  Patrice A. Melancon
'            University of Texas at Austin
'            Center for Research in Water Resources
'            pmelancon@mail.utexas.edu
'            1)  Modified to reflect concentration rather than elevation
'            2)  Modified one of the messages boxes for better readibility.
'
theView       = av.getActiveDoc
' *** thePrj        = theView.GetProjection
' *** if (thePrj.IsNull) then
' ***   hasPrj = false
' ***   msgbox.warning("The data needs to be projected"
' ***        +NL+"into a cartesian coordiante system","Projection Needed - Exiting!")
' ***   exit
' *** else
' ***   hasPrj = true
' *** end
```

```
err1 = "Active themes must be a polyline theme and a grid
theme."

if (theView.GetActiveThemes.Count <> 2) then
 msgbox.error(err1,"You need two selected themes...")
 return(nil)
end

theFTheme     = theView.GetActiveThemes.Get(0)
if (theFTheme.is(FTHEME)) then
  theFTab = theFtheme.GetFTab
else
' *** Modified lines
  theFTheme = theView.GetActiveThemes.Get(1)
  if(theFTheme.is(FTHEME)) then
    theFTab = theFTheme.GetFTab
  else
    MsgBox.Error (err1 ,"None of the selected themes is a
feature theme...")
    return(nil)
  end
end
theClassName = theFTab.GetShapeClass.GetClassName
if ((theClassName = "Polyline").Not) then
  MsgBox.Error (err1,"The feature theme is not a polyline
theme...")
  return(nil)
end

theGTheme = theView.GetActiveThemes.Get(1)
if (theGTheme.is(GTHEME))then
  theGrid = theGTheme.GetGrid
else
' *** Modified line
  theGTheme = theView.GetActiveThemes.Get(0)
  if(theGTheme.is(GTHEME)) then
    theGrid = theGTheme.GetGrid
  else
    MsgBox.Error (err1,"None of the selected themes is a grid theme...")
    return(nil)
  end
end

theGraphics   = theView.GetGraphics

theSet = theFtab.GetSelection
if (theSet.count = 0) then
  MsgBox.Error ("The active polyline theme must have at least one
selected line.","Try Again...")
  return(nil)
end

theShapeIn    = theFTab.FindField("Shape")

'for each rec in the bit, merge into a polyline
c =0
for each rec in theSet
  theLine=theFtab.ReturnValue(theShapeIn, rec)
  if (c = 0) then
    allLines = theLine
  else
    allLines = allLines.returnMerged(theLine)
  end
  c=c+1
end

allLines.clean
```

```
’ *** Modified line
ddd = graphicShape.make(allLines)
theGraphics.addbatch(ddd)

’get the length of the resulting line
’ *** Modified line
lineLength = allLines.returnLength

’get number of divisions from user
numDivisions = msgbox.input("The selected lines total " +
lineLength.asString  + " units in length.  They will be divided
into even length intervals.  How many
divisions?","Profiler","10")
if (numDivisions = nil)then
  exit
end
numDivisions = numDivisions.asNumber

lengthPerDiv = lineLength/numDivisions
percentInc = (lengthPerDiv/lineLength)*100

startPt = allLines.asList.get(0).get(0)
centerPt = allLines.returnCenter
’ *** Modified line
startPtZ = theGrid.CellValue (startPt, Prj.MakeNull)
’ *** Modified line
centerPtZ = theGrid.CellValue (centerPt, Prj.MakeNull)
’ ***** if (startPtZ > centerPtZ) then
’ *****  allLines.flip
’ ***** nd

theList = {}

’disect the line
dist = 0
for each i in 0..100 by percentInc
  eachPt = allLines.Along(i)

’theGraphics.Add(graphicShape.Make(eachPt.clone.returnProjected(the
Prj)))
’ *** Modified line
  theZ = theGrid.CellValue (eachPt, Prj.MakeNull)
  theList.add({eachPt, dist, theZ, "Segment", i.clone})
  dist = dist + lengthPerDiv
end


’make a dbf file and vtab to store the distance and z data
MADefault = fileName.make("$HOME").makeTmp("StrPr_","dbf")
MAOutput  = fileDialog.put( MADefault,"*.dbf","Output table of line
lengths and elevations." )
if (MAOutput = nil) then
  theFTab.SetSelection(theSet)
  theFTab.UpdateSelection
  msgBox.info("No name entered, procedure cancelled","Exiting
Procedure")
  return nil
end
MAOutput.setExtension("dbf")
theVtab = Vtab.makeNew(MAOutput, dbase)
theMeanATable = table.make(theVtab)
fSamNum = field.make("Num", #FIELD_SHORT, 5, 0)
fDistance = field.make("Distance", #FIELD_DOUBLE, 15, 1)
fzVal = field.make("Concentration", #FIELD_DOUBLE, 15, 1)
fiVal = field.make("Per_Dist", #FIELD_DOUBLE, 15, 4)
ftype = field.make("Type", #FIELD_CHAR, 10, 0)
theVTab.addFields({fSamNum, fDistance, fzVal, ftype, fiVal})
’add the data
```

```
count = 0
for each k in theList
  mDistance = k.get(1)
  mzVal = k.get(2)
  mtype = k.get(3)
  miVal = k.get(4)
  rec= theVtab.addRecord
  theVtab.setValue(fSamNum, rec, count)
  theVtab.setValue(fDistance, rec, mDistance)
  theVtab.setValue(fzVal, rec, mzVal)
  theVtab.setValue(fiVal, rec, miVal)
  count=count+1
end
theMeanATable.SetName(MAOutput.asString +
"_Profile_Table")

’chart the grid values vs. the line end points
if(theList.count < 100) then
  ’make a chart of the Mean Area data
  theDistance = theVtab.FindField("Distance")
  newChart = Chart.make(theVTab, {fzVal})
  newChart.SetRecordLabelField(theDistance)
  newChart.SetSeriesFromRecords(false)

newChart.GetChartDisplay.SetType(#CHARTDISPLAY_LIN
E)
  newChart.GetChartDisplay.SetSeriesColor (0,
Color.GetBlue)
  anXAxis = newChart.GetXAxis
  anXAxis.SetName ("Distance")
  anXAxis.SetLabelVisible (True)
  anYAxis = newChart.GetYAxis
  anYAxis.SetName ("Grid Value")
  anYAxis.SetLabelVisible (True)
  newChart.GetTitle.SetName("Themes used: " +
theFTheme.GetName+ " and "+ theGtheme.GetName)
  newChart.getChartLegend.SetVisible (false)
  newChart.SetName(MAOutput.asString + "_Profile_Chart")
  newChart.GetWin.Open
else
  msgbox.info("No graph produced because the number of points used is
greater than or equal to 100, the maximum which can be
graphed.","Line Profiler")
end

theGraphics.endBatch
theGraphics.Invalidate
```

Script: profilerwithpoints.ave

```
'
'ArcView 3.0a Avenue Script: BE.ProfilesWithFeaturePts Ver 1.0
'
'Use to create elevation profiles of selected lines and selected point features.
'
'Requires Spatial Analyst Extension.
'
'Requires three active themes, The first a point theme (the feature points) and the second a
'line theme and the third a grid theme of interest.  Points do not need to be
'exactly on the line. Uses request PointPosition to find point on line nearest to feature point.
'
'Requires feature points to be selected.
'
'Requires lines to be selected. In general, selected lines should be connected for results
'to be realistic. There is no programmatic check to ensure selected lines are connected. In general, selected lines
'should not contain multiple branching for results to be realistic. That is, each node should connect no more than
'two _selected_ line segments.
'
'Merges selected lines then finds interval points along the merged line at equal intervals.  User is queried for how
'many divisions of merged line.
'
'Queries active grid theme cells for values at interval points and selected feature points.
'
'Outputs a dbf file of distances starting at the lowest interval point and includes all interval points, feature
'points and corresponding grid values. Dbf table contains a field "Type" indicating if a distance is
'an interval point or a feature point.
'
'Outputs a scatter-diagram graph (the line profile) of distance from origin vs. z values if no more
'than about 50 points are produced. Use a more robust graphing package to graph larger outputs.
'
'Use a more robust graphic package to construct scatter-diagrams which differentiate interval and
'feature points by color.
'
'Bill Eichenlaub
'bill_eichenlaub@nps.gov
'
'Date: 5/17/1998
'
'Francisco "Paco" Olivera
'folivera@mail.utexas.edu
'
'Date: 9/15/98
'
'Modified by:  Patrice A. Melancon
'           University of Texas at Austin
'           Center for Research in Water Resources
'           pmelancon@mail.utexas.edu
'           1)  Modified to reflect concentration values rather than elevation values.
'           2)  Modified one of the messages boxes for readibility
'
```

```
theView       = av.getActiveDoc
' *** thePrj       = theView.GetProjection

' *** if (thePrj.IsNull) then
' ***   hasPrj = false
' ***   msgbox.warning("The data needs to be projected"
' ***         +NL+"into a cartesian coordiante
system","Projection Needed - Exiting!")
' ***   exit
' *** else
' ***   hasPrj = true
' *** end

err1 = "Active themes must be a point theme, a polyline theme
and a grid theme."

if (theView.GetActiveThemes.Count <> 3) then
 msgbox.error(err1,"You need three selected themes...")
 return(nil)
end

' *** Identifying the Point Theme ***

thePtFTheme = theView.GetActiveThemes.Get(0)
if (thePtFTheme.is(FTHEME)) then
  thePtFTab = thePtFtheme.GetFTab
  theClassName = thePtFTab.GetShapeClass.GetClassName
  if ((theClassName = "point").Not) then
    thePtFTheme = theView.GetActiveThemes.Get(1)
    if (thePtFTheme.is(FTHEME)) then
      thePtFTab = thePtFtheme.GetFTab
      theClassName = thePtFTab.GetShapeClass.GetClassName
      if ((theClassName = "point").Not) then
        thePtFTheme = theView.GetActiveThemes.Get(2)
        if (thePtFTheme.is(FTHEME)) then
          thePtFTab = thePtFtheme.GetFTab
          theClassName = thePtFTab.GetShapeClass.GetClassName
          if ((theClassName = "point").Not) then
            MsgBox.Error (err1,"None of the selected themes is a feature or
point theme...")
            return(nil)
          end
        end
      end
    end
  end
end

' *** Identifying the PolyLine Theme ***

theFTheme = theView.GetActiveThemes.Get(0)
if (theFTheme.is(FTHEME)) then
  theFTab = theFtheme.GetFTab
  theClassName = theFTab.GetShapeClass.GetClassName
  if ((theClassName = "polyline").Not) then
    theFTheme = theView.GetActiveThemes.Get(1)
    if (theFTheme.is(FTHEME)) then
      theFTab = theFtheme.GetFTab
      theClassName = theFTab.GetShapeClass.GetClassName
      if ((theClassName = "polyline").Not) then
        theFTheme = theView.GetActiveThemes.Get(2)
        if (theFTheme.is(FTHEME)) then
          theFTab = theFtheme.GetFTab
          theClassName = theFTab.GetShapeClass.GetClassName
          if ((theClassName = "polyline").Not) then
            MsgBox.Error (err1,"None of the selected themes is a feature or
polyline theme...")
```

```
          return(nil)
        end
      end
    end
  end
 end
end

' *** Identifying the Grid Theme ***

theGTheme = theView.GetActiveThemes.Get(0)
if ((theGTheme.is(GTHEME)).Not)then
  theGTheme = theView.GetActiveThemes.Get(1)
  if ((theGTheme.is(GTHEME)).Not)then
    theGTheme = theView.GetActiveThemes.Get(2)
    if ((theGTheme.is(GTHEME)).Not)then
      MsgBox.Error (err1,"None of the selected themes is  a Grid
theme...")
      return(nil)
    else
      theGrid = theGTheme.GetGrid
    end
  else
    theGrid = theGTheme.GetGrid
  end
else
  theGrid = theGTheme.GetGrid
end

' ***************************************

theGraphics   = theView.GetGraphics

thePtSet = thePtFtab.GetSelection
thePtSetCount = thePtSet.count
if (thePtSetCount = 0) then
  MsgBox.Error ("The active point theme must have at least one
selected point.","Try Again...")
  return(nil)
end

theSet = theFtab.GetSelection
if (theSet.count = 0) then
  MsgBox.Error ("The active polyline theme must have at least one
selected line.","Try Again...")
  return(nil)
end

thePtShapeIn    = thePtFTab.FindField("Shape")
theShapeIn    = theFTab.FindField("Shape")

'for each rec in the bit, merge into a polyline
c =0
for each rec in theSet
  theLine=theFtab.ReturnValue(theShapeIn, rec)
  if (c = 0) then
    allLines = theLine
  else
    allLines = allLines.returnMerged(theLine)
  end
  c=c+1
end

allLines.clean

ddd = graphicShape.make(allLines)
'theGraphics.addbatch(ddd)
```

```
'get the length of the resulting line
lineLength = allLines.returnLength

'get number of divisions from user
numDivisions = msgbox.input("Selected lines total " +
lineLength.asString  + " units in length.  They will be divided
into even lengths. How many divisions?","Line Profiler","10")
if (numDivisions = nil)then
  exit
end
numDivisions = numDivisions.asNumber

lengthPerDiv = lineLength/numDivisions
percentInc = (lengthPerDiv/lineLength)*100

startPt = allLines.asList.get(0).get(0)
centerPt = allLines.returnCenter
startPtZ = theGrid.CellValue (startPt, Prj.MakeNull)
centerPtZ = theGrid.CellValue (centerPt, Prj.MakeNull)
' ***** if (startPtZ > centerPtZ) then
' *****  allLines.flip
' ***** end

featureDict = dictionary.make(thePtSetCount + 1)
featureKeyList = list.make
'get the points on the line closest to each feature point
'use pointPosition to get percentage and along to get point
for each rec in thePtSet
  thePt=thePtFtab.ReturnValue(thePtShapeIn, rec)
  featurePer = allLines.pointPosition(thePt)
  featureIntPt = allLines.along(featurePer)
  featureDist = (featurePer/100)*lineLength
  featureKeyList.add(featurePer)
  featureDict.add(featurePer, {featureIntPt, featureDist, featurePer})
end

featureKeylist.sort(True)
theList = {}

'disect the line
dist = 0
for each i in 0..100 by percentInc
  for each pt in featureKeylist
    dictList=featureDict.get(pt)
    sampPer = dictList.get(2)
    sampIntPt = dictList.get(0)
    sampDist = dictList.get(1)
    iLast = i.clone - percentInc
    if ((iLast < sampPer) and (i > sampPer)) then
      theSampIntZ = theGrid.CellValue (sampIntPt, Prj.MakeNull)
      theList.add({sampIntPt, sampDist, theSampIntZ, "Feature",
sampPer})
    end
  end
  eachPt = allLines.Along(i)
  'theGraphics.Add(graphicShape.Make(eachPt.clone))
  theZ = theGrid.CellValue (eachPt, Prj.MakeNull)
  theList.add({eachPt, dist, theZ, "Interval", i.clone})
  dist = dist + lengthPerDiv
end

'make a dbf file and vtab to store the distance and z data
MADefault = fileName.make("$HOME").makeTmp("StrPr_","dbf")
MAOutput  = fileDialog.put( MADefault,"*.dbf","Output table of line
lengths and concentrations." )
if (MAOutput = nil) then
  theFTab.SetSelection(theSet)
```

```
  theFTab.UpdateSelection
  msgBox.info("No name entered, procedure
cancelled","Exiting Procedure")
  return nil
end
MAOutput.setExtension("dbf")
theVtab = Vtab.makeNew(MAOutput, dbase)
theMeanATable = table.make(theVtab)
fSamNum = field.make("Num", #FIELD_SHORT, 5, 0)
fDistance = field.make("Distance", #FIELD_DOUBLE, 15, 1)
fzVal = field.make("Concentration", #FIELD_DOUBLE, 15,
1)
ffeatureZVal = field.make("Pt_Conc", #FIELD_DOUBLE, 15,
1)
fiVal = field.make("Per_Dist", #FIELD_DOUBLE, 15, 4)
ftype = field.make("Type", #FIELD_CHAR, 10, 0)
theVTab.addFields({fSamNum, fDistance, fzVal,
ffeatureZVal, ftype, fiVal})
'add the data in the order of the sorted key list
count = 0
for each k in theList
  mDistance = k.get(1)
  mzVal = k.get(2)
  mtype = k.get(3)
  miVal = k.get(4)
  rec= theVtab.addRecord
  theVtab.setValue(fSamNum, rec, count)
  theVtab.setValue(fDistance, rec, mDistance)
  theVtab.setValue(fzVal, rec, mzVal)
  theVtab.setValue(fiVal, rec, miVal)
  theVtab.setValue(ftype, rec, mtype)
  if (mtype = "Feature")then
    theVtab.setValue(ffeatureZVal, rec, mZVal)
    else
    theVtab.setValue(ffeatureZVal, rec, nil)
  end
  count=count+1
end
theMeanATable.SetName(MAOutput.asString +
"_Line_Point_Profile_Table")

'chart the grid values vs. the line end points
if(theList.count < 51) then
  'make a chart
  theDist = theVtab.FindField("Distance")
' ***  nChart = Chart.make(theVTab, {fDistance, fzVal})
  nChart = Chart.make(theVTab, {fzVal})
  nChart.SetRecordLabelField(theDist)
  nChart.SetSeriesFromRecords(false)
' ***
nChart.GetChartDisplay.SetType(#CHARTDISPLAY_XYSCATTER)
  nChart.GetChartDisplay.SetType(#CHARTDISPLAY_LINE)
  nChart.GetChartDisplay.SetSeriesColor(0, Color.GetBlue)
  aXAxis = nChart.GetXAxis
  aXAxis.SetName ("Distance")
  aXAxis.SetLabelVisible (True)
  anYAxis = nChart.GetYAxis
  anYAxis.SetName ("Grid Value")
  anYAxis.SetLabelVisible (True)
' ***  nChart.GetChartDisplay.SetSeriesColor(1, Color.GetBlue)
  nChart.GetTitle.SetName("Themes used: " + theFTheme.GetName + "
and "+ theGtheme.GetName   + NL + "Number of intervals: " +
numDivisions.asString + ".   Interval length: " + lengthPerDiv.asString
+" distance units." + NL + "Chart shows interval points and feature
points.")
  nChart.getChartLegend.SetVisible (false)
  nChart.SetName(MAOutput.asString + "_Line_Point_Profile_Chart")
  nChart.GetWin.Open
```

```
else
  msgbox.info("No graph produced because the number of
interval and feature points is greater than ArcView can handle.
Use another program to produce a scatter diagram of the output
table.","Line Profiler")
end

theGraphics.endBatch
theGraphics.Invalidate
```

Script: Ptsrcfcgrid.ave

```
'
'
'----------------------------
'--- Creation information ---
'----------------------------
'
'Name: concgrid.ave
'Version: 1.0
'Date: 02/17/97
'Author: Ferdi Hellweger
'       Center for Research in Water Resources
'       The University of Texas at Austin
'       ferdi@crwr.utexas.edu
'
'Modified: 02/28/97
'         Ann Quenzer
'         Center for Research in Water Resources
'         The University of Texas at Austin
'         quenzer@mail.utexas.edu
'         1) changed the message box description to reflect the
'                               script
'         2) added purpose and description
'         3) changed pathname for the data file to be saved
'         4) took out error message of only one theme found
'
'Modified:  6/23/98
'          Patrice Melancon, CRWR, UT,
pmelancon@mail.utexas.edu
'          1)  Edited the script and purpose to support conversion
of a point coverage
'          of point source outfalls to a grid.
'          New Name: ptsrcgrid.ave
'
'Modified:  10/29/98
'          Patrice Melancon
'          1)  Commented out the sediment part - that will be another script
in a project file for sediment.
'          New Name:  ptsrcfcgrid.ave
'
'---------------------------
'--- Purpose/Description ---
'---------------------------
'
'A load grid is computed for the STP outfalls from a point coverage
using the
'FC load field of the attribute table.  Normally, all other grid cells
'would have a value of nodata, but this script employs an 'isnull'
condition statement
'to change the nodata cells to a value of zero.  The resulting current (as
of Jul 98)
'grid is called stpfcgrid with units of 1x10^7 FC/yr.
'
'Note - There was a problem with creating the STP FC grid with the
load values in million FC/yr, thus the use of units of 1x10^7 fc/yr.
'One of the STP outfalls exceeds one million million FC/yr.  This
causes
'a problem with creating the grid.  I am not sure what the problem is, but
'ensure that the values in the FC load field of the STP point coverage
don't exceed 1,000,000.
'
'----------------
'--- Get view ---
'----------------
'
theview = av.getactivedoc
'
```

```
'-----------------
'--- Get theme ---
'-----------------
'
thethemes = theview.getthemes
if (thethemes.count = 0) then
   msgbox.error("No themes found", "STP FC GRID")
   exit
end
thefthemes = list.make
for each thetheme in thethemes
   if (thetheme.getclass.getclassname = "ftheme") then
      thefthemes.add(thetheme)
   end
end
if (thefthemes.count = 0) then
   msgbox.error("No feature themes found", "STP FC GRID")
   exit
end
theptheme = msgbox.listasstring(thefthemes, "STP Point
Coverage", "STP FC GRID")
if (theptheme = nil) then
   exit
end
thepftab = theptheme.getftab
thepshapef = thepftab.findfield("shape")
thepshape = thepftab.returnvalue(thepshapef, 0)
if (not (thepshape.getclass.getclassname = "point")) then
   msgbox.error("Theme needs to be a point theme", "STP FC
GRID")
   exit
end
'
'-----------------
'--- Get field ---
'-----------------
'
thepfields = thepftab.getfields
fcfield = msgbox.listasstring(thepfields, "Choose Fecal Coliform field",
"STP FC GRID")
if (fcfield = nil) then
   exit
end
'ssfield = msgbox.listasstring(thepfields, "Choose Sediment field","STP
GRID")
'if (ssfield = nil) then
'   exit
'end
'
'-----------------
'--- Calculate ---
'-----------------
'
cellsize = number.makenull
dummmy = grid.getanalysiscellsize(cellsize)
extent = rect.makenull
dummy = grid.getanalysisextent(extent)

fcgrid = grid.makefromftab(thepftab, prj.makenull, fcfield, {cellsize,
extent})
stpfcgrid = (fcgrid.isnull).con(0.asgrid,fcgrid)
'ssgrid = grid.makefromftab(thepftab, prj.makenull, ssfield, {cellsize,
extent})
'stpssgrid = (ssgrid.isnull).con(0.asgrid,ssgrid)

fcgridname = msgbox.input("Name the STP FC Grid","STP FC
GRID","stpfcgrid")
```

```
fcgridfilename =
FN.merge(av.getproject.getworkdir.asstring,fcgridname)
stpfcgrid.savedataset(fcgridfilename)
stpfcgtheme = gtheme.make(stpfcgrid)
theview.addtheme(stpfcgtheme)
stpfcgtheme.setvisible(false)
'
'ssgridname = msgbox.input("Name the STP Seidment
Grid","STP Sediment GRID","stpssgrid")
'ssgridfilename =
FN.merge(av.getproject.getworkdir.asstring,ssgridname)
'stpssgrid.savedataset(ssgridfilename)
'stpssgtheme = gtheme.make(stpssgrid)
'theview.addtheme(stpssgtheme)
'stpssgtheme.setvisible(false)
'
'final message to user
'
message = "Fecal Coliform STP load grid calculated."
msgbox.info(message,"STP FC GRID")
'
'-----------
'--- End ---
'-----------
'
```

Script: Ptsrcssgrid.ave

```
'
'
'---------------------------
'--- Creation information ---
'---------------------------
'
'Name: concgrid.ave
'Version: 1.0
'Date: 02/17/97
'Author: Ferdi Hellweger
'       Center for Research in Water Resources
'       The University of Texas at Austin
'       ferdi@crwr.utexas.edu
'
'Modified: 02/28/97
'        Ann Quenzer
'        Center for Research in Water Resources
'        The University of Texas at Austin
'        quenzer@mail.utexas.edu
'        1) changed the message box description to reflect the
'                         script
'        2) added purpose and description
'        3) changed pathname for the data file to be saved
'        4) took out error message of only one theme found
'
'Modified:  12/29/98
'        Patrice Melancon, CRWR, UT,
pmelancon@mail.utexas.edu
'        Edited the script and purpose to support conversion of a
point coverage
'        of point source outfalls to a grid.  Commented out the
FC parts of the script.
'        New Name:  ptsrcssgrid.ave
'
'--------------------------
'--- Purpose/Description ---
'--------------------------
'
'A load grid is computed for the STP outfalls from a point coverage
using the
'FC load and SS load fields of the attribute table.  Normally, all other
grid cells
'would have a value of nodata, but this script employs an 'isnull'
condition statement
'to change the nodata cells to a value of zero.  The resulting current
grids are called
'stpfcgrid and stpssgrid with units of 1x10^7 FC/yr and pounds/yr
respectively.
'
'Note - There was a problem with creating the STP FC grid with the
load values in million FC/yr.
'One of the STP outfalls exceeds one million million FC/yr.  This
causes
'a problem with creating the grid.  I am not sure what the problem is, but
'ensure that the values in the FC load field of the STP point coverage
don't exceed 1,000,000.
'If need be, adjust the units.
'
'This script has the Fecal Coliform parts commented out so it only runs
the Sediment part of the script.
'
'---------------
'--- Get view ---
'---------------
'
theview = av.getactivedoc
```

```
'
'-----------------
'--- Get theme ---
'-----------------
'
thethemes = theview.getthemes
if (thethemes.count = 0) then
   msgbox.error("No themes found", "STP SS GRID")
   exit
end
thefthemes = list.make
for each thetheme in thethemes
   if (thetheme.getclass.getclassname = "ftheme") then
      thefthemes.add(thetheme)
   end
end
if (thefthemes.count = 0) then
   msgbox.error("No feature themes found", "STP SS GRID")
   exit
end
theptheme = msgbox.listasstring(thefthemes, "STP Point
Coverage", "STP SS GRID")
if (theptheme = nil) then
   exit
end
thepftab = theptheme.getftab
thepshapef = thepftab.findfield("shape")
thepshape = thepftab.returnvalue(thepshapef, 0)
if (not (thepshape.getclass.getclassname = "point")) then
   msgbox.error("Theme needs to be a point theme", "STP SS
GRID")
   exit
end
'
'-----------------
'--- Get field ---
'-----------------
'
thepfields = thepftab.getfields
'fcfield = msgbox.listasstring(thepfields, "Choose Fecal Coliform field",
"STP GRID")
'if (fcfield = nil) then
'   exit
'end
ssfield = msgbox.listasstring(thepfields, "Choose Sediment field","STP
SS GRID")
if (ssfield = nil) then
   exit
end
'
'-----------------
'--- Calculate ---
'-----------------
'
cellsize = number.makenull
dummmy = grid.getanalysiscellsize(cellsize)
extent = rect.makenull
dummy = grid.getanalysisextent(extent)

'fcgrid = grid.makefromftab(thepftab, prj.makenull, fcfield, {cellsize,
extent})
'stpfcgrid = (fcgrid.isnull).con(0.asgrid,fcgrid)
ssgrid = grid.makefromftab(thepftab, prj.makenull, ssfield, {cellsize,
extent})
stpssgrid = (ssgrid.isnull).con(0.asgrid,ssgrid)

'fcgridfilename =
FN.merge(av.getproject.getworkdir.asstring,"stpfcgrid")
```

```
'stpfcgrid.savedataset(fcgridfilename)
'stpfcgtheme = gtheme.make(stpfcgrid)
'theview.addtheme(stpfcgtheme)
'stpfcgtheme.setvisible(false)
'
ssgridfilename =
FN.merge(av.getproject.getworkdir.asstring,"stpssgrid")
stpssgrid.savedataset(ssgridfilename)
stpssgtheme = gtheme.make(stpssgrid)
theview.addtheme(stpssgtheme)
stpssgtheme.setvisible(false)
'
'final message to user
'
message = "STP SS grid calculated."
msgbox.info(message,"STP SS GRID")
'
'-----------
'--- End ---
'-----------
'
```

Script: Sedibayreduction.ave

```
'
'
'---------------------------
'--- Creation information ---
'---------------------------
'
'Name: pickload.ave
'Version: 1.0
'Date: 02/11/97
'Author: Ferdi Hellweger
'       Center for Research in Water Resources
'       The University of Texas at Austin
'       ferdi@crwr.utexas.edu
'
'Modified on 7/20/98 by Patrice A. Melancon
(pmelancon@mail.utexas.edu)
'       Center for Research in Water Resources, University of
Texas at Austin
'       New Name:  pickbayvalue.ave
'       1)  Fixed the script so that it works in ArcView; added in
option to select a value grid;
'       2)  added in option to select the polygon theme to then
get the centroids on.
'       3)  Set the new field to 'Acc Flow' for now; could be
changed for other variables.
'
'Modified by:  Patrice A. Melancon
'       Date:  29 Oct 98
'           1)  Modified so that user picks a value grid and then
specifies name for new field.
'       2)  Modified so that the attribute table of the polygon
theme is not altered.  A new .dbf file and
'           table are created, and all values are written to the new table
and .dbf file.
'       New Name:  pickbayvalue.ave
'
'Modified by:  Patrice A. Melancon
'       Date:  9 Feb 99
'       1)  Modified to reflect percent reduction of load to the bay
segments.
'       New Name:  script to bayreduction.ave
'
'Modified by:  Patrice A. Melancon
'           Date:  10 Feb 99
'           1)  Modified for use with sediment files and project.
'           New Name:  sedibayreduction.ave
'
'--------------------------
'--- Purpose/Description ---
'--------------------------
'
'This program picks up the accumulated value for each polygon in the
modeled bay segments coverage (baymodel)
'from whatever grid you tell it to.  The grid that you specify should be
an accumulated grid (ie, flow accumulation
'has been calculated already) based on the flow direction from the
connectsink modified DEM
'grid with the cellvalue request. A new table and .dbf file are created
and the value is written to a field
'that the user specifies.  The script will ask for two identifiers since
there are two segments named 'main bay.'  The user should
'identify the segment name as the primary identifier and the growing
management as the secondary identifier.
'This script only queries one grid at a time, so if you are interested in
more than one grid, you
'will need to run this script multiple times.
```

```
'
'----------------
'--- Get view ---
'----------------
'
theview = av.getactivedoc
vgraphics = theview.getgraphics
'
'------------------
'--- Get themes ---
'------------------
'
thethemes = theview.getthemes
if (thethemes.count = 0) then
    msgbox.error("No themes found", "Bay Reduction")
    exit
end
'get the grid themes
thegthemes = list.make
for each thetheme in thethemes
  if(thetheme.getclass.getclassname = "gtheme") then
    thegthemes.add(thetheme)
  end
end
if (thegthemes.count = 0) then
  msgbox.error("No grid themes found","Bay Reduction")
  exit
end
'get the coverage themes
thefthemes = list.make
for each thetheme in thethemes
  if(thetheme.getclass.getclassname = "ftheme") then
    thefthemes.add(thetheme)
  end
end
if (thefthemes.count = 0) then
  msgbox.error("No coverage themes found","Bay Reduction")
  exit
end
'
'Get the pre bmp accumulated load grid associated with runoff
'
pregtheme = msgbox.listasstring(thegthemes,"Pre-BMP Acc Runoff
Load","Bay Reduction")
if (pregtheme = nil) then
  exit
end
'
'Get the post bmp accumulated load grid associated with runoff
'
postgtheme = msgbox.listasstring(thegthemes,"Post-BMP Acc Runoff
Load","Bay Reduction")
if (postgtheme = nil) then
  exit
end
'
'get the accumulated load grid associated with baseflow
'
basegtheme = msgbox.listasstring(thegthemes,"Acc Baseflow
Load","Bay Reduction")
if (basegtheme = nil) then
  exit
end
'
'get the accumulated supplemental sediment load
'
supplgtheme = msgbox.listasstring(thegthemes,"Supplemental
Load","Bay Reduction")
```

```
if (supplgtheme = nil) then
  exit
end
’
’Pick the polygon coverage that you want the values for
’
baytheme = msgbox.listasstring(thefthemes,"Bay Polygon
Theme","Bay Reduction")
if (baytheme = nil) then
  exit
end
’
’---------------------
’--- Set up themes ---
’---------------------
’
’grid theme
’
pregrid = pregtheme.getgrid
postgrid = postgtheme.getgrid
basegrid = basegtheme.getgrid
suppgrid = supplgtheme.getgrid
’
thecellsize = pregrid.getcellsize
’
’polygon theme
’
bayftab = baytheme.getftab
if (bayftab = nil) then
   msgbox.error("Can’t open polygon theme","Bay Reduction")
   exit
end
’
bayshapef = bayftab.findfield("shape")
if (bayshapef = nil) then
   msgbox.error("Can’t find ’shape’ field in polygon theme","Bay
Reduction")
   exit
end
’
’Create a new table and .dbf file and then populate it with appropriate
information
’
polytablename=msgbox.input("Select a name for the results table - be
sure to leave the .dbf extension on the end","Bay Reduction","*.dbf")
if (polytablename.right(4).ucase = ".DBF") then
  polytblfilename =
FN.merge(av.getproject.getworkdir.asstring,polytablename)
else
  polytablename = polytablename.merge(".dbf")
  polytblfilename =
FN.merge(av.getproject.getworkdir.asstring,polytablename)
end
’
theVtab = Vtab.MakeNew(polytblfilename,dbase)
’
’get two identifier fields from the point coverage attribute table
’
ident1f = msgbox.choice(bayftab.getfields,"Pick the field that you want
to carry over as the primary identifier field","Bay Reduction")
newident1f = ident1f.clone
ident2f = msgbox.choice(bayftab.getfields,"Pick the field that you want
to carry over as the secondary identifier field","Bay Reduction")
newident2f = ident2f.clone
’
’Create fields for the table
’
’Select a field name for the value you are interested in
```

```
'
valueinterest = msgbox.input("Enter a name to correspond
with the value field that you selected earlier - this will become
the name of the value field in the new table","Bay
Reduction","Reduction")
valuef = field.make(valueinterest, #FIELD_FLOAT, 10, 0)
theVtab.addfields({newident1f,newident2f,valuef})
'
'-----------------
'--- Calculate ---
'-----------------
'
'Note that due to instabilities in the flowaccumulation
algorithm
'at sinks the accumulated value can not be simply picked of the
grid at the
'centroid (the sink).  The accumulated value is the integral of
the grid
'values of the 8 cells surrounding the centroid.
'
'--- Initial set up ---
'
'--- Loop ---
'
for each bayrec in bayftab
   '
   'get the identifier for the polygon
   '
   ident1v = bayftab.returnvalue(ident1f,bayrec)
   ident2v = bayftab.returnvalue(ident2f,bayrec)
   '
   'get centroid
   '
   bayshape = bayftab.returnvalue(bayshapef, bayrec)
   cenbay = bayshape.returncenter
   cenx = cenbay.getx
   ceny = cenbay.gety
   '
   'plot centroid
   '
   cengs = graphicshape.make(cenbay)
   vgraphics.add(cengs)
   '
   'check if centroid is in polygon
   '
   inside = cenbay.iscontainedin(bayshape)
   if (not inside) then
      msgbox.error("Polygon centroid not inside polygon", "Bay
Reduction")
   end
   '
   'get values for 8 cells around centroid
   '
   pickx = cenx + (0 * thecellsize)
   picky = ceny + (1 * thecellsize)
   pickp = point.make(pickx, picky)
   prev1 = pregrid.cellvalue(pickp,Prj.MakeNull)
   postv1 = postgrid.cellvalue(pickp,Prj.MakeNull)
   basev1 = basegrid.cellvalue(pickp,Prj.MakeNull)
   suppv1 = suppgrid.cellvalue(pickp,Prj.MakeNull)
   '
   pickx = cenx + (1 * thecellsize)
   picky = ceny + (0 * thecellsize)
   pickp = point.make(pickx, picky)
   prev2 = pregrid.cellvalue(pickp,Prj.MakeNull)
   postv2 = postgrid.cellvalue(pickp,Prj.MakeNull)
   basev2 = basegrid.cellvalue(pickp,Prj.MakeNull)
   suppv2 = suppgrid.cellvalue(pickp,Prj.MakeNull)
```

```
’
pickx = cenx + (-1 * thecellsize)
picky = ceny + (0 * thecellsize)
pickp = point.make(pickx, picky)
prev3 = pregrid.cellvalue(pickp,Prj.MakeNull)
postv3 = postgrid.cellvalue(pickp,Prj.MakeNull)
basev3 = basegrid.cellvalue(pickp,Prj.MakeNull)
suppv3 = suppgrid.cellvalue(pickp,Prj.MakeNull)
’
pickx = cenx + (0 * thecellsize)
picky = ceny + (-1 * thecellsize)
pickp = point.make(pickx, picky)
prev4 = pregrid.cellvalue(pickp,Prj.MakeNull)
postv4 = postgrid.cellvalue(pickp,Prj.MakeNull)
basev4 = basegrid.cellvalue(pickp,Prj.MakeNull)
suppv4 = suppgrid.cellvalue(pickp,Prj.MakeNull)
’
’add up all 4 values for the total value
’
prevaluev = prev1 + prev2 + prev3 + prev4
postvaluev = postv1 + postv2 + postv3 + postv4
basevaluev = basev1 + basev2 + basev3 + basev4
suppvaluev = suppv1 + suppv2 + suppv3 + suppv4
’
’calculate the total pre and post loads
’
totalpre = prevaluev + basevaluev + suppvaluev
totalpost = postvaluev + basevaluev + suppvaluev
’
’calculate the percent reduction
’
valuev = (totalpre - totalpost)/totalpre*100
’
   ’Add a record to the new table and write percent reduction value to
new record
   ’
   therec = theVtab.addrecord
   theVtab.setvalue(newident1f,therec,ident1v)
   theVtab.setvalue(newident2f,therec,ident2v)
   theVtab.setvalue(valuef,therec,valuev)
   ’
end
’
’make the new table non editable
’
theVtab.seteditable(false)
’
baytable = Table.Make(theVtab)
baytable.setname(polytablename)
baytable.GetWin.Open
’
’final message to user
’
message = "Reduction to bay segments calculated"
msgbox.info(message,"Bay Reduction")
’
’-----------
’--- End ---
’-----------
’
```

Script: Sedibmpeffect.ave

```
'
'
'----------------------------------
'---------Creation Info-------------
'----------------------------------
'
'Name:  bactibmpeffect.ave
'Version:  1.0
'Date:  8 Sep 98
'Author: Patrice Melancon
'       Center for Research in Water Resources
'       The University of Texas at Austin
'       pmelancon@mail.utexas.edu
'
'Modified by:  P. Melancon
'       Date:  29 Dec 98
'       1)  Edited script to reflect sediment loads.
'       New Name:  sedibmpeffect.ave
'
'------------------------------------
'-----------Purpose/Description-------
'------------------------------------
'
'This script calculates a new runoff sediment grid to account
for the effects of BMPs on CAFO lands.
'This script does not affect the baseflow bacti grid since it is
assumed that BMPs don't affect baseflow.
'This scripts requires a landuse grid, a grid of average runoff
sediment load and baseflow sediment load, and a flow
direction grid.
'A MultiInput box will get information on BMP
implementation and associated reductions.
'An effective reduction for CAFO BMPs is calculated.  The
RiparianAreas/Fencing BMP is the only applicable BMP for sediment.
'A grid is created to represent the remaining load - the landuse grid is
queried
'and for all CAFO land the load remaining is calculated by the runoff
load * the percent
'remaining (which is represented by 1 - effective reduction) and is
written to the result grid;
'for all other lands, the original runoff load is written to the result grid
(representing no reduction).
'Optionally, flow accumulation is done on the resultant runoff load grid
to get a new accumulated runoff grid.
'Another option allows the user to flow accumulate the baseflow
sediment load grid if that was not done in the
'previous step.
'
'There are number of lines that are commented out dealing with more
BMPs and gradations of proper manure application.
'These lines have been left in for potential future use.
'
'---------------
'--- Get view ---
'---------------
'
theview = av.getactivedoc
'
'----------------
'--- Get theme ---
'----------------
'
thethemes = theview.getthemes
if (thethemes.count = 0) then
   msgbox.error("No themes found", "BMP Effect")
   exit
```

```
end
’
thegthemes = list.make
for each thetheme in thethemes
   if (thetheme.getclass.getclassname = "gtheme") then
      thegthemes.add(thetheme)
   end
end
’
if (thegthemes.count = 0) then
   msgbox.error("No grid themes found","BMP Effect")
   exit
end
’
’get the landuse grid
’
lusetheme = msgbox.listasstring(thegthemes,"Landuse
Grid","BMP Effect")
if (lusetheme = nil) then
   exit
end
lusegrid = lusetheme.getgrid
’
’get the runoff FC load per cell grid
’
rosstheme = msgbox.listasstring(thegthemes,"Runoff SS Load
Grid","BMP Effect")
if (rosstheme = nil) then
   exit
end
rossgrid = rosstheme.getgrid
’
’get the baseflow FC load per cell grid
’
bfsstheme = msgbox.listasstring(thegthemes,"Baseflow SS Load
Grid","BMP Effect")
if (bfsstheme = nil) then
   exit
end
bfssgrid = bfsstheme.getgrid
’
’get the flow direction grid
’
fdrtheme = msgbox.listasstring(thegthemes,"Flow Direction
Grid","BMP Effect")
if (fdrtheme = nil) then
   exit
end
fdrgrid = fdrtheme.getgrid
’
’
’Set up the BMP effectiveness parameters
’
BMPlabels = list.make
BMPdefaults = list.make
effectlist = list.make
’BMPlabels = {"% CAFOs with Adequate Storage","% Reduction for
Adequate Storage","% CAFOs with Proper Manure Handling","%
Reduction for Proper Handling","% CAFOs with Grade A
Application","% Reduction for Grade A Application","% CAFOs with
Grade C Application","% Reduction for Grade C Application","%
CAFOs with Grade F Application","% Reduction for Grade F
Application","% CAFOs with Riparian Areas/Fencing","% Reduction
for Riparian Areas/Fencing"}
’BMPdefaults = {"","","","","","","","","","","",""}
BMPlabels = {"% CAFOs with Riparian Areas/Fencing","% Reduction
for Riparian Areas/Fencing"}
BMPdefaults = {"",""}
```

```
effectlist = MsgBox.MultiInput("Enter Percentages as Decimals","BMP Effects",BMPlabels,BMPdefaults)
'ASapplied = effectlist.get(0).asnumber
'ASred = effectlist.get(1).asnumber
'PMHapplied = effectlist.get(2).asnumber
'PMHred = effectlist.get(3).asnumber
'GrAapplied = effectlist.get(4).asnumber
'GrAred = effectlist.get(5).asnumber
'GrCapplied = effectlist.get(6).asnumber
'GrCred = effectlist.get(7).asnumber
'GrFapplied = effectlist.get(8).asnumber
'GrFred = effectlist.get(9).asnumber
'Ripapplied = effectlist.get(10).asnumber
'Ripred = effectlist.get(11).asnumber
'
'ASPHapplied = effectlist.get(0).asnumber
'ASPHred = effectlist.get(1).asnumber
'PAapplied = effectlist.get(2).asnumber
'PAred = effectlist.get(3).asnumber
Ripapplied = effectlist.get(0).asnumber
Ripred = effectlist.get(1).asnumber

'
'Set up the Septic System effect parameters
'
'Septiceff = MsgBox.Input("% of Septic Systems Failing (as a decimal)","BMP Effect","")
'Septicrem = Septiceff.asnumber
'
'Determine the total BMP effectiveness and corresponding percent remaining
'
'ASeff= ASapplied*ASred
'PMHeff = PMHapplied*PMHred
'Appeff = (GrAapplied*GrAred) + (GrCapplied*GrCred) + (GrFapplied*GrFred)
'Ripeff = Ripapplied*Ripred
'BMPeff = (1 - ((1-ASeff)*(1-PMHeff)*(1-Appeff)*(1-Ripeff)))
'BMPrem = (1 - BMPeff)
'effmsg = "The % remaining is"++BMPrem.asstring
'msgbox.info(effmsg,"BMP Effect")
'
'ASPHeff= ASPHapplied*ASPHred
'PAeff = PAapplied*PAred
Ripeff = Ripapplied*Ripred
BMPeff = Ripeff
BMPrem = (1 - BMPeff)
effmsg = "The % remaining after CAFO BMPs is"++BMPrem.asstring
msgbox.info(effmsg,"BMP Effect")

'Calculate the resultant runoff sediment grid accounting for BMPs
'Note - the BMP reduction is only applied to CAFO land use lands; the effect of failing septic systems is applied to rural residential lands
'
newrossload = (lusegrid = 23.asgrid).con((BMPrem.asgrid*rossgrid),rossgrid)
newroname = msgbox.input("Name the new resultant runoff sediment grid","BMP Effect","bmpsediload")
newrossfilename = FN.merge(av.getproject.getworkdir.asstring,newroname)
newrossload.savedataset(newrossfilename)
newrotheme = gtheme.make(newrossload)
theview.addtheme(newrotheme)
newrotheme.setvisible(false)
'
'Check to see if the user wants to do Flow Accumulations
'
```

```
accum = MsgBox.yesno("Do you wish to conduct flow
accumulation on the new runoff load grid now?","BMP
Effect",true)
if (accum) then
  newaccgrid = (fdrgrid.flowaccumulation(newrossload))
  newaccname = msgbox.input("Name the new accumulated
runoff bacti grid","BMP Effect","accbmpsedim")
  newaccsfilename =
FN.merge(av.getproject.getworkdir.asstring,newaccname)
  newaccgrid.savedataset(newaccsfilename)
  newaccstheme = gtheme.make(newaccgrid)
  theview.addtheme(newaccstheme)
  newaccstheme.setvisible(false)
  '
  'check, if the user did not already run flow accumulation on
the baseflow sediment grid, would they like to do it now
  '
  accum2 = msgbox.yesno("If you did not already flow
accumulate the sediment grid for baseflow, do you wish to do
that now?","BMP Effect",true)
  if (accum2) then
    baccsgrid = (fdrgrid.flowaccumulation(bfssgrid))
    baccsname = msgbox.input("Name the accumulated
sediment grid associated with baseflow","Bacti
Load","baccsgrid")
    baccsfilename =
FN.merge(av.getproject.getworkdir.asstring,baccsname)
    baccsgrid.savedataset(baccsfilename)
    baccstheme = gtheme.make(baccsgrid)
    theview.addtheme(baccstheme)
    baccstheme.setvisible(false)
    '
    'final message to user
    '
    message = "Reduced accumulate runoff sediment grid calculated."
    msgbox.info(message,"BMP Effect")
  else
    '
    'final message to user
    '
    message = "Reduced accumulated runoff sediment grid calculated."
    msgbox.info(message,"BMP effect")
  end
else
  '
  'final message to user
  '
  message = "Reduced average per cell runoff sediment grid calculated."
  msgbox.info(message,"BMP Effect")
end
'
'--------------------------
'----------End-------------
'--------------------------
```

```
Script: Sediconcvalue.ave
'
'
'---------------------------
'--- Creation information ---
'---------------------------
'
'Name: bacticoncvalue.ave
'Version: 1.0
'Date: 17 Jul 98
'Author:  Patrice A. Melancon
'        Center for Research in Water Resources
'        University of Texas at Austin
'        pmelancon@mail.utexas.edu
'
'Modified: 28 December 1998
'         Patrice A. Melancon
'         Edited the script for use with sediment values
'         New Name:  sediconcvalue.ave
'-----------------------------
'----Purpose/Description-------
'-----------------------------
'
'This script was written to change/set default runoff and
baseflow concentration parameters based on land use.
'It requires a landuse coverage.  The landuse coverage attribute
table is edited to add appropriate fields and
'then populated based on landuse code.  EMC values are in
mg/L.
'The user may accept the defaults or may change the values.
Changing values will not change the default
'values.  Default values may be changed by editing the script.
'-----------------------------------------
'
' get the view
'
theview = av.getactivedoc
'
'get the themes
'
thethemes = theview.getthemes
if (thethemes.count = 0) then
  msgbox.error("no themes found", "Set Concentration Values")
  exit
end
thefthemes = list.make
for each thetheme in thethemes
  if (thetheme.getclass.getclassname = "ftheme") then
    thefthemes.add(thetheme)
  end
end
if (thefthemes.count = 0) then
  msgbox.error("No coverage themes found", "Set Concentration
Values")
  exit
end
'
'Pick the landuse theme that contains and EMC field
'
atheme = msgbox.listasstring(thefthemes, "Landuse Theme", "Set
Concentration Values")
if (atheme = nil) then
  exit
end
'
'set up fields for the suspended sediment concentrations
'
```

```
concFTab = atheme.getFTab
if (concFTab = nil) then
  msgbox.error("Can't open the landuse theme","Set
Concentration Values")
  exit
end
'
bfsedimf = concFTab.findfield("Bf_ss_conc")
if (bfsedimf = nil) then
  addfield = msgbox.yesno("Can't find 'Baseflow SS Conc'
field in the attribute table.  Add it?","Set Concentration
Values",true)
  if (addfield) then
    concFTab.SetEditable(true)
    bfsedimf = field.make("Bf_ss_conc",#FIELD_FLOAT,10,1)
    concFTab.AddFields({bfsedimf})
    concFTab.seteditable(false)
  else
    exit
  end
end
rosedimf = concFTab.findfield("Ro_ss_conc")
if (rosedimf = nil) then
  addfield = msgbox.yesno("Can't find 'Runoff SS Conc' field
in attribute table.  Add it?","Set Concentration Values",true)
  if (addfield) then
    concFTab.SetEditable(true)
    rosedimf =
field.make("Ro_ss_conc",#FIELD_FLOAT,10,1)
    concFTab.AddFields({rosedimf})
    concFTab.seteditable(false)
  else
    exit
  end
end
'
'---------------------------------
'-----Set 'EMC' Concentrations----
'---------------------------------
'
'make the attribute table editable
concFTab.seteditable(true)
'
'find the grid-code field
'
lufields = concFTab.getfields
lusef = msgbox.listasstring(lufields,"Choose Landuse ID Field","Set
Concentration Values")
if (lusef = nil) then
  msgbox.error("You need to have a Landuse ID field.","Set
Concentration Values")
  exit
end
'Set the various concentration parameters.
conclabels = list.make
concdefaults = list.make
conclist = list.make
sedimz = 0
'set Sediment concentrations
sedlabels = {"Urban BaseFlow","Urban Runoff","RuralRes
BaseFlow","RuralRes Runoff","RuralInd
Baseflow","RuralIndRunoff","AgLand Baseflow","AgLand
Runoff","CAFO Baseflow","CAFO Runoff","Forest/Range
Baseflow","Forest/Range Runoff","Barren Baseflow","Barren Runoff"}
seddefaults =
{"5","60","5","60","5","150","5","100","5","200","5","20","5","20"}
sedlist = MsgBox.MultiInput("Enter Concentrations (mg/L)","Sediment
Concentrations",sedlabels,seddefaults)
```

```
bfsedur = sedlist.get(0).asnumber
rosedur = sedlist.get(1).asnumber
bfsedrr = sedlist.get(2).asnumber
rosedrr = sedlist.get(3).asnumber
bfsedri = sedlist.get(4).asnumber
rosedri = sedlist.get(5).asnumber
bfsedag = sedlist.get(6).asnumber
rosedag = sedlist.get(7).asnumber
bfsedcafo = sedlist.get(8).asnumber
rosedcafo = sedlist.get(9).asnumber
bfsedfor = sedlist.get(10).asnumber
rosedfor = sedlist.get(11).asnumber
bfsedbar = sedlist.get(12).asnumber
rosedbar = sedlist.get(13).asnumber
’
’Go through each record and depending on the land use code,
assign a concentration
’For Landuse = 0 (’nodata’ areas) and water and wetlands, value
assigned is zero.
for each rec in concFTab
’get the value for the land use from the ’grid-code’ field.
  lusev = concFTab.ReturnValue(lusef, rec)
  if (lusev = 0) then
    bfsedimv = sedimz
    rosedimv = sedimz
  elseif ((lusev >10) and (lusev <18)) then
    bfsedimv = bfsedur
    rosedimv = rosedur
  elseif (lusev = 18) then
    bfsedimv = bfsedrr
    rosedimv = rosedrr
  elseif (lusev = 19) then
    bfsedimv = bfsedri
    rosedimv = rosedri
  elseif ((lusev >20) and (lusev <25) and (lusev <> 23)) then
    bfsedimv = bfsedag
    rosedimv = rosedag
  elseif (lusev =23) then
    bfsedimv = bfsedcafo
    rosedimv = rosedcafo
  elseif ((lusev >30) and (lusev <44)) then
    bfsedimv = bfsedfor
    rosedimv = rosedfor
  elseif ((lusev >50) and (lusev <63)) then
    bfsedimv = sedimz
    rosedimv = sedimz
  else
    bfsedimv = bfsedbar
    rosedimv = rosedbar
  end
  concFTab.setvalue(bfsedimf,rec,bfsedimv)
  concFTab.setvalue(rosedimf,rec,rosedimv)
end
’
concFTab.SetEditable(false)
concTable = Table.Make(concFTab)
concTable.setname("Sediment Conc Values")
concTable.GetWin.Open
message = "Sediment Concentration Values Assigned Based on Land
Use."
MsgBox.info(message,"Set Concentration Values")
’
’-------------
’---End-------
’-------------
```

Script: Sedigrid.ave

```
'
'---------------------------
'--- Creation information ---
'---------------------------
'
'Name: concgrid.ave
'Version: 1.0
'Date: 02/17/97
'Author: Ferdi Hellweger
'       Center for Research in Water Resources
'       The University of Texas at Austin
'       ferdi@crwr.utexas.edu
'
'Modified: 02/28/97
'        Ann Quenzer
'        Center for Research in Water Resources
'        The University of Texas at Austin
'        quenzer@mail.utexas.edu
'        1) changed the message box description to reflect the
script
'        2) added purpose and description
'        3) changed pathname for the data file to be saved
'        4) took out error message of only one theme found
'
'Modified:  6/29/98
'         Patrice Melancon
'         Center for Research in Water Resources
'         pmelancon@mail.utexas.edu
'         1)  Changed the purpose to reflect a grid of bacteria
'         2)  Changed the name to bactigrid.ave
'
'Modified:  8/15/98
'         Patrice Melancon
'         1)  Added the STP Point Source load
'
'Modified:  12/12/98
'         Patrice Melancon
'         1)  Modified the script for use with sediment loads
'         New Name:  sedigrid.ave
'
'--------------------------
'--- Purpose/Description ---
'--------------------------
'This script requires a landuse coverage, the grid for the STP point
source SS load, the avg baseflow grid, the avg runoff grid,
'(both in cf/yr) and a flow direction grid.  Concentration grids are
computed for the land surface using the landuse coverage
'which has the EMC values for baseflow and runoff in the attribute
table.  Values for sediment from the landuse coverage are mg/L.
'The resultant grids are multiplied by the avg baseflow and runoff flow
grids (in cf/yr)
'with an appropriate conversion
(mg/L*cf/yr*1000L/35.31cf*#/.4536kg*kg/10^6mg*ton/2000# =
3.14*10^-8) factor to give load grids in
'tons/yr.  STP point source SS load grid (in #/yr) is divided by 2000 and
added to the runoff load grid.  Percell grids are called
'bfsedigrid and rosedigrid.  An optional weighted flowaccumulation is
calculated on each (runoff and baseflow) load grid - the user
'has the option to skip doing a weighted FAC.  The resulting grids are
called raccsgrid and baccsgrid and are in tons/yr.
'
'---------------
'--- Get view ---
'---------------
'
theview = av.getactivedoc
```

```
'-----------------
'--- Get theme ---
'-----------------
'
thethemes = theview.getthemes
if (thethemes.count = 0) then
   msgbox.error("No themes found", "Sediment Load")
   exit
end
thefthemes = list.make
for each thetheme in thethemes
   if (thetheme.getclass.getclassname = "ftheme") then
      thefthemes.add(thetheme)
   end
end
thegthemes = list.make
for each thetheme in thethemes
   if (thetheme.getclass.getclassname = "gtheme") then
      thegthemes.add(thetheme)
   end
end
if (thefthemes.count = 0) then
   msgbox.error("No feature themes found", "Sediment Load")
   exit
end
if (thegthemes.count = 0) then
   msgbox.error("No grid themes found","Sediment Load")
   exit
end
'
'get the landuse theme
'
theptheme = msgbox.listasstring(thefthemes, "Landuse
Theme", "Sediment Load")
if (theptheme = nil) then
   exit
end
thepftab = theptheme.getftab
thepshapef = thepftab.findfield("shape")
thepshape = thepftab.returnvalue(thepshapef, 0)
if (not (thepshape.getclass.getclassname = "polygon")) then
   msgbox.error("Landuse Theme needs to be a polygon theme",
"Sediment Load")
   exit
end
'
'get the SS Point source grid
'
stpgtheme = msgbox.listasstring(thegthemes, "STP SS Point Source
Grid","Sediment Load")
if (stpgtheme = nil) then
   exit
end
'
'get the baseflow grid theme
'
thebftheme = msgbox.listasstring(thegthemes, "Avg BaseFlow Grid (in
cf/yr)","Sediment Load")
if (thebftheme = nil) then
   exit
end
'
'get the runoff grid theme
'
therotheme = msgbox.listasstring(thegthemes, "Avg Runoff Flow Grid
(in cf/yr)","Sediment Load")
if (therotheme = nil) then
   exit
```

```
end
'
'get the flow direction theme
'
fdrtheme = msgbox.listasstring(thegthemes,"Flow Direction
Grid","Sediment Load")
if (fdrtheme = nil) then
   exit
end
'
'-----------------
'--- Get field ---
'-----------------
thepfields = thepftab.getfields
thebfcfield = msgbox.listasstring(thepfields, "Choose Baseflow
Sediment concentration field", "Sediment Load")
if (thebfcfield = nil) then
   exit
end
therocfield = msgbox.listasstring(thepfields, "Choose Runoff
Sediment concentration field", "Sediment Load")
if (therocfield = nil) then
   exit
end
'
'-----------------
'--- Calculate ---
'-----------------
'get the flow grids and get the cell size and extent
'
bflowgrid = thebftheme.getgrid
rflowgrid = therotheme.getgrid
'
cellsize = bflowgrid.getcellsize
extent = bflowgrid.getextent
'
bfconcgrid = grid.makefromftab(thepftab, prj.makenull, thebfcfield,
{cellsize, extent})
'bfconcfilename =
FN.merge(av.getproject.getworkdir.asstring,"bfconcgrid")
'bfconcgrid.savedataset(bfconcfilename)
'
roconcgrid = grid.makefromftab(thepftab, prj.makenull, therocfield,
{cellsize, extent})
'roconcfilename =
FN.merge(av.getproject.getworkdir.asstring,"roconcgrid")
'roconcgrid.savedataset(roconcfilename)
'
'calculate the load as flow * concentration with conversion to tons/yr
'
bloadgrid = bfconcgrid * bflowgrid * 0.0000000314.asgrid
bloadname = msgbox.input("Name the average sediment grid associated
with baseflow","Sediment Load","bfsedigrid")
bloadfilename =
FN.merge(av.getproject.getworkdir.asstring,bloadname)
bloadgrid.savedataset(bloadfilename)
'
rloadgrid1 = roconcgrid * rflowgrid * 0.0000000314.asgrid
'
stpgrid = stpgtheme.getgrid
'
rloadgrid = (rloadgrid1 + (stpgrid / 2000.AsGrid))
rloadname = msgbox.input("Name the average sediment grid associated
with runoff","Sediment Load","rosedigrid")
rloadfilename = FN.merge(av.getproject.getworkdir.asstring,rloadname)
rloadgrid.savedataset(rloadfilename)
'
'Check if the user wants to do flow accumulations right now
```

```
'
accum = MsgBox.yesno("Do you wish to conduct flow
accumulations on the load grids now?","Sediment Load",true)
if (accum) then
  '
  'do a weighted flow accumulation on the each of runoff load
and baseflow load
  '
  '
  'get the flow direction grid
  '
  fdrgrid = fdrtheme.getgrid
  raccsgrid = (fdrgrid.flowaccumulation(rloadgrid))
  raccsname = msgbox.input("Name the accumulated sediment
grid associated with runoff","Sediment Load","raccsgrid")
  raccsfilename =
FN.merge(av.getproject.getworkdir.asstring,raccsname)
  raccsgrid.savedataset(raccsfilename)
  raccstheme = gtheme.make(raccsgrid)
  theview.addtheme(raccstheme)
  raccstheme.setvisible(false)
  '
  baccsgrid = (fdrgrid.flowaccumulation(bloadgrid))
  baccsname = msgbox.input("Name the accumulated sediment
grid associated with baseflow","Sediment Load","baccsgrid")
  baccsfilename =
FN.merge(av.getproject.getworkdir.asstring,baccsname)
  baccsgrid.savedataset(baccsfilename)
  baccstheme = gtheme.make(baccsgrid)
  theview.addtheme(baccstheme)
  baccstheme.setvisible(false)
  '
  rseditheme = gtheme.make(rloadgrid)
  theview.addtheme(rseditheme)
  rseditheme.setvisible(false)
  '
  bseditheme = gtheme.make(bloadgrid)
  theview.addtheme(bseditheme)
  bseditheme.setvisible(false)
  '
  'final message to user
  '
  message = "Accumulated and Per Cell SS load grids calculated."
  msgbox.info(message,"Sediment Load")
else
  rseditheme = gtheme.make(rloadgrid)
  theview.addtheme(rseditheme)
  rseditheme.setvisible(false)
  '
  bseditheme = gtheme.make(bloadgrid)
  theview.addtheme(bseditheme)
  bseditheme.setvisible(false)
  '
  'final message to user
  '
  message = "Average per cell SS load grids calculated."
  msgbox.info(message,"Sediment Load")
end
'
'-----------
'--- End ---
'-----------
'
```

Script: Sedilocatedbmp.ave

```
'
'
'---------------------------
'--- Creation information ---
'---------------------------
'
'Name: bactilocatedbmp.ave
'Version: 1.0
'Date: 01/28/99
'Author: Patrice A. Melancon
'       Center for Research in Water Resources
'       The University of Texas at Austin
'       pmelancon@mail.utexas.edu
'
'Modified by:  Patrice A. Melancon
'       Date:  9 Feb 99
'       1)  Modified for use with sediment files and project.
'       New Name:  sedilocatedbmp.ave
'
'---------------------------------------------------
'-------Purpose/Description--------------------------
'---------------------------------------------------
'
'This script calculates the effect of a located BMP.  Script allows a user to identify one located point BMP
'interactively on the display.  The user identifies accumulated runoff load and accumulated supplemental load,
'as well as the accumulated runoff flow.
'The user also identifies the removal efficiency of the located BMP.
'The script will return the concentration at the point before and after the implementation of the located BMP.
'
'---------------------------------------------------
'
' get the view
'
theview = av.getactivedoc
thedisplay = theview.getdisplay
'
'get the themes
'
thethemes = theview.getthemes
if (thethemes.count = 0) then
  msgbox.error("No Themes Found", "Located BMPs")
  exit
end
'
thegthemes = list.make
for each thetheme in thethemes
  if (thetheme.getclass.getclassname = "gtheme") then
    thegthemes.add(thetheme)
  end
end
if (thegthemes.count = 0) then
  msgbox.error("No grid themes found", "Located BMPs")
  exit
end
'
pnt = thedisplay.returnuserpoint
pntx = pnt.getx
pnty = pnt.gety
userPoint = Point.MakeNull
userPoint = Point.Make(pntx,pnty)
'
```

```
lrgtheme = msgbox.listasstring(thegthemes, "Accumulated
Runoff Sediment Load","Located BMPs")
if (lrgtheme = nil) then
  exit
end
’
chrgtheme = msgbox.listasstring(thegthemes, "Accumulated
Supplemental Sediment Load","Located BMPs")
’
flrgtheme = msgbox.listasstring(thegthemes, "Accumulated
Runoff (cf/yr)","Located BMPs")
if (flrgtheme = nil) then
  exit
end
’
lrgrid = lrgtheme.getgrid
chrgrid = chrgtheme.getgrid
flrgrid = flrgtheme.getgrid
’
’
’pick off the value of the load from the grid
’
load1 = lrgrid.cellvalue(userPoint,Prj.MakeNull)
load2 = chrgrid.cellvalue(userPoint,Prj.MakeNull)
load = load1 + load2
flow = flrgrid.cellvalue(userPoint,Prj.MakeNull)
’
’calculate the concentration before removal
’
conc = (load/flow) * 32033232
’
’have the user identify the removal efficiency of the located
BMP
’
BMPeffect = msgbox.input("Enter the removal efficiency of this BMP
(as a decimal)","Located BMPs","")
’
loadremv = load * BMPeffect.asnumber
loadremn = load - loadremv
’
’calculate the concentration after removal
’
newconc = (loadremn/flow) * 32033232
’
msgbox.report("The concentration at the point before implementing the
BMP is"++conc.asstring++"mg/L"+"."+NL+
"The concentration after implmenting the BMP
is"++newconc.asstring++"mg/L"+".","Located BMPs")
’
```

Script: Sedipredconc.ave

```
'
'
'----------------------------
'--- Creation information ---
'----------------------------
'
'Name: predconcgrid.ave
'Author: Patrice A. Melancon
'       Center for Research in Water Resources
'       The University of Texas at Austin
'       pmelancon@mail.utexas.edu
'       Date:  6 Oct 98
'Modified:  Patrice A. Melancon
'         29 Dec 98
'         Modified the script for sediment calculations.
'                   New Name:  sedipredconc.ave
'
'Modified:  Patrice A. Melancon
'         12 Jan 99
'         Modified to add in the contribution from channel
processes.
'
'---------------------------
'--- Purpose/Description ---
'---------------------------
'
'This program calculates a predicted concentration grid for
sediment.  This grid is for total flow (ie, accounts for baseflow
and
'runoff).  This script requires accumulated and average grids
for sediment loads (in tons/yr) and flows (in cf/yr) associated
with
'both baseflow and runoff.  Also requires the accumulated supplemental
load.
'This program adds the accumulated grids to the average grids, then
adds baseflow grids to runoff grids to get total grids.  Next, the
'program divides the total load grid by the total flow grid with an
appropriate conversion factor to get a grid
'of resulting concentration expressed as mg/L.
'The conversion factor is
tons/yr*yr/cf*35.1cf/1000L*2000#/ton*0.4536kg/#*10^6mg/kg =
32033232
'This script that deals with sediment is called sedipredconc.ave.
'
'----------------
'--- Get view ---
'----------------
'
theview = av.getactivedoc
'vgraphics = theview.getgraphics
'
'------------------
'--- Get themes ---
'------------------
'
thethemes = theview.getthemes
if (thethemes.count = 0) then
   msgbox.error("No active themes found", "Concentration Grid")
   exit
end
'
thegthemes = list.make
for each thetheme in thethemes
  if(thetheme.getclass.getclassname = "gtheme") then
    thegthemes.add(thetheme)
  end
```

```
end
if (thegthemes.count = 0) then
  msgbox.error("No grid themes found","Concentration Grid")
  exit
end
'
'get all of the runoff related grids
'
lrgtheme = msgbox.listasstring(thegthemes, "Accumulated
Runoff Sediment Load","Concentration Grid")
if (lrgtheme = nil) then
  exit
end
alrgtheme = msgbox.listasstring(thegthemes, "Average Runoff
Sediment Load","Concentration Grid")
if (alrgtheme = nil) then
  exit
end
flrgtheme = msgbox.listasstring(thegthemes, "Accumulated
Runoff (cf/yr)","Concentration Grid")
if (flrgtheme = nil) then
  exit
end
aflrgtheme = msgbox.listasstring(thegthemes, "Average
Runoff (cf/yr)","Concentration Grid")
if (aflrgtheme = nil) then
  exit
end
chrgtheme = msgbox.listasstring(thegthemes, "Accumulated
Supplemental Sediment Load","Concentration Grid")
if (chrgtheme = nil) then
  exit
end
'
'get all the baseflow related grids
'
lbgtheme = msgbox.listasstring(thegthemes, "Accumulated Baseflow
Sediment Load","Concentration Grid")
if (lbgtheme = nil) then
  exit
end
albgtheme = msgbox.listasstring(thegthemes, "Average Baseflow
Sediment Load","Concentration Grid")
if (albgtheme = nil) then
  exit
end
flbgtheme = msgbox.listasstring(thegthemes, "Accumulated Baseflow
(cf/yr)","Concentration Grid")
if (flbgtheme = nil) then
  exit
end
aflbgtheme = msgbox.listasstring(thegthemes, "Average Baseflow
(cf/yr)","Concentration Grid")
if (aflbgtheme = nil) then
  exit
end
'
'--------------------
'--- Set up themes ---
'--------------------
'
'grid themes
'
lrgrid = lrgtheme.getgrid
flrgrid = flrgtheme.getgrid
alrgrid = alrgtheme.getgrid
aflrgrid = aflrgtheme.getgrid
chlrgrid = chrgtheme.getgrid
```

```
'
lbgrid = lbgtheme.getgrid
flbgrid = flbgtheme.getgrid
albgrid = albgtheme.getgrid
aflbgrid = aflbgtheme.getgrid
'
'set the analysis properties
'
ae = theView.GetExtension(AnalysisEnvironment)
ae.setcellsize(#ANALYSISENV_VALUE,lrgrid.getcellsize)
ae.setextent(#ANALYSISENV_VALUE,lrgrid.getextent)
'
load = lrgrid + alrgrid + lbgrid + albgrid + chlrgrid
flow = flrgrid + aflrgrid + flbgrid + aflbgrid
concgrid = (load/flow) * (32033232.asgrid)
'
concname = msgbox.input("Give the resultant grid a
name","Concentration Grid","")
concfilename =
FN.merge(av.getproject.getworkdir.asstring,concname)
concgrid.savedataset(concfilename)
concgtheme = gtheme.make(concgrid)
theview.addtheme(concgtheme)
concgtheme.setvisible(false)
'
message = "Predicted Sediment Concentration Grid
Calculated"
msgbox.info(message,"Concentration Grid")
'
'-----------
'--- End ---
'-----------
'
```

Script:Tillflow.ave
'
'
'----------------------------
'--- Creation information ---
'----------------------------
'
'Name: rogridland.ave
'Version: 1.0
'Date: 09/02/97
'Author: Ann Quenzer
' Center for Research in Water Resources
' The University of Texas at Austin
' quenzer@mail.utexas.edu
'
'Modified: 3/5/98 by Patrice Melancon
' Center for Research in Water Resources
' The University of Texas at Austin
' pmelancon@mail.utexas.edu
' New Name: tillflow.ave
' 1) New Runoff equations inserted for Tillamook Bay Project.
' 2) Modified Purpose/Description
'
'---------------------------
'--- Purpose/Description ---
'---------------------------
'
'Computes runoff grids in in/yr and cf/yr from the precipitation grid using the LTAA PRISM grid (precip).
'Uses the runoff and baseflow equations calculated from Microsoft Excel (precipdata1.xls)
'regression tool using the relationship between precipitation and streamflow.
'This script also takes into account that the runoff coefficient generated from
'water is 1 and for baseflow is 0, so it checks the landuse id and for values in the 50s (corresponding to water
'bodies), it sets the grid value to the precipitation grid value for runoff and 0 for baseflow.
'This script calculates a grid of baseflow, surface runoff, as well
'as total flow and is the average value of flow for each grid cell.
'The 'nameflow'in is in units of in/yr; the 'nameflow'cf is in units of cf/yr.
'
'The conversion factor of 833.3 is from in/yr * cellsize (100ft*100ft) * 1ft/12in
'
'There are a block of grid cells in the upper left corner (outside the county line, basically in the ocean) where the
'precipitation has been set to zero (orignial grid had value of -999) and the computed runoff grid value is negative
'(see the runoff equation: -15.478). There is a condition statement that sets the runoff of these negative values to
'zero.
'
'Note - The command that saves the flow (in/yr) grids are currently commented out. The totalflow (cf/yr) save grid command is also currently commented out.
'
'There is an option to compute accumulated flow grids as part of this run. If they are not computed now, they can be computed later using accflow.ave
'
'----------------
'--- Get view ---

```
’----------------
’
theview = av.getactivedoc
’
’------------------
’--- Get themes ---
’------------------
’
thethemes = theview.getthemes
if (thethemes.count = 0) then
   msgbox.error("No themes found", "FLOW GRID")
   exit
end
thegthemes = list.make
for each thetheme in thethemes
   if (thetheme.getclass.getclassname = "gtheme") then
      thegthemes.add(thetheme)
   end
end
if (thegthemes.count = 0) then
   msgbox.error("No grid themes found", "FLOW GRID")
   exit
end
pretheme = msgbox.listasstring(thegthemes, "Precipitation
Grid", "FLOW GRID")
if (pretheme = nil) then
   exit
end
lusetheme = msgbox.listasstring(thegthemes, "Landuse
Grid","FLOW GRID")
if (lusetheme = nil) then
   exit
end
fdrtheme = msgbox.listasstring(thegthemes,"Flow Direction
Grid","FLOW GRID")
if (fdrtheme = nil) then
   exit
end
’
’get the flow direction grid
’
fdrgrid = fdrtheme.getgrid
’
’-----------------
’--- Calculate ---
’-----------------
’
pregrid = pretheme.getgrid
lusegrid = lusetheme.getgrid
’
cellsize = pregrid.getcellsize
extent = pregrid.getextent
’cellsize = number.makenull
’dummmy = grid.getanalysiscellsize(cellsize)
’extent = rect.makenull
’dummy = grid.getanalysisextent(extent)
’
’
basegrid1 = ((lusegrid < 50.asgrid).con(((0.5188.asgrid * pregrid) +
1.857.asgrid), (0.asgrid)))
basegrid2 = ((lusegrid >= 60.asgrid).con(((0.5188.asgrid * pregrid) +
1.857.asgrid), (0.asgrid)))
’basegrid3 = (((lusegrid >= 50.asgrid) and (lusegrid <=
59.asgrid)).con((0.asgrid), (0.asgrid)))
rungrid1 = ((lusegrid < 50.asgrid).con(((0.3763.asgrid * pregrid) -
15.478.asgrid), (0.asgrid)))
```

```
rungrid2 = ((lusegrid >= 60.asgrid).con(((0.3763.asgrid *
pregrid) - 15.478.asgrid), (0.asgrid)))
rungrid3 = (((lusegrid >= 50.asgrid) and (lusegrid <=
59.asgrid)).con(pregrid, (0.asgrid)))
rogridba = (basegrid1 + basegrid2)
rogridro1 = (rungrid1 + rungrid2 + rungrid3)
'
'change all negative values of runoff to 0
'
rogridro = (rogridro1 < 0).con(0.asgrid, rogridro1)
rogridto = (rogridba + rogridro)
'
'robafilename =
FN.merge(av.getproject.getworkdir.asstring,"baseflowin")
'rogridba.savedataset(robafilename)
'robagtheme = gtheme.make(rogridba)
'theview.addtheme(robagtheme)
'robagtheme.setvisible(false)
'
'rorofilename =
FN.merge(av.getproject.getworkdir.asstring,"runoffin")
'rogridro.savedataset(rorofilename)
'rorogtheme = gtheme.make(rogridro)
'theview.addtheme(rorogtheme)
'rorogtheme.setvisible(false)
'
'rotofilename =
FN.merge(av.getproject.getworkdir.asstring,"ttlflowin")
'rogridto.savedataset(rotofilement)
'rotogtheme = gtheme.make(rogridto)
'theview.addtheme(rotogtheme)
'rotogtheme.setvisible(false)
'
'------------
'--Convert from in/yr to cf/yr--
'------------
rogridbacf = (rogridba * 833.3.asgrid).int
rogridrocf = (rogridro * 833.3.asgrid).int
rogridtocf = (rogridto * 833.3.asgrid).int
'
robacfname = msgbox.input("Name the average per cell baseflow
grid","FLOW GRID","baseflowcf")
robacffilename =
FN.merge(av.getproject.getworkdir.asstring,robacfname)
rogridbacf.savedataset(robacffilename)

'
rorocfname = msgbox.input("Name the average per cell runoff
grid","FLOW GRID","runoffcf")
rorocffilename =
FN.merge(av.getproject.getworkdir.asstring,rorocfname)
rogridrocf.savedataset(rorocffilename)
'
'rotocfname = msgbox.input("Name the average per cell total flow
grid","FLOW GRID","ttlflowcf")
'rotocffilename =
FN.merge(av.getproject.getworkdir.asstring,rotocfname)
'rogridtocf.savedataset(rotocffilename)
'rotocfgtheme = gtheme.make(rogridtocf)
'theview.addtheme(rotocfgtheme)
'rotocfgtheme.setvisible(false)
'
'Check if the user wants to do flow accumulations of baseflow and
runoff at this time
'
accum = MsgBox.yesno("Do you wish to conduct flow accumulations
on the runoff and baseflow grids now?","FLOW GRID",true)
if (accum) then
```

```
 ’
 ’do a weighted flow accumulation on the runoff and baseflow
 ’
 accbfgrid = (fdrgrid.flowaccumulation(rogridbacf))
 accbfname = msgbox.input("Name the accumulated baseflow
grid","FLOW GRID","accbflow")
 accbffilename =
FN.merge(av.getproject.getworkdir.asstring,accbfname)
 accbfgrid.savedataset(accbffilename)
 accbftheme = gtheme.make(accbfgrid)
 theview.addtheme(accbftheme)
 accbftheme.setvisible(false)
 ’
 accrogrid = (fdrgrid.flowaccumulation(rogridrocf))
 accroname = msgbox.input("Name the accumulated runoff
grid","FLOW GRID","accrunoff")
 accrofilename =
FN.merge(av.getproject.getworkdir.asstring,accroname)
 accrogrid.savedataset(accrofilename)
 accrotheme = gtheme.make(accrogrid)
 theview.addtheme(accrotheme)
 accrotheme.setvisible(false)
 ’
 robacfgtheme = gtheme.make(rogridbacf)
 theview.addtheme(robacfgtheme)
 robacfgtheme.setvisible(false)
 ’
 rorocfgtheme = gtheme.make(rogridrocf)
 theview.addtheme(rorocfgtheme)
 rorocfgtheme.setvisible(false)
 ’
 ’final message to user
 ’
 message = "Average and Accumulated Flow Grids Calculated"
 msgbox.info(message,"FLOW GRID")
 ’
else
 robacfgtheme = gtheme.make(rogridbacf)
 theview.addtheme(robacfgtheme)
 robacfgtheme.setvisible(false)
 ’
 rorocfgtheme = gtheme.make(rogridrocf)
 theview.addtheme(rorocfgtheme)
 rorocfgtheme.setvisible(false)
 ’
’final message to user
 ’
 message = "Average per cell flow grids calculated."
 msgbox.info(message,"FLOW GRID")
end
’
’-----------
’--- End ---
’-----------
’
```

Script:Wtfac.ave

```
’
’
’---------------------------
’--- Creation information ---
’---------------------------
’
’Name: wfacgrid.ave
’Version: 1.0
’Date: 02/17/97
’Author: Ferdi Hellweger
’       Center for Research in Water Resources
’       The University of Texas at Austin
’       ferdi@crwr.utexas.edu
’
’Modified: 02/28/97
’        Ann Quenzer
’        Center for Research in Water Resources
’        The University of Texas at Austin
’        quenzer@mail.utexas.edu
’        1) changed the conversions to reflect project
’        2) changed the message box descriptions to reflect the
script
’        3) computes an integer grid
’        4) added purpose and description
’
’Modified:  09/17/98
’         Patrice A. Melancon
’         Center for Research in Water Resources
’         The University of Texas at Ausitn
’         pmelancon@mail.utexas.edu
’         1) edited the script to be a generic weighted flow
accumulation script
’         New Name:  wtfac.ave
’
’--------------------------
’--- Purpose/Description ---
’--------------------------
’
’Computes a weighted flow accumulation using the specified flow
direction grid.
’The user specifies the grid to be accumulated and a name for the
resultant grid.
’
’---------------
’--- Get view ---
’---------------
’
theview = av.getactivedoc
’
’-----------------
’--- Get themes ---
’-----------------
’
thethemes = theview.getthemes
if (thethemes.count = 0) then
   msgbox.error("No themes found", "WFAC GRID")
   exit
end
thegthemes = list.make
for each thetheme in thethemes
   if (thetheme.getclass.getclassname = "gtheme") then
      thegthemes.add(thetheme)
   end
end
if (thegthemes.count = 0) then
   msgbox.error("No grid themes found", "WFAC GRID")
```

```
    exit
end
fdrtheme = msgbox.listasstring(thegthemes, "Flow direction
theme", "WFAC GRID")
if (fdrtheme = nil) then
    exit
end
ldtheme = msgbox.listasstring(thegthemes, "Pick a grid to
accumulate", "WFAC GRID")
if (ldtheme = nil) then
    exit
end
'
'-----------------
'--- Calculate ---
'-----------------
'
fdrgrid = fdrtheme.getgrid
ldgrid = ldtheme.getgrid
'
cellsize = number.makenull
dummmy = grid.getanalysiscellsize(cellsize)
extent = rect.makenull
dummy = grid.getanalysisextent(extent)
'
facgrid = (fdrgrid.flowaccumulation(ldgrid))
name = msgbox.input("Enter a name for the resultant
grid","WFAC GRID","")
facfilename =
FN.merge(av.getproject.getworkdir.asstring,name)
facgrid.savedataset(facfilename)
facgtheme = gtheme.make(facgrid)
theview.addtheme(facgtheme)
facgtheme.setvisible(false)
'
'final message to user
'
message = "Accumulated grid calculated."
msgbox.info(message,"WFAC GRID")
'
'-----------
'--- End ---
'-----------
'
```

APPENDIX B

USER'S GUIDE

Bacteria project file, bactimodel.apr. Sediment project file, sedimodel.apr.

In general, the two files work exactly the same. Reference will be made to the bactimodel.apr file. Differences for sediment project file will be outlined at the end.

Important – you must set the working directory before running anything.
Important – scripts require the user to name created grids. If a menu item is run more than once in the same project, the user must either give the new grid a new name or change the working directory so that the created grid is saved somewhere else.

**** ArcView does NOT overwrite existing files, so don't forget about proper naming of created grids! If you are not careful, the scripts will attempt to overwrite an existing file and will crash.

Before running any script, check the analysis extent and cellsize. For consistency, use the same as the dem or flow direction grid.

Discharge Analysis

Connect Bays/Rivers (optional step – if already done, add in the connectsink DEM grid) – alters the DEM to force flow to each of the 5 bay segments; script name is connectsink.ave

Requires: Filled DEM (bdemfill grid), baymodel polygon coverage, and bayarc arc coverage
Produces: connectsink grid

Flow Direction (optional – if done, add in flowdir grid) – determines direction of flow; flowdir should reflect the connectsink DEM grid; script name is hydro.direction

Requires: connectsink modified DEM grid
Produces: flowdir grid

Flow Accumulation (optional step – if already done, add in flowacc grid) – determines the accumulation downstream; each cell's value is the number of cells upstream of the cell; script name is hydro.accumulation

Requires: flow direction grid

Produces: flowacc grid

Create Baseflow and Runoff Grids – creates average per cell or accumulated runoff and baseflow grids (accumulated grids are optional). For new run, use new file name or set new working directory; script name is tillflow.ave

Requires: Precipitation grid, land use grid, and flowdir grid
Produces: baseflowcf, runoffcf, accbflow (optional), and accrunoff (optional) – grids

Accumulate Flows (optional step – if you did not already accumulate them). For new run, use new file name or set new working directory; script name is accflow.ave

Requires: PerCell runoff and baseflow grids and flowdir grid
Produces: accbflow and accrunoff - grids

NPS Analysis

Set EMC defaults – Sets EMC values based on landuse. New run overwrites EMC values in the attribute table; script name is bacticoncvalue.ave

Requires: Polygon coverage of landuse; this coverage must be editable (ie, it can not be loaded directly off a CDROM)
Produces: alteration to landuse attribute table to include populated columns for EMC values

Create STP FC grid (optional – if done, add in ptsrcfcgrid to the view) – takes a point coverage of outfalls and converts it to a grid representation. For new run, use new file name or set new working directory; script name is ptsrcfcgrid.ave

Requires: Outfall point coverage with annual FC load in the attribute table (FC load value must be < 1*10^6; divide by some power of 10 if necessary; current values are *10^7; if changed, script will have to be changed to reflect)
Produces: ptsrcfcgrid and ptsrcssgrid

Create Non-Pt Src FC Grids – Creates average per cell and/or accumulated (accumulated grids are optional) bacti grids associated with runoff and baseflow. For new run, use new file name or set new working directory; script name is bactigrid.ave

Requires: runoff grid, baseflow grid, landuse coverage with EMC values set, flow direction grid (for accumulated grid calculation), and point source grid
Produces: bactimodel – bfbactigrid, robactigrid, raccbgrid (optional), and baccbgrid (optional); sedimodel – bfsedigrid, rosedigrid, baccsgrid (optional), and raccsgrid (optional)

BMP Effects – Creates a new runoff bacti grid to account for BMP reductions of load associated with CAFO land and rural residential lands. Option to conduct flow accumulation of new grid. Additional option to run flow accumulation on the baseflow bacti grid if that was not done in the Bacti Grid step. For new run, use new file name or set new working directory; script name is bactibmpeffect.ave

Requires: average bacti grid associated with runoff and baseflow, land use grid, and flow direction grid (for accumulated grid calculation)
Produces: bactimodel – bmpbactiload and accbmpbacti (optional); sedimodel – bmpsediload and accbmpsedim (optional)

BMP Bay Reduction – This tool allows the user to see the percent reduction in each of the bay segments that result from non-located BMP implementation. Picks value off the accumulated load grids, calculates a pre and post total load, and the percent reduction for each bay segment. These values are written to a .dbf file and a table of the results is created; script name is bayreduction.ave

Requires: bay polygon theme, accumulated pre-BMP runoff load, accumulated post-BMP runoff load, and accumulated baseflow load.
Produces: table in ArcView with reductions realized for each of the bay segments

Pick Point Values – Picks off values of accumulated runoff and baseflow bacteria load, accumulated runoff and baseflow, and calculates a concentrations associated with runoff and baseflow. These values are written to a .dbf file and a table of the results is created; script name is pickbactisep.ave

Requires: point coverage of interest, accumulated bacti grids for runoff and baseflow, and accumulated flow grids for runoff and baseflow
Produces: table in ArcView with flow, load, and concentration values for points of interest

Pick Bay Values – Picks the accumulated value of a selected grid (flow or bacti) for each segment of the modeled bay. The user is asked to select two identifiers (there are two segments called 'main bay') – one should be the segment name, the second the growing management. The user is also asked to name the new column that will contain the results of the query. The values are written to a .dbf file and a table of the results is created. This script only queries one value grid, so if more than one value grid is of interest, the script should be run multiple times; script name is pickbayvalue.ave

> Requires: an accumulated value grid and the modeled bay segment polygon coverage (baymodel)
> Produces: table in ArcView with value of grid of interest for each bay segment

Predicted Concentration Grid – The script adds the accumulated loads grid to the average load grids, adds the accumulated flow grids to the average flow grids, and then adds loads and flows from baseflow to runoff for total load and flow values. It then divides the resultant total load by the resultant total flow with an appropriate conversion factor to produce a concentration grid for the watershed in fc/100ml. Script name is bactipredconc.ave

> Requires: accumulated and average load AND flow grids for BOTH baseflow and runoff
> Produces: bmpbactipredconc or bmpsediconc

Misc Tools

Clip A Grid to a Polygon – allows you to clip a grid to the specific extent of a polygon coverage; script name is gridclip.ave.

> Requires: a polygon coverage and a grid to be clipped; new grid is temporary, so must be saved using Theme/Save Dataset

Generic Wt'd Flow Accumulation – works the same as normal flow accumulation except that instead of just counting the number of cells upstream, it adds up the values in a specified weight grid of all the cells upstream of any given cell; script name is wtfac.ave.

> Requires: Flow direction grid and a weight grid
> Produces: An accumulated grid

Profiler with Points - will take a selected stream segment (must be a polyline), divide that segment into a user specified number of evenly spaced sub-lengths and then create a table with the distance along the length and the concentration at each division point. In addition, allows the user to specify points of interest to determine concentrations for in addition to the sub-length points. The user must select one segment from the polyline coverage, and one or more points from the point coverage. The point, polyline, and grid of interest themes must all be active when the tool is selected (use the shift key to select more than one theme). The must also appear in the legend frame in that specific order: point, line, then grid; script name is profilerwithpoints.ave.

> Requires: point coverage, polyline coverage of rivers/streams, and predicted concentration grid; in the View, the point coverage must be above the polyline coverage which must be above the grid.
> Produces: a .dbf file of distance and concentration that can be opened in Excel to produce graphs of concentration profiles

Profiler – works the same as profiler with points, but uses on the line coverage, not the point coverage; script name is profiler.ave.

Located BMP Tool 

This tool allows the user to calculate the effect of placing a located BMP (eg, detention pond) at a point in the watershed. The user will interactively locate the point of the BMP with the mouse/cursor. The user will input the effectiveness of the located BMP. The script will return a message box with the predicted concentration before and after implementation of the BMP; script called locatedbmp.ave.

> Requires: accumulated runoff load grid and accumulated runoff flow grid; the version for sediment also requires the accumulated supplemental sediment load

Differences for Sediment Project File

NPS Analysis/Supplemental Load Grid – this grid creates an accumulated sediment load grid to account for inputs other than those based strictly on land use (ef, channel processes). Creates a virtual concentration grid based on a relationship with the flow accumulation (representing the drainage area) which is then multiplied by the sum of accumulated runoff and accumulated baseflow; script called dasedigrid.ave.

> Requires: accumulated runoff and accumulated baseflow grids and the flow accumulation grid
> Produces: chaccsgrid (accumulated supplemental sediment load grid)

NPS Analysis/Predicted Concentration Grid – in addition to the grids required for the bacteria project run, this also requires the accumulated supplemental load grid.

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APPENDIX C
TUTORIAL EXERCISE

Water Quality Loading in Tillamook Bay

Center for Research in Water Resources

The University of Texas at Austin

Prepared by: Patrice Melancon and David R. Maidment

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5 February 1999

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Goals of the Exercise

This exercise is based on an exercise written for the Corpus Christi Bay National Estuary Project by Ann Quenzer. Tillamook Bay is also part of the EPA's National Estuary Program. This exercise has taken the Corpus Christi Bay framework and utilized data for

Tillamook Bay to calculate annual loadings of fecal coliforms and suspended sediment. It has also incorporated further work done specific to the TBNEP goals.

The purpose of this exercise is to show how Arcview 3.1 with Spatial Analyst (v 1.1) and the Hydrology Extensions can be used to provide estimates of nonpoint source pollutant loads to a receiving body of water. This exercise also incorporates point sources. For this exercise, the receiving water is Tillamook Bay on the northern coast of Oregon. The Miami, Kilchis, Wilson, Trask, and Tillamook are the five major rivers that drain into Tillamook Bay.

You will use a coverage of land uses in the Tillamook Bay watershed and associate Estimated Mean Concentration (EMC) values of various pollutant constituents with those land uses. These EMC values describe average concentration of pollutants in baseflow and surface runoff for a given land use. Then you will create an EMC grid and multiply it by a grid of average annual total flow in the basin. The result will be the annual loading of the constituent to each grid cell in the basin, i.e. Load = Flow * Concentration, or L (Mass/Time) = Q (Volume/Time) * C (Mass/Volume).

Best Management Practices (BMPs) are incorporated and accounted for in the model. There are 3 non-located BMPs that apply to CAFO dairy lands and one BMP that applies to rural residential lands. In addition, there is a tool that will allow the user to determine the effect of a located BMP placed in the watershed.

Finally, you'll perform a flow accumulation on the cell-based loads to determine average annual loads to the rivers and the bay. You will also explore how those loads change as you follow a river from it's headwaters to the mouth to the bay.

Computer and Data Requirements

This exercise makes use of ArcView 3.1 using the Spatial Analyst and the Hydrology Extensions. The necessary avenue scripts are contained within the project file.

Note that the landuse coverage and baymodel coverage cannot be used directly from the CDROM - they will need to be imported (from the landuse.e00 and baymodel.e00 export files) to your workspace.

Be sure to get or import all of the following files:

- **Baymodel** (polygon coverage of bay segments) - you will need to import this one to your working directory! Don't use the one on the CDROM.
- **Bayarc** (arc coverage of bay segments)
- **Bdemfill** (grid of the burned in DEM that has been filled with the Hydrology/Fill function)

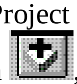
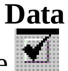
- **Landuse** (coverage of land use in the Tillamook Bay watershed) - you will need to import this one to your working directory! Don't use the one on the CDROM.
- **Outfalls** (point coverage of point source outfall locations)
- **Mouth** (point coverage of the river mouths)
- **Ensstormpts** (point coverage of monitoring points)
- **Lulccomposite** (grid representation of land use)
- **Profriver.shp** (shapefile of the 5 major rivers) ** there are 3 files that you need - .shx, .shp, and .dbf
- **Precip** (grid of precipitation)
- **bactimodel.apr** (the project file for the exercise)
- **landuse.avl** (legend editor color scheme for land use data)

This exercise is rather memory intensive because it creates quite a few grids.

Assignment Procedure

Start ArcView and open the project **bactimodel.apr**. The first thing that you need to do is set the work directory for the project - a message box will pop up to remind you to do this. Go to the project window and select **Project/Properties**. In the box called **Work Directory**, set the path to your working directory. This is ***very important*** so that the grids/coverages that you will be creating will be saved in the right place. Also, if the project is run more than once on the same computer, you will need to either create a new working directory and set the project/properties to reflect that, or you will need to change the names of the created grids. For each created grid, you will be presented with a default name that can be changed. Click on **File/Extensions** and check that the **Spatial Analyst** and **Hydrologic Modeling** are turned on. Also, you should save the .apr file to your local working directory now (after setting the work directory), and work from there throughout the exercise. You may want to periodically save the project as you work just in case ArcView crashes; that way you won't have to start all over. Also, did you remember to import the landuse and baymodel coverages? These coverages have to be imported to your working directory because the scripts actually edit the attribute table.

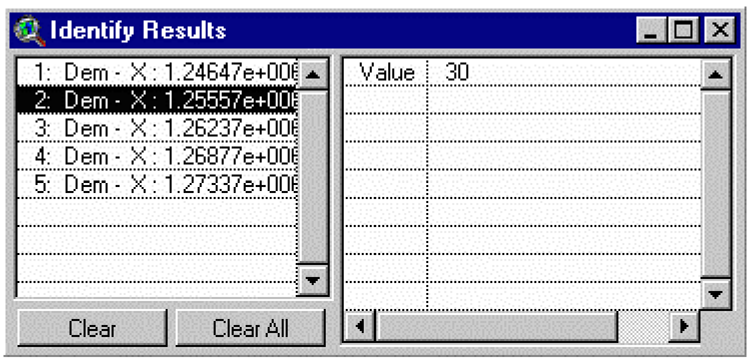
1. Getting Acquainted with the Basin DEM

Go to the Project Window and Open View 1. Add the **Bdemfill** grid to the view by clicking on , change the Data Source Type to **Grid Data Source**, highlight **bdemfill**, and click **OK**. Once the theme has been added, check the  box next to the theme to view the DEM of the area. The Bdemfill grid is a specially modified DEM of the region that has the land surface cells not on the stream raised by 2000 ft from their original elevation so that the cells on the stream will be clearly defined and coincident with the mapped streams of the Tillamook Bay basin. This has the effect of "burning in" the stream paths into the DEM. In this case, the stream paths have included the bay segments in the burn in process. Refer to the project report on Modeling the Hydrology of Tillamook Bay for more detail.

At any time in the exercise you may hide the legend of any theme by making the theme active and going to **Theme/Hide/Show Legend**.

Take a look at the DEM. Zoom in to the area around the bay on the center left region of the grid. Let's take a look at some of the cell elevations within the grid. Make the **Bdemfill** theme active by clicking on its display in the Legend bar of the View window. Click on the identify tool .

Go to the view and click on some points on the grid. Remember that most of the cell elevations have been artificially raised as part of the burning in process. These values are land surface elevations in feet above mean sea level.



Let's take a look at the properties of this grid. With the grid **bdemfill** theme active, choose **Theme/Properties**. Information is presented on grid cell-size, number of rows and number of columns. The parameters of this projection are defined by the Oregon Lambert projection; units are feet. For further details about the parameters of this projection, see http://osu.orst.edu/dept/tbaynep/maps.html

2. Using the Project File

There are 3 Menu Bar groups that will be used. They are "Discharge Analysis," "NPS Analysis," and "Misc Tools." You will work through these in a sequential fashion. Let's start with the Discharge Analysis group.

You should already have the **bdemfill** grid in the View. In a later part of this exercise, we will be determining pollutant loads and conducting weighted flow accumulations to collect these loads in the rivers and subsequently into the bay. To be able to do this, we need to connect the rivers and the bay segments hydrologically in the model. This is accomplished by altering the **bdemfill** grid. This grid currently reflects the fact that the elevations of the land in the bay are below sea level, and thus lower than the surrounding land. However, in order to model the accumulation of pollutants into the 5 different segments of the bay, we need to artificially create a large sink in each of the bay segments at the segment's centroid. If we did not create these sinks, the flow would follow the naturally developed channels from the uppermost segment out to the ocean. For this exercise, we will not look at flow within the bay or between bay segments; we will merely focus on what is delivered to each bay segment.

Add the **bayarc** theme and the **baymodel** (polygon) theme - **Remember to add baymodel from your working directory**. Go to **Analysis/Properties** and check that the Analysis Extent and Cell Size are set to "Same as **bdemfill**." Go to the **Discharge Analysis** pull down menu and select "**Connect Bay/Rivers**." Once the program is running, it will ask you to specify the bay polygon theme, the bay arc theme, and the filled DEM. It will also ask if you would like to save the temporary data sets. Do not save these files - they are not needed and they take up a lot of file space. This step takes a while to run, so please be patient. Get up and stretch your legs for a minute, say hello to your neighbor! A new grid is calculated called **connectsink**.

Next a flow direction must be computed on the **connectsink** grid. Make the **connectsink** theme active. Go to **Analysis/Properties** and check that the Analysis Extent and Cell Size are set to "Same as **bdemfill**." Go to the **Discharge Analysis** pull down menu and select "**Flow Direction**." This will compute the flow direction grid that will be used later on in the exercise. This flow direction grid is a temporary grid, so if you want to keep it, use **Theme/Save Dataset** and give it a name (maybe flowdir). Each bay segment has a centroid identified by the black dot. The flow directions are set so that the water and pollutant loads, once they enter a bay segment, migrate to the centroid where they can be measured easily. Next, go the the **Discharge Analysis** menu and select **"Flow Accumulation."** This step will create a grid that describes the number of cells upstream of any given cell.

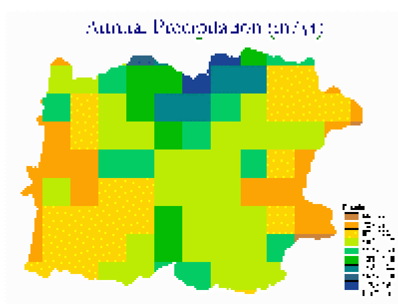
The segments of Tillamook Bay shown in this exercise were set in order to manage the oyster fisheries in the bay. In the most inland segments, no oyster fishing is permitted because the runoff waters into the bay are too polluted by bacteria from dairy waste and other runoff. In the segments nearer the ocean, oyster fishing is permitted except when the Tillamook rivers are in flood, in which case oyster fishing is prohibited. One of the objectives of the research on which this exercise is based is to examine more precisely how large the bacteria loads are and how they can be reduced by better waste management.

The next step in the **Discharge Analysis** menu is the **"Create Baseflow and Runoff Grids."** You will actually do that step in a bit. First, let's examine the model representation of precipitation.

3. Annual Precipitation in the Basin

Tillamook Bay is located on the coast of Oregon in the rainy Pacific Northwest. The basin has quite a lot of mountainous land. The basin averages between 90 inches/yr of rain in the flat, lowlands and upwards of 150 inches/yr of rain in the forested areas at higher elevations. The USDA Natural Resources Conservation Service and Oregon State University are publishing annual and monthly precipitation grids of the United States, developed using an interpolation process called PRISM, and verified by consultation with State climatologists. The grid is an annual long term average of precipitation and is based on data from 1961-1990. The original precipitation data are presented in mm/yr. The data presented in this exercise have been converted to in/yr. In this exercise, you will use the portion of this annual precipitation grid for the Tillamook Bay basin.

Using the button, add the grid **precip** (remember to change to grid data source). When the theme shows up in the legend of the view, double click on the **precip** symbol to bring up the Legend Editor window. In the Legend Editor, change the color scheme to get a ramped effect. Click on the arrow next to the Color Ramps box, scroll down, and select the **Precipitation** color scheme or another color scheme to your liking (you may want to make the NoData cells transparent). When you are finished, select Apply in the Legend Editor window and then close the Legend Editor. Finally, select for the **precip** theme in the View Legend. You should be able to easily see the distribution of average precipitation in the Tillamook Bay Basin.



Save your project so that if ArcView crashes, you won't have to recreate everything.

Use the identify tool to check out some values of precipitation in the basin. Note that the units of these values are in in/yr. With the **precip** theme highlighted, use **Theme/Properties** to check out cell size, number of cells, etc.

4. Create the Surface Runoff and Baseflow Grids

Mathematical relationships have been determined between average precipitation and baseflow and surface runoff in the basin. These relationships are based on a calculated longterm average precipitation grid, daily rainfall data at the Tillamook 1W raingage (near the city of Tillamook), and daily flow data from the Wilson River USGS flow gage which is located up from the bay in the forested area. For details on how these relationships were derived, please see the report "Modeling the Hydrology of Tillamook Bay."

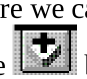
The rainfall/discharge relationships are:

Q(r) = 0.3763(P) – 15.478 For Surface Runoff (in/yr)

Q(b) = 0.5188(P) + 1.857 For Baseflow (in/yr)

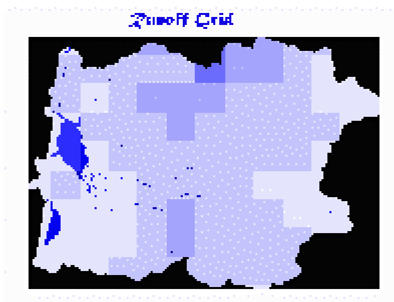
Q = Q(r) + Q(b)

Where Q = total runoff (in/yr) and P = average precipitation (in/yr)

An Avenue script has been written to calculate the two components of streamflow and convert them to units of cubic feet/yr for the Tillamook Bay Basin. The script inserts the **precip** grid into the rainfall/discharge equations to calculate discharge grids, one for surface runoff and one for baseflow. This script looks at a grid of the land use and checks the value of that grid to determine which parcels of land are water. For areas that are water, there is no baseflow component, so Q(b) is set to zero, and all of the precipitation is transformed into surface runoff, so Q(r) = P. So, before we can run the script, we need to add in the grid of the land use for the basin. Using the  button, add the **lulccomposite** grid (remember to change to grid data source). This grid was created from a larger land use/land cover coverage that can be downloaded from an EPA website or a USGS website. This is discussed in more detail in Section 5 of this exercise.

There is a pre-prepared color scheme that was developed for land use that we will use for this grid. Double click on the **lulccomposite** symbol to bring up the **Legend Editor**, click on **load**, and select **landuse.avl**. A dialog box will pop up and ask for a Field - select "value." Now select the  button to turn on the **lulccomposite** theme in your view.

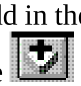
You are now going to calculate the flow grids. Before you do this, go to **Analysis/Properties** and set the Analysis Extent to "Same as bdemfill" and Analysis Cell Size to "Same As bdemfill." Go to the drop down menu called **Discharge Analysis** and select "**Create Baseflow and Runoff Grids"**. You will be asked to select the theme within the view which will be used as the precipitation input (**precip**) and the land use grid (**lulccomposite**). The grids are calculated, saved in the working directory and added to the view as "baseflowcf" and "runoffcf." You are also given the option to run weighted flow accumulations on both grids now. These accumulated flow grids will be required later on, so they will need to be calculated eventually. However, if you decide not to run the weighted flow accumulations at the current time, they can be run later on using **Discharge Analysis/Accumulate Flows.** The flow grids will be displayed in the view. Feel free the change the color scheme using the Legend Editor. Here is what the surface runoff grid should look like:

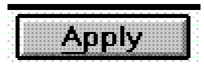


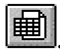
5. Linking Land Use to Estimated Mean Concentration (EMC) of Pollutants

Now you are going to associate EMC values of various pollutant constituents to the land use types. For this exercise, we will focus on fecal coliform bacteria. This method of determining pollutant concentrations based on the land use type is fairly common in nopoint source pollution control. The expected levels of bacteria for various land use types have been taken from various literature sources or from monitoring data. The fecal coliform concentration associated with diary operations (land use # 23 - CAFO) has been based on information found in a 1983 ASAE publication on Bacterial Pollution (Crane, et al, 1983).

The **landuse** coverage uses the Anderson Land Use Code classification system, in which major land use types are broken out into 9 categories. Seven of these 9 categories show up in the Tillamook Bay land use coverage. The landuse coverage was created from a larger land use/land cover coverage. Files for the state of Oregon based on 1:250,000 map sheet names can be downloaded from the USGS Land Use/Land Cover site. The Vancouver dataset is the one used in this study. These files are in UTM coordinates and have been converted to the Oregon Lambert Projection. Land Use data are also available from the EPA Geographic Information Retrieval and Analysis System (GIRAS) ftp site: ftp.epa.gov:/pub/EPAGIRAS/wgiras. You can access this site using any FTP program. The file 'lva45122.e00.gz' is the quad sheet that contains Tillamook County. The file was in Albers projection and was re-projected to the Oregon Lambert projection. The larger coverage was converted to a grid and clipped down to the extent of the study area. The clipped land use/land cover coverage was modified to incorporate two non-standard land use classifications (rural residential and rural industrial) that the TBNEP office is using. The clipped land use grid was also modified based on additional data from a more detailed representation of land use and development in the lowland areas.

Add in the **landuse** coverage (**remember to add from your working directory)** by using the  button (remember to set the data source type to 'feature data source'). Again, use the pre-developed color scheme for the landuse data. Double click on the **landuse** symbol to bring up the Legend Editor, click on **load**, and select **landuse.avl**. When it asks for

Field, select "grid code." Click on the 

button and then close the Legend Editor. Now select  for the **landuse** theme in your view and note where all the different land use categories in the basin are. Open the attribute table using the table button . Notice there are no concentration values here yet.

A script has been written to allow the user to either accept default concentration values or update them to reflect more current data. The EMC values for fecal coliform are in units of fc/100ml. Extra fields are written to the attribute table of the landuse coverage and populated based on the land use code (grid code). Go to the **NPS Analysis** pull down menu and select "**Set EMCs**." The script will ask you to select the land use coverage - select **landuse**. You may also be prompted to add fields for baseflow and runoff fecal coliform concentrations. If you are prompted, select "**yes**" in both cases. Use "Gridcode" as the attribute field which indicates land use type. Once the script has finished running, it will pull up a table that you can examine to see the EMC values.

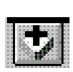
Here are the EMC values for Fecal Coliform in number of bacteria per 100ml:

Land Use Type	**Baseflow**	**Runoff**
11-17 Urban	100	10000
18 Rural Residential	100	10000
19 Rural Industrial	100	10000
21,22,24 Various Agricultural land	100	1500
23 CAFO Dairy Lands	1000	30000
31- 43 Forest and range	5	20
51 - 62 Water, wetlands	0	0
72-75 Barren	5	20

Notice that the numbers are higher for runoff than for baseflow and that by far the highest numbers are for runoff from CAFO Dairy Lands. These values have been taken from the literature and are concentration values. Now we'll multiply them by the volume of water flow to get pollutant loads.

6. Estimating Annual Loadings

We will now use the land use coverage to create per cell load grids as well as accumulated grids of fecal coliform bacteria in baseflow and surface runoff. The script that does this also incorporates a point source grid of Sewage Treatment Plant outfalls. So, you will need to create the point source grid theme first.

Using the  button, add in the **outfalls** coverage. If you open the attribute table with the  button, you will see fields for annual FC load and annual SS (for sediment) load.

Go to the **NPS Analysis** pull down menu and select **"Create Pt Src FC Grid."** You will be prompted with input boxes to identify the point source point coverage and the load field. The script will run and will add the grid to the view. If you turn on the **ptsrcfcgrid** grid, you will basically see a large square that is all one color with a value of zero. This is because the each of the 6 outfall loads have been assigned to one individual grid cell with all of the rest being assigned a value of zero. This point source grid is added to the runoff load. If you add in the **outfalls** coverage, you can see where to zoom in to see the individual grid cells that actually have a value other than zero. Note that these values are *10^7 fc/yr. Yes, that is a quirky unit to use, but that's what was needed to be able to convert the point coverage into a grid. The script that is invoked takes the units into account, so you don't have to worry about that.

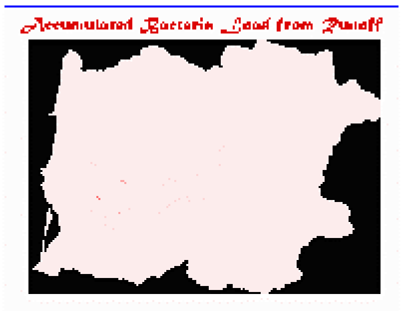
Be sure that you still have the **flow direction** grid, **baseflowcf** grid, and **runoffcf** grids in the view. Go to **Analysis/Properties** and check that the Analysis Extent and Cell Size are set to "Same as **bdemfill**." Then go to the **NPS Analysis** pull down menu and select "**Create Non-Pt Src FC Grids**." There will be a series of dialog boxes to fill in - they are self explanatory. Remember that the average flow grids are the per cell grids (baseflowcf and runoffcf) that were created in the **Flow Grids** step. The bactigrid.ave script takes the land use coverage and creates two virtual grids (these are temporary grids that don't ever actually get saved) from the attribute table - one is a grid that has the baseflow EMC numbers as the cell value; the other grid has the runoff EMC numbers as the cell value. These grids are multiplied by the baseflowcf and runoffcf flow grids, respectively, employing a conversion factor of 283 to get load grids in fecal coliform per year (fc/yr). The contribution from the point sources is added in to the runoff load grid. These per cell load grids are named **bfbactigrid** (for baseflow) and **robactigrid** (for runoff). In effect, for each cell, the load is computed as

Load = Flow * Concentration

For bacteria loads, concentration is in fc/100ml and flow is in cf/yr.

Once these grids are calculated, the user is prompted for whether or not flow accumulations should be calculated. Go ahead and select yes. These flow accumulations are actually weighted flow accumulations. Rather than just counting the number of cells upstream of a particular point, a weighted flow accumulation will add up the values in the designated weight grid for all cells upstream of any given point. The accumulated load grids are named **baccbgrid** (for baseflow) and **raccbgrid** (for runoff). Both grids will be added to the view. If you had selected not to accomplish flow accumulations, the per cell load grids would have been added to the view. Again, this step takes a little while to run, so it's time for another leg stretch. There is also a tool in the **Misc Tools** drop down menu that is a generic weighted flow accumulation tool. This tool can be used to calculate a weighted flow accumulation on any grid of interest.

The accumulated grid of bacteria associated with surface runoff should look like this:



This is not a very exciting graphic to look at, but if you will notice the darker areas that indicate the larger loads correspond to the locations of the rivers.

7. Accounting for BMPs

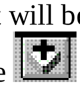
There a 4 non-located BMPs that will be accounted for in the model. They are as follows:

- Proper Manure Storage and Handling - applies to CAFO dairy lands
- Proper Manure Application - applies to CAFO dairy lands
- Presence of Riparian Area/Fencing - applies to CAFO dairy lands
- Proper functioning Septic Systems - applies to rural residential lands

Make sure that you still have the **bfbactigrid, robactigrid, lulccomposite**, and flow direction grids in the View. Under the **NPS Analysis** menu bar, select **"BMP Effects."** You will be prompted with input boxes to identify the required grids, and then you will be presented an input box to enter vales for the effectiveness and level of implementation of the CAFO related BMPs. Next, you will be presented with an input box for the percent of septic systems that are estimated to be failing. After naming the resultant grid (the default is bmpbactiload), you will be asked if you would like to conduct a weighted flow accumulation of the new runoff load grid. Go ahead and do this. The default name for the new accumulated grid is accbmpbacti. You will also be offered the option to flow accumulate the baseflow load grid if you haven't already done that.

There is a tool available that allows you to examine what the effect would be of installing a located BMP such as a detention pond or created wetland. This tool runs using the  button. You will identify the location of the located BMP using the mouse/ cursor. You will then be asked to identify a series of grids. The result is a message box indicating the predicted concentration before and after implementation of the BMP. This tool requires the accumulated load (**accbmpbacti**) and accumulated flow (**accrunoff**) associated with runoff. You may want to add in the **streamgrid** as a reference for selecting a location for the BMP. Click on the View, then click on the  button, and use the mouse to click on the location of the BMP.

8. Picking off values

The other two menu items on the **NPS Analysis** menu are both for picking values off of grids. The first one, **Pick Point Values**, allows the user to specify a point coverage of interest and then query grids to get the accumulated load and flow as well as resultant concentration for runoff and baseflow. This item requires that the user identify the accumulated load grids (for runoff and baseflow) as well as the accumulated flow grids (again, runoff and baseflow). You will also be asked to select an identifier from the point coverage attribute table that will be carried over to the results table which is written to a separate .dfb file. Using the  button, add in the **mouths** coverage. You will use this as the point coverage of interest. Go to **NPS Analysis/Pick Point Values**, and identify the required themes. When asked for an identifier field, you can use either "River" or "Watershed." You will also need to name the resultant .dbf file – remember to go to your working directory if for some reason it doesn't default to it.

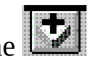
The second menu item, **Pick Bay Values**, allows you to pick off values for each of the 5 bay segments. This item requires the baymodel coverage and the grid that you are interested in querying. This grid of interest should be an accumulated grid (ie, baccbgrid or accrunoff). You will be prompted for a new field name where the results will be stored, as well as two identifiers to be carried over to the results table which is written to a separate .dbf file. You can use the "Segment Name" as the primary field and "Growing Mgmt" as the secondary field.

9. Concentration Profiles

One of the tools in the **Misc Tools** menu allows us to examine how the concentration of a pollutant varies from the headwaters to the mouth of a river. Before we do that, we need to calculate a grid of predicted concentration. And, we need accumulated flow grids to do this. If you didn't accumulate the flow grids earlier, you will need to do that now using the **Discharge Analysis/Accumulate Flows** function. So, check your **Analysis/Properties** to make sure that things are set to "Same as **bdemfill**." Next, we will take the load grids and the flow grids and divide the two with an appropriate conversion factor to come up with a grid of predicted concentrations in fc/100ml for the entire basin. This step requires quite a number of input grids:

- Accbmpbacti (accumulated runoff load grid that has BMPs accounted for)
- Robactigrid (average per cell runoff load grid)
- Accrunoff (accumulated runoff)
- Runoffcf (average per cell runoff)
- Baccbgrid (accumulated baseflow load grid)
- Bfbactigrid (average per cell runoff)
- Accbflow (accumulated baseflow)
- Baseflowcf (average per cell baseflow)

Go to the pull down menu and select **Concentration Grid**. The dialog boxes are self-explanatory. The user will be prompted for a name for the resultant grid, and it will be added to the view.

Now we will look at how the concentration varies along the length of the Wilson River. We will also determine the concentration at a couple of reference points using the **ensstormpts** point coverage. Using the  button, add in the profriver.shp shapefile and the **ensstormpts** coverage. Using the select tool , select the Wilson River line segment and the points from **ensstormpts** that are on the Wilson River (use the shift key to select more than one theme. The point theme should be above the line theme which is above the concentration grid. Make sure that the point theme, the **profriver.shp,** and the concnetration grid themes are active. Go to the **Misc Tools** pull down menu and select "**Profiler with Points**."

A dialog box will give you the total length in units (which are actually feet in our case) and ask you for the number of segments that you would like the length divided into for the analysis. You can divide it into as many segments as you feel is appropriate to get a feel for how the concentration changes - probably about 100. Hit **OK** and give the file a name (preferably somewhere in your working directory, and one that makes sense to you) to save to. You will get a message saying that there are too many segments to plot in ArcView, so take the .dbf file that you saved and open it in excel and create a nice graphic of how concentration changes along the length of the river. If you look at the headings of the columns in excel, you will see that the profile script named the value of interest (in our case, the predicted concentration) "elevation" by default. You should change this header to something more appropriate in excel. Also, you will notice that the points from the selected point coverage are singled out as feature values - these can be used for reference comparison with monitoring data.

10. Differences in the 'sedimodel.apr' Project File

The sedimodel.apr project file is set up to deal with sediment loads and the resulting concentrations. Loads are calculated in tons/yr and concentrations are calculated in mg/L. Appropriate conversion factors are written into the scripts.

The other difference is that the sediment model has an extra step in the **NPS Analysis** menu to create a supplemental load grid. This additional step is called **"Supplemental Load Grid."** The loads and concentrations predicted by the model accounting only for contribution from land use are very low compared to sampling data. The average reported concentrations exhibit a trend increasing with increasing drainage area. The predicted concentrations based strictly on land use do not show a trend with drainage area; in fact, the predicted concentrations are almost the same for all 5 rivers and average about 12 mg/L. There must be another contribution to the sediment load grid. This supplemental contribution may be related to channel processes. A supplemental accumulated load grid is created based on linear regression of the reported concentrations with the drainage area (which is represented by the **flowacc** grid) subtracting out the contribution from land use. Assuming that this supplemental load is related to channel processes, an accumulated supplemental load is only calculated for those cells coincident with the modeled stream network. The **flowacc** grid is queried for those cells with a value > 1000 (the threshold used to define a stream in the model) and the following equation is used to create a virtual grid of supplemental concentration:

SC = (0.000379 * FAC) + 9.2
where SC = supplemental concentration and FAC = flow accumulation value

This virtual grid is multiplied by the total accumulated flow to produce a grid of supplemental accumulated sediment load.

To run this step, you need to have the **flowacc** grid, the **accbflow**, and **accrunoff** grids in the View. Select **NPS Analysis/Supplemental Load Grid**, identify the required grids, and let it calculate. The new grid is an accumulated grid and is named **chaccsgrid** by default.

The other differences are that the **NPS Analysis/Predicted Concentration Grid** menu item and the Located BMP tool (the  button) will ask for the accumulated supplemental load grid in the runs.

References:

[1] Crane, S.R., Moore, J.A., Grismer, M.E., and Miner, J.R. 1983. "Bacterial Pollution from Agricultural Sources: A Review." *Transactions of the ASAE*. pp. 858-872.

APPENDIX D
METADATA

Accbflow
Accbmpbacti
Accbmpsedim
Accprecip
Accrunoff
Avgprecip
Baccbgrid
Baccsgrid
Baseflowcf
Bathdem
Bathgrclip
Bayarc
Baymodel
Baywater1
Bdemfill
Bfbactigrid
Bfsedigrid
Bmpbacticonc
Bmpbactiload
Bmpsediconc
Bmpsediload
Burndem
Chaccsgrid
Connectsink
Demarea
Eandspts
Ensstormpts
Epariverpts
Fldplnwspts
Flowacc
Flowdir
Kilchis
Kilchislu
Landuse
Lulcarea
Lulccomposite
Miami
Miamilu
Mjrsubwspts
Mouth
Outfalls
Precip
Profriver
Ptsrcfcgrid
Ptsrcssgrid
Raccbgrid
Raccsgrid
Raingage
River
Rivbasin
Riverbasin
Robactigrid
Rosedigrid
Runoffcf
Streamgrid
Subbasin
Subriver
Subwsheds
Tccasample
Tillamook
Tillamooklu
Tillbuf2k
Trask
Trasklu
Usgsgage
Usgspoly
Usgsriv
Usgswsheds
Wilson
Wilsonlu

DATA SET IDENTIFICATION:

Data File Name:	Accbflow
Description:	Grid format representation of accumulated baseflow throughout the watershed
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid
Scale:	Cell Size = 100 ft
Export File Size:	34.8 MB
Extent of Coverage:	Tillamook Bay watershed Xmin = 414253.5 Ymin = 1316609.125 Xmax = 599253.5 Ymax = 1450209.125 # of Rows = 1336 # of Columns = 1850
Quality/Limitations:	This grid is based on the baseflowcf grid and the flow direction grid for the watershed (flowdir).
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Data Type	Floating Point
Value	Accumulated baseflow, cubic feet/yr Range: 0 to 58.3 x 10^9

SOURCE INFORMATION:

Data Source:	Baseflowcf grid, representing the average baseflow in each grid cell.
Methods:	Created by calculating a weighted flow accumulation with the baseflowcf grid as the weight grid.
Organization:	See Provider Information

Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Accbmpbacti
Description:	Grid format representation of accumulated bacteria load generated in runoff throughout the watershed after the implementation of BMPs
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid
Scale:	Cell Size = 100 ft
Export File Size:	34.8 MB
Extent of Coverage:	Tillamook Bay watershed Xmin = 414253.5 Ymin = 1316609.125 Xmax = 599253.5 Ymax = 1450209.125 # of Rows = 1336 # of Columns = 1850
Quality/Limitations:	This grid is based on the bmpbactiload (representing annual bacteria load in the study area after the implementation of BMPs).
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Data Type	Floating Point
Value	Accumulated annual bacteria load, fecal coliform/yr Range: 0 to 5,152,867,149,152,256

SOURCE INFORMATION:

Data Source:	Derived from the bmpbactiload, representing the average annual bacteria load in each grid cell after accounting for reductions realized by the implementation of BMPs.
Methods:	Created by running the 'bactibmpeffects.ave' script and using the optional weighted flow accumulation using the bmpbactiload as the weight grid.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Accbmpsedim
Description:	Grid format representation of accumulated sediment load generated in runoff throughout the watershed after the implementation of BMPs
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid
Scale:	Cell Size = 100 ft
Export File Size:	34.8 MB
Extent of Coverage:	Tillamook Bay watershed Xmin = 414253.5 Ymin = 1316609.125 Xmax = 599253.5 Ymax = 1450209.125 # of Rows = 1336 # of Columns = 1850
Quality/Limitations:	This grid is based on the bmpsediload (representing annual sediment load in the study area after the implementation of BMPs).

Positional Accuracy:

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Data Type	Floating Point
Value	Accumulated annual sediment load, tons/yr Range: 0 to 22,589.523

SOURCE INFORMATION:

Data Source:	Derived from the bmpsediload, representing the average annual sediment load in each grid cell after accounting for reductions realized by the implementation of BMPs.
Methods:	Created by running the 'sedibmpeffects.ave' script and using the optional weighted flow accumulation using the bmpsediload as the weight grid.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Accprecip
Description:	Grid format representation of accumulated precipitation for each grid cell throughout the watershed
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid
Scale:	Cell Size = 100 ft
Export File Size:	34.8 MB
Extent of Coverage:	Tillamook Bay watershed Xmin = 414253.5 Ymin = 1316609.125 Xmax = 599253.5 Ymax = 1450209.125 # of Rows = 1336 # of Columns = 1850
Quality/Limitations:	This grid is based on the precip grid which was obtained from the Oregon State University PRISM website and the flow direction grid for the watershed (flowdir).
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Data Type	Floating Point
Value	Accumulated precipitation, inches/yr Range: 0 to 131.7M

SOURCE INFORMATION:

Data Source:	Oregon State University PRISM program
Methods:	This grid was calculated by a weighted flow accumulation using the precip grid as the weight grid and the flowdir grid as the flow direction grid.
Organization:	Oregon State University
Contact:	
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name: Accrunoff

Description:	Grid format representation of accumulated surface runoff throughout the watershed
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:	
Feature Type:	Grid
Scale:	Cell Size = 100 ft
Export File Size:	34.8 MB
Extent of Coverage:	Tillamook Bay watershed Xmin = 414253.5 Ymin = 1316609.125 Xmax = 599253.5 Ymax = 1450209.125 # of Rows = 1336 # of Columns = 1850
Quality/Limitations:	This grid is based on the runoffcf grid and the flow direction grid for the watershed (flowdir).
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:	
Data Type	Floating Point
Value	Accumulated runoff, cubic feet/yr Range: 0 to 26.2×10^9

SOURCE INFORMATION:	
Data Source:	Runoffcf grid, representing the average surface runoff in each grid cell.
Methods:	Created by calculating a weighted flow accumulation with the runoffcf grid as the weight grid.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Avgprecip
Description:	Grid format representation of average precipitation for the drainage area upstream of each grid cell throughout the watershed
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid
Scale:	Cell Size = 100 ft
Export File Size:	34.8 MB
Extent of Coverage:	Tillamook Bay watershed Xmin = 414253.5 Ymin = 1316609.125 Xmax = 599253.5 Ymax = 1450209.125 # of Rows = 1336 # of Columns = 1850
Quality/Limitations:	This grid is based on the precip grid which was obtained from the Oregon State University PRISM website and the flow direction grid for the watershed (flowdir).
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Data Type	Floating Point
Value	Average precipitation, inches/yr Range: 44.5 to 193.5

SOURCE INFORMATION:

Data Source:	Oregon State University PRISM program
Methods:	This grid was calculated in Map Calculator by adding the accprecip grid and the precip grid and then dividing the sum by the sum of the flowacc grid (which is based on the flowdir grid) plus one. This method is used rather than dividing the accprecip by the flowacc because some cells have a value of zero for the flowacc (a local high) resulting in a nodata value. The afore-mentioned method avoids values of nodata.
Organization:	Oregon State University
Contact:	
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Baccbgrid
Description:	Grid format representation of accumulated bacteria load generated in baseflow throughout the watershed
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid
Scale:	Cell Size = 100 ft
Export File Size:	34.8 MB
Extent of Coverage:	Tillamook Bay watershed Xmin = 414253.5 Ymin = 1316609.125 Xmax = 599253.5 Ymax = 1450209.125 # of Rows = 1336 # of Columns = 1850
Quality/Limitations:	This grid is based on the bfbactigrid (representing annual bacteria load in the study area).

Positional Accuracy:

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Data Type	Floating Point
Value	Accumulated annual bacteria load, fecal coliform/yr Range: 0 to 868,997,645,991,936

SOURCE INFORMATION:

Data Source:	Derived from the bfbactigrid, representing the average annual bacteria load in each grid cell.
Methods:	Created by running the 'bactigrid.ave' script and using the optional weighted flow accumulation using the bfbactigrid as the weight grid.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Baccsgrid
Description:	Grid format representation of accumulated sediment load generated in baseflow throughout the watershed
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid
Scale:	Cell Size = 100 ft
Export File Size:	34.8 MB

Extent of Coverage:	Tillamook Bay watershed Xmin = 414253.5 Ymin = 1316609.125 Xmax = 599253.5 Ymax = 1450209.125 # of Rows = 1336 # of Columns = 1850
Quality/Limitations:	This grid is based on the bfsedigrid (representing annual sediment load in the study area).
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Data Type	Floating Point
Value	Accumulated annual sediment load, tons/yr Range: 0 to 9156.025

SOURCE INFORMATION:

Data Source:	Derived from the bfsedigrid, representing the average annual sediment load in each grid cell.
Methods:	Created by running the 'sedigrid.ave' script and using the optional weighted flow accumulation using the bfsedigrid as the weight grid.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Baseflowcf
Description:	Grid format representation of average baseflow generated in each grid cell throughout the watershed
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon

Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid
Scale:	Cell Size = 100 ft
Export File Size:	34.8 MB
Extent of Coverage:	Tillamook Bay watershed Xmin = 414253.5 Ymin = 1316609.125 Xmax = 599253.5 Ymax = 1450209.125 # of Rows = 1336 # of Columns = 1850
Quality/Limitations:	This grid is based on the precip grid (representing annual rainfall in the study area) and mathematical relationships derived between rainfall and baseflow in the basin.
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Data Type	Integer
Value	Average baseflow, cubic feet/yr Range: 0 to 85,219

SOURCE INFORMATION:

Data Source:	Precip grid, representing the average annual precipitation in each grid cell.
Methods:	Created by running the 'tillflow.ave' script. This script is coded with the derived relationship between rainfall and baseflow for the watershed. The script inserts the precip grid (in inches of rain per year) into the rainfall-baseflow equation and converts from in/yr (a depth of flow) to cubic feet per year based on the grid cell size (or land area).

Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Bathdem
Description:	Grid format representation of land surface elevation in the watershed; this grid reflects elevations below MSL in the area of the bay.
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid
Scale:	Cell Size = 100 ft
Export File Size:	34.8 MB
Extent of Coverage:	Tillamook Bay watershed with a 2000 ft buffer around it Xmin = 414253.5 Ymin = 1316609.125 Xmax = 599253.5 Ymax = 1450209.125 # of Rows = 1336 # of Columns = 1850
Quality/Limitations:	This grid is based on the demare grid and a surface interpolated from the B95pts point coverage on the TBNEP CDROM. See metadata for these two layers for more information.
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000

False northing (meters):	0.000

Attributes:

Data Type	Floating Point
Value	Land surface elevation in feet MSL Range: -55.848 to 1847.113 ft

SOURCE INFORMATION:

Data Source:	B95pts point coverage from TBNEP CDROM; demarea created by CRWR.
Methods:	The bathdem grid was created by merging the demarea grid with the bathgrclip. The 'merge.ave' script was used with the bathgrclip grid as the primary grid and the demarea grid as the secondary grid. The values of the bathgrclip grid replace the elevation value (in almost all cases zero) of the demarea grid in the area of the bay to reflect the bay's bathymetry.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Bathgrclip
Description:	Grid format representation of land surface elevation in the bay
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid
Scale:	Cell Size = 100 ft
Export File Size:	1.4 MB
Extent of Coverage:	Tillamook Bay Xmin = 424862.656 Ymin = 1374043.375 Xmax = 450862.656 Ymax = 1411343.375 # of Rows = 373

	# of Columns = 260
Quality/Limitations:	This grid is based on a surface interpolated from the B95pts point coverage on the TBNEP CDROM. See metadata for B95pts point coverage for more information.
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Data Type	Floating Point
Value	Land surface elevation in feet MSL Range: -55.848 to 3.350 ft

SOURCE INFORMATION:

Data Source:	B95pts point coverage from TBNEP CDROM.
Methods:	The bathgrclip grid was created using the ArcView command 'Surface/Interpolate Grid' with Inverse Distance Weighting as the method and 'depth' (from the B95pts coverage attribute table) as the z-field. Grid was clipped to the extent of the shellmgt coverage (from TBNEP CDROM) using the 'gridclip.ave' script.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Bayarc
Description:	Polyline coverage of modeled management segments of Tillamook Bay
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712

Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Polygon
Scale:	
Export File Size:	15 KB
Extent of Coverage:	Tillamook Bay Xmin = 424813.7 Ymin = 1374024.5 Xmax = 448820.2 Ymax = 1411327.3
Quality/Limitations:	This coverage is a polyline representation of a modeled version of the bay segments.
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Length	Length of the polyline segment; feet
Gridcode	Code corresponding to grid representation of the bay segments 27 = Main Bay, Prohibited 28 = Main Bay, Conditional 29 = Cape Meares 30 = Flower Pot 31 = Upper Bay

SOURCE INFORMATION:

Data Source:	Modeled bay segment coverage created from 'shellmgt' coverage from TBNEP CDROM
Methods:	The baymodel polygon coverage was converted to a shapefile and then converted to a polyline coverage using the 'shapearc' and 'build…lines' commands in Arc/Info.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec
1	Fnode#	4	5	B	-
5	Tnode#	4	5	B	-
9	Lpoly#	4	5	B	-
13	Rpoly#	4	5	B	-
17	Length	4	12	F	3
21	Bayarc#	4	5	B	-
25	Bayarc-id	4	5	B	-
29	Fnode_	8	11	F	0
37	Tnode_	8	11	F	0
45	Lpoly_	8	11	F	0
53	Rpoly_	8	11	F	0
61	Baymodel_	8	11	F	0
69	Baymodel_I	8	11	F	0
77	ID	8	10	F	0
85	Gridcode	8	10	F	0

DATA SET IDENTIFICATION:

Data File Name:	Baymodel
Description:	Polygon coverage of modeled management segments of Tillamook Bay
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Polygon
Scale:	
Export File Size:	15 KB
Extent of Coverage:	Tillamook Bay Xmin = 424813.7 Ymin = 1374024.5 Xmax = 448820.2 Ymax = 1411327.3
Quality/Limitations:	This coverage is a polygon representation of a modeled version of the bay segments.
Positional Accuracy:	
Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)

Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Area	Calculated surface area of bay segment
Perimeter	Calculated perimeter length of bay segment
Segment Name	Name of Bay Segment
Growing Mgmt	Specifies if shellfish growing is allowed in the segment

SOURCE INFORMATION:

Data Source:	Modeled bay segment coverage created from 'shellmgt' coverage from TBNEP CDROM
Methods:	'Shellmgt' coverage converted to a grid. In Arc/Info, using ArcTools, grid was edited to cleanup the bay segment representation by deleting thin 'fingers' at the edges of the bay. In addition, northern edge of the Main Bay/Prohibited was extended a bit north to ensure that the centroid of that segment would lie within the polygon. This edited grid coverage was then converted back into a polygon coverage. The attribute table was edited to add the sgement name and growing management columns. These edits were made for modeling purposes only.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec
1	Fnode#	4	5	B	-
5	Tnode#	4	5	B	-
9	Lpoly#	4	5	B	-
13	Rpoly#	4	5	B	-
17	Length	4	12	F	3
21	Bayarc#	4	5	B	-
25	Bayarc-id	4	5	B	-
29	Fnode_	8	11	F	0
37	Tnode_	8	11	F	0
45	Lpoly_	8	11	F	0
53	Rpoly_	8	11	F	0
61	Baymodel_	8	11	F	0
69	Baymodel_I	8	11	F	0
77	ID	8	10	F	0

85	Gridcode	8	10	F	0

DATA SET IDENTIFICATION:

Data File Name:	Baywater1
Description:	Grid format representation of waters of interest (rivers, streams, and the bay itself)
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid
Scale:	Cell Size = 100 ft
Export File Size:	52.9 MB
Extent of Coverage:	Tillamook Bay watershed Xmin = 410873.425 Ymin = 1288730.171 Xmax = 610073.425 Ymax = 1477130.171 # of Rows = 1884 # of Columns = 1992
Quality/Limitations:	
Positional Accuracy:	This grid is based on the lriver, lstream, and shellmgt coverages from the TBNEP CDROM.

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Data Type	Interger
Value	1 = water of interest Nodata = not water of interest

SOURCE INFORMATION:

Data Source:	Lriver, lstream, and shellmgt coverages.
Methods:	The baywater1 grid was created by merging grid representations of the lriver, lstream, and shellmgt coverages. Each coverage was converted to a grid in ArcView using the 'Theme/Convert to Grid' command. In ArcInfo/Grid, all grid cells were converted to a value of 1 (for water of interest) or Nodata (elsewhere) using a condition command. The three grids were merged in ArcInfo/Grid using the merge command. This grid was edited using ArcTools to get a single cell line coverage representation of the streams and rivers that would match a modeled stream network based on the Digital Elevation Model using ArcView's Hydrologic Modeling functions.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Bdemfill
Description:	DEM representation (burndem grid) that has been altered to eliminate false sinks. This alteration is required to process the DEM using ArcView's Hydrologic Modeling functions.
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid
Scale:	Cell Size = 100 ft
Export File Size:	34.8 MB
Extent of Coverage:	Tillamook Bay watershed Xmin = 414253.5 Ymin = 1316609.125 Xmax = 599253.5 Ymax = 1450209.125 # of Rows = 1336

	# of Columns = 1850
Quality/Limitations:	This grid is based on the burndem grid. See metadata for the burndem grid for additional information.
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Data Type	Floating Point
Value	Elevation of land surface, feet Range: 65.300 to 3947.113

SOURCE INFORMATION:

Data Source:	Burndem grid.
Methods:	In ArcView using the Hydrologic Modeling extension, the burndem grid is filled using the Hydro/Fill command. This command looks for any local sinks in the DEM that would cause a discontinuity in the modeled hydrology. These local sinks are edited out of the DEM.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Bfbactigrid
Description:	Grid format representation of average bacteria load generated in baseflow in each grid cell throughout the watershed
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073

Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid
Scale:	Cell Size = 100 ft
Export File Size:	34.8 MB
Extent of Coverage:	Tillamook Bay watershed Xmin = 414253.5 Ymin = 1316609.125 Xmax = 599253.5 Ymax = 1450209.125 # of Rows = 1336 # of Columns = 1850
Quality/Limitations:	This grid is based on the baseflowcf grid (representing annual baseflow in the study area) and EMC values that are assigned based on landuse to represent concentration of bacteria in baseflow.
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Data Type	Floating Point
Value	Average annual bacteria load, fecal coliform/yr Range: 0 to 15,191,440,384

SOURCE INFORMATION:

Data Source:	Derived from the baseflowcf grid, representing the average annual baseflow in each grid cell.
Methods:	Created by running the 'bactigrid.ave' script. This script creates a virtual concentration grid of fc/100ml based on EMC values assigned based on land use and multiplies that grid by the baseflow grid and converts to fecal coliform per year with an appropriate conversion factor.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Bfsedigrid
Description:	Grid format representation of average sediment load generated in baseflow in each grid cell throughout the watershed
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid
Scale:	Cell Size = 100 ft
Export File Size:	34.8 MB
Extent of Coverage:	Tillamook Bay watershed Xmin = 414253.5 Ymin = 1316609.125 Xmax = 599253.5 Ymax = 1450209.125 # of Rows = 1336 # of Columns = 1850
Quality/Limitations:	This grid is based on the baseflowcf grid (representing annual baseflow in the study area) and EMC values that are assigned based on landuse to represent concentration of sediment in baseflow.
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Data Type	Floating Point
Value	Average annual sediment load, tons /yr

	Range: 0 to 0.013

SOURCE INFORMATION:

Data Source:	Derived from the baseflowcf grid, representing the average annual baseflow in each grid cell.
Methods:	Created by running the 'sedigrid.ave' script. This script creates a virtual concentration grid of mg/L sediment based on EMC values assigned based on land use and multiplies that grid by the baseflow grid and converts to tons of sediment per year with an appropriate conversion factor.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Bmpbacticonc
Description:	Grid format representation of predicted bacteria concentration throughout the watershed (accounting for reductions gained from the implementation of BMPs)
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid
Scale:	Cell Size = 100 ft
Export File Size:	34.8 MB
Extent of Coverage:	Tillamook Bay watershed Xmin = 414253.5 Ymin = 1316609.125 Xmax = 599253.5 Ymax = 1450209.125 # of Rows = 1336 # of Columns = 1850
Quality/Limitations:	This concentration grid is based on derived relationships between discharge and rainfall and discharge quality which is determined based on land use

Positional Accuracy:

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Data Type	Floating Point
Value	Predicted bacteria concentration, fc/100ml Range: 0 to 54,159.215

SOURCE INFORMATION:

Data Source:	
Methods:	Created by running the 'bactipredconc.ave' script. This script determines predicted concentrations based on modeled discharge and loads in the basin; accumulated load is divided by accumulated flow.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Bmpbactiload
Description:	Grid format representation of average bacteria load generated in runoff in each grid cell throughout the watershed accounting for reductions gained from the implementation of BMPs
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid

Scale:	Cell Size = 100 ft
Export File Size:	34.8 MB
Extent of Coverage:	Tillamook Bay watershed Xmin = 414253.5 Ymin = 1316609.125 Xmax = 599253.5 Ymax = 1450209.125 # of Rows = 1336 # of Columns = 1850
Quality/Limitations:	This grid is based on the robactigrid (representing annual bacteria load in runoff prior to implementation of BMPs) and user specified information of level of BMP implementation and BMP effectiveness – see the CRWR report for the levels assumed for this grid.
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Data Type	Floating Point
Value	Average annual bacteria load, fecal coliform/yr Range: 0 to 1,113,900,056,576

SOURCE INFORMATION:

Data Source:	Derived from the robactigrid, representing the average annual bacteria load in runoff in each grid cell.
Methods:	Created by running the 'bactibmpeffect.ave' script. This script reduces the per cell bacteria load by multiplying the robactigrid by the effective reduction gained from the implementation of BMPs. Reductions are only applied to CAFO dairy lands (land use code 23) and rural residential lands (land use code 18).
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Bmpsediload
Description:	Grid format representation of average sediment load generated in runoff in each grid cell throughout the watershed accounting for reductions gained from the implementation of BMPs
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid
Scale:	Cell Size = 100 ft
Export File Size:	34.8 MB
Extent of Coverage:	Tillamook Bay watershed Xmin = 414253.5 Ymin = 1316609.125 Xmax = 599253.5 Ymax = 1450209.125 # of Rows = 1336 # of Columns = 1850
Quality/Limitations:	This grid is based on the rosedigrid (representing annual sediment load in runoff prior to implementation of BMPs) and user specified information of level of BMP implementation and BMP effectiveness – see the CRWR report for the levels assumed for this grid.
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Data Type	Floating Point
Value	Average annual sediment load, tons/yr Range: 0 to 51.0

SOURCE INFORMATION:

Data Source:	Derived from the rosedigrid, representing the average annual sediment load in runoff in each grid cell.
Methods:	Created by running the 'sedibmpeffect.ave' script. This script reduces the per cell sediment load by multiplying the rosedigrid by the effective reduction gained from the implementation of BMPs. Reductions are only applied to CAFO dairy lands (land use code 23).
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Bmpsediconc
Description:	Grid format representation of predicted sediment concentration throughout the watershed (accounting for reductions gained from the implementation of BMPs)
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid
Scale:	Cell Size = 100 ft
Export File Size:	34.8 MB
Extent of Coverage:	Tillamook Bay watershed Xmin = 414253.5 Ymin = 1316609.125 Xmax = 599253.5 Ymax = 1450209.125 # of Rows = 1336 # of Columns = 1850
Quality/Limitations:	This concentration grid is based on derived relationships between discharge and rainfall and discharge quality which is assigned based on land use
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Data Type	Floating Point
Value	Predicted sediment concentration, mg/L Range: 0 to 22,502.064

SOURCE INFORMATION:

Data Source:	
Methods:	Created by running the 'sedipredconc.ave' script. This script determines predicted concentrations based on modeled discharge and loads in the basin; accumulated load is divided by accumulated flow.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Burndem
Description:	Grid format representation of Digital Elevation Model altered to raise elevation of the land surface while maintaining the elevation in grid cells classified as part of the 'waters of interest'(see baywater1 grid)
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid
Scale:	Cell Size = 100 ft
Export File Size:	34.8 MB

Extent of Coverage:	Tillamook Bay watershed Xmin = 414253.5 Ymin = 1316609.125 Xmax = 599253.5 Ymax = 1450209.125 # of Rows = 1336 # of Columns = 1850
Quality/Limitations:	This grid is based on the bathdem grid. See metadata for the bathdem grid for additional information.
Positional Accuracy:	The 'waters of interest' are based on the lstream, lriver, and shellmgt coverages from the TBNEP CDROM.
Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Data Type	Floating Point
Value	Elevation of land surface, feet Range: 44.152 to 3947.113

SOURCE INFORMATION:

Data Source:	Bathdem and baywater1 grids created by CRWR.
Methods:	In ArcView using Map Calculator, the bathdem grid is multiplied by the baywater1 grid. This produces a grid with the original elevation (including bathymetry data) in the cells representing the waters of interest and nodata elsewhere. This grid is named 'dem' using the ArcView command Theme/Properties. With Map Calculator, a value of 2000 is added to the bathdem grid. This grid is named 'demplus' using Theme/Properties. The 'merge.ave' script is used to merge the 'dem' grid as the primary grid into the 'demplus' grid as the secondary. This has the effect of preserving the original elevation in the cells representing the waters of interest and raising all other land surface elevations by a value of 2000 feet. Next, using Map Calculator, the elevation of all cells of the resultant grid is raised by a value of 100 feet. This step is necessary to eliminate any negative elevation values, a step required to process the DEM using

	ArcView's Hydrologic Modeling functions. To summarize, the burndem grid represents land surface elevations plus 2100 feet for areas other than the waters of interest. Cells representing waters of interest have a value of the original elevation (including bathymetry data) plus 100 feet.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Chaccsgrid
Description:	Grid format representation of accumulated supplemental sediment load related to drainage area/channel processes throughout the watershed after the implementation of BMPs
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid
Scale:	Cell Size = 100 ft
Export File Size:	34.8 MB
Extent of Coverage:	Tillamook Bay watershed Xmin = 414253.5 Ymin = 1316609.125 Xmax = 599253.5 Ymax = 1450209.125 # of Rows = 1336 # of Columns = 1850
Quality/Limitations:	This grid is based on the flow accumulation grid and a relationship derived between drainage area (represented as the flow accumulation value rather than measured area is square miles or acres) and the flow weighted average sediment concentration reported by E&S Environmental Chemistry in 1998.
Positional Accuracy:	

Projection: Lambert

Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Data Type	Floating Point
Value	Accumulated annual supplemental sediment load, tons/yr Range: 0 to 1,245,350.5

SOURCE INFORMATION:

Data Source:	Based on the flow accumulation grid.
Methods:	Created by running the 'dasedigrid.ave' script; the script queries the flow accumulation grid for grid cells with a value greater than 1000; for those cells, the flow accumulation value is inserted into an equation relating flow accumulation to concentration to determine a concentration value; this concentration is multiplied by the sum of the accumulated runoff and baseflow discharge grid to determine an accumulated supplemental sediment load grid, representing channel processes.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Connectsink
Description:	DEM representation (bdemfill) that has been altered to hydrologically connect the stream network and the bay segments.
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid
Scale:	Cell Size = 100 ft
Export File Size:	34.8 MB
Extent of Coverage:	Tillamook Bay watershed Xmin = 414253.5 Ymin = 1316609.125 Xmax = 599253.5 Ymax = 1450209.125 # of Rows = 1336 # of Columns = 1850
Quality/Limitations:	This grid is based on the bdemfill grid. See metadata for the bdemfill grid for additional information.
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Data Type	Floating Point
Value	Elevation of land surface, feet Range: -1194.974 to 3947.113

SOURCE INFORMATION:

Data Source:	Bdemfill grid.
Methods:	The bdemfill grid is altered to place a 'nodata' cell (to serve as a sink) at the centroid of each bay segment polygon. The values of cells within each segment polygon are altered to force flow toward the 'nodata' cell at each centroid. This has the effect of distinguishing modeled flow to each of the bay segments. The alteration is accomplished in ArcView using the 'connectsink.ave' script.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Demarea
Description:	Grid format representation of land surface elevation
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid
Scale:	Cell Size = 100 ft
Export File Size:	34.8 MB
Extent of Coverage:	Tillamook Bay watershed with a 2000 ft buffer around it Xmin = 414253.5 Ymin = 1316609.125 Xmax = 599253.5 Ymax = 1450209.125 # of Rows = 1336 # of Columns = 1850
Quality/Limitations:	This grid is based on the elev_g7.e00 export file provided by the TBNEP office. See metadata for the elev grid for additional information.
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Data Type	Floating Point
Value	Land surface elevation in feet MSL Range: 0 to 1847.113 feet

SOURCE INFORMATION:

Data Source:	Original Digital Elevation Model grid was provided by TBNEP as the export file grid_g7.e00.

Methods:	The demarea grid was created by resampling the elev_g7 grid from a cell size of 98.425 ft to a cell size of 100 ft. The grid was then clipped to the extent of the tillbuf2k polygon coverage using the script 'gridclip.ave.'
Organization:	TBNEP
Contact:	
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Eandspts
Description:	Point coverage of all sampling locations used during the 1996-1997 sampling effort by E&S Environmental Chemistry, Inc.
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Point; 70 point features
Scale:	
Export File Size:	17 KB
Extent of Coverage:	Tillamook Bay watershed Xmin = 430969.5 Ymin = 1329275.1 Xmax = 504820.6 Ymax = 1426140.0
Quality/Limitations:	Locations based UTM coordinates provided E&S.
Positional Accuracy:	See Quality/Limitations. As needed, locations adjusted to ensure that location coincides with modeled stream network.

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000

False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

X-coord	UTM Easting coordinate
Y-coord	UTM Northing coordinate
Station_name	Name of the sampling location; all locations are along one of 5 main rivers or in the bay.

SOURCE INFORMATION:

Data Source:	Location UTM coordinates provided by E&S Environmental
Methods:	Point coverage created in ArcInfo based on UTM coordinates. Projected in Oregon Lambert projection using the aml projection file 'utmlamb.' As needed, locations were adjusted to ensure that location coincides with modeled stream network.
Organization:	E&S Environmental Chemistry, Inc
Contact:	Tim Sullivan
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec
1	Area	4	12	F	3
5	Perimeter	4	12	F	3
9	Eandspts#	4	5	B	-
13	Eandspts_id	4	5	B	-
17	X-coord	4	12	F	3
21	Y-coord	4	12	F	3
25	Station_name	16	16	C	-

DATA SET IDENTIFICATION:

Data File Name:	Ensstormpts
Description:	Point coverage of primary and forest/ag interface sampling locations used during the 1996-1997 sampling effort by E&S Environmental Chemistry, Inc. Subset of Eandspts.
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Point; 10 point features

Scale:	
Export File Size:	5 KB
Extent of Coverage:	Tillamook Bay watershed Xmin = 448521.5 Ymin = 1359084.9 Xmax = 503435.8 Ymax = 1425574.6
Quality/Limitations:	Locations based UTM coordinates provided E&S.
Positional Accuracy:	See Quality/Limitations. As needed locations adjusted to ensure that location coincides with modeled stream network.
Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

X-coord	UTM Easting coordinate
Y-coord	UTM Northing coordinate
Station_name	Name of the sampling location; all locations are along one of 5 main rivers or in the bay.
Samptype	Indicates if the sample location is the primary sampling point (routine) or indicative of the forest/agricultural land interface (ForestAg).

SOURCE INFORMATION:

Data Source:	Location UTM coordinates provided by E&S Environmental
Methods:	Point coverage created in ArcInfo based on UTM coordinates. Projected in Oregon Lambert projection using the AML projection file 'utmlamb.' As needed locations adjusted to ensure that location coincides with modeled stream network.
Organization:	E&S Environmental Chemistry, Inc
Contact:	Tim Sullivan
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec
1	Area	4	12	F	3
5	Perimeter	4	12	F	3
9	Ensstormpts#	4	5	B	-

13	Ensstormpts-ID	4	5	B	-
17	Eandspts_	8	11	F	0
25	Eandspts_I	8	11	F	0
33	X-coord	8	12	F	3
41	Y-coord	8	12	F	3
49	Station_na	16	16	C	-
65	Samptype	10	10	C	-

DATA SET IDENTIFICATION:	
Data File Name:	Epariverpts
Description:	Point coverage of routine EPA river sampling sites, one per river. Also a subset of Eandspts and of Wqsta (from TBNEP CDROM).
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	
DATA SET DESCRIPTION:	
Feature Type:	Point; 5 point features
Scale:	
Export File Size:	4 KB
Extent of Coverage:	Tillamook Bay watershed Xmin = 448523.2 Ymin = 1350681.4 Xmax = 458882.8 Ymax = 1412072.0
Quality/Limitations:	Locations based on latitude and longitude information from the Wqsta point coverage attribute table.
Positional Accuracy:	See Quality/Limitations. As needed locations adjusted to ensure that location coincides with modeled stream network.
Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Storet	The designated EPA Storet Sampling Location number
Long	Location longitude coordinate.
Lat	Location latitude coordinate.
Eandspoint	E&S sampling location name.

SOURCE INFORMATION:

Data Source:	Database with storet numbers and lat/long information provided by TBNEP office
Methods:	Point coverage created in ArcInfo based on Lat/Long coordinates. Projected in Oregon Lambert projection using the AML projection file 'orlamb.'
Organization:	TBNEP Office
Contact:	
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec
1	Area	4	12	F	3
5	Perimeter	4	12	F	3
9	Epariverpts#	4	5	B	-
13	Epariverpts_id	4	5	B	-
17	Storet	4	6	B	-
21	Long	8	17	F	6
29	Lat	8	17	F	6
37	Eandspoint	16	16	C	-

DATA SET IDENTIFICATION:

Data File Name:	Fldplnwspts
Description:	Point coverage of sub-watershed drainage points in the lowland floodplain area
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Point; 11 points
Scale:	
Export File Size:	5 KB
Extent of Coverage:	Tillamook Bay watershed Xmin = 447227.0

	Ymin = 1343761.4 Xmax = 484915.1 Ymax = 1384840.5
Quality/Limitations:	This coverage represents drainage points for sub-watersheds in the floodplain. Locations were selected based on input from TBNEP office.
Positional Accuracy:	See Quality/Limitations. As needed locations adjusted to ensure that location coincides with modeled stream network.
Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Watershed	Name of the Watershed draining to that point

SOURCE INFORMATION:

Data Source:	Locations of drain points selected in conjunction with TBNEP staff.
Methods:	Points added directly in ArcView using 'View/New Theme' command as a point theme. Shapefile .dbf attribute table edited to add Watershed Name. Converted to a point coverage in ArcInfo using 'shapearc' command.
Organization:	TBNEP Office
Contact:	Bruce Follansbee
Date:	August 1998

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec
1	Area	4	12	F	3
5	Perimeter	4	12	F	3
9	Fldplnwspts#	4	5	B	-
13	Fldplnwspts-id	4	5	B	-
17	ID	8	8	F	0
25	Watershed	30	30	C	-

DATA SET IDENTIFICATION:

Data File Name:	Flowacc

Description:	Modeled representation of the accumulation of hydrologic flow based on the Digital Elevation Model (in this case, the connectsink grid).
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid
Scale:	Cell Size = 100 ft
Export File Size:	34.8 MB
Extent of Coverage:	Tillamook Bay watershed Xmin = 414253.5 Ymin = 1316609.125 Xmax = 599253.5 Ymax = 1450209.125 # of Rows = 1336 # of Columns = 1850
Quality/Limitations:	This grid is based on the flowdir grid. See metadata for the flowdir grid for additional information.
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Data Type	Floating Point
Value	Accumulated flow; represents the number of cells upstream of any given point based on the Flow Direction Grid. Does not include the cell being queried in the count. Range: 0 to 1213892

SOURCE INFORMATION:

Data Source:	Flowdir grid.

Methods:	In ArcView using the Hydrologic Modeling extension, the Hydro/Flow Accumulation command is executed with the flowdir grid identified as the flow direction grid.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Flowdir
Description:	Modeled representation of the direction of hydrologic flow based on the Digital Elevation Model (in this case, the connectsink grid).
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid
Scale:	Cell Size = 100 ft
Export File Size:	34.8 MB
Extent of Coverage:	Tillamook Bay watershed Xmin = 414253.5 Ymin = 1316609.125 Xmax = 599253.5 Ymax = 1450209.125 # of Rows = 1336 # of Columns = 1850
Quality/Limitations:	This grid is based on the connectsink grid. See metadata for the connectsink grid for additional information.
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000

Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Data Type	Integer
Value	Direction of hydrologic flow 1 – East 2 – Southeast 4 – South 8 – Southwest 16 – West 32 – Northwest 64 – North 128 – Northeast

SOURCE INFORMATION:

Data Source:	Connectsink grid.
Methods:	In ArcView using the Hydrologic Modeling extension, the Hydro/Flow Direction command is executed with the connectsink grid identified as the filled DEM.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Kilchis shapefile (includes .dbf/.sbn/.sbx/.shp/.shx files)
Description:	Polygon shapefile of modeled Kilchis River watershed
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Polygon
Scale:	
Export File Size:	N/A
Extent of Coverage:	Kilchis River watershed
Quality/Limitations:	This shapefile is a polygon representation of the modeled Kilchis River watershed. The modeled

	representation is based on a modified version of the Digital Elevation Model provided by TBNEP. Drain point for the river determined in conjunction with TBNEP office.
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Gridcode	Relates to the raster representation of the watershed as part of the watershed delineation process
Area	Calculated surface area of the watershed (ft^2)
Perimeter	Calculated perimeter length of watershed (ft)
Watershed	Name of the watershed

SOURCE INFORMATION:

Data Source:	Watershed delineation based on connectsink grid with mouth point coverage identifying the drain points for the river basins. Location of mouths of the rivers determined in conjunction with TBNEP office.
Methods:	In ArcView, with the rivbasin shapefile in the View, use the select tool to select the Kilchis polygon. Then use Theme/Convert to shapefile to get a shapefile of only the Kilchis River basin.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Kilchislu
Description:	Modeled representation of the land use in the Kilchis River watershed
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon

Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid
Scale:	Cell Size = 100 ft
Export File Size:	5.1 MB
Extent of Coverage:	Kilchis River watershed Xmin = 449953.5 Ymin = 1380209.125 Xmax = 510753.5 Ymax = 1440109.125 # of Rows = 599 # of Columns = 608
Quality/Limitations:	This grid is based on USGS Land Use/Land Cover information and more detailed data from the TBNEP 'lowpoly' coverage.
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Data Type	Integer
Value	Land Use Code (some codes may not be found in this grid) 11 – Urban Residential 12 – Urban Commercial Services 13 – Urban Industrial 14 – Urban Transportation/Communications 15 – Urban Industrial and Commercial 16 – Mixed Urban 17 – Other Urban 18 – Rural Residential (not std Anderson LU Code) 19 – Rural Industrial (not std Anderson LU code) 21 – Cropland and Pasture 22 – Orchards, Groves, Vineyards, and Nurseries 23 – Confined Feeding Operations

24 – Other Agricultural Land
31 –Herbaceous Rangelands
32 – Shrub and Brush Rangelands
33 – Other Rangeland
41 – Deciduous Forest
42 – Evergreen Forest
43 – Other Forest
51 – Streams and Canals
52 – Lakes
53 – Reservoirs
54 – Bays and Estuaries
61 – Forested Wetlands
62 – Nonforested Wetlands
71- Dry Salt Flats
72 – Beaches
73 – Sandy Areas Other than Beaches
74 – Bare Exposed Rock
75 – Strip Mines, Quarries, Gravel Pits
76 – Transitional Area
77 – Mixed Barren Land

SOURCE INFORMATION:

Data Source:	Area land use polygon coverage obtained from EPA GIRAS ftp site; dowloaded file lva45122.e00. Lowpoly polygon coverage representing more detail in the lowland areas obtained from TBNEP office
Methods:	Created by clipping the lulccomposite grid to the extent of the modeled Kilchis River watershed using the gridclip.ave script.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Landuse
Description:	Polygon coverage of land use
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Polygon
Scale:	1:250,000 (USGS data); 1:40,000 (low_poly data)
Export File Size:	2.8 MB
Extent of Coverage:	Tillamook Bay watershed Xmin = 414273.4 Ymin = 1316630.1 Xmax = 599273.4 Ymax = 1450230.1
Quality/Limitations:	Based on USGS land use information and data from low_poly coverage provided by TBNEP.
Positional Accuracy:	
Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Area	Calculated surface area of land use polygon
Perimeter	Calculated perimeter length of land use polygon
Gridcode	Land use identification code; based in part on the Anderson Land use code (some codes may not be found in this coverage) 11 – Urban Residential 12 – Urban Commercial Services 13 – Urban Industrial 14 – Urban Transportation/Communications 15 – Urban Industrial and Commercial 16 – Mixed Urban 17 – Other Urban 18 – Rural Residential (not std Anderson LU Code) 19 – Rural Industrial (not std Anderson LU code) 21 – Cropland and Pasture 22 – Orchards, Groves, Vineyards, and Nurseries 23 – Confined Feeding Operations 24 – Other Agricultural Land 31 –Herbaceous Rangelands 32 – Shrub and Brush Rangelands 33 – Other Rangeland 41 – Deciduous Forest 42 – Evergreen Forest 43 – Other Forest

	51 – Streams and Canals 52 – Lakes 53 – Reservoirs 54 – Bays and Estuaries 61 – Forested Wetlands 62 – Nonforested Wetlands 71- Dry Salt Flats 72 – Beaches 73 – Sandy Areas Other than Beaches 74 – Bare Exposed Rock 75 – Strip Mines, Quarries, Gravel Pits 76 – Transitional Area 77 – Mixed Barren Land

SOURCE INFORMATION:

Data Source:	USGS Landuse Coverage obtained via the internet; supplemental detailed land use data obtained through low_poly coverage provided by TBNEP office
Methods:	File 'lva45122.e00' downloaded from EPA GIRAS ftpsite. Imported to get land use polygon coverage. Converted to a grid based on land use gridcode. Data from low_poly polygon coverage edited to add field for land use gridcode, converted to a grid, and merged in to larger land use grid. Converted back to polygon using the 'gridpoly' command to obtain this coverage.
Organization:	USGS land use data obtained from ftpsite – ftp.epa.gov:/pub/EPAGIRAS/wgiras. Low_poly coverage obtained from TBNEP office.
Contact:	
Date:	July 1998

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec
1	Area	4	12	F	3
5	Perimeter	4	12	F	3
9	Landuse#	4	5	B	-
13	Landuse-id	4	5	B	-
17	Grid-code	4	8	B	-

DATA SET IDENTIFICATION:

Data File Name:	Lulcarea
Description:	Modeled representation of the land use in the Tillamook Bay watershed before alteration based on lowpoly coverage
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon

Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid
Scale:	Cell Size = 100 ft
Export File Size:	34.8 MB
Extent of Coverage:	Tillamook Bay watershed Xmin = 414253.5 Ymin = 1316609.125 Xmax = 599253.5 Ymax = 1450209.125 # of Rows = 1336 # of Columns = 1850
Quality/Limitations:	This grid is based only on USGS Land Use/Land Cover information.
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Data Type	Integer
Value	Land Use Code (some codes may not be found in this grid) 11 – Urban Residential 12 – Urban Commercial Services 13 – Urban Industrial 14 – Urban Transportation/Communications 15 – Urban Industrial and Commercial 16 – Mixed Urban 17 – Other Urban 21 – Cropland and Pasture 22 – Orchards, Groves, Vineyards, and Nurseries 23 – Confined Feeding Operations 24 – Other Agricultural Land 31 –Herbaceous Rangelands 32 – Shrub and Brush Rangelands

33 – Other Rangeland
41 – Deciduous Forest
42 – Evergreen Forest
43 – Other Forest
51 – Streams and Canals
52 – Lakes
53 – Reservoirs
54 – Bays and Estuaries
61 – Forested Wetlands
62 – Nonforested Wetlands
71- Dry Salt Flats
72 – Beaches
73 – Sandy Areas Other than Beaches
74 – Bare Exposed Rock
75 – Strip Mines, Quarries, Gravel Pits
76 – Transitional Area
77 – Mixed Barren Land

SOURCE INFORMATION:

Data Source:	Area land use polygon coverage obtained from EPA GIRAS ftp site; dowloaded file lva45122.e00.
Methods:	Using ArcView's Import 71, import the lva45122.e00 file. Project from albers equal area to Oregon lambert. Convert from polygon coverage to grid using 'Lucode' as the field for cell values. Reduce to the extent of the tillbuf2k coverage in ArcInfo/Grid.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Lulccomposite
Description:	Modeled grid representation of the land use in the basin.
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid

Scale:	Cell Size = 100 ft
Export File Size:	34.8 MB
Extent of Coverage:	Tillamook Bay watershed Xmin = 414253.5 Ymin = 1316609.125 Xmax = 599253.5 Ymax = 1450209.125 # of Rows = 1336 # of Columns = 1850
Quality/Limitations:	This grid is based on USGS Land Use/Land Cover information and more detailed data from the TBNEP 'lowpoly' coverage.
Positional Accuracy:	
Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000
Attributes:	
Data Type	Integer
Value	Land Use Code (some codes may not be found in this grid) 11 – Urban Residential 12 – Urban Commercial Services 13 – Urban Industrial 14 – Urban Transportation/Communications 15 – Urban Industrial and Commercial 16 – Mixed Urban 17 – Other Urban 18 – Rural Residential (not std Anderson LU Code) 19 – Rural Industrial (not std Anderson LU code) 21 – Cropland and Pasture 22 – Orchards, Groves, Vineyards, and Nurseries 23 – Confined Feeding Operations 24 – Other Agricultural Land 31 –Herbaceous Rangelands 32 – Shrub and Brush Rangelands 33 – Other Rangeland 41 – Deciduous Forest 42 – Evergreen Forest 43 – Other Forest 51 – Streams and Canals

52 – Lakes
53 – Reservoirs
54 – Bays and Estuaries
61 – Forested Wetlands
62 – Nonforested Wetlands
71- Dry Salt Flats
72 – Beaches
73 – Sandy Areas Other than Beaches
74 – Bare Exposed Rock
75 – Strip Mines, Quarries, Gravel Pits
76 – Transitional Area
77 – Mixed Barren Land

SOURCE INFORMATION:

Data Source:	Area land use polygon coverage obtained from EPA GIRAS ftp site. Lowpoly polygon coverage representing more detail in the lowland areas obtained from TBNEP office
Methods:	Selected polygons in the lowpoly coverage were assigned land use codes – see the full CRWR report for specifics on assignments. The lowpoly coverage was converted to a grid. The lulcarea grid was merged into with the grid representation of the lowpoly coverage.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Miami shapefile (includes .dbf/.sbn/.sbx/.shp/.shx files)
Description:	Polygon shapefile of modeled Miami River watershed
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Polygon
Scale:	
Export File Size:	N/A
Extent of Coverage:	Miami River watershed

Quality/Limitations:	This shapefile is a polygon representation of the modeled Miami River watershed. The modeled representation is based on a modified version of the Digital Elevation Model provided by TBNEP. Drain point for the river determined in conjunction with TBNEP office.
Positional Accuracy:	
Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000
Attributes:	
Gridcode	Relates to the raster representation of the watershed as part of the watershed delineation process
Area	Calculated surface area of the watershed (ft^2)
Perimeter	Calculated perimeter length of watershed (ft)
Watershed	Name of the watershed

SOURCE INFORMATION:

Data Source:	Watershed delineation based on connectsink grid with mouth point coverage identifying the drain points for the river basins. Location of mouths of the rivers determined in conjunction with TBNEP office.
Methods:	In ArcView, with the rivbasin shapefile in the View, use the select tool to select the Miami polygon. Then use Theme/Convert to shapefile to get a shapefile of only the Miami River basin.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

DATA SET IDENTIFICATION:

Data File Name:	Miamilu
Description:	Modeled representation of the land use in the Miami River watershed
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon

Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid
Scale:	Cell Size = 100 ft
Export File Size:	3.2 MB
Extent of Coverage:	Miami River watershed Xmin = 439053.5 Ymin = 1399209.125 Xmax = 488353.5 Ymax = 1444509.125 # of Rows = 453 # of Columns = 493
Quality/Limitations:	This grid is based on USGS Land Use/Land Cover information and more detailed data from the TBNEP 'lowpoly' coverage.
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Data Type	Integer
Value	Land Use Code (some codes may not be found in this grid) 11 – Urban Residential 12 – Urban Commercial Services 13 – Urban Industrial 14 – Urban Transportation/Communications 15 – Urban Industrial and Commercial 16 – Mixed Urban 17 – Other Urban 18 – Rural Residential (not std Anderson LU Code) 19 – Rural Industrial (not std Anderson LU code) 21 – Cropland and Pasture 22 – Orchards, Groves, Vineyards, and Nurseries 23 – Confined Feeding Operations

24 – Other Agricultural Land
31 –Herbaceous Rangelands
32 – Shrub and Brush Rangelands
33 – Other Rangeland
41 – Deciduous Forest
42 – Evergreen Forest
43 – Other Forest
51 – Streams and Canals
52 – Lakes
53 – Reservoirs
54 – Bays and Estuaries
61 – Forested Wetlands
62 – Nonforested Wetlands
71- Dry Salt Flats
72 – Beaches
73 – Sandy Areas Other than Beaches
74 – Bare Exposed Rock
75 – Strip Mines, Quarries, Gravel Pits
76 – Transitional Area
77 – Mixed Barren Land

SOURCE INFORMATION:

Data Source:	Area land use polygon coverage obtained from EPA GIRAS ftp site; dowloaded file lva45122.e00. Lowpoly polygon coverage representing more detail in the lowland areas obtained from TBNEP office
Methods:	Created by clipping the lulccomposite grid to the extent of the modeled Miami River watershed using the gridclip.ave script.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Mjrsubwspts
Description:	Point coverage of major sub-watershed drainage points in the Tillamook Bay Basin
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Point; 19 points
Scale:	
Export File Size:	6 KB
Extent of Coverage:	Tillamook Bay watershed Xmin = 446530.2 Ymin = 1332162.1 Xmax = 554572.7 Ymax = 1425965.9
Quality/Limitations:	This coverage represents drainage points for major sub-watersheds in the basin. Locations were selected based on input from TBNEP office.
Positional Accuracy:	See Quality/Limitations. As needed locations adjusted to ensure that location coincides with modeled stream network.

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Watershed	Name of the Watershed draining to that point

SOURCE INFORMATION:

Data Source:	Locations of drain points selected in conjunction with TBNEP staff.
Methods:	Points added directly in ArcView using 'View/New Theme' command as a point theme. Shapefile .dbf attribute table edited to add Watershed Name. Converted to a point coverage in ArcInfo using 'shapearc' command.
Organization:	TBNEP Office
Contact:	Bruce Follansbee
Date:	August 1998

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec
1	Area	4	12	F	3
5	Perimeter	4	12	F	3
9	Mjrsubwspts#	4	5	B	-
13	Mjrsubwspts-id	4	5	B	-

17	ID	8	8	F	0
25	Watershed	30	30	C	-

DATA SET IDENTIFICATION:

Data File Name:	Mouth
Description:	Point coverage of locations of mouths of 5 major rivers in basin
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Point; 5 points
Scale:	
Export File Size:	4 KB
Extent of Coverage:	Tillamook Bay watershed Xmin = 442825.1 Ymin = 1372273.9 Xmax = 450117.2 Ymax = 1406575.9
Quality/Limitations:	Locations based on the tillsub coverage on the TBNEP CDROM and determined in conjunction with TBNEP staff.
Positional Accuracy:	See Quality/Limitations. As needed locations adjusted to ensure that location coincides with modeled stream network.

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

River	The river
Watershed	The river that drains to the outlet point

SOURCE INFORMATION:

Data Source:	Location of river mouth determined from tillsub coverage with input from TBNEP staff.
Methods:	Points added directly in ArcView using 'View/New Theme' command as a point theme. Shapefile .dbf attribute table edited to add River and Watershed Name. Converted to a point coverage in ArcInfo using 'shapearc' command.
Organization:	TBNEP
Contact:	Bruce Follansbee
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec
1	Area	4	12	F	3
5	Perimeter	4	12	F	3
9	Mouth#	4	5	B	-
13	Mouth-id	4	5	B	-
17	ID	8	8	F	0
25	River	16	16	C	-
41	Watershed	30	30	C	-

DATA SET IDENTIFICATION:

Data File Name:	Outfalls
Description:	Point coverage of Sewage Treatment Plant Outfalls in the basin
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Point; 6 points
Scale:	
Export File Size:	5 KB
Extent of Coverage:	Tillamook Bay watershed Xmin = 437536.4 Ymin = 1357112.9 Xmax = 464745.3 Ymax = 1406263.0
Quality/Limitations:	This point coverage is an edited version of the outfall coverage on the TBNEP CDROM. The outfall point coverage was missing two outfall points. Fecal coliform and sediment annual loads based on average

	values from discharge monitoring reports for the facilities.
Positional Accuracy:	The two additional points, Bay City and Port of Tillamook, were based on GPS readings obtained by TBNEP office personnel. The Bay City point location based on the GPS readings was moved based on input from TBNEP staff.
Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Plant	Name of the facility
Rm	River mile
Long	Location longitude coordinate
Lat	Location latitude coordinate
Annual_fc_load	Estimated annual load of fecal coliform bacteria
Annual_sedi_load	Estimated annual load of sediment

SOURCE INFORMATION:

Data Source:	Based on outfall coverage from TBNEP CDROM. Location data for Bay City and Port of Tillamook obtained from TBNEP staff. Discharge monitoring reports (DMRs, for calculating annual pollutant loads) obtained from TBNEP staff.
Methods:	Outfall point coverage converted to shapefile. Shapefile edited to add points based on location information provided by TBNEP. Fields added for annual FC and SS loads. Shapefile converted back to coverage using ArcInfo 'shapearc' command.
Organization:	TBNEP
Contact:	Don Reynolds – point location lat/long for POTB and BC outfalls; Roxanna Hinzman – DMR reports
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec
1	Area	4	12	F	3
5	Perimeter	4	12	F	3
9	Outfalls#	4	5	B	-
13	Outfalls-id	4	5	B	-

17	Plant	25	25	C	-
42	Rm	4	4	F	1
46	Long	8	12	F	4
54	Lat	8	12	F	4
62	Annual_fc_load	16	16	I	-
78	Annual_sedi_load	16	16	I	-

DATA SET IDENTIFICATION:

Data File Name:	Precip
Description:	Grid format representation of average annual precipitation in each grid cell throughout the watershed
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid
Scale:	Cell Size = 100 ft
Export File Size:	34.8 MB
Extent of Coverage:	Tillamook Bay watershed Xmin = 414253.5 Ymin = 1316609.125 Xmax = 599253.5 Ymax = 1450209.125 # of Rows = 1336 # of Columns = 1850
Quality/Limitations:	This grid was obtained from the Oregon State University PRISM website.
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Data Type	Floating Point
Value	Average precipitation, inches/yr Range: 56.3 to 193.5

SOURCE INFORMATION:

Data Source:	Oregon State University PRISM program
Methods:	The original grid was downloaded from the OSU PRISM website and was in 100 mm/yr. The grid was first reprojected from geographic projection into the Oregon Lambert Projection. The grid was resampled to a 100 foot cell size and clipped down to the tillbuff2k coverage. The grid was also converted from 100 mm/yr to in/yr using Map Calculator.
Organization:	Oregon State University
Contact:	
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Profriver shapefile (includes .dbf /.shp/.shx files)
Description:	Polyline shapefile of the 5 major rivers in the watershed from modeled headwaters down toward outlet
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Polyline
Scale:	
Export File Size:	N/A
Extent of Coverage:	Tillamook Bay watershed
Quality/Limitations:	This shapefile is a polyline representation of the 5 rivers in watersheds. The modeled representation is based on a modified version of the Digital Elevation Model provided by TBNEP (see connectsink metadata for more details). The modeled rivers are based on a flow accumulation threshhold of 1000 grid cells to define a stream. This shapefile was developed strictly for use with the 'Profiler' tool to examine concentration profiles.

Positional Accuracy:

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

River Name	The river represented by the polyline

SOURCE INFORMATION:

Data Source:	Based on connectsink grid.
Methods:	Stream trace tool ('S' button) used in the hydrology.apr project file. This project file is based on prepro3.apr, an ArcView project file developed by CRWR research group specifically for doing watershed delineation. Streams were traced from the headwaters (determined from the streamgrid); the 'S' button tool traces down to the outlet point (at the bay segment centroids). The Tillamook and Trask River polylines were cutoff at the point where they converge with each other. The Wilson was cutoff at the point where it converges with the Tillamook/Trask Rivers.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Ptsrcfcgrid
Description:	Grid format representation of annual bacteria load from point sources
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid
Scale:	Cell Size = 100 ft
Export File Size:	34.8MB
Extent of Coverage:	Tillamook Bay watershed Xmin = 414253.5 Ymin = 1316609.125 Xmax = 599253.5 Ymax = 1450209.125 # of Rows = 1336 # of Columns = 1850
Quality/Limitations:	Load values based on average values determined from Discharge Monitoring Points for 6 Wastewater Treatment Plants; time period 1997 – 1998 (roughly).
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Data Type	Integer
Value	Annual bacteria load represented as # of fecal coliform * 10^7 per year Range: 0 to 111390.0 (units - *10^7 fecal coliform/yr)

SOURCE INFORMATION:

Data Source:	Outfall coverage from TBNEP CD for locations; discharge monitoring reports for load information.
Methods:	The outfall coverage was edited to add in two missing discharge points. The attribute table was edited to add fields for annual load. Annual loads were estimated from discharge monitoring reports. The coverage was converted to a grid using the ptsrcfcgrid.ave script. This script assigns the annual load value to the grid cell coincident with the point location and a value of zero elsewhere.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Ptsrcssgrid
Description:	Grid format representation of annual sediment load from point sources
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid
Scale:	Cell Size = 100 ft
Export File Size:	34.8MB
Extent of Coverage:	Tillamook Bay watershed Xmin = 414253.5 Ymin = 1316609.125 Xmax = 599253.5 Ymax = 1450209.125 # of Rows = 1336 # of Columns = 1850
Quality/Limitations:	Load values based on average values determined from Discharge Monitoring Points for 6 Wastewater Treatment Plants; time period 1997 – 1998 (roughly).
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Data Type	Integer
Value	Annual sediment load represented as pounds per year Range: 0 to 103323 (units - pounds/yr)

SOURCE INFORMATION:

Data Source:	Outfall coverage from TBNEP CD for locations; discharge monitoring reports for load information.
Methods:	The outfall coverage was edited to add in two missing discharge points. The attribute table was edited to add fields for annual load. Annual loads were estimated from discharge monitoring reports. The coverage was converted to a grid using the ptsrcssgrid.ave script. This script assigns the annual load value to the grid cell coincident with the point location and a value of zero elsewhere.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Raccbgrid
Description:	Grid format representation of accumulated bacteria load generated in runoff throughout the watershed
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid
Scale:	Cell Size = 100 ft
Export File Size:	34.8 MB
Extent of Coverage:	Tillamook Bay watershed Xmin = 414253.5 Ymin = 1316609.125 Xmax = 599253.5 Ymax = 1450209.125 # of Rows = 1336 # of Columns = 1850
Quality/Limitations:	This grid is based on the robactigrid (representing annual bacteria load in the study area).
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83

Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Data Type	Floating Point
Value	Accumulated annual bacteria load, fecal coliform/yr Range: 0 to 9,779,821,995,360,256

SOURCE INFORMATION:

Data Source:	Derived from the robactigrid, representing the average annual bacteria load in each grid cell.
Methods:	Created by running the 'bactigrid.ave' script and using the optional weighted flow accumulation using the robactigrid as the weight grid.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Raccsgrid
Description:	Grid format representation of accumulated sediment load generated in runoff throughout the watershed
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid
Scale:	Cell Size = 100 ft
Export File Size:	34.8 MB
Extent of Coverage:	Tillamook Bay watershed Xmin = 414253.5 Ymin = 1316609.125 Xmax = 599253.5

	Ymax = 1450209.125 # of Rows = 1336 # of Columns = 1850
Quality/Limitations:	This grid is based on the rosedigrid (representing annual sediment load in the study area).
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Data Type	Floating Point
Value	Accumulated annual sediment load, tons/yr Range: 0 to 22,669.705

SOURCE INFORMATION:

Data Source:	Derived from the rosedigrid, representing the average annual sediment load in each grid cell.
Methods:	Created by running the 'sedigrid.ave' script and using the optional weighted flow accumulation using the rosedigrid as the weight grid.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Raingage
Description:	Point coverage of National Climatic Data Center rain gage locations
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Point; 7 points
Scale:	
Export File Size:	5 KB
Extent of Coverage:	Tillamook Bay watershed Xmin = 431913.5 Ymin = 1271525.6 Xmax = 550385.2 Ymax = 1464120.4
Quality/Limitations:	Location coordinates obtained from NCDC.
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Gage_name	Name of the rain gage
Latitude	Location latitude coordinate
Longitude	Location longitude coordinate

SOURCE INFORMATION:

Data Source:	Location data obtained from National Climatic Data Center
Methods:	The point coverage was created in ArcView using an avenue script with geographic coordinates. This point coverage was projected to Oregon Lambert using the 'orlamb' aml script.
Organization:	
Contact:	
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec
1	Area	4	12	F	3
5	Perimeter	4	12	F	3
9	Raingage#	4	5	B	-
13	Raingage-id	4	5	B	-
17	Gage_Name	20	20	C	-
37	Latitude	8	16	F	4
45	Longitude	8	16	F	4

DATA SET IDENTIFICATION:	
Data File Name:	Rivbasin shapefile (includes .dbf /.shp/.shx files)
Description:	Polygon shapefile of modeled basins for the 5 major rivers in the watershed
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	
DATA SET DESCRIPTION:	
Feature Type:	Polygon
Scale:	
Export File Size:	N/A
Extent of Coverage:	Tillamook Bay watershed
Quality/Limitations:	This shapefile is a polygon representation of the modeled river basin watersheds. The modeled representation is based on a modified version of the Digital Elevation Model provided by TBNEP (see connectsink metadata for more details). Drain point for the rivers (see mouth metadata) determined in conjunction with TBNEP office.
Positional Accuracy:	
Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000
Attributes:	
Gridcode	Relates to the raster representation of the watershed as part of the watershed delineation process 2307 – Miami River 2308 – Kilchis River 2309 – Wilson River 2310 – Trask River 2311 – Tillamook River

Area	Calculated surface area of the watershed (ft^2)
Perimeter	Calculated perimeter length of watershed (ft)
Watershed	Name of the watershed

SOURCE INFORMATION:

Data Source:	Watershed delineation based on connectsink grid with mouth point coverage identifying the drain points for the river basins. Location of mouths of the rivers determined in conjunction with TBNEP office.
Methods:	Watershed delineation performed using hydrology.apr project file. This project file is based on prepro3.apr, an ArcView project file developed by CRWR research group specifically for doing watershed delineation. Outlet points for 5 major river basins identified from the mouth point coverage. See full CRWR report for details.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	River shapefile (includes .dbf /.shp/.shx files)
Description:	Polyline shapefile of modeled stream network in the 5 major river basins in the watershed
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Polyline
Scale:	
Export File Size:	N/A
Extent of Coverage:	Tillamook Bay watershed
Quality/Limitations:	This shapefile is a polyline representation of the modeled rivers in the major basin watersheds based on a modified version of the Digital Elevation Model provided by TBNEP (see connectsink metadata for more details). Flow accumulation threshhold of 1000 grid cells used to define a stream. Drain point for the

	rivers (see mouth metadata) determined in conjunction with TBNEP office.
Positional Accuracy:	
Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Gridcode	Relates to the raster representation of the watershed as part of the watershed delineation process. 2307 – Miami River 2308 – Kilchis River 2309 – Wilson River 2310 – Trask River 2311 – Tillamook River
Length	Calculated length of the stream segment
Wshcode	Same as the gridcode

SOURCE INFORMATION:

Data Source:	Watershed delineation based on connectsink grid with mouth point coverage identifying the drain points for the river basins. Location of mouths of the rivers determined in conjunction with TBNEP office.
Methods:	Watershed delineation and stream network identification performed using hydrology.apr project file. This project file is based on prepro3.apr, an ArcView project file developed by CRWR research group specifically for doing watershed delineation. Outlet points for 5 major river basins identified from the mouth point coverage. See full CRWR report for details.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Riverbasin
Description:	Grid representation of modeled river basins in the watershed
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid
Scale:	Cell Size = 100 feet
Export File Size:	34.8 MB
Extent of Coverage:	Tillamook Bay watershed Xmin = 414253.5 Ymin = 1316609.125 Xmax = 599253.5 Ymax = 1450209.125 # of Rows = 1336 # of Columns = 1850
Quality/Limitations:	The modeled representation of the river basins is based on a modified version of the Digital Elevation Model provided by TBNEP (see connectsink metadata for more details). Drain points for the gages (see mouth metadata) determined in conjunction with TBNEP staff.
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Data Type	Integer
Value	Watershed Code 2307 – Miami River 2308 – Kilchis River 2309 – Wilson River 2310 – Trask River

2311 – Tillamook River

SOURCE INFORMATION:

Data Source:	Watershed delineation based on connectsink grid with mouth point coverage identifying the drain points for the river basins.
Methods:	Watershed delineation performed using hydrology.apr project file. This project file is based on prepro3.apr, an ArcView project file developed by CRWR research group specifically for doing watershed delineation. Outlet points for river basins identified from the mouth point coverage. See full report for details.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Robactigrid
Description:	Grid format representation of average bacteria load generated in runoff in each grid cell throughout the watershed
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid
Scale:	Cell Size = 100 ft
Export File Size:	34.8 MB
Extent of Coverage:	Tillamook Bay watershed Xmin = 414253.5 Ymin = 1316609.125 Xmax = 599253.5 Ymax = 1450209.125 # of Rows = 1336 # of Columns = 1850
Quality/Limitations:	This grid is based on the runoffcf grid (representing annual runoff in the study area) and EMC values that are assigned based on landuse to represent concentration of bacteria in runoff.

Positional Accuracy:

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Data Type	Floating Point
Value	Average annual bacteria load, fecal coliform/yr Range: 0 to 1,113,900,056,576

SOURCE INFORMATION:

Data Source:	Derived from the runoffcf grid, representing the average annual runoff in each grid cell.
Methods:	Created by running the 'bactigrid.ave' script. This script creates a virtual concentration grid of fc/100ml based on EMC values assigned based on land use and multiplies that grid by the runoff grid and converts to fecal coliform per year with an appropriate conversion factor.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Rosedigrid
Description:	Grid format representation of average sediment load generated in runoff in each grid cell throughout the watershed
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid
Scale:	Cell Size = 100 ft
Export File Size:	34.8 MB
Extent of Coverage:	Tillamook Bay watershed Xmin = 414253.5 Ymin = 1316609.125 Xmax = 599253.5 Ymax = 1450209.125 # of Rows = 1336 # of Columns = 1850
Quality/Limitations:	This grid is based on the runoffcf grid (representing annual runoff in the study area) and EMC values that are assigned based on landuse to represent concentration of sediment in runoff.
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Data Type	Floating Point
Value	Average annual sediment load, tons /yr Range: 0 to 51.0

SOURCE INFORMATION:

Data Source:	Derived from the runoffcf grid, representing the average annual runoff in each grid cell.
Methods:	Created by running the 'sedigrid.ave' script. This script creates a virtual concentration grid of mg/L sediment based on EMC values assigned based on land use and multiplies that grid by the runoff grid and converts to tons of sediment per year with an appropriate conversion factor.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Runoffcf
Description:	Grid format representation of average surface runoff generated in each grid cell throughout the watershed
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid
Scale:	Cell Size = 100 ft
Export File Size:	34.8 MB
Extent of Coverage:	Tillamook Bay watershed Xmin = 414253.5 Ymin = 1316609.125 Xmax = 599253.5 Ymax = 1450209.125 # of Rows = 1336 # of Columns = 1850
Quality/Limitations:	This grid is based on the precip grid (representing annual rainfall in the study area) and mathematical relationships derived between rainfall and runoff in the basin.
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:	
Data Type	Integer
Value	Average surface runoff, cubic feet/yr Range: 4,755 to 119,647

SOURCE INFORMATION:

Data Source:	Precip grid, representing the average annual precipitation in each grid cell.

Methods:	Created by running the 'tillflow.ave' script. This script is coded with the derived relationship between rainfall and runoff for the watershed. The script inserts the precip grid (in inches of rain per year) into the rainfall-runoff equation and converts from in/yr (a depth of flow) to cubic feet per year based on the grid cell size (or land area).
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Streamgrid
Description:	Grid format representation of rivers and tributaries within the watershed
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid
Scale:	Cell Size = 100 ft
Export File Size:	34.8 MB
Extent of Coverage:	Tillamook Bay watershed Xmin = 410873.425 Ymin = 1288730.171 Xmax = 610073.425 Ymax = 1477130.171 # of Rows = 1884 # of Columns = 1992
Quality/Limitations:	This grid is based on the flowacc grid which is based on a modified version of the Digital Elevation Model provided by TBNEP (see connectsink metadata for more details).
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980

1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Data Type	Interger
Value	1 = part of the modeled stream network Nodata = not part of the modeled stream network

SOURCE INFORMATION:

Data Source:	Stream definition based on connectsink grid
Methods:	Stream definition performed using hydrology.apr project file. This project file is based on prepro3.apr, an ArcView project file developed by CRWR research group specifically for doing watershed delineation. Streams defined using a flow accumulation threshold of 1000 grid cells.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Subbasin shapefile (includes .dbf /.shp/.shx files)
Description:	Polygon shapefile of modeled basins in the watershed; represents major sub-watersheds within the 5 river basins, as well as sub-watersheds in the floodplain
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Polygon
Scale:	
Export File Size:	N/A
Extent of Coverage:	Tillamook Bay watershed
Quality/Limitations:	This shapefile is a polygon representation of the modeled sub-watersheds. The modeled representation

	is based on a modified version of the Digital Elevation Model provided by TBNEP (see connectsink metadata for more details). Drain point for the sub-watersheds are identified by three point coverages – mouth, mjrsubwspts, and fldplnwspts – all of these points were located based on input from the TBNEP office.
Positional Accuracy:	
Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Gridcode	Relates to the raster representation of the watershed as part of the watershed delineation process. 2307 – Upper Main Stem Miami 2308 – North Fork – Kilchis 2309 – South Fork – Kilchis 2310 – Devil's Lake Fork – Wilson 2311 – South Fork – Wilson 2312 – North Fork – Wilson 2313 – Mouth of Miami 2314 – Upper Main Stem Kilchis 2315 – Little South Fork – Kilchis 2316 – Vermilyea Slough 2317 – Stasek Slough 2318 – Mouth of Kilchis 2319 – Mouth of Wilson 2320 – Hall Slough 2321 – Little North Fork – Wilson 2322 – Mouth of Trask 2323 – Upper Main Stem – Wilson 2324 – Mouth of Tillamook 2325 – Dougherty Slough 2326 – Hoquarten Slough 2327 – North Fork of North Fork – Trask 2328 – Mid Fork of North Fork – Trask 2329 – McKenzie Creek 2330 – North Fork – Trask 2331 – South Fork – Trask 2332 – Gold Creek 2333 – Upper Main Stem – Trask

	2334 – Chance Road 2335 – Mill Creek 2336 – Anderson Creek 2337 – East Fork of South Fork – Trask 2338 – Middle Main Stem – Tillamook 2339 – Bewley Creek 2340 – Fawcett Creek 2341 – Upper Main Stem – Tillamook
Length	Calculated length of the stream segment
Wshcode	Same as the gridcode

SOURCE INFORMATION:

Data Source:	Watershed delineation based on connectsink grid with mouth point coverage identifying the drain points for the river basins. Location of mouths of the rivers determined in conjunction with TBNEP office.
Methods:	Watershed delineation and stream network identification performed using hydrology.apr project file. This project file is based on prepro3.apr, an ArcView project file developed by CRWR research group specifically for doing watershed delineation. Outlet points for 5 major river basins identified from the mouth point coverage. See full CRWR report for details.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Subriver shapefile (includes .dbf /.shp/.shx files)
Description:	Polyline shapefile of modeled stream network in the subbasins in the watershed (corresponds to sub-basin shapefile)
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type: Polyline
Scale:
Export File Size: N/A
Extent of Coverage: Tillamook Bay watershed
Quality/Limitations: This shapefile is a polyline representation of the modeled rivers in the sub-basins. The modeled representation is based on a modified version of the Digital Elevation Model provided by TBNEP (see connectsink metadata for more details). The modeled rivers are based on a flow accumulation threshhold of 1000 grid cells to define a stream. Drain points for the river segments (see mouth, fldplnpts, and mjrsubwspts metadata) determined in conjunction with TBNEP office.
Positional Accuracy:

Projection: Lambert
Datum: NAD83
Units: International Feet, 3.28084 (0.3048 meters)
Spheroid: GRS1980
1st Standard Parallel: 43 00 0.000
2nd Standard Parallel: 45 30 0.000
Central Meridian: -120 30 0.000
Latitude of Origin: 41 45 0.000
False easting (meters): 400000.000
False northing (meters): 0.000

Attributes:

Gridcode: Relates to the raster representation of the watershed as part of the watershed delineation process.
2307 – Upper Main Stem Miami
2308 – North Fork – Kilchis
2309 – South Fork – Kilchis
2310 – Devil's Lake Fork – Wilson
2311 – South Fork – Wilson
2312 – North Fork – Wilson
2313 – Mouth of Miami
2314 – Upper Main Stem Kilchis
2315 – Little South Fork – Kilchis
2316 – Vermilyea Slough
2317 – Stasek Slough
2318 – Mouth of Kilchis
2319 – Mouth of Wilson
2320 – Hall Slough
2321 – Little North Fork – Wilson
2322 – Mouth of Trask
2323 – Upper Main Stem – Wilson
2324 – Mouth of Tillamook
2325 – Dougherty Slough

	2326 – Hoquarten Slough 2327 – North Fork of North Fork – Trask 2328 – Mid Fork of North Fork – Trask 2329 – McKenzie Creek 2330 – North Fork – Trask 2331 – South Fork – Trask 2332 – Gold Creek 2333 – Upper Main Stem – Trask 2334 – Chance Road 2335 – Mill Creek 2336 – Anderson Creek 2337 – East Fork of South Fork – Trask 2338 – Middle Main Stem – Tillamook 2339 – Bewley Creek 2340 – Fawcett Creek 2341 – Upper Main Stem – Tillamook
Length	Calculated length of the stream segment
Wshcode	Same as the gridcode
Arcid	Internal ArcView identifier
From_Node	Internal ArcView identifier
To_Node	Internal ArcView identifier

SOURCE INFORMATION:

Data Source:	Watershed delineation based on connectsink grid with mouth/fldplnwspts/mjrsubwspts point coverages identifying the drain points for the river basins. Location of points determined in conjunction with TBNEP office.
Methods:	Watershed delineation and stream network identification performed using hydrology.apr project file. This project file is based on prepro3.apr, an ArcView project file developed by CRWR research group specifically for doing watershed delineation. Outlet points for sub-basins identified from the mouth/fldplnwspts/mjrsubwspts point coverages.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Subwsheds
Description:	Grid representation of modeled subwatersheds in the watershed

Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid
Scale:	Cell Size = 100 feet
Export File Size:	34.8 MB
Extent of Coverage:	Tillamook Bay watershed Xmin = 414253.5 Ymin = 1316609.125 Xmax = 599253.5 Ymax = 1450209.125 # of Rows = 1336 # of Columns = 1850
Quality/Limitations:	The modeled representation of the subwatersheds is based on a modified version of the Digital Elevation Model provided by TBNEP (see connectsink metadata for more details). Drain points for the gages (see mouth/fldplnwspts/mjrsubwspts metadata) determined in conjunction with TBNEP staff.
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Data Type	Integer
Value	Watershed Code 2307 – Upper Main Stem Miami 2308 – North Fork – Kilchis 2309 – South Fork – Kilchis 2310 – Devil's Lake Fork – Wilson 2311 – South Fork – Wilson 2312 – North Fork – Wilson 2313 – Mouth of Miami 2314 – Upper Main Stem Kilchis

2315 – Little South Fork – Kilchis
2316 – Vermilyea Slough
2317 – Stasek Slough
2318 – Mouth of Kilchis
2319 – Mouth of Wilson
2320 – Hall Slough
2321 – Little North Fork – Wilson
2322 – Mouth of Trask
2323 – Upper Main Stem – Wilson
2324 – Mouth of Tillamook
2325 – Dougherty Slough
2326 – Hoquarten Slough
2327 – North Fork of North Fork – Trask
2328 – Mid Fork of North Fork – Trask
2329 – McKenzie Creek
2330 – North Fork – Trask
2331 – South Fork – Trask
2332 – Gold Creek
2333 – Upper Main Stem – Trask
2334 – Chance Road
2335 – Mill Creek
2336 – Anderson Creek
2337 – East Fork of South Fork – Trask
2338 – Middle Main Stem – Tillamook
2339 – Bewley Creek
2340 – Fawcett Creek
2341 – Upper Main Stem – Tillamook

SOURCE INFORMATION:

Data Source:	Watershed delineation based on connectsink grid with mouth/fldplnwspts/mjrsubwspts point coverages identifying the drain points for the river basins.
Methods:	Watershed delineation performed using hydrology.apr project file. This project file is based on prepro3.apr, an ArcView project file developed by CRWR research group specifically for doing watershed delineation. Outlet points for river basins identified from the mouth/fldplnwspts/mjrsubwspts point coverages. See full report for details.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Tccasample
Description:	Point coverage of sampling locations used by the TCCA Creamery. Subset of Eandspts.
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Point; 8 point features
Scale:	
Export File Size:	5 KB
Extent of Coverage:	Tillamook Bay watershed Xmin = 447911.75 Ymin = 1371754.625 Xmax = 482115.438 Ymax = 1378155.5
Quality/Limitations:	Locations based UTM coordinates provided E&S.
Positional Accuracy:	See Quality/Limitations. As needed locations adjusted to ensure that location coincides with modeled stream network.

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

X-coord	UTM Easting coordinate
Y-coord	UTM Northing coordinate
Station_name	Name of the sampling location; all locations are along one of 5 main rivers or in the bay.
Location	Descriptive location reference.

SOURCE INFORMATION:

Data Source:	Location UTM coordinates provided by E&S Environmental
Methods:	Point selected from the eandspoints coverage and saved as a new point coverage.

Organization:	E&S Environmental Chemistry, Inc
Contact:	Tim Sullivan
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec
1	Area	4	12	F	3
5	Perimeter	4	12	F	3
9	Tccasample#	4	5	B	-
13	Tccasample_id	4	5	B	-
17	Eandspts_	8	11	F	0
25	Eandspts_i	8	11	F	0
33	X-coord	8	12	F	3
41	Y-coord	8	12	F	3
49	Station_na	16	16	C	-
65	Location	30	30	C	-

DATA SET IDENTIFICATION:

Data File Name:	Tillamook shapefile (includes .dbf/.sbn/.sbx/.shp/.shx files)
Description:	Polygon shapefile of modeled Tillamook River watershed
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Polygon
Scale:	
Export File Size:	N/A
Extent of Coverage:	Tillamook River watershed
Quality/Limitations:	This shapefile is a polygon representation of the modeled Tillamook River watershed. The modeled representation is based on a modified version of the Digital Elevation Model provided by TBNEP. Drain point for the river determined in conjunction with TBNEP office.
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980

1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Gridcode	Relates to the raster representation of the watershed as part of the watershed delineation process
Area	Calculated surface area of the watershed (ft^2)
Perimeter	Calculated perimeter length of watershed (ft)
Watershed	Name of the watershed

SOURCE INFORMATION:

Data Source:	Watershed delineation based on connectsink grid with mouth point coverage identifying the drain points for the river basins. Location of mouths of the rivers determined in conjunction with TBNEP office.
Methods:	In ArcView, with the rivbasin shapefile in the View, use the select tool to select the Tillamook polygon. Then use Theme/Convert to shapefile to get a shapefile of only the Tillamook River basin.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Tillamooklu
Description:	Modeled representation of the land use in the Tillamook River watershed
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid
Scale:	Cell Size = 100 ft
Export File Size:	4.6 MB
Extent of Coverage:	Tillamook River watershed

	Xmin = 430753.5 Ymin = 1323009.125 Xmax = 495853.5 Ymax = 1372409.125 # of Rows = 494 # of Columns = 651
Quality/Limitations:	This grid is based on USGS Land Use/Land Cover information and more detailed data from the TBNEP 'lowpoly' coverage.
Positional Accuracy:	
Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Data Type	Integer
Value	Land Use Code (some codes may not be found in this grid) 11 – Urban Residential 12 – Urban Commercial Services 13 – Urban Industrial 14 – Urban Transportation/Communications 15 – Urban Industrial and Commercial 16 – Mixed Urban 17 – Other Urban 18 – Rural Residential (not std Anderson LU Code) 19 – Rural Industrial (not std Anderson LU code) 21 – Cropland and Pasture 22 – Orchards, Groves, Vineyards, and Nurseries 23 – Confined Feeding Operations 24 – Other Agricultural Land 31 –Herbaceous Rangelands 32 – Shrub and Brush Rangelands 33 – Other Rangeland 41 – Deciduous Forest 42 – Evergreen Forest 43 – Other Forest 51 – Streams and Canals 52 – Lakes 53 – Reservoirs 54 – Bays and Estuaries

	61 – Forested Wetlands 62 – Nonforested Wetlands 71- Dry Salt Flats 72 – Beaches 73 – Sandy Areas Other than Beaches 74 – Bare Exposed Rock 75 – Strip Mines, Quarries, Gravel Pits 76 – Transitional Area 77 – Mixed Barren Land

SOURCE INFORMATION:

Data Source:	Area land use polygon coverage obtained from EPA GIRAS ftp site; dowloaded file lva45122.e00. Lowpoly polygon coverage representing more detail in the lowland areas obtained from TBNEP office
Methods:	Created by clipping the lulccomposite grid to the extent of the modeled Tillamook River watershed using the gridclip.ave script.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Tillbuf2k
Description:	Polygon coverage of the tillsub coverage buffered by 2000ft
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Polygon
Scale:	
Export File Size:	15 KB
Extent of Coverage:	Tillamook Bay Xmin = 414253.5 Ymin = 1316609.125 Xmax = 599206.5 Ymax = 1450249.5
Quality/Limitations:	Based on the tillbuf2k coverage provided from TBNEP.

Positional Accuracy:

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

SOURCE INFORMATION:

Data Source:	Based on the tillsub coverage from TBNEP CDROM
Methods:	Created in Arc/Info using the buffer command and a buffer distance of 2000 feet. Used only to clip grids to the extent of the watershed.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec
1	Area	4	12	F	3
5	Perimeter	4	12	F	3
9	Tillbuf2k#	4	5	B	-
13	Tillbuf2k-id	4	5	B	-
17	Inside	4	5	B	-

DATA SET IDENTIFICATION:

Data File Name:	Trask shapefile (includes .dbf/.sbn/.sbx/.shp/.shx files)
Description:	Polygon shapefile of modeled Trask River watershed
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Polygon
Scale:	
Export File Size:	N/A

Extent of Coverage:	Trask River watershed
Quality/Limitations:	This shapefile is a polygon representation of the modeled Trask River watershed. The modeled representation is based on a modified version of the Digital Elevation Model provided by TBNEP. Drain point for the river determined in conjunction with TBNEP office.
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Gridcode	Relates to the raster representation of the watershed as part of the watershed delineation process
Area	Calculated surface area of the watershed (ft^2)
Perimeter	Calculated perimeter length of watershed (ft)
Watershed	Name of the watershed

SOURCE INFORMATION:

Data Source:	Watershed delineation based on connectsink grid with mouth point coverage identifying the drain points for the river basins. Location of mouths of the rivers determined in conjunction with TBNEP office.
Methods:	In ArcView, with the rivbasin shapefile in the View, use the select tool to select the Trask polygon. Then use Theme/Convert to shapefile to get a shapefile of only the Trask River basin.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Trasklu
Description:	Modeled representation of the land use in the Trask River watershed

Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid
Scale:	Cell Size = 100 ft
Export File Size:	15.5 MB
Extent of Coverage:	Trask River watershed Xmin = 445453.5 Ymin = 1328509.125 Xmax = 582753.5 Ymax = 1398509.125 # of Rows = 800 # of Columns = 1373
Quality/Limitations:	This grid is based on USGS Land Use/Land Cover information and more detailed data from the TBNEP 'lowpoly' coverage.
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Data Type	Integer
Value	Land Use Code (some codes may not be found in this grid) 11 – Urban Residential 12 – Urban Commercial Services 13 – Urban Industrial 14 – Urban Transportation/Communications 15 – Urban Industrial and Commercial 16 – Mixed Urban 17 – Other Urban 18 – Rural Residential (not std Anderson LU Code) 19 – Rural Industrial (not std Anderson LU code) 21 – Cropland and Pasture

22 – Orchards, Groves, Vineyards, and Nurseries
23 – Confined Feeding Operations
24 – Other Agricultural Land
31 –Herbaceous Rangelands
32 – Shrub and Brush Rangelands
33 – Other Rangeland
41 – Deciduous Forest
42 – Evergreen Forest
43 – Other Forest
51 – Streams and Canals
52 – Lakes
53 – Reservoirs
54 – Bays and Estuaries
61 – Forested Wetlands
62 – Nonforested Wetlands
71- Dry Salt Flats
72 – Beaches
73 – Sandy Areas Other than Beaches
74 – Bare Exposed Rock
75 – Strip Mines, Quarries, Gravel Pits
76 – Transitional Area
77 – Mixed Barren Land

SOURCE INFORMATION:

Data Source:	Area land use polygon coverage obtained from EPA GIRAS ftp site; dowloaded file lva45122.e00. Lowpoly polygon coverage representing more detail in the lowland areas obtained from TBNEP office
Methods:	Created by clipping the lulccomposite grid to the extent of the modeled Trask River watershed using the gridclip.ave script.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Usgsgage
Description:	Point coverage USGS discharge gage locations
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073

Email: pmelancon@mail.utexas.edu
Date Acquired:

DATA SET DESCRIPTION:

Feature Type: Point; 2 points
Scale:
Export File Size: 3 KB
Extent of Coverage: Tillamook Bay Watershed
Xmin = 486524.344
Ymin = 1361374.250
Xmax = 494620.281
Ymax = 1377274.875
Quality/Limitations: This point coverage is based on latitude and longitude information obtained through the USGS.

Positional Accuracy:

Projection: Lambert
Datum: NAD83
Units: International Feet, 3.28084 (0.3048 meters)
Spheroid: GRS1980
1st Standard Parallel: 43 00 0.000
2nd Standard Parallel: 45 30 0.000
Central Meridian: -120 30 0.000
Latitude of Origin: 41 45 0.000
False easting (meters): 400000.000
False northing (meters): 0.000

Attributes:

Gage_numbe: USGS Designated Number for the gage
Gage_name: Name of the USGS discharge gage (corresponds to the River name)
Latitude: Location latitude coordinate
Longitude: Location longitude coordinate

SOURCE INFORMATION:

Data Source: Location data obtained from USGS.
Methods: The point coverage was created in ArcView using an avenue script with geographic coordinates. This point coverage was projected to Oregon Lambert using the 'orlamb' aml script.
Organization: See Provider Information
Contact: See Provider Information
Date:

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec
1	Area	4	12	F	3
5	Perimeter	4	12	F	3
9	USGSgage#	4	5	B	-

13	USGSgage-id	4	5	B	-
17	Gage_Numbe	8	16	F	0
25	Gage_Name	16	16	C	-
41	Latitude	8	16	F	6
49	Longitude	8	16	F	6

DATA SET IDENTIFICATION:

Data File Name:	Usgspoly shapefile (includes .dbf /.shp/.shx files)
Description:	Polygon shapefile of modeled gaged basins for the Wilson and Trask rivers in the watershed
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Polygon
Scale:	
Export File Size:	N/A
Extent of Coverage:	Tillamook Bay watershed
Quality/Limitations:	This shapefile is a polygon representation of the model delineated watersheds for the two USGS discharge gages. The modeled representation is based on a modified version of the Digital Elevation Model provided by TBNEP (see connectsink metadata for more details). Drain points for the gages (see usgsgage metadata) determined by the USGS and reported with flow data records.
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Gridcode	Relates to the raster representation of the watershed as part of the watershed delineation process

	2307 – Wilson River (gaged) 2308 – Trask River (gaged)
Area	Calculated surface area of the watershed (ft^2)
Perimeter	Calculated perimeter length of watershed (ft)
Watershed	Name of the watershed

SOURCE INFORMATION:

Data Source:	Watershed delineation based on connectsink grid with usgsgage point coverage identifying the drain points for the gaged basins.
Methods:	Watershed delineation performed using hydrology.apr project file. This project file is based on prepro3.apr, an ArcView project file developed by CRWR research group specifically for doing watershed delineation. Outlet points for gaged basins identified from the usgsgage point coverage. See full CRWR report for details.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Usgsriv shapefile (includes .dbf /.shp/.shx files)
Description:	Polyline shapefile of modeled stream network in the drainage basins for the USGS discharge gages
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Polyline
Scale:	
Export File Size:	N/A
Extent of Coverage:	Tillamook Bay watershed
Quality/Limitations:	This shapefile is a polyline representation of the modeled rivers in the 2 gaged basins. The modeled representation is based on a modified version of the Digital Elevation Model provided by TBNEP (see connectsink metadata for more details). The modeled

	rivers are based on a flow accumulation threshhold of 1000 grid cells to define a stream. Drain point for the rivers (see usgsgage metadata) determined from data from the USGS.
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Gridcode	Relates to the raster representation of the watershed as part of the watershed delineation process. 2307 – Wilson River (gaged) 2308 – Trask River (gaged)
Length	Calculated length of the stream segment
Wshcode	Same as the gridcode
Arcid	Internal ArcView identifier
From_Node	Internal ArcView identifier
To_Node	Internal ArcView identifier

SOURCE INFORMATION:

Data Source:	Watershed delineation based on connectsink grid with usgsgage point coverage identifying the drain points for the basins. Location of gages determined from USGS data.
Methods:	Watershed delineation and stream network identification performed using hydrology.apr project file. This project file is based on prepro3.apr, an ArcView project file developed by CRWR research group specifically for doing watershed delineation. Outlet points for gaged basins identified from the usgsgage point coverage
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:	
Data File Name:	Usgsriv shapefile (includes .dbf /.shp/.shx files)
Description:	Polyline shapefile of modeled stream network in the drainage basins for the USGS discharge gages
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	
DATA SET DESCRIPTION:	
Feature Type:	Polyline
Scale:	
Export File Size:	N/A
Extent of Coverage:	Tillamook Bay watershed
Quality/Limitations:	This shapefile is a polyline representation of the modeled rivers in the 2 gaged basins. The modeled representation is based on a modified version of the Digital Elevation Model provided by TBNEP (see connectsink metadata for more details). The modeled rivers are based on a flow accumulation threshhold of 1000 grid cells to define a stream. Drain point for the rivers (see usgsgage metadata) determined from data from the USGS.
Positional Accuracy:	
Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000
Attributes:	
Gridcode	Relates to the raster representation of the watershed as part of the watershed delineation process. 2307 – Wilson River (gaged) 2308 – Trask River (gaged)
Length	Calculated length of the stream segment
Wshcode	Same as the gridcode
Arcid	Internal ArcView identifier
From_Node	Internal ArcView identifier

To_Node	Internal ArcView identifier

SOURCE INFORMATION:

Data Source:	Watershed delineation based on connectsink grid with usgsgage point coverage identifying the drain points for the basins. Location of gages determined from USGS data.
Methods:	Watershed delineation and stream network identification performed using hydrology.apr project file. This project file is based on prepro3.apr, an ArcView project file developed by CRWR research group specifically for doing watershed delineation. Outlet points for gaged basins identified from the usgsgage point coverage
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	USGSwsheds
Description:	Grid representation of modeled gaged basins for the Wilson and Trask rivers in the watershed
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid
Scale:	Cell Size = 100 feet
Export File Size:	34.8 MB
Extent of Coverage:	Wilson River and Trask River gaged watersheds Xmin = 414253.5 Ymin = 1316609.125 Xmax = 599253.5 Ymax = 1450209.125 # of Rows = 1336 # of Columns = 1850
Quality/Limitations:	The modeled representation of the gaged watersheds is based on a modified version of the Digital Elevation

	Model provided by TBNEP (see connectsink metadata for more details). Drain points for the gages (see usgsgage metadata) determined by the USGS and reported with flow data records.
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Data Type	Integer
Value	Watershed Code 2307 – Wilson River (gaged) 2308 – Trask River (gaged)

SOURCE INFORMATION:

Data Source:	Watershed delineation based on connectsink grid with usgsgage point coverage identifying the drain points for the gaged basins.
Methods:	Watershed delineation performed using hydrology.apr project file. This project file is based on prepro3.apr, an ArcView project file developed by CRWR research group specifically for doing watershed delineation. Outlet points for gaged basins identified from the usgsgage point coverage. See full CRWR report for details.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Wilson shapefile (includes .dbf/.sbn/.sbx/.shp/.shx files)
Description:	Polygon shapefile of modeled Wilson River watershed
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon

Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Polygon
Scale:	
Export File Size:	N/A
Extent of Coverage:	Wilson River watershed
Quality/Limitations:	This shapefile is a polygon representation of the modeled Wilson River watershed. The modeled representation is based on a modified version of the Digital Elevation Model provided by TBNEP. Drain point for the river determined in conjunction with TBNEP office.
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Gridcode	Relates to the raster representation of the watershed as part of the watershed delineation process
Area	Calculated surface area of the watershed (ft^2)
Perimeter	Calculated perimeter length of watershed (ft)
Watershed	Name of the watershed

SOURCE INFORMATION:

Data Source:	Watershed delineation based on connectsink grid with mouth point coverage identifying the drain points for the river basins. Location of mouths of the rivers determined in conjunction with TBNEP office.
Methods:	In ArcView, with the rivbasin shapefile in the View, use the select tool to select the Wilson polygon. Then use Theme/Convert to shapefile to get a shapefile of only the Wilson River basin.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

DATA SET IDENTIFICATION:

Data File Name:	Wilsonlu
Description:	Modeled representation of the land use in the Wilson River watershed
Provider:	Center for Research in Water Resources (CRWR)
Contact:	Patrice A. Melancon
Address:	PRC Bldg 119, University of Texas, Austin, TX 78712
Phone:	(512) 471-0073
Email:	pmelancon@mail.utexas.edu
Date Acquired:	

DATA SET DESCRIPTION:

Feature Type:	Grid
Scale:	Cell Size = 100 ft
Export File Size:	17.6 MB
Extent of Coverage:	Wilson River watershed Xmin = 446953.5 Ymin = 1365009.125 Xmax = 597153.5 Ymax = 1448309.125 # of Rows = 833 # of Columns = 1502
Quality/Limitations:	This grid is based on USGS Land Use/Land Cover information and more detailed data from the TBNEP 'lowpoly' coverage.
Positional Accuracy:	

Projection:	Lambert
Datum:	NAD83
Units:	International Feet, 3.28084 (0.3048 meters)
Spheroid:	GRS1980
1st Standard Parallel:	43 00 0.000
2nd Standard Parallel:	45 30 0.000
Central Meridian:	-120 30 0.000
Latitude of Origin:	41 45 0.000
False easting (meters):	400000.000
False northing (meters):	0.000

Attributes:

Data Type	Integer
Value	Land Use Code (some codes may not be found in this grid)

11 – Urban Residential
12 – Urban Commercial Services
13 – Urban Industrial
14 – Urban Transportation/Communications
15 – Urban Industrial and Commercial
16 – Mixed Urban
17 – Other Urban
18 – Rural Residential (not std Anderson LU Code)
19 – Rural Industrial (not std Anderson LU code)
21 – Cropland and Pasture
22 – Orchards, Groves, Vineyards, and Nurseries
23 – Confined Feeding Operations
24 – Other Agricultural Land
31 –Herbaceous Rangelands
32 – Shrub and Brush Rangelands
33 – Other Rangeland
41 – Deciduous Forest
42 – Evergreen Forest
43 – Other Forest
51 – Streams and Canals
52 – Lakes
53 – Reservoirs
54 – Bays and Estuaries
61 – Forested Wetlands
62 – Nonforested Wetlands
71- Dry Salt Flats
72 – Beaches
73 – Sandy Areas Other than Beaches
74 – Bare Exposed Rock
75 – Strip Mines, Quarries, Gravel Pits
76 – Transitional Area
77 – Mixed Barren Land

SOURCE INFORMATION:

Data Source:	Area land use polygon coverage obtained from EPA GIRAS ftp site; dowloaded file lva45122.e00. Lowpoly polygon coverage representing more detail in the lowland areas obtained from TBNEP office
Methods:	Created by clipping the lulccomposite grid to the extent of the modeled Wilson River watershed using the gridclip.ave script.
Organization:	See Provider Information
Contact:	See Provider Information
Date:	

FILE STRUCTURE:

Column	Item Name	Width	Output	Type	N. Dec

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VITA

Patrice Angelle Melancon was born in Orange, California on July 30, 1965, the daughter of Loretta Diermann Melancon and Leonard Paul Melancon. After completing her work at Slidell High School, Slidell, Louisiana, in 1983, she entered the University of Southwestern Louisiana in Lafayette, Louisiana where she was enrolled in the Civil Engineering program. She participated in the Air Force Reserve Officer Training Corps (AFROTC) program and was commissioned a Second Lieutenant in the United States Air Force upon receipt of her Bachelor of Science degree from the University of Southwestern Louisiana in May 1988. For the next nine years, Patrice complete three active duty tours with the Air Force as a Bioenvironmental Engineer. One of her three tours was overseas in the United Kingdom. She separated from the active duty Air Force in August 1998 and entered the Graduate School at the University of Texas at Austin the same month. She maintains her military status as a Civil Engineer in the Air Force Reserves.

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